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Fishing for Advice

The Case of the Norwegian Reference Fleet

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List of Abbreviations

ACOM: (ICES) Advisory Committee
AFWG: Arctic Fisheries Working Group
ANT: Actor Network Theory
CFP: The Common Fisheries Policy
CPUE: Catch Per Unit of Effort
EAFM: Ecosystem Approach to Fisheries Management
EEZ: Exclusive Economic Zone
FAO: Food and Agriculture Organization
FDG: Fisheries Dynamic Group
FEK: Fishers Ecological Knowledge
GMO: Gene Modified Organism
ICES: International Council for the Exploration of the Sea
IMR: Institute of Marine Research
RAC: Regional Advisory Council
RF: Reference Fleet
STS: Science and Technology Studies
TAC: Total Allowable Catch

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Abstract

This dissertation is about the changing relationship between science and society and the attempt to organize knowledge production and advisory processes in new ways: How can the relations between science and society be organized in a way that ensures sound advice as well as democratic ideals such as transparency and inclusion? Is it possible to relax the boundary between science and society without making it too blurry? How can arenas be built where scientists and stakeholders can cooperate effectively in knowledge production? How can lay people and their knowledge be included in advisory processes? To include stakeholders and at the same provide sound scientific advice, new solutions that require more openness in scientific processes are called for.

In order to explore such solutions, the dissertation turn to the fisheries sector, where the top-down, traditional divide between science and other forms of knowledge is obvious: scientists are the experts with relevant and reliable knowledge for fisheries management. In recent decades, however, fisher stakeholders are identified as having valuable knowledge based on their experiences. Some also argue that fishers are experience based experts. But how to include them in a meaningful way, and how they are experts, are issues that are still open for debate. In Norway, the Institute of Marine Research runs a project called the Norwegian Reference Fleet, where fishers are invited to participate in knowledge production for advice. The Reference Fleet project provides a relevant framework to investigate empirically how to solve dilemmas related to the organization of knowledge production and advisory processes in more open, yet effective ways. The thesis makes a detailed account of how fishers are included by describing the knowledge chains in which they participate, and what happens to the knowledge as it is made to circulate and used for advice in fisheries management issues. Based on ethnographic methods, the Reference Fleets' knowledge production has been followed wherever it has taken place: in laboratories and at sea; and in formal and informal settings.

Theoretically, this thesis is supported by Science and Technology Studies, and Actor Network Theory in particular. The thesis aims to contribute to the on-going discourses on the 'lay expert' and how to open up science for stakeholders. It demonstrates that it is possible to include stakeholders in knowledge production for advice, and that lay people can become experts. However, it also argues that this hinges on participation at appropriate stages in the process, and that lay people, like scientists, needs access to both laboratories and authorization mechanisms in order to be included or be part of the expertise.

Chapter 1

Scientific Advice and Relations between Experts and Non-Experts

> Why are scientists considered experts? They become experts because society asks them questions.
>
> *Jan Andersen, 15 April 2008*

This rhetorical question was raised by a fisher during fieldwork, and it sets the stage well for this dissertation: What does it take to be an expert? Who has reliable and relevant knowledge? Who should society turn to for advice on difficult and controversial questions? Can lay people be experts? Or is the role of expert only available to scientists?

As suggested by the fisher, society usually turns to scientists for expert advice. It is hardly an exaggeration to say that scientific experts play an indispensable role in sorting out complex and controversial issues in modern society (1988; Fischer 2000; Gieryn 1999; Hilgartner 2000). Today, scientists provide advice to governments on nearly every area of policy, be it climate change, public health, air quality or natural resource management (Collins and Evans 2007; Gieryn 1999; Hilgartner 2000). Scientific expertise is a primary source of cognitive authority – a socially legitimate power (Jasanoff et al. 1995).

Since science is perceived as objective and autonomous from political contingencies, scientific experts are useful in order to legitimize the actions of governments (Jasanoff et al. 1995). This is based on the belief that a strict and formal separation between science and society is both possible and necessary (Gieryn 1983; Gieryn 1999). In line with Merton's ethos of science, science must be 'pure' and autonomous in order to function as an objective source of advice in controversial issues (Merton 1996 [1942]). In order to produce expert advice in line with these ideals, advisory bodies have become a preferred institutional solution. Advisory bodies have a specific institutional architecture where a clear-cut separation between the realms of politics and science is considered an achievable goal (CEC 2007; Hilgartner 2000). This framework imposes a strict boundary – or at least the appearance of one – for what can count as expertise. This institutional and epistemological pattern is followed in numerous fields of public concern such as nuclear power (CEC 1996; Wynne 1989b), medicine control (EMEA 2006; Epstein 1996), food safety (CEC 2000; Jasanoff 1990), biotechnology (CEC 2002; Jasanoff 1990), climate science (Løvbrand 2007; Shackley and Wynne 1996), and resource management (CEC 2000; Wilson and Degnbol 2002). Science produced for both regulatory and policy issues can be referred to as 'regulatory science' (Jasanoff 1990) or 'mandated science' (Funtowicz and Ravetz 1993)

While expert advice is often called for and relied upon, attitudes towards science are mixed (CEC 2002; CEC 2007; Fischer 2000; Nowotny et al. 2001). Despite society's institutionalized trust in science, this trust is not unlimited and more negative perceptions of science are readily available. While science offers solutions to many problems, it is sometimes also involved in the creation of such problems. As suggested by the Chernobyl disaster and 'mad cow' disease, we live in a 'risk society' (Beck 1992) where science is involved in both the production of and the solutions to such risk. There is an extensive range of examples from different areas of policy where the traditional boundaries between science and society are challenged. In modern society, then, the authority of experts is assumed *and* questioned (Aronwitz 1988; Collins and Evans 2007; Fischer 2000; Hilgartner 2000). Just think about the controversies with regard to global warming, vaccination programmes and the recent economic collapse. As noted by Fischer:

> [T]he increasing unwillingness of citizens to accept uncritically the trained judgment of the experts has become one of the central issues of our time (Fischer 2000: 9).

Even if science is considered key to solve complex issues of public concern, there is still a problem with the way science interacts with the wider society (Wynne 1989a). Since science is generated in esoteric, closed rooms, preventing participation and transparency, the legitimacy of its advice is sometimes vulnerable. This legitimacy problem can be broken down along two different but interrelated dimensions. First, it is a democratic problem (Caddy and Cochrane 2001; FAO 1995; Hauge 2008; Liberatore and Funtowicz 2003). Since science and scientific advice play such an important role in modern society, democratic principles suggest that the public should participate in the processes whereby knowledge is created and expert advice formulated (Liberatore and Funtowicz 2003). Second, since there is a bias towards scientific training and credentials in advisory processes, other forms of knowledge are often excluded. This means that relevant knowledge is sometimes excluded on formal grounds (Collins and Evans 2007; Jasanoff 1987; Wynne 1996). Since the 1990s, however, there has been an increasing focus on people's knowledge; and there is a tendency to argue that lay knowledge is just as valuable as scientific knowledge (Collins and Evans 2002;

Collins and Evans 2007; Prior 2003a). These two trends often meet in discussions of the 'lay expert' (Collins and Evans 2002; Prior 2003a).

With Fischer (2000) we can say that there is a trend towards arguing for opening science up, and that a more democratic and legitimate advisory process is achieved if civil society is generously included. A major challenge with making science more democratic, however, concerns how this can be achieved without impairing its effectiveness in delivering sound advice. The legitimacy of advice is important but so is effective problem solving, especially when we are faced with complex issues that need an urgent solution, such as climate change, nuclear waste, and overfishing (Fischer 2000). The exclusion of forms of knowledge other than science can no doubt be rectified by including stakeholders' knowledge in advisory processes. Nevertheless, opening up science this way immediately raises the question about what roles stakeholders should have and how they might interfere with the credibility and soundness of its products (Collins and Evans 2007; Merton 1996 [1942]).

On the one hand, science is established and largely accepted at a societal level as a standard procedure for certifying knowledge as expertise (CEC 2007). On the other hand, scientific advisory processes are increasingly perceived as illegitimate exactly due to their exclusion of other than scientists as experts. This is the dilemma. While blurring the boundaries between science and society can lead to more effective policy making, this can easily be at the expense of the quality of advice (1990). How can science be opened up without losing its edge? With Guston (2001) we can ask how the boundary between science and society can be relaxed without making it too blurry.

This is the issue I address in my thesis. I examine what I referred to above as mandated or regulatory science, that is, situations when scientific (and other knowledge) is mobilized for policy advice. My focus is on the possibilities and dilemmas of making advisory processes more inclusive or democratic; how stakeholders and their knowledge[1] can be included in advisory processes. In the following, I investigate whether it is possible to organize the relations between scientists and stakeholders in order to maintain sound advice at the same time as democratic ideals of openness and inclusion are maintained. How can we build arenas where scientists and stakeholders can cooperate effectively in knowledge production? These are the dilemmas that form the subject matter of this dissertation.

[1] Labels and definitions of different types of knowledge are many, overlapping and at times confusing. I understand the numerous terms such as indigenous, traditional, local, and – of particular importance here – fishers' knowledge as closely related and partly overlapping.

[2] It is common to refer to the breakdown of the spring spawning herring, mackerel and North Sea herring in 1970 as the year the relationship between the IMR and the fishers changed in a definitive way (Maurstad 1997) The

How do we Examine Changes in the Science-Society Relationship?

Today, we are already seeing signs of change in the relationship between science and society. How knowledge is produced both within and outside of science is changing, and society invents new ways of communicating with science (Gibbons et al. 1994; Nowotny et al. 2001). The interest and calls for science programmes that include forms of knowledge other than science are increasing under labels such as ‘participatory research’ (Fischer 2000) and ‘cooperative research’ (Johnson 2007). Other suggested solutions are extended peer review (Funtowicz and Ravetz 1993) and consensus conferences (Joss and Durant 1995). Examples of how participation in knowledge production is broadened in practice are available from the health sector, where patients’ knowledge is included (Epstein 1996; NAPCRG 1998) and food security, where lay people are included in pre-and post-harvest activities with regard to the dangers of gene modified food (Wynne 2001). In the European context, the EU supports participatory research programmes where science and stakeholders collaborate (CEC 2007). In the fisheries context, a programme entitled ‘Bridging the knowledge gap between fishermen and science’ (GAP1 2011) exemplifies this trend. In the US context, several programmes have been established, like the Northeast Cooperative Research Partners Program and the National Marine Fisheries Service Cooperative Research Partners Program (Johnson and van Densen 2007).

Changes in the boundaries between science and society are already taking place, then. The increasing distrust in science is not simply reflected in the way traditional expert advice is received, but it is generating a search for alternative ways to organize the relationship between science and society. Since the traditional model still holds a dominant position, and no consensus is emerging on an alternative, it might be appropriate to call these attempts ‘experiments’ (Callon and Muniesa 2007).

One such experiment, and the case I have selected for further examination, is the Norwegian Reference Fleet (RF). The RF provides an empirical case of an arena that is blurring the boundaries between scientists and fishers. Here, fishers and scientists meet, cooperate and interact in different ways to mobilize knowledge for resource management purposes (IMR 2007a). Like many fields of policy, fisheries management bases the advisory processes on scientific advice produced for its specific purpose (Hauge 2008; Nielsen 2008; Wilson 2009). In the case of fisheries, the role of expert advice is highly structured and heavily guarded. In northern Europe, one specific expert body, the International Council for the Exploration of the Sea (ICES), holds a privileged position as the certified scientific advisor within fisheries resource management. At the outset, then, the boundaries between scientists and fishers with regard to knowledge provision are rigidly drawn. In fishery, for resource management purposes, the experts are unequivocally scientists, while fishers are absolutely not. This asymmetry makes the fisheries context an interesting setting. The RF, whose explicit purpose is to engage fishers in knowledge provision for management purposes, represents a major departure from the normal state of affairs. Based on a long-term ethnographic case study of the RF from 2005 to 2011, I will examine how the boundaries between science and fishers' knowledge are affected by the project.

To understand the RF – what it is, what it can do, why it came about, what problems it is intended to solve and the social technologies and materials mobilized for its construction – we need to look briefly into this sector, with particular emphasis on how knowledge is mobilized for management purposes.

The Fisheries

The Ministry of Fisheries and Coastal Affairs is responsible for the fisheries in Norway, including the management of fishery resources. On the Ministry's official website, the 'Regulatory Chain' (see Figure 1 below) is used to explain how fish stocks are managed in Norway, including how scientific advice is utilized. This expert structure is connected to the establishment of the Norwegian 200-mile Exclusive Economic Zone (EEZ) in 1977 (Hoel and Sydnes 2005), and the legal foundation for the role of the coastal state as a resource manager of fisheries established with the Law of the Sea (UNCLOS) (Hoel and Sydnes 2005; Holm 2001). The re-organization that took place with the establishment of the management cycle depicted by the Regulatory Chain is described as a 'closing of the commons' (Hersoug 2005) and an 'invisible revolution' (Holm 2001). Here, it is enough to note what this regime shift meant for the relationship between fishers and fishery scientists. While fishers and scientists used to have overlapping interests, this changed drastically when after the 'invisible revolution' scientists became the expert witnesses for the coastal state in closing the commons[2] (Holm 2001). In this position, marine science shifted from being the ally of the fishers in finding fish into being the adversary, enrolled in a management system designed to prevent the fishers from catching too many fish.

[2] It is common to refer to the breakdown of the spring spawning herring, mackerel and North Sea herring in 1970 as the year the relationship between the IMR and the fishers changed in a definitive way (Maurstad 1997) The relationship between the IMR and the fishers has been tense ever since, together with a growing distrust (Hauge 2008; Skorstad 2005).

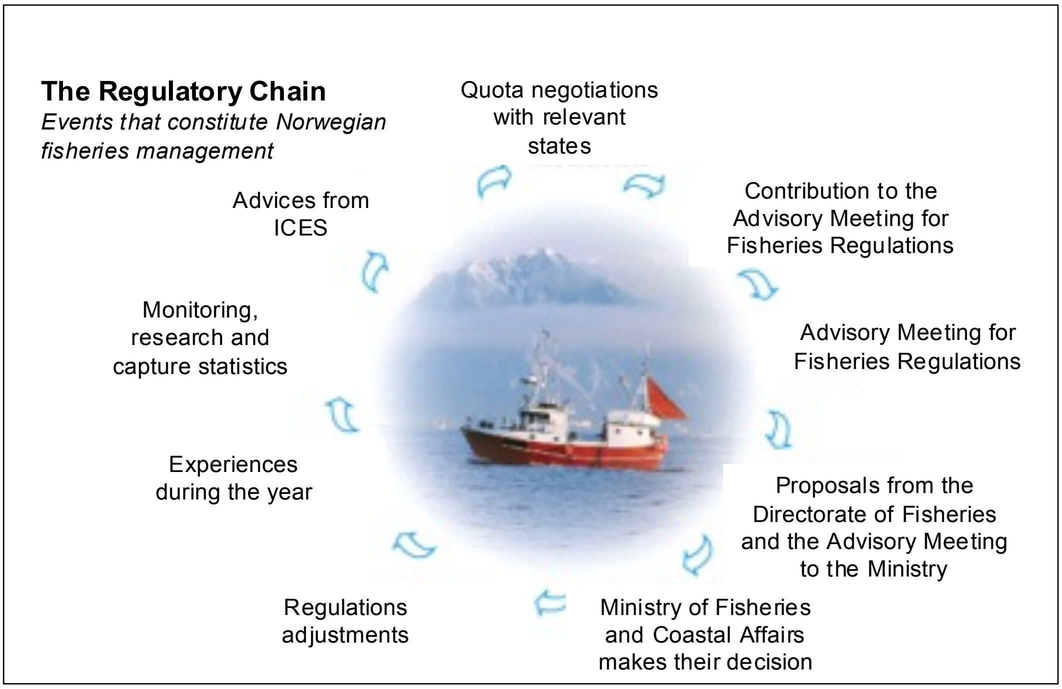


Figure 1: The Regulatory Chain. Adapted from the homepage of the Fisheries Directorates (Fiskeridirektoratet 2010). An advisory meeting is held in November/December each year. In order to follow up the different regulations and experience of their operation, several systems for control and surveillance are in place. Linked to these control and surveillance systems are also numerous procedures for data collection. The Regulatory Chain then enters a new annual circle, with data collection from research, catch statistics and surveillance as well as analysis of data throughout the year in order for the ICES to assess the fisheries and give advice.

The Regulatory Chain is hence organized around decisions about how much the fishers are allowed to harvest from the (commercially important) fish stocks each year. An important concept and intervention instrument here is the Total Allowable Catch (TAC). The size of the TAC for each of the important fish stocks is decided each year (see Figure 1 above). Since most of the commercially important fish stocks in Norwegian fisheries are shared with other states, this happens within the framework of international negotiations. After the TACs have been decided, they form the basic premises for the development of specific fisheries regulations for each fishery. This is a complex process, where, among other things, the stakeholders are invited to comment and to propose amendments to the regulations. This occurs within the framework of the advisory meetings for fisheries regulations, which are held every year in June and November.

While the process of implementing the TACs is interesting in itself, the most important process for the purpose of this thesis is what goes on before the TAC is decided. Each year, this starts with monitoring of the resources, research and capture statistics (see Figure 1). In Norway, the Institute of Marine Research (IMR) is the state agency responsible for doing research and giving scientific advice on issues regarding the management of marine resources. Conducting regulatory or mandated science, the IMR aims at filling in the knowledge gaps defined by policy issues, and at prediction rather than description and explanation (Jasanoff 1990; Jasanoff et al. 1995). Based on a ‘funding letter’ from the Ministry of Fisheries and Coastal Affairs, the IMR is in charge of executing the numerous tasks that this involves, such as collecting landing data and conducting surveys in order to produce the data necessary.

This data is made available to the International Council for the Exploration of the Sea (ICES), which transforms it into advice (see Figure 1, and Wilson 2009). ICES is the advisory body that gives advice about TACs, amongst other issues. The ICES is ‘the organization that coordinates and promotes marine research in the North Atlantic’ (ICES 2008a). According to the ICES strategic plan, the organization is

> [R]esponsible for the provision of the highest quality objective scientific advice on sustainable use of living marine resources and the protection of the marine environment. (…) and informing the public objectively and effectively about marine ecosystem issues. (ICES 2000)

The ICES was established in 1902 in order to facilitate marine science and is located in Copenhagen (Rozwadowski 2002; Schwach 2000). Since 1964, the ICES has been the official intergovernmental scientific institution in the North Atlantic fisheries management context (Schwach 2000).

As the Regulatory Chain illustrates, stakeholders *are* included in the management process. It is nevertheless important to note that fishers’ participation is restricted when it comes to knowledge issues. The advisory meeting where fishers are included is held after the assessment of each stock is done, and after the TAC has been undertaken. The advisory meeting has a consultative function where stakeholders can voice their opinion, and the ministry can choose whether or not to take this information into consideration. Also, the total size of the TAC is not an item for discussion, only the distribution of the TACs between stakeholders and the practical implementations of the regulations. This means that the fishers and other stakeholders are not in a position where they are invited to influence or even comment on assessments and TAC decisions. What remains open for stakeholders to influence pertains to the distribution of (given) quotas, as well as the practical regulation of the way these are fished. When it comes to the assessment of stocks, then, the fishers are effectively excluded from the knowledge production and the assessment process.

In general, fisheries management in the North Atlantic is based on the top-down

Regulatory Chain (Dankel 2009; Hauge 2008; Rozwadowski 2002; Wilson 2009). While fishers and other stakeholders may have better access to decision-making arenas in Norway than is the case within the EU and the Common Fishery Policy (CFP), this is not the case when it comes to the issue of knowledge provision. If anything, the boundary between science and non-science is guarded even more strictly in Norway than in most other countries. According to the IMR:

> Norway is well known for *giving more weight to fisheries independent data than other countries*. Such data from [IMR's] own surveys are more reliable than what can be collected from landing statistics (…). (Gullestad 1996: 12. Emphasis added)

Simply put, the organization of the Regulatory Chain and the knowledge structure on which it relies establishes a particular natural social order where the roles are well defined: scientists give expert advice and fishers follow it (Dankel 2009). As a result, science is the primary source for expert advice in modern fisheries resource management. The assessment of fish stocks is the exclusive domain of marine scientists; they hold an institutionalized responsibility for collecting and interpreting data, developing methods, performing the assessments and transforming them into advice (Hauge 2008; Nielsen 2008).

For different reasons, however, the authority granted to science in the context of fisheries management is increasingly being challenged. It is in this context that the RF was established, as a new trust-based cooperation between fishers and scientists.

Fisheries Management in Crisis

The RF is quite a drastic break with the way the fishery sector traditionally organizes the relations between experts and stakeholders when it comes to resource management issues. Whereas the practices that constitute the Regulatory Chain exclude fishers from knowledge provision, the RF is explicitly established and organized with the purpose of including them. So, how a project like the RF has come about needs some explanation. Here, I will point to two main thrusts of criticism of the fishery system which have been central in making it possible to look for new arrangements between science and fishers.

First, the established top-down management regime is experiencing a crisis since many of the important fish stocks in the world are overfished despite the best expert advice (Caddy and Cochrane 2001; FAO 2008; Hutchings and Myers 1994; Pauly and McClean

2003). There are numerous examples of stock collapses and overexploitation which have generated a perception of a global fisheries crisis (Finlayson 1994; Hutchings and Myers 1994; Johannes et al. 2000)[3]. According to the Food and Agriculture Organization of the United Nations (FAO) (2008), 80 per cent of the world fish stocks are either fully exploited or overexploited, despite the establishment of the centralized approach to fisheries management (se also i.e. Dankel 2009; Pauly and McClean 2003). The fisheries crisis as such, which is complex and multi-layered, is beyond the scope of this dissertation. What is relevant here is that the fishery sector has become vulnerable to criticism and is searching for reform. One aspect of this is an openness towards increased stakeholder participation (Degnbol 2003).

Secondly, there is an influential discourse suggesting that fishers' knowledge should be included in advice (Davis and Ruddle 2010; Holm 2003; Johannes et al. 2000; McGoodwin et al. 2000; Neis et al. 1999). Within what Holm (2003) labels Fishers' Ecological Knowledge (FEK) research[4], the focus has been on demonstrating that the conventional scientific rejection of fishers' knowledge is problematic and arrogant (Johannes et al. 2000; Maurstad and Sundet 1998; Neis and Felt 2000). On the contrary, the argument goes; fishers' knowledge is useful for management purposes and can even improve the management of fisheries (Daw 2008; Johannes et al. 2000; Neis and Felt 2000)[5]. FEK researchers' argument that fishers should be included in the knowledge production gained force with the collapse of the Northern cod stock off Canada in the 1990s: 'Ignore fishers' knowledge and miss the boat', became the slogan (Hutchings and Myers 1994; Johannes et al. 2000). Thanks to FEK researchers the argument that fishers' knowledge is useful and can, at least as an addition to scientific knowledge, strengthen fisheries management, is widely accepted (Maurstad 2002; Maurstad 2004; Neis and Felt 2000; Pálsson 2000; Wrobleski 1998). Increasing stakeholders' participation is suggested to improve both the legitimacy issues and the knowledge base for advice (Wilson et al. 2003).

How FEK is defined, what it comprises and what it can do for management, has been examined extensively elsewhere and will not be repeated here (Daw 2008; Hall-Arber and

[3] This perception is underlined with documentaries like Rupert Murreys "the end of the line": Imagine a world without fish" (Murray 2008) which is part of 'a global campaign for citizens to demand better marine policies'.
[4] Since I will be working with fishers, I will rely on FEK research. This is further described in chapter 2. See also Davis and Ruddle (2010), who use the labels IEK, LEK and TEK for social research concerning Indigenous Ecological Knowledge, Local Ecological Knowledge and Traditional Ecological Knowledge. Since I do not wish to limit the discussion to fishers' ecological knowledge, I will mostly use the term fishers' knowledge or fishers' experience-based knowledge.
[5] This is typically related to fishers' close relationship to their local environment and their understanding of complex ecosystem interactions. For instance, Neis et al. (1999) show how fishers can perceive trends that are hidden in landing, and hence Catch Per Unit of Effort data (which is further described later. See also Daw (2008) for more on 'how fishers' knowledge counts'.

Pederson 1999; Johannes et al. 2000; Maurstad 2004; McCay et al. 2006; McGoodwin et al. 2000; Murray et al. 2006; Neis and Felt 2000; Pálsson 2000; Ruddle 1994; Soto 2006; Wrobleski 1998). In part, at least, the growing focus on fishers' knowledge is a reflection of the general process of change in society referred to by concepts like 'governance' and 'good governance'(FAO 2003; Kooiman et al. 2005). FEK research, together with a perceived crisis situation and the general acceptance of UNCED Agenda 21 and 'good governance' ideals like legitimacy, transparency and stakeholders' participation, has made it more problematic to maintain the exclusion of fishers, and the traditional scientific arrogance is now rarely seen. Simply put, fisheries management is a context that suffers from problems of credibility, legitimacy and compliance (Linke et al. 2011; Nielsen 2008; Wilson 2009).

The crisis in fisheries management and the development of more complex relationships between science and society has been pivotal for setting the stage for a new organizational framework. Both FEK and STS[6] researchers have argued since the 1980s that lay people, like fishers, have knowledge that can be relevant for controversial issues like Aids (Epstein 1996), radiation (Wynne 1996) and fisheries (Neis and Felt 2000). Exactly how stakeholders may participate in knowledge provision, or even take on expert roles, has received less attention, however. Even if ideas of more open advisory processes where stakeholders are included in knowledge production are recognized and increasingly taken for granted, there are no ready institutional solutions established for how to best achieve this. How fishers should be included, what tasks they can perform and how the cooperation between fishers and scientists should be organized remain open questions.

An important dilemma concerns how one can trust the result of knowledge production processes when those with a stake, and hence interests, can impact the advice (Collins and Evans 2002). In the thesis I investigate what we can learn about such things from the case of the RF. How can stakeholders, in this case fishers, be included in knowledge production for advice? How and to what extent was this actually achieved within the RF? Has the quality of the information products suffered as a consequence? If not, how was that avoided? Is it reasonable to say that fishers, through the RF, have become experts? In other words, can the RF serve as a model for greater stakeholder involvement in knowledge provision?

[6] STS stands for Science and Technology Studies. Science studies is a term that is used to refer to the work of scholars that adopt a social constructivist view of science from science and technology studies, sociology of science and other approaches that examine scientific knowledge production in relation to the cultural, social and political (See, for instance, Johnson 2007).

The Reference Fleet

The RF is run by the Norwegian Institute of Marine Resources (IMR). The RF is a practical example of what we discussed above: It is an arena where stakeholders (fishers) are invited to participate in knowledge production for fisheries management in cooperation with scientists. In its official presentation of the RF, the IMR informs us that the RF is:

> a small group of Norwegian fishing vessels that are paid to provide the Institute of Marine Research (IMR) with detailed information about their fishing activity and catches on a regular basis. (…) It is a new project that aims to improve data collection and information flow both to and from the fishermen (IMR 2007a).

Furthermore, the IMR underlines that the RF is

> a trust based co-operation between fishermen and scientists (…) [and] a very useful data collection platform for many purposes [since] it reduces controversies and fosters a joint 'ownership' spirit for data and results (IMR 2007a)[7].

In comparison with the normal way scientific information and advice has been produced for fisheries management, the RF arrangement on the face of it certainly appears to be more inclusive. One of the IMR scientists who initiated the RF in 2000, Åsmund Bjordal, describes it as follows:

> What is new with the reference fleet is that these vessels are doing research while fishing, and that the responsibility for the data collection lies with the fishers. (…) [It] is the amount and the broad character of the relationship [between fishers and scientists] that marks the beginning of a new era (Bjordal 2003, my translation).

What Bjordal describes is an arena where fishers are performing tasks that usually have been the responsibility of scientists. Fishers are conducting research. The RF is an arena that is

[7] This is a summary from the IMR's own presentation of the Reference Fleet, 'The Institute of Marine Research's Reference Fleet Programme: Trust based co-operation between fishermen and scientists'.

based on trust and cooperation in a context riddled with distrust and a strict isolation of science from interference from stakeholders. The RF, then, represents an interesting move from the traditional model, where fishers have been excluded, towards a model where fishers' input is considered useful and important. The RF is a response to the calls for inclusion of fishers as stakeholders in the esoteric space of fisheries science. How they contribute, however, must be examined further.

The institutional landscape where fishers and scientists live seems to be changing with the RF since fishers and their knowledge are now welcomed, taken seriously and put to use. Seen against the backdrop of the traditional situation, where fishers' knowledge claims were usually dismissed as 'anecdotal' and generally untrustworthy (Johannes et al. 2000; Neis and Felt 2000), this certainly is an important change. At the very least, the RF is a rhetorical commitment to the democratic turn described above. But it seems to be more than that. The RF is the largest project at the IMR. In 2009, 25 IMR scientists were working with the project and the budget was approximately 7.1 million USD (IMR 2009a). The allocation of resources both in terms of effort and cost signals that the work done by the RF is considered important and that the RF is more than a fad or a symbolic gesture towards change.

At the same time, there are several 'black boxes' that need to be opened up in order to find out what the RF is, and exactly how fishers are included. To what roles and tasks are the RF fishers given access with the RF? Are they participating in the shaping of policy questions, do they interpret any of the data collected and do they have a say in what knowledge is relevant and how it should be collected? Is the RF a relevant and useful model for how advisory processes can make room for both science and experience based knowledge? Is the RF opening up for fishers as experience-based experts?

How to Study Fishers' Inclusion in Knowledge Production

As suggested by several scholars, there is no unbridgeable gap between science and non-science (Guston 2001; Holm 2003). If we want to engage stakeholders in knowledge production and advice, there are many possible ways to ensure their participation. Below, I will take a closer look at how the advisory process is organized within the ICES framework and suggest how, within this context, stakeholders can be included.

The ICES gives advice about a number of management instruments, such as gear restrictions, minimum sizes and closed seasons, as well as controlling fishing effort through catch or harvest quotas (Hauge 2008; Holm and Nielsen 2004; Wilson 2009). In the following, I will focus on advice produced as input for TAC negotiations. This is what Holm and Nielsen (2004) might have called the heart of the TAC machine; the place where we find the advisory process in its most sophisticated form.

Figure 2 illustrates how knowledge is provided for fisheries resource management purposes. The starting point here is, as suggested in the figure, the provision of knowledge within the established Regulatory Chain (Figure 1 above). For my purpose here, which is to develop a framework that allows me to pinpoint exactly what role the fishers take within the RF, it is unhelpful to see knowledge provision as a single process. Instead, it is better to divide the knowledge production into separate but interrelated stages. As suggested in Figure 2 below, we can distinguish three such stages; data collection, assessment and advice.

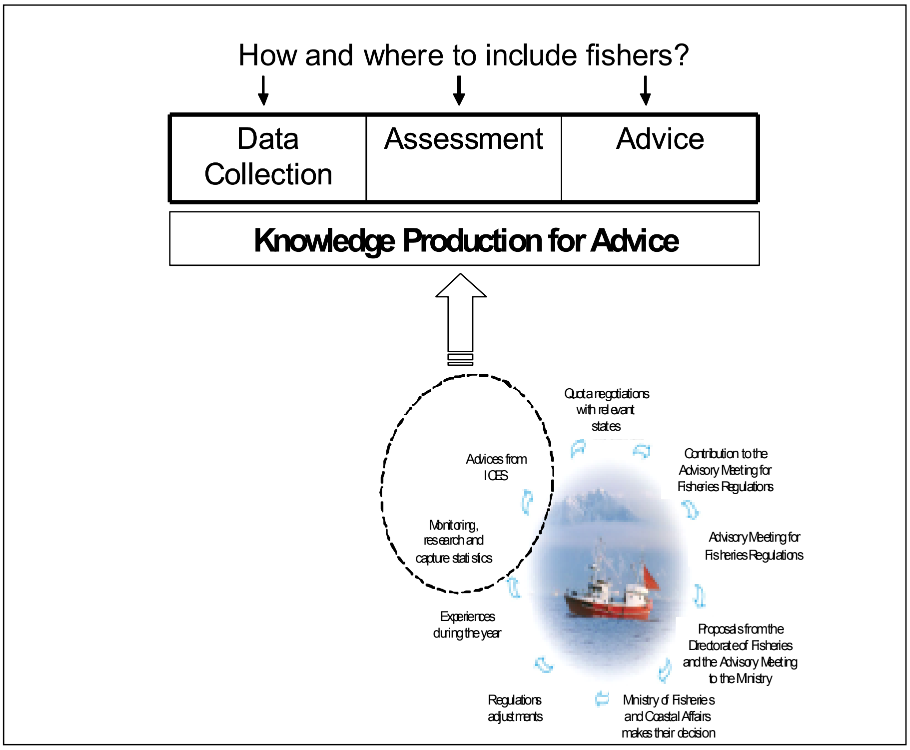


Figure 2: Knowledge production for advice. This illustrates the part of the advisory process where knowledge is produced for TAC advice. I divide the knowledge production into three stages: data collection, assessment and advice. See text for further explanation.

At the first stage, *data collection*, the research and laboratory work considered necessary to produce relevant knowledge or science is performed. Data from both research survey vessels (fishery independent data) and from fishers' vessels (fishery dependent data, like registered catch and electronic logbooks) is collected and flows into the national marine laboratories like the IMR. Several procedures are in place to control and refine the data, and scientists at the IMR as well as the National Data Centre are in charge of transforming it into the desired format and checking the quality. As we expect from STS work (Latour 1987), these transformation processes are highly regulated and heavily instrumented (see for instance Øvredal and Totland 2002 as well as chapters 4 and 5 in this thesis).

The data is put to work in the second stage, assessment, as it travels to the ICES with scientists who participate in the ICES working groups (WG). In these WGs, scientists work together with the data, formatting it and checking its reliability and quality, they play with different scenarios, they tweak and tune the data in their sophisticated models. The aim is to make an assessment, to estimate the size of a given fish stock, and predict how it would develop under different catch regimes (TACs) (see Wilson 2009 for a detail description of how the assessments are done).

This takes us to the third stage, advice. The ICES has delegated the advisory authority to the Advisory Committee (ACOM), which is the 'sole competent body for ICES scientific advice' (ICES 2008a). ACOM considers the draft assessments made by the WGs, and on this basis produces advice for policy makers for each fish stock (of some commercial importance). This advice is produced in order to answer the key question of how much fish can be caught while ensuring long-term sustainability (Rozwadowski 2002; Wilson 2009).

Within the established system – before the RF, that is – fishers were practically excluded from all these stages. To be fair, there were some contributions of so-called fisheries-dependent data in the first stage, data collection. But these data are simply the standardized landing information, recorded at the landing stations, and can hardly be counted as including fishers in knowledge production in a real sense. We can say that fishers were, with this slight modification, excluded from the knowledge production. To the extent that the RF is changing this, then it will be by allowing the fishers to contribute to one or more of the stages or knowledge functions. While this certainly makes my inquiry more specific, it is still not enough. What exactly is meant by inclusion? What is, specifically, the depth and commitment of the fishers' participation?

Participation is a complex notion, the meaning and scope of which is open to debate, as pointed out by Rowe and Frewer (2004). Participation can be filled with different meanings, varying from different levels of communication (receive information or voice opinion) with no input in the decision making process per se, to participation with inputs that have an impact on the process (Aronstein 1969; Oxley Green and Hunton-Clarke 2003; Rowe and Frewer 2004). Aronstein's (1969) 'Ladder of Citizen Participation', for instance, describes three general levels referred to as 'non-participation', 'tokenism' and 'citizen power'.

As this suggests, fishers can be included not only in different stages of knowledge production, but also, for each stage, at different levels of participation or varying degrees of decision making authority (Rowe and Frewer 2004). This is illustrated in Figure 3 below. In the figure, the horizontal axis represents the three knowledge functions – data collection, assessment and advice – while the vertical axis represents the level of responsibility accorded to stakeholders.

Stage of Knowledge Production →

Level of Responsibility ↓

Data Collection	Assessment	Advice
Working with science	Working with science	Working with science
In addition to science	In addition to science	In addition to science
Responsible for	Responsible for	Responsible for

Figure 3: Model for how to think about the inclusion of fishers in knowledge production for TAC advice. See text for explanation

Remember that, at the outset, there was little participation by fishers in knowledge production. From this starting point, the easiest and least demanding way to get involved, I suggest, is through some form of cooperative venture with scientists. This means that the first row in the table of Figure 3, where fishers are included by working together with scientists, is of a category that can involve many levels of cooperation. This can mean communication efforts which are crucial for trust and cooperation (Van Densen and McCay 2006), or research activities that can range from 'chartering commercial vessels for research to the full integration of fishers in all stages of research' (Johnson and van Densen 2007: 834). I will return to this later, for now, this must suffice.

A different form of involvement, suggested by the next row in the figure, occurs when fishers are in a position to provide knowledge *in addition to* and independent of scientists. This could, for instance, involve fishers doing their own assessments and giving advices of their own in addition to the scientists' advice. That would mean that fishers would produce competing sources of knowledge and advice. There are many different varieties of how this could be realized. A practical illustration is the 'Fishers' North Sea Stock Survey'(Napier 2010):

> The Fishers' North Sea Stock Survey is an annual survey of fishers' perceptions of the state of fish stocks in the North Sea, with the aim of making their knowledge of the state of fish stocks available to fisheries scientists and fisheries managers (introduction on webpage, Napier 2010).

In this case, surveys are carried out by circulating a questionnaire to North Sea fishers in five European countries. The survey's purpose is to assess how fishers perceive changes in the state of selected fish stocks. The result of the survey is then made available for ACOM, which considers it when giving advice. Hence, fishers' experience based knowledge is collected *in addition to* science and assessed by scientists before it is made available for the ACOM. The weight given to their advice in comparison with the authorized experts' advice, however, is unclear.

Yet another way in which fishers could be involved in knowledge provision is suggested in the third row of the table. Here fishers are in a position to take *responsibility for knowledge provision*. This would be a reversal of the established situation, where science (on mandate from the coastal state) is responsible for providing knowledge for fisheries management whereas fishers are excluded. Instead, then, the provision of knowledge for management purposes would be part of the responsibilities of fishers, secured, for instance, as a condition for being allowed to engage in fishing activities in the first place. Exactly how this could be done in practice need not concern us here. While giving fishers the responsibility for knowledge production may seem far fetched, at least in the northern European context today, examples exist. In New Zealand, for instance, quota holders hire their own scientists to make stock assessments additional to those of the national advisory body and the fishing industry has actually taken over some of the research contracts itself (Hersoug 2002). Note that this form of involvement does not necessarily imply that the fishers actually perform the tasks in question, be it data collection, assessment or advice. Being in charge opens up the possibility that fishers employ others, for instance, scientific institutions, to undertake (parts of) this on their behalf. For instance, since the assessments are based on complicated statistical models which require training to understand and years of specialized education to do, it may be unrealistic for fishers do the assessments themselves. However, fishers could be responsible and hence accountable for one or all of the knowledge functions in the advisory process.

To summarize, the table in Figure 3 represents a general space (comprising nine broad categories) of what it could mean for fishers to be included in knowledge provision for management purposes. This is a useful starting point for the inquiry into what the RF is achieving and how: Whatever the RF is accomplishing, it should be possible to record it by ticking off one or several of the boxes in the table. In addition, I want to suggest that the more functions we can tick off along the horizontal dimension, and the deeper level of commitment they are engaged in along the vertical dimension, the more responsibility and higher level of participation fishers are afforded. This table, then, serves as a rough diagnostic tool for the way the RF involves fishers in knowledge production.

This brings me to another important issue, namely that of expertise. While fishers' participation can be addressed by way of this table, it does not by itself sort out the question of what it takes to be an expert. One could ask how many knowledge functions must be available for stakeholders' participation or how deep their level of participation in order for fishers to be considered to be experts, but there are no obvious answers to this. The notion of expertise is a relative term and it also depends on the processes by which cognitive authority is granted. I will come back to this in the next chapter. As a starting point, however, I can indicate that the more stages that are open for the fishers (horizontal axis), and the more decision-making authority they are granted (vertical axis), the closer the fishers get to the expert role.

Research Questions

Figure 3 suggests that the RF can have many possible configurations. Based on this, I will investigate how the RF opens the way for fisher participation and how it organizes the relations between science and stakeholders. First, I want to know how the RF fishers are included in knowledge production for fisheries management. My first research question is simply: *How are the RF fishers included in knowledge production for management?* To investigate exactly how fishers are included in knowledge production and how knowledge is made to circulate within the fisheries network, I will undertake a detailed examination of the knowledge production that goes on within the RF. More specifically, I ask: *Is it reasonable to* *say that the fishers, through the RF, are becoming experts?* Fisher stakeholders are identified as having valuable knowledge based on their experiences. But how and where fishers can be included in a meaningful way is related to the arena established for their participation. What kind of resources are allocated in terms of financial support, equipment, training and authorization? How is the arena connected to and integrated in the formal advisory process? In order to investigate these issues, my third research question is: *What are the material and institutional conditions for the RF fishers' participation in the knowledge provision of the advisory process*?

Pursuing these three research questions will allow me to give a comprehensive portrait of what the RF has achieved in terms of the inclusion of fishers in knowledge production. At the same time, however, the thesis will show what the RF has not achieved. That is, my examination will, in addition to a detailed account of the depth of involvement the fishers have gained in different kinds of knowledge work, allow me to say something about the knowledge functions from which the fishers are still excluded, the degree of that exclusion and the types of barriers that exist. This suggests the fourth research question, which concerns what it would take to overcome such barriers: *If we wanted to extend fisher involvement in knowledge provision beyond that which is achieved through the RF, how could that be accomplished?*

How to Navigate in this Dissertation

As a part of this dissertation I have followed the RF – the fishers and their cooperation with the IMR – closely since 2005. One of my ambitions was to observe, in as much detail as possible, the knowledge production processes in practice. This was done through lengthy fieldwork conducted at sea with the RF vessels, with the IMR in Bergen and at the ICES in Copenhagen. Hence, in the following, I set out to explore how knowledge is produced and performed in the knowledge-intensive system that fisheries management is, and more specifically, I look into the interaction between the formal experts, represented by the scientists at the IMR, and the key stakeholders, represented by the fishers that are part of the RF.

In the next chapter, chapter 2, I situate my dissertation theoretically. In particular, this is a presentation of some key concepts from Actor Network Theory (ANT) as well as what expertise can be, and I will also draw on the large body of literature that has investigated what experience-based knowledge is. In chapter 3, I will describe the methods used during fieldwork, relying heavily on the anthropological traditions of participatory observation and interviews. In order to investigate my first line of inquiry, a thorough description of RF practices is necessary, and this is provided in chapters 4 and 5. Both chapters are mainly ethnographical. In chapter 4, I survey the main knowledge arenas within the RF and provide the reader with a thick description of the fieldwork context. Chapter 5 is inspired by Latour and Woolgar's 'laboratory life' and Latour's 'Pandora's Hope'. Here, I follow the practices in the laboratory and on the fishing vessels, tracing the data flow produced on the basis of the fish that are caught in the fishing gear. While Latour's focus is mainly on the transformation between the world and the words, I will pay attention to how fishers are included in the knowledge chains. Whereas the spotlight in chapter 5 is on the knowledge produced by fishers, chapter 6 represents a slight change of focus. Here I turn to the boundary work that takes place within the RF. I will mainly focus on how the RF also is an arena where fishers and scientists negotiate what the RF is and should be, and I look for clues for how the data from the RF is authorized. I am also searching for knowledge that may circulate outside the knowledge chains produced for stock assessment.

By the end of chapter 6, all the pieces necessary to address my main research questions are in place, and we can investigate how the RF fishers are included, what the conditions are, and if they have become experts in the process. In chapter 7, then, I address these questions explicitly and also return to the general dilemmas of opening up science and how to include a plurality of knowledge.

Chapter 2

Conceptual Tools for Analysing Advisory Processes

> Where does science leave off, and society – or technology – begin? Where is the border between science and non-science? Which claims or practices are scientific? Who is a scientist? What *is* science? (Gieryn 1995: 393)

In chapter 1, I established the object of inquiry, which is the changing relationship between science and society and the attempt to organize knowledge production and advisory processes in more open ways without losing too much of their credibility. In this chapter, I will discuss and delineate the theoretical perspectives and conceptual tools I need to undertake this inquiry. What is science? Why has it gained such a privileged position? How is scientific knowledge different from lay knowledge? What is expertise and how does it come about? Can non-scientists be experts?

In order to address these questions, I will rely on Actor Network Theory (ANT) as my main resource. ANT is not one homogenous theory but rather 'a set of related methodologies that are based on a relational heuristic as opposed to a 'substance' heuristic' (Nielsen 2008: 69). In ANT, reality is understood as heterogeneous networks, and fisheries management is an example of such a heterogeneous network, where fish, fishers, scientists, knowledge, advisory bodies and technology meet and mix (Holm 2000; Johnsen 2004a; Nielsen 2008).

In the following, the purpose is not to explain what ANT is and what it can do. Readers interested in this can turn elsewhere (Asdal 2003; Holm 2001; Latour 1987; Latour 1993; Latour 2005; Latour and Woolgar 1986; Law 2004). Instead, I focus on analytical concepts in ANT that have been particularly important for the analysis, namely the notions of the 'laboratory' and 'translations chains'. Using ANT as my main theoretical resource I investigate how actor networks and translation chains are made and maintained, focusing on how the RF includes fishers in the production of knowledge for fisheries management. Latour makes an effort to understand science in the making; my project is to understand what happens when the laboratory, in this case by way of the RF, is opened up to actor types – fishers – that do not fulfil standard expectations of what scientists look like. Inspired by ANT, I will follow the strategies used to construct, maintain and operate the translation chains by which data on fish stocks are produced, and how the fishers are involved in that work through the RF.

After introducing ANT and my key concepts below, I turn to two related conceptual issues that are of great importance to the analysis; expertise and experience based knowledge. Expertise is important because it is interrelated with the question of how cognitive authority is awarded: why and how scientists tend to be asked for advice as experts, and lay people tend not to be even when they have experience and insights pertinent to the issue at hand. Experience based knowledge, and the possibility of 'experience based expertise', is important here as it is related to the question of opening up science. When non-scientists are included in advisory processes, we must also consider what they bring to such processes, and how that differs from what scientists bring, and whether they might qualify as experts.

ANT: Laboratories and Translation Chains

A key issue within ANT is that power differentials (e.g., science versus non-science) cannot be explained properly by looking at 'the social' alone; we must also take the material into account (Latour 1987; Latour and Woolgar 1986). In ANT, all the epistemological privileges of science are abolished, at least at the outset. This does not mean that science and other forms of knowledge, like fishers' knowledge, are the same since

> science is a type of local knowledge that employs a number of mundane but powerful technologies – writing, counting and specialized metrologies – to make itself harder and tougher. While these technologies do not give access to truth, they do work, in that knowledge claims that are produced by such means usually have much greater likelihood of being accepted and as valid and put to work than those knowledge claims that are not (Holm 2003: 25).

Science, in other words, depends on much more than discursive practice (Latour 1987; Latour and Woolgar 1986). This takes us to two key concepts in ANT; translation processes and laboratories.

Translation involves movement and transformation. It includes the methods and techniques employed, and embraces both linguistic and material objects (Callon 1986; Johnsen 2004a; Latour 1987). Callon and Latour (1981: 279) define translation as

> all negotiations, intrigues, calculations, acts of persuasion and violence, thanks to which an actor or force takes, or causes to be conferred on itself, authority to speak or to act on behalf of another actor or force (Callon and Latour 1981: 279).

In other words, the process of translation is about constructing networks behind statements in such a way that they are stabilized as facts about reality. The point is to align entities in a way that makes it possible for a one actor to be the spokesperson for the collective; hence the others are silenced. At the end of a successful translation process, the networks become invisible and the actor stands out as a point of power and control.

Of special importance for this dissertation is how science through meticulous work makes complex knowledge objects visible and manageable (see also Asdal 2003). This type of work takes place in laboratories. Latour and Woolgar (1986) define a laboratory as a place where science is performed:

> The workplace and the set of productive forces, which makes construction possible[8] (Latour and Woolgar 1986: 243) .

During my fieldwork, I visited several places that can be considered laboratories in this sense; at sea, at the IMR in Bergen, and in the ICES headquarters in Copenhagen. It is important to note that, in line with ANT, I use the concept of a laboratory in a broad sense. Sometimes, it becomes a metaphor for science as such: a laboratory is a place where scientific knowledge production takes place.

With the help of inscription devices – any arrangement for labelling, naming, counting and measuring (Law 2004: 19) – science can produce translation chains, networks that make it possible for knowledge objects to travel. The material items that form the starting point of such chains, in this thesis mainly fish, are quickly left behind as they are transformed into text by inscription devices. These textual objects maintain their relationship to the material object, and the chain can always be followed back to the starting point. In ANT, the stable relationship between the represented and the representation is not assumed, but is seen as a practical accomplishment. The point of the

[8] Latour offers a different but similar definition: A laboratory is a place where scientists work, or more precisely, 'any place that gathers one or more instruments together' (Latour 1987: 69).

scientific procedures is exactly to make sure that the relationship holds; that the mobile becomes immutable, that the representation keeps on representing.

Inscriptions, as defined by Latour and Woolgard (1986), are text or images that have been treated in a laboratory and become visible as extracts, where the content has been cleaned, redrawn, and displayed as figures supporting a text (Latour 1987; Latour 1999; Latour and Woolgar 1986). Typically, inscriptions are two-dimensional, super-imposable and combinable. Inscriptions always allow for new translations while keeping some of the original traits intact. Inscriptions are also referred to as immutable mobiles. Immutable mobiles have three features that make them crucial to science; they are mobile, stable and combinable (Latour 1987: 222).

A main concern in ANT is to describe how scientists enroll and arrange various heterogeneous resources – text, technologies, and humans and so on – to form networks that ensure that their findings come to be seen as facts. ANT has been criticized for reducing everything to politics, power and interests (Amsterdamska 1990), and Latour's work has sometimes been read as if the laboratory is the source of all power (Asdal 2003). Such an interpretation is indicated by the title of Latour's essay, 'Give me a laboratory and I will raise the world' (1983), for instance. I do not agree with this interpretation. What is important in ANT, and useful for my thesis, is how scientists, with the help of the inscription devices and procedures of the laboratory, sometimes manage to form alliances with actors, objects and issues outside the laboratory. As a consequence of this, other actors are silenced through a process of translation as the scientists become the obligatory passage point for knowledge, power, information, influence (Latour 1987; Latour 1999).

Even though ANT, as I understand it, does not support the notion that the laboratory is the source of all power, the power of science is indeed impressive. One of its great achievements, by way of setting up and stabilizing translation chains, is to conjure up and set in motion knowledge objects which, without science, would be invisible and inaccessible. Through translation chains scientists are able to make real and manageable things that before science did its work remained outside the range of experience. The objects of interest to science are typically invisible to the bare senses, be it odourless gases, atoms or viruses that are too small to see, or things that are too big or widely distributed to apprehend, like fish stocks. With the help of inscription devices, science constructs places to see from that allow an unobstructed view of phenomena or knowledge objects that normally are veiled. In this way, science allows for the 'God view' (Haraway 1988) and the possibility of 'action at a distance' (Latour 1987).

What Is Expertise and Who Get To Be Experts?

As described in chapter 1, fisheries resource management is organized around the issue of how much fish can be caught each year (see Figure 1, above). In this context, fisheries science has become indispensable for answering questions concerning fish stocks; how they are doing under the current fishing pressure, whether they are growing or shrinking, how much fishing pressure is advisable in the coming season, and so on. Without doubt, then, the knowledge processes of the laboratories, the technologies of inscription and representation and the power of the invisible objects mobilized through translation chains, qualify the marine scientists of the IMR and ICES as the preeminent experts in the modern world of fisheries.

A more difficult question, however, is whether the fishers, included in the laboratory through the RF, also get to be experts. Does the establishment of the RF imply acknowledgement of the experience of fishers as an important source of knowledge? Does it allow fishers' knowledge to be mobilized towards resource management decisions? Do fishers, through their access to the practices of the laboratory, become more knowledgeable than they used to be? Such questions must in the end be addressed empirically, through a detailed examination of what goes in the RF. This is the task for the empirical chapters below, but the answers also hinge on the precise meaning of the concept of expertise.

In modern society, scientific knowledge is considered the 'gold standard' when it comes to reliable knowledge. Science has achieved this position, at least in part, due to the strengths of the processes used to create it (Aronwitz 1988; Hoppe 2005). I will take as a starting point that an important ingredient of expertise is to have access to methods, materials and instrumentations – a laboratory in short – that allow the construction of credible knowledge claims. Using ANT parlance, stable and reversible translation chains are key to credible knowledge. To the extent that expertise can be identified with credible knowledge, the expert role would primarily be available for those following the scientific process for knowledge production. Solid knowledge chains are established through access to and command of scientific technologies and procedures; hence scientists get to be the experts.

While credible knowledge is an important ingredient in expertise, however, it is not the only ingredient. Expertise, I will suggest, is not the same as having credible knowledge, be it practical or theoretical, produced through experience or laboratory practices. In addition to the skills and instrumentation for producing solid knowledge chains, expertise is related to social processes of allocating cognitive authority to some persons or groups. In modern society, science has the cognitive authority to make persuasive affirmations and judgements about the nature and meaning of the world (Epstein 1996; Gieryn 1995; Hilgartner 2000). The expert status granted, for instance, to an advisory body is not something that is 'automatically bestowed on any group that seeks it' (Hilgartner 2000: 5). It is only when knowledge is issued according to specific procedures and certified by specific institutions that it becomes expertise. Credible knowledge is not enough: to become an expert, you also need to be recognized and authorized as one.

In contrast to Evans and Collins, who argue that expertise can be seen as a continuum of knowledge states from knowledge to complete expertise (Collins and Evans 2002; Collins and Evans 2007; Evans and Collins 2008), it is more useful for my purposes to distinguish between the construction of credible knowledge and the process of granting cognitive authority. While these two dimensions sometimes go together, as Evans and Collins suggest, they sometime do not. In the fisheries, for instance, access to the expert role and participation in formal advisory processes hinge on explicit and formal processes of authorization[9]. Such authorization processes must be understood and examined on their own terms; it is not obvious that they always and necessarily are conditioned on the quality of the knowledge in question. While such a relationship is often taken for granted in society – the expert is that exactly because of his or her command of the issue – we are here interested in how such trust is established, its limitations, and whether it can be extended to actors other than scientists. We therefore cannot prefigure such a relationship by making it part of the definition of the concept of expertise.

In science, peer review is an important authorization mechanism. Here, the quality of the knowledge claims, and the appropriateness of their production, is scrutinized and certified by other scientists. In this process, the 'private' knowledge claims of individual scientists are authorized by being supported by the relevant scientific community. In this way, science comes with quality procedures to make sure that the translation chains will hold up under pressure. With Jasanoff (1985), we can say that scientific peer review is an authorization mechanism that places the credibility of the knowledge claims at the centre of attention.

[9] While having 'interactional expertise', which entails that stakeholders (or scientists) have 'enough expertise to interact interestingly with participants' (Collins and Evans 2002: 254), certainly is useful, it does not qualify as being part of the formal expertise. The way advisory processes are organized in advisory bodies today (see chapter 1) there is no room for 'contributory expertise' either, where stakeholders would have enough expertise to contribute to science (Collins and Evans 2002) in advisory processes. Rather, numerous procedures are in place in order to eliminate any impact from knowledge that is not authorized as science.

In science, then, the two analytical dimensions of expertise that I suggested above – laboratory practices and authorization – are thoroughly integrated (Jasanoff 1985). The translation chains or networks are stabilized through peer review by mobilizing the scientific community behind them. Accordingly, peer review forms part of what Latour (1993) calls translation processes, as described above, the painstaking process of displacements and transformations, negotiations and adjustments that it takes to create a scientific fact (Callon 1986; Latour 1987).

Nevertheless, peer review and other authorization processes can sometimes take another form, and be more similar to the process Latour calls 'purification' (Latour 1987; Latour 1993). Latour describes purification as a process where the processes of knowledge construction are 'blackboxed'. That is, the translation process by which the networks are constructed is hidden. Instead of making explicit the work or representation, facts are presented as self-evident and 'true' substitutes for the objects they represent. In this way, purification can also be understood as the opposite of transparency. Latour (1987) illustrates the conceptual pair of translation and purification by reference to the two-faced Janus (Latour 1987). On one side, translation is about 'science-in-the-making', when knowledge claims are still subject to revision, and disagreements are seen as an integral part of the process (Latour 1987). On the other side of the Janus face, purification results in 'ready-made science', the final cleaned-up product, for instance, presented as a scientific fact, where scientists have reached a stable consensus and speak with a unified voice (Latour 1987).

Science's two faces, and hence the notion of translation and purification, can be understood as 'backstage' and 'frontstage' performances (Goffman 1959; Hilgartner 2000). The networks are produced backstage, and only the neat, controlled frontstage performance, as purified ready-made science, is made available to the larger audience. As suggested by the theatrical metaphor here, it is in particular when science goes public, when laboratory products are made to circulate outside the laboratory, that the process of blackboxing is particularly apparent. This is because, outside the laboratory, the consensus produced backstage is (at least potentially) challenged.

As suggested above, peer review is part of the processes of translation in Latourian terms. It contributes to the transparent process of science-in-the-making, where the actor-networks are being constructed. In the case of frontstage science, when scientific products are presented as ready-made knowledge, however, peer review takes the form of purification, as part of the process by which science claims authority as science. In the mandated science context, that is, when science is mobilized to address policy questions, this is often the case (Nielsen 2008). In mandated science, the main audience for the scientific products is not other scientists. Quite often, science is mobilized exactly because the issue at hand is controversial. On the public stage, it is not sufficient for knowledge claims to be credible and produced according to scientific method, they must also be salient, useful and relevant for the question at hand (Wilson 2009). This entails that mandated science will be subject to external scrutiny and deconstruction, the controversies of the issue easily spill over to the science that is mobilized to manage it (Johnson 2007).

Hilgartner (2000), influenced by Goffman (1959), has examined how advisory bodies employ 'stage management' in order to produce authoritative advice and maintain the expert role. He demonstrates how authority is not something automatically bestowed on advisory bodies. Rather, advisory bodies assert, cultivate and guard their authority actively through a variety of strategies. The enactment of certainty is important in advisory bodies' frontstage performance (Hilgartner 2000). Backstage, however, controversies are common and the certainty of advice is often discussed. Non-scientists have limited insight into how the networks of non-human and human actors are formed since it is hidden, and then presented as facts when they are in a position to represent something. The networks of translations are produced 'backstage', and only the carefully controlled and purified 'frontstage' performance is accessible to the audience. However, despite strategies like stage management and speaking as a collective body, advisory bodies are often contested when their advice enters the public scene: 'Even the protection provided by speaking in a collective voice, to advise as a committee and to generate authority in a self-authorizing way, does not confer immunity against contestation' (Nowotny 2003: 152). Nevertheless, society turns to science when faced with concerns of a public policy nature.

From the above then, we can see that there are many approaches to how to understand the systematic work and effort that is needed to both generate and maintain science cognitive authority. This is the process that Hilgartner (2000) labels frontstage performances, Latour (1987) refers to it as purification while Gieryn (1983) calls it boundary work.

In mandated science, to sum up, there are some very real boundaries that separate an expert from a non-expert. It does not suffice to have reliable knowledge to be an expert. In addition, experts must be recognized and authorized as experts. Even if fishers or other stakeholders have loads of relevant knowledge, that does not make them into experts by itself. In the fishery sector, the expert role is monopolized by marine science, and maintained by institutionalized boundary strategies. As a consequence, knowledge that does not meet the criteria of having the necessary formal authorization is excluded even if it could be both relevant and reliable.

Experience Based Knowledge and Expertise

From the discussion above, it is easy to understand how and why scientists get to be experts. They have both the resources and instruments to make reliable knowledge chains (through the laboratory), and they have come to a position where society has granted them cognitive authority. While this explains why scientists often get to be experts, it does not in itself exclude the possibility of non-scientists as experts. This is of importance since I will consider how the RF arena relates to the potential for including fishers' experience based knowledge. How, then, does experience based knowledge relate to this issue? To what extent is it reliable and credible, and, if it is not, how can it become more so? Can it be regarded or authorized as expertise? These questions will be addressed in the following.

One part of this problem is fairly straightforward. This is the question of authorization. In order for stakeholders to be regarded as experts, there must be procedures and arenas in place that authorize them as experts. In the present state of the Norwegian fisheries there are no arenas that serve this purpose. Within the established management regime, the knowledge or expertise of fishers is not acknowledged. One of the key questions in this thesis concerns whether and to what extent the Reference Fleet can change that. As suggested by the argument above, however, such authorization is usually granted on the faith that the individuals or groups in question are holders of credible knowledge. In the following, we examine this question. Do lay people have credible knowledge? How can we be sure that experience based knowledge has the necessary quality?

There are numerous examples from the science studies tradition demonstrating how persons other than scientists can be knowledgeable and how, sometimes, such knowledge can be mobilized and 'win' over established scientific knowledge claims. In the 1980s, STS scholars began research on the encounters between science and society, for instance, about the radioactive effects of Chernobyl, environmental issues and new medical interventions (CEC 2007), showing that the public mistrust in science was not just based on public ignorance (Irwin and Wynne 1996; Irwin and Michaels 2003). Wynne (1989a) described how French farmers managed to fight GMO food experts and how sheep farmers have relevant knowledge (1996), and Epstein (1996) examined the power and credibility struggles between patients and medical expertise. Other cases of STS studies on how other than scientists can have useful knowledge include the farmers' seed movements and the animal rights movement (Jasper and Nelkin 1992). Over the past years, then, STS researchers have observed and analysed public participation linked to science and innovation, with a focus on who is given a voice and who is not (CEC 2007: 57). This literature is too extensive to discuss to its full extent here[10]. For my purpose, the point is that the institutionalized trust in science is organized in a way that excludes other knowledge forms which could both be relevant and improve the production of knowledge for advice.

In fisheries, a substantial body of research has sought to characterize and collect fishers' experience based knowledge. This tradition, which is inspired from similar approaches in other fields (Agrawal 1995; Chambers 1997; Sillitoe 1998), has used different labels to describe the knowledge in question, like Local Ecological Knowledge, Indigenous Ecological Knowledge and Traditional Ecological Knowledge. Traditional Ecological Knowledge, for instance, is defined by Berkes et al. (1998: 5) as 'a cumulative body of knowledge, practice and belief evolving by adaptive processes and handed down through generations by cultural transmission'. A substantial number of scholars have demonstrated how stakeholders have relevant and valuable knowledge for policy issues. Some studies focus on the participation of the general citizen (Fischer 2000) while others look at stakeholders with specialized knowledge based on their work and experiences. In the fisheries context, researchers have sought to demonstrate the value of fishers' knowledge and how it can be a source of relevant information for management issues (Johannes et al. 2000; Johnson 2010; McGoodwin et al. 2000; Neis and Felt 2000; Neis et al. 1999; Pálsson 2000). These studies show how fishers have reliable knowledge about issues like stock structures, spatial and temporal locations for fish populations, fish behaviour, migration patterns, spawning grounds and bottom characteristics (Maurstad 2004; McGoodwin et al. 2000; Neis and Felt 2000). Numerous studies show how fishers' knowledge is local, experience based and different from science and at the same time it is relevant, reliable and valid[11].

From the above, we can see that a large and influential body of literature has demonstrated that experience based knowledge can be reliable and credible even if it is

[10] Readers interested in this topic can consult Gieryn's review of empirical studies of boundary work in his contribution to the *Handbook of Science and Technology Studies* (1995).

[11] A complete review of all these contributions is beyond the scope of this dissertation, but can be found elsewhere (see for instance Soto 2006).

local and depends on experience rather than scientific methods for its production. At the same time, however, this research shows that numerous factors contribute to differences in stakeholder knowledge, including how reliable it is. Such factors count things like social status, curiosity, type of gear, type of practices, age and so on (For a review, see Holm 2003; Neis et al. 1999). While non-scientists, like fishers, certainly know many things, then, this knowledge is not organized in a way that makes it easy to use for policy purposes as it is. In science, by contrast, there are mechanisms for testing and certifying knowledge claims, for instance, by peer review. Also, for mandated science, there are usually explicit procedures for formatting the knowledge in such a way that it effectively addresses the policy issue in question. This is part of the work undertaken by advisory bodies (Jasanoff 1990). No comparable mechanisms are readily available for experience-based knowledge.

Obviously, then, much knowledge is available through experience. At the same time, however, a lot of the knowledge that science is after cannot be accessed through experience alone. This depends on the knowledge objects and the position of the knowledge holder in relation to this object. Prior (2003a), for instance, demonstrates how difficult it can be to obtain knowledge of the full range of some knowledge objects, like a disease. Davis and Ruddle (2010) demonstrate how complex ecosystem processes like predator-prey dynamics cannot be fully understood using experience alone. In general, and as argued above, one of the points of science, its main source of power, is that it gives access to knowledge objects that otherwise would be out of reach. Asdal (2003), for instance, shows how science uses different technologies to help create nature as a quantifiable, comparable and hence controllable and manageable object for advisory bodies. One cannot expect lay people to have knowledge of such knowledge objects without the (scientific) knowledge instruments that made them available in the first place. In order to make associations between sick animals and fluoride pollution, for instance, science can produce quantitative data and produce knowledge chains to move them from the field and to the laboratory and back again; and hence become a source for intervention and power (Asdal 2003). This does not mean that 'abstract' objects like pollution, viruses, gravitational waves and so on do not exist without science. Rather, it means that when experience as a strategy is not sufficient, science has some very effective strategies, such as translation chains, that can make complex knowledge objects that are spread in time and space manageable.

In the case of fisheries management, as we shall see, the fish stock is an important knowledge object. Fish stocks are not a directly observable object. As suggested by Nielsen

(2008), they keep themselves under water and hence are difficult to observe. They are dispersed over vast areas. How fast they grow, individually and as a collective, is difficult to measure and varies with a number of factors. How successfully they spawn, and hence the strength of the successive year classes, changes from one year to the next. Stock assessment, then, is a challenging task. It took over a 100 years to develop the methodologies, instruments and skills that made fish stock assessment practical, and hence made fisheries resources available for modern management (Rozwadowski 2002). The fish stock as a measurable and manageable object is produced by a complex network of standardizations, data collection, data cleaning procedures and model assumptions (Nielsen 2008: 218). As such, it is a scientific object, and only observable by the laboratory practices that produced it in the first place.

FEK research sometimes reads as if it claims that fishers, without having to resort to scientific instrumentation, already have access to knowledge about fish stocks as part of their experience based store of knowledge. But this is problematic, since the existence of fish stocks depends on laboratory practices. Of course, fishers have knowledge. Obviously, that knowledge may be useful for management purposes. But this cannot be taken to mean the fishers, without the instrumentation and procedures of science, will be in the same position to observe fish stocks as the scientists. Had this concerned the skills of catching fish, it would be a different matter. But the issue concerns an invisible object, invented by science in the first place, by way of scientific instrumentation and laboratory practices.

The point I have made above should be fairly obvious. The reason that it is necessary to make it anyway is connected to a particular feature, or perhaps interpretation, of the research on fishers' knowledge. If one reads FEK and STS research, at least superficially, this can be taken to mean that lay people actually have knowledge on a par with scientists (Holm 2003). According to Holm (2003), there is a tendency within FEK research to 'blackbox' all the tedious work that is necessary to clean up and organize fishers' knowledge. He argues that since this process is not made transparent, it generates the impression that fishers already have a body of knowledge that management can tap into.

If one takes a closer look at these cases, however, one can see that lay people's knowledge does not come to be reliable or relevant as science on its own, according to Holm (2003). He makes a thorough analysis of how such knowledge claims depend on the work of scientific strategies to become reliable and valid. Following methods for data collections and procedures for cleaning up and testing, FEK researcher enables lay people's knowledge to enter the frontstage as facts. What is important here is that fishers rely on scientists for their knowledge to be validated as reliable knowledge claims, since they are purifying the fishers' knowledge 'backstage'.

Holm (2003) describes this as a reversed boundary strategy since it seeks to collapse the boundaries between science and fishers' knowledge, while doing boundary work. In this version of boundary work, FEK researchers make a substantial effort to downplay the differences between science and fishers' knowledge as well as their own role in purifying and testing it. This becomes a problem when investigating who the experts are, in line with my definition of it, since the purification processes that take place on the FEK and STS researchers' 'backstage' is invisible and produces an unrealistic impression of what lay people can have reliable knowledge about.

Knowledge and Science: Letting Go of the Grand Dichotomies

In line with the STS argument, I understand science as cultural and embedded in practices, just like fishers' knowledge is. This means that there is not, at least at the outset, a basic difference between scientific and other forms of knowledge. Science is a type of local knowledge that utilizes a few mundane tricks – counting, writing and the utilization of a bunch of material devices – to make itself harder and stronger, as pinpointed in the citation of Holm (2003) at the beginning of this chapter. Such tricks are available for persons other than scientists, including stakeholders like fishers, and using them will not threaten them or their culture.

This approach is not shared by all students of local or traditional knowledge. A more typical standpoint, it would seem, is that local knowledge, like indigenous, traditional and fishers' knowledge, is fundamentally different from science. For instance, Agrawal argues that any attempt to integrate it with science will necessarily alienate it from its original holders and disempower them (Agrawal 1995). Others, like Berkes (1999), describe local knowledge, like fishers' knowledge, as a body of sacred knowledge that exists in binary opposition to science. Just as scientists (and maybe society) sometimes idealize science as the only way to true knowledge, there is a tendency in this research of idealizing local knowledge as sacred and holy ecological wisdom (Bjørkan and Qvenild 2010; Davis and Ruddle 2010; Krech 1999). As a growing body of literature underscores, this notion of lay or experience based experts is based on romantic ideas of (noble) local peoples with sacred access to truth (Bjørkan and Qvenild 2010; Collins and Evans 2007; Holm 2003; Krech 1999; Prior 2003a).

The understanding of either fishers' or scientists' knowledge as having privileged access to true, better or sacred knowledge is not useful for my purpose here. If we assume either one of the groups can be fact producers and the other as based upon beliefs, this would entail that an asymmetric relationship is introduced already at the outset of the study of fishers and scientists. Like Latour, I recognize that such divides can be helpful for contrast, but they do not provide any useful explanation for what science or other form of knowledge is (Latour and Woolgar 1986). Hence, we should let go of the grand dichotomies.

I follow Latour's approach that the power of the laboratory – of science as such – is found in its material setting, and that such power can be mobilized with reference to any kind of knowledge claim. In line with a constructivist view of knowledge production, fishers' knowledge in its basic form is not much different from scientists' knowledge. Importantly, though, science is systematically and painstakingly refined to make it a coherent and fortified (but not necessarily true) body of knowledge (Latour 1987: 42), while fishers' knowledge usually is not. Scientists are explicitly and intensely preoccupied with refining and testing their knowledge claims, fishers are more interested in fishing. With the support of the laboratory (where knowledge chains can be constructed) and methods for testing and authorizing knowledge (like peer review) scientists get to be empowered. If stakeholders with experience based knowledge adopted the same type of strategies, it could also empower them. This would certainly change their knowledge; that would be the point. But it would not, at least at the outset, change their culture or disempower them otherwise.

During my fieldwork on board a fishing vessel, the skipper said that they lose more fish in the mornings, since 'cod has a floppy mouth in the morning'. Let us take this statement as an example of an experience-based knowledge claim, grounded on the skipper's extensive experience during 23 years working at sea. I was sitting with the skipper, observing the same images on a television screen on the bridge. As it happens, however, I had a counting device between me and the screen. My job on this occasion was to make observations and collect data as part of a project comparing the efficiency of different vessels using the same fishing technique[12]. What is important here is that I was making observations, with the help of a simple counting device, of the fish that were caught and the fish that fell off the hooks. The same type of recording was undertaken onboard

[12]This fieldtrip and its purpose is further described in the methodological chapter.

two other vessels located nearby. Since I was sitting together with the skipper, making ‘scientific’ observations exactly pertinent to the claim he was making – ‘cod have floppy mouths in the morning’ – I could check his claim. His experience based observation was indeed verified, as demonstrated in Table 1. The table show that this December morning, the vessel lost almost 3% more fish in the morning than later in the afternoon.

Vessel Name	Date	Time	Cod that falls off
	09.12.2008	08.15	4.47 %
Geir	09.12.2008	16.23	1.29 %

Table 1: The number of cod lost in the morning and the afternoon on a fishing vessel. These numbers support the skipper’s observation.

So far so good. By counting and writing, I was able to confirm the skipper’s claim. Note, however, that the scientific devices I had at my disposal made it possible to speed up time. Instead of his 23 years, I could do the job in ten days. Nevertheless, in this example, the scientist (me) and the fisher (the skipper) shared the local view. That is, my position was not one from ‘nowhere’, but from exactly the same as the skipper, viewing the same screen in the steering house.

When I left the vessel and went back to my office, a change of position took place. This became possible because similar observations were made for the other two vessels. All the numbers collected by the counting devices from the ten days at sea were transferred to a laptop computer, where anyone with access could play with them and add the numbers together at any time and place, just as I have done in Table 2.

As we see from Table 2, the data from the other two vessels did not coincide with mine. While the situated experiences of the skipper on board MS *Geir* was that cod have a ‘floppy mouth’ in the morning, the opposite seemed to be the case for the other two vessels. Hence, these numbers did not support the skipper’s argument as a knowledge claim that is reliable for the behaviour of cod in general.

Vessel Name	Date	Time	Cod that falls off
Geir	30.11.2008	07.05	0.51 %
	30.11.2008	15.35	0.31 %
Vonar	30.11.2008	07.45	1.17 %
	30.11.2008	19.05	2.39 %
Loran	30.11.2008	07.55	1.23 %
	30.11.2008	17.08	2.41 %

Table 2: The number of lost cod in all three vessels. All numbers were recorded and sent in by scientists onboard the three vessels and later put together. This shows that while MS *Geir* loses more cod in the morning than in the afternoon, the other two vessels lose more cod in the afternoon than in the morning.

We can start to see that there were some limitations to the skipper's knowledge claims, even if *his* experiences could be verified as valid, at least locally. The skipper's experience based knowledge was situated, local and individual – some would call it anecdotal (Wilson 2009). Much the same as Prior's (2003a) patients demonstrated important knowledge about their own bodies, fishers are knowledgeable about the fish which they experience at a particular time with a particular vessel and gear. But the base of their experience is limited, making their knowledge partial, while the knowledge object (fish stocks) is immensely complex. Accordingly, this is a question of scale: while the skipper's knowledge claim is true, it is not linked to the necessary scale that characterizes fish stocks as a knowledge object (Wilson 2009).

When knowledge objects are intrinsically difficult to access and the urgency of the matter is high, science is often considered the best source of advice. If experience based knowledge strategies are not sufficient to gain the full picture, this does not necessarily mean that science is the only option. An alternative would be to give stakeholders, like fishers, access to a laboratory. With the right tools and proper training, fishers' knowledge can become as powerful as science. This does not change fishers' knowledge, at least not in any sinister way. The skipper's 23 years of experience would not be deleted if he were to get access to a counting device. He would just get access to a better point of view, a place from where he could see the issue at hand unobstructed.

Here, then, I reject the grand dichotomies between science and non-science. This is of course a conventional ANT position when it comes to the 'facts' presented by 'frontstage' science. In addition however, I think it is important to avoid the mirror image purification, in which lay people are granted mysterious access to truth. It is understandable, of course, given the success of science, that some would utilize the God trick (Haraway 1988) to grant authority to lay knowledge. I must admit that I sympathize with the project of empowering stakeholders. Given the arrogance of science, with its traditional position of writing off lay knowledge claims as anecdotal on formal grounds, the idea of reversing the situation and putting lay people's knowledge first is alluring. But, in line with ANT, I will resist this temptation. Since it is simply obscuring the issue at hand, I must reject all efforts to make the knowledge production process less transparent.

Chapter 3

Follow the Fish: Doing Multi-Sited Fieldwork in a Fish Infested Setting

The Reference Fleet (RF) offers a rich case for studying how fisheries management can become more open, and how we can bridge the gap between fishers and scientists. This is an arena where we can study how fishers' experience based knowledge can be useful for management purposes and how we can organize the inclusion of fishers as key stakeholders. The boundary work that goes on in order to generate a gap between science and experience based knowledge is at the heart of both anthropological and STS research. But how can I study the RF, and how can I study both knowledge production and boundary work? In this chapter, I turn to methodology, and I will describe how my fieldwork was choreographed – mostly by me, but there were instances where other powerful choreographers, like time and skills, affected my access to different stages and roles which constitute the field of fisheries management.

Methodologically, STS underlines the importance of ethnography, a method associated with anthropology, where empirical material is collected and there is no hunt for a universal truth (Asdal 2003; Johnsen 2004a; Latour and Woolgar 1986). Usually, ANT inspired analysis starts from concrete, empirical situations, like the process of knowledge production within the RF. Inspired by Latour's 'first rule of method' (1987: 21) I followed the IMR scientists and the fishers' practices in the making of a new 'knowledge arena' (the RF) before it has become a stable product, a black box, and hence less transparent and understandable. More precisely, I followed the fish from being caught at sea through all the different steps by which it is transformed into an item that can be a part (or rejected as a part) of stock assessment. In line with ANT, the material and technology are here considered as actors in the scientific construction of reality. I trace the RF network, following the fish, in order to study the practices within the RF. This entails that throughout the fieldwork I have followed the same object, or more precisely: I have followed the construction of fish as the same object in different sites and in different stages of the construction process[13]. As I will describe in the following, a lot of the labour realized within the RF happens in places that

[13] Another similar method is 'progressive contextualization' which has many aspects in common with 'follow the actor' (for more on progressive contextualization, see Vayda 1983).

must be considered as laboratories, even though they may not look like that. So this is a concrete, empirical study of scientists' and fishers' practices where the laboratory is central, and here I can mention the IMR and the ICES in particular. However, my focus on practices also takes me outside the laboratory, such as onto the fishing vessels. In addition, my aim to understand the RF and its practices takes me to the annual meetings, where the RF fishers and scientists also meet. The work I have done can be described as extensive ethnographic research which has turned out to be multi-sited as the fish I follow have taken me to numerous arenas.

Below, I will discuss the methods I used, as well as specific concerns that came up during my fieldwork. I also reflect on practical issues that I encountered with regard to three elements that are central to the fieldwork process; the fieldwork experience, the object studied and the account produced – the ethnography (Jenkins 1994). My fieldwork has, as mentioned, taken me to several arenas, and I have a wealth of data such as field notes and documents, photographs and figures. Here, I describe some of the strategies that I have employed in order to avoid being overwhelmed by the proliferation of information. First however, I will introduce the main arenas more thoroughly: this is important since their respective peculiarities have had impacts on my research strategies. Finally, I will add some reflections with regard to doing anthropological fieldwork.

Main Sites

Latour asks where we can start a study of science and technology (Latour 1987). Timing is crucial, he argues, and urges us – those who study technoscience – to find the place in time and space where whatever we study is getting established. It is important to study a black box before it is closed and 'ready made science', hence it should be 'science in the making' when we enter the process. When it comes to the RF, the relationship between fishers and scientists and the construction of fish as knowledge objects is quite easily accessed since the RF model was newly established and is still in the making. Accordingly, the 'backdoor' to study the RF knowledge production in action can be understood as currently open, or at least not closed.

The RF is a project that includes both fishers and scientists, and involves several arenas or laboratories for the production, qualification and interpretation of knowledge. The material, practical and economic challenges are different in each setting. The RF involves different groups of people who work in different geographic spaces at different times of the year with quite different, yet related, tasks. The main characters in this dissertation are the fishers who are part of the RF, and the scientists at the IMR who work with the RF. The fishers' work mainly takes place on the high seas or along the rocky Norwegian coast; while for the most part, scientists do their work at the IMR. With the RF, however, these two groups have an arena (or rather, an assemblage of different arenas) which gives them the opportunity to meet and share their experiences with regard to fish stocks. Sometimes they visit each other; the scientists go to the vessels and once a year the fishers travel to the RF annual meetings at the IMR. While both groups are organized around fishing, their practices differ in many aspects.

I have followed the fish as it has travelled from one site to the next, and how the cycle of the fish, and hence my fieldwork, is related to the Regulatory Chain is illustrated in Figure 4 below. When the TAC is set, the RF is allocated its share of the quota for Norway, and goes out to sea both to fish and to collect data, which is sent to the IMR continuously. At the IMR, the scientists gather the data from the RF and include some of it in their data base, or data bank, which is the term used by the IMR. Then, some of the IMR scientists bring the data to the ICES in order to use it to give a new TAC advice for different stocks, and the cycle repeats itself. In addition, the IMR arranges an annual meeting with both coastal and the offshore fishers. The annual meeting is an arena where fishers and scientists evaluate the work the RF does and show where the traces of the fish collected have ended up; this is a setting where they evaluate their relationship and negotiate the role of the RF, their tasks and the prize of the data collected. While the Coastal Reference Fleet (Coastal RF) annual meeting is held in December, the Offshore Reference Fleet (Offshore RF) annual meeting is held in August/September. The RF, then, is not a project that exists in one place or space, but it is distributed in time and space – and this is reflected in my fieldwork.

Parts of the data gathered from my informants during fieldwork, observed practices, comments, statements and so on, have been made anonymous. There are several reasons for this. The informant has sometimes asked that their statements remain anonymous, and I wanted to respect this. For the most part, however, the informants have not asked me to make them anonymous, but still, some of the information can be unpleasant to read for those who are linked to it. For instance, it may be offensive for an informant to read some of the statements, even if they are not controversial by nature as such. In addition, one of my informants sadly passed away as I was writing this thesis. In order to make it clear that I am using fictive rather than informants' real names, it will have quotation marks the first time it is presented (i.e. 'Per'). The anonymization here is not meant to make it impossible to trace the sources, and the choices are made based on my subjective judgement. Those who are familiar with the RF may understand who gave some of the statements since the RF and the IMR are relatively small ‘tribes’ and so is the Norwegian fisheries context. When the informants have explicitly asked to be made anonymous, however, I have removed the context that makes it traceable back to that specific person. Some of the material was gathered in written form, like e-mails or when the informants are performing as official subjects. In these cases, where I am not observing and participating in their daily lives, I will use their name and sometimes their title. Hence, I will use three different dimensions for my informants: not anonymous (name), anonymous to those unfamiliar with the fisheries context (fictional name) and finally, totally anonymous (no name, removing the necessary context). In order to separate quotes from informants or extracts from my fieldnotes, I will use textboxes.

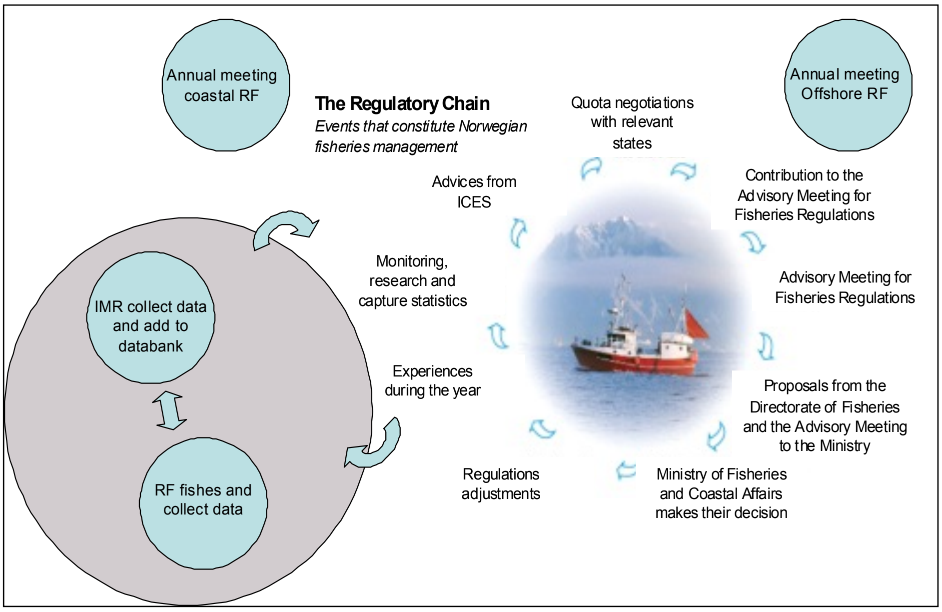


Figure 4: The Reference Fleet in relation to the ‘Regulatory Chain’

Fieldwork with the IMR

In 2005, the idea for this thesis took form, and with my particular interest in the fisheries context the RF caught my eye as a good case study for boundary work between science and society. Formally, the RF is a project owned by the IMR. In order to get access to my main object of interest, then, I had to start there. I called the head of the RF, Kjell Nedreaas. I described to him briefly what my PhD dissertation would do, and his immediate response was

> Yes! That would be very interesting. It is nice to get several perspectives, and that someone is interested in what we are doing.

At the time, my PhD was still without funding, but Nedreaas invited me to the Offshore RF annual meeting that autumn, at the IMR's expense. Nedreaas also helped me gain access to the ICES. This was important since one has to apply to be present at the meetings, and he took care of all the practical issues. Hence, from the first minute I felt very welcome, and I was granted access to the field immediately. This also included access to the fishers and their practices.

The IMR is the advisory body of Norwegian fisheries management, and this is the place the scientific expertise for fisheries management in general and stock assessment in specific is located[14]. The IMR gives advice on approximately 40 of the 60 stocks of commercial importance, of which 26 are managed by quotas (Gullestad 1996). The IMR in conjunction with the ICES is the Centre of Calculation for Norwegian fisheries management (Johnsen 2004b; Latour 1987). The IMR has a staff of almost 700 and is quite a complex organization. While the headquarters is located in Bergen, there is one department in Tromsø and in addition, there are three research stations and several research vessels[15] which are at sea for a total of 1600 days a year. There are eighteen thematic research groups at the IMR, which includes both scientists and technical staff who are also part of different project groups across the research groups. At the IMR, the RF is organized by one of the thematic research groups; the Fisheries Dynamic Group (FDG). Accordingly, this is where I did my fieldwork. However, as we will see later, the FDG is a rather mobile tribe.

In order to study the IMR's knowledge practices related to the RF, my plan was to 'go native' with the FDG to the greatest degree possible and I moved to Bergen in September 2007 to stay here for the next eight months. At the IMR, I found myself overwhelmed with all the information and everything that was going on, despite my familiarity with such a site. There are meetings, conferences and policies, documents, punching of data[16], friendships, birthdays and cups of coffee. The cups of coffee have been of particular importance to my fieldwork, and this has to do with how the work is organized at the FDG. As far as I could observe, the most important tool for the FDG members is the computer. In fact, I think I can go so far as to say that this is a community where one needs a computer in order to be a

[14] It can also be mentioned that half of the IMR's funding comes from the Norwegian Ministry of Fisheries and Coastal Affairs.
[15] For more about the IMR's research vessels, see the website (IMR 2010b).
[16] This verb 'to punch' is a term of jargon used in Norway and at the IMR which means 'to enter [data]'. Hence, it does not involve 'punching' in the literal sense of punch-cards or striking with your fist, but is just the tem used for operations like, i.e. keying in data from the source on to a computer. Since it has a satisfyingly dynamic and physical feel to it, I will use both the terms 'to punch' and 'to enter' data interchangeably.

member. The computer is a productive force in fisheries management and can be understood as a laboratory in itself, since it provides it own ‘test-bench’ environment (Knorr Cetina 1999: 35). A large amount of data is placed on the IMR’s data bank, to which the employees have access. The computer is a digital world that generates new possibilities for where and how science can be produced, and actors and vast networks are connected by computers and the internet. With their computer, they work in a controlled environment where results can be reproduced over and over again. When it comes to stock assessment, my experience is that the IMR scientist’s workplace can be anywhere, as long as they have a computer or a laptop with the necessary data. Hence, the IMR scientists can be anywhere physically, as long as their computer is attached to the virtual network of the IMR. Accordingly, this is not a traditional laboratory study since the laboratory I study can be anywhere in time and space. In other words, the network that produces the objects I study, fish, is widely distributed. It is a virtual network bound together with e-mails and VPN clients and the knowledge objects seem to float around, but never unintentionally. For an outsider, it is a confusing world filled with equations, spreadsheets, theories about a natural equilibrium and models about fish at a certain age.

As described above, the scientists seem to be able to work anywhere as long as they have their laptop computers with them. A lot of the work they do is virtual and the frames are basically provided by a computer and access to the IMR data. At the IMR, each person has an office space with a computer; an important portion of their work goes on in the office behind closed doors. For the most part, IMR scientists’ work is executed at the IMR headquarters. However, an important part of the scientists’ practices also takes place on scientific surveys, and at the ICES. So how could I study their work? I soon realized that it would be a great source of annoyance and not very constructive if I stayed in their offices. The coffee room, however, is the heart of the FDG social and official life. It is the equivalent of an agora, plaza or town square, and this is where a lot of the interaction between the FDG staff takes place. Here, they come when they are tired and need a break, when they hear laughter and are curious about what is going on, to read the newspaper or just to talk or relax. In this space, I was quite sure that I was not taking up their time, and they could choose to go whenever they wanted to. At the same time, I could see intimate details of their ‘tribal life’: of working, eating; the arrangements for the day’s work, and how the different scientists worked both alone and together, planning projects and conferences or just hanging out – just like Malinowski (1932[1987]) did with the Trobrianders. In the coffee room, I observed and tried to make sense of the scientists’ practices. Sitting there, I reflected and took notes, of which the extract from my field notes, below, is a sample:

Field notes: Thoughts after first week at the IMR
When someone comes to get a coffee, we talk. Sometimes this turns into an informal interview. There are good stories that are told here. In a way the IMR scientists are educating me, as I learn how to become a good scientist. For instance, they tell stories from the surveys, which I understand as narratives that tell me who they are: who gets seasick, if it is good or bad to get sea sick etc.

Picture 1: The FDG coffee room and hallway

Sometimes I participated in their discussions, and sometimes they invited me to their offices to show me some of their findings, samples or pictures. Sitting there, I made notes either on the computer or on paper, or read some of the fishery papers containing articles they often discussed. This strategy also provided me with some important interviews, where I took careful notes:

Field notes: Interview with Bjordal 8 April 2008
We (Irene, Merete and I) are sitting at the coffee table. A man comes in, asking for Kjell. I ask him what his name is, and he presents himself as Bjordal (the guy that Hestenes from the National Data Centre told me to talk to!). I am excited, and tell him: ‘It is you I am supposed to talk to!’ He responds positively, sits down and looks at me. I tell him that I have not prepared an interview, but this is not a problem. He was one of the persons behind the reference fleet, and he talks for about half an hour.

I have detailed notes from what Bjordal told me in the interview, which I transcribed onto my computer later, adding the above reflections. Some of the interviews started as conversations and turned gradually into an interview. For instance, someone would say something interesting, and I would ask them to wait while I got a pen and paper. Often, this would change the situation, and the informants would sometimes change what they had just said to a more formal tone.

Even if I explained to the FDG scientists why I prefered to sit at the coffee table, I had continuous offers to borrow an office. They seem to find it odd that this is where I worked. After a couple of months of fieldwork, this changed since I was hired to enter RF data for them, by Huse.

You know the program, and it takes too much time to train somebody else. Do you think you could do some hours of punching for us?

This raised some concerns with regard to the validity of my material, and Borge asked me:

What will this do with your methods, and the validity of your material?

However, according to theories on participatory observation this is not a problem, since the researcher can immerse herself in the life of people who are studied to different degrees, ranging from total participation to simple observation, or something in between (Blaikie 2000). This gave me additional insight into how they work as well as access to their meetings with regard to entering the RF data. As a 'puncher', I had access to their laboratory and the network with IMR's data bank, the forms, the spreadsheets and computer programs they use. Hence, I could share the RF scientists' experiences as a human, working with a machine which is attached to a data bank. Some reflections with regard to how this affected my fieldwork are presented later.

In order to make some sense out of what they were doing, I noted all the IMR scientists' practices, while I tried to keep my eye on the RF data. Working with the FDG, I shared and observed discussions, jokes, trivial events, such as punching data, and other more dramatic events such as reaching a deadline or talking to the media. These events formed my daily life, as well as theirs. Reflecting on his fieldwork, Malinowski wrote:

> It must be remembered that as the natives saw me constantly every day, they ceased to be interested or alarmed, or made self-conscious about my presence, and I ceased to be a disturbing element in the tribal life which I was to study, altering it by my very approach, as always happens with a new-comer to every savage community. (Malinowsky 1932[1987]: 7-8)

This is true to some extent with regard to my fieldwork. Mostly, the FDG seemed to consider me as one of them, but sometimes, even after several months of fieldwork, they still noticed my presence. This was always in a friendly way. Sometimes they made jokes about me being like a spy, and sometimes I made that joke. Sometimes I reminded people about the fact that I was studying them, and sometimes they reminded me.

Key informants	Number of Interviews	Participatory observation
Kjell Nedreaas, Irene Huse, Asbjørn Borge, Otte Bjelland and Janicke Skardal, Merete Nilsen, Jarle Vedholm, Harald Gjøsæter	Countless semi-structured and informal and formal interviews and e-mails with key informants 1 formal taped interview with Kjell Nedreaas.	Eight months, including daily work (2007–2008), five annual meetings (2005–2009), several meetings (2007–2008) and one international conference

Table 3: Fieldwork with the IMR.

Investigating the Practices of the Reference Fleet Vessels

The RF consists of thirty-four vessels in total. They are selected from the Norwegian fishing fleet, which comprises approximately 7000 vessels . The fleet can be categorized and subdivided along different lines for different purposes. An important categorization is the division between coastal and offshore vessels, which reflects differences in size as well as in type of gear, organizational practices, type of fishing, cultural expression, and so on. Both coastal and offshore vessels are part of the RF, and according to the usual pattern of differential treatment, they are organized separately. In 2000 the Offshore RF was established, and is composed of sixteen vessels. The Coastal RF was established in 2005, and consists of eighteen vessels (8–16 metres long)[17]. All of the fishers were very approachable and friendly, and offered their help and gave me the information I asked for. They were also very positive about having me onboard. The fishers have generously offered their time and invited me to join them in their activities. The considerable number of vessels that comprise the RF (34 in 2007), presented me with a myriad of options – and limitations – with regard to where and how to do fieldwork. Given the practical and economic limitations of my project, I could not visit all the vessels. I did fieldwork onboard two of the Coastal RF vessels and one Offshore RF vessel. I did not select the vessels to visit randomly. Below, I describe how I ended up on the particular vessels. Since my intention is not to address a type of research question for which generalization across the whole RF is relevant, the absence of a random sample is not a problem.

The fishers and their culture are unfamiliar to me in the sense that I am not a fisher myself, and I am not from a traditional fishing community. I grew up in an industrial city, which is well known for having the only iron works in Norway. Hence, my visits to the boats have been more like the traditional anthropological visits to an unknown culture. This culture is organized around how and where to find as much fish as possible. I believe that the fishers regarded me as belonging in the same category as the scientists from the IMR despite my constantly reminding them that I am not. The vocabulary onboard the boats was also unfamiliar to me, and fishers seemed to communicate in monosyllables, grunts or body language more than phrases understandable to others.

[17] Information based on the IMR's publication 'havforskningstema' ((IMR 2007a) In 2010, the Offshore RF consisted of seventeen vessels, while the Coastal RF had the same number of vessels as in 2007.

Fieldwork with the Offshore RF

During my first visit to the offshore RF annual meeting in 2005, I soon realized that these vessels were out of reach for me, since they stay at sea for up to a month. That left me with the boats that make short trips in coastal areas, which narrowed my fieldwork down to the Coastal RF. In 2008, however, I got the chance to visit one of the seagoing vessels for two weeks thanks to an external project[18] at the Norwegian College of Fisheries Science, and I could include ethnographic work with the Offshore RF after all. I will briefly introduce the project and the work I did onboard the MS *Geir* in addition to fieldwork, since it provided an important framework for my practices on board this vessel.

My main task onboard MS *Geir*, which is an autoliner, was to register the quantities of fish that come aboard or fall off the lines. There were three different boats in the project; *Geir*, *Vonar* and *Loran*. MS *Geir* has a special feature, called a moon-pool. The moon-pool is a 'hole' in the middle of the boat where the lines and hooks – and fish – come in. Each vessel had two scientists onboard, and I worked eight-hour shifts with a representative from the Fisheries Directorate. The task was to register the cod, haddock and Greenland halibut in three different categories: the fish that came in directly; the fish that fell in the moon-pool and were picked up again with the long hook; and the fish that were lost. These registrations took place on the bridge, where one can watch what happens down in the moon pool on monitors showing images relayed by several cameras operating there.

Most of my time was spent on the bridge together with the skippers, watching the fish and fishers on the screens, and my plan was to observe the fishers on MS *Geir* and their knowledge production for the RF, in between the shifts. During the first days, however, I was very sea sick; I could not eat and I slept a lot. After this passed, I could spend some of my free time together with the fishers and they taught me how to work in the 'split' where the gear is fixed and, importantly, they took me along to do the sampling for the RF. Innumerable conversations, small talk and discussions took place during the ten days I spent at sea. Many of the field notes onboard MS *Geir* were taken before I went to sleep, directly onto my computer in Microsoft Word, in between the shifts. I made one formal interview/observation session with the two fishers that handle the RF data, and for this interview I brought my note pad and a camera. An example of the field notes from MS *Geir* is presented below:

[18] These projects are further described by the Fishery and Aquaculture Industry Research Fund A film is also available on their webpage (Fiskerifond 2008).

Field notes Geir, 1 December

Nice day! I've been in the moon pool all day with the fishers. (…). I took some pictures of the cod they weigh and measure for the reference fleet. SCHEDULE A MEETING FOR THE RF SAMPLING!

Busy days: the shifts are 8-8-4, or something. Actually, I believe that there are some of the fishers who I still have not met?

The field notes are all taken in Norwegian, often in my dialect and the fishers' dialect. Most of the fishers on board are from the west coast of Norway, and some of the richness in the material is lost in translation.

Field notes Geir, 14 November

I ask the skipper just loosely about the Reference Fleet: Why did you want to join?

The skipper: No, I was thinking about the money, you know [looks at me, laughs]

The skipper's remark is a typical way of talking about money in Norway, and the fishers in the west are, lightheartedly, known for their focus on money (see, for instance, Vea 2009) . Importantly, even if he underlined the economic aspect in *words*, which played on a stereotype of fishers from the west, I had a *feeling* that there was more to his decision to join the RF. I did not push the skipper further on the subject, but after spending a lot of hours together with him, he came back to this issue. The skipper then explained how it was his father that disagreed with how stock assessment is done, and he wanted scientists to realize how autoliners and trawlers (used in surveys) get very different catches. However, this does not exclude money or quotas as an important motivation for joining the RF – which it is, according to my experiences.

MS *Geir* is a huge, shelter decked autoliner and the fishers' work takes place inside. Since both the fishers and I worked shifts, I got to know some of them better than others. When I managed to interact with the fishers again as my seasickness passed, being seasick seemed to be a kind of a '*rite de passage*' (Turner 1987; Van Gennep 2004 [1960]). They shared their stories about how sick they have been, and it ended up being a kind of ‘icebreaker’.

Key informants	Number of Interviews	Participatory observation
The skipper The RF samplers who are mainly two fishers	A large number of semi-structured and informal interviews, as well as discussion and conversations about the RF	Ten days on board MS *Geir*, fishing between Jan Mayen and Tromsø.

Table 4: Fieldwork with the Offshore RF.

Fieldwork with the Coastal RF

The Coastal RF vessels are spread along the Norwegian coast, and I could visit all of them in theory. However, I had to choose two of the vessels: I wanted to visit them together with an IMR scientist, who visits them on a regular basis, to observe their interactions; and also to visit one alone to observe the fishers’ practices without the IMR’s presence.

The trips to the vessels seem important to both the scientists and the fishers, and both groups underline the significance of this in the annual meetings, emails and phone calls. The visits are also time consuming and very expensive with regard to the journeys and working hours as well as equipment. During my fieldwork, the FDG scientists were not planning to visit any boats before Christmas 2007, since the boats had to be re-evaluated before they get a new four-year contract with the RF in 2008. Still, I had the opportunity to visit *Oddson* together with Huse, on a three-day fishing trip in November 2007.

We slept on the vessels and I could observe Huse and the fishers’ interactions closely. This is a busy, wet and cold place for fieldwork, but I had access to all the actors all the time, and we could talk in between the fishing sites. Here, I was constantly worried about being in their way and hampering their work. The fishers in the Coastal RF work outdoors, efficiently and with tools that I am not familiar with. While the scientists’ most important asset is the computer, which I am familiar with, the fishers’ work and identity is closely related to the boat and their equipment. Taking notes was difficult onboard *Oddson*. It was wet, very cold and busy. Here, I took notes when I could on the bridge or before I went to sleep. The notes were originally in Norwegian, written on paper and later transferred to the computer. Hence, they have been ‘cleaned up’.

Field notes Oddson, 13 November 2008

Huse used to be a fisher, and for instance, she knows how to fix ropes. The fishers think this is excellent. A fisher said to the skipper, in an approving and joking tone: 'You married the wrong woman!'

As this example demonstrates, the notes are written as a narrative, describing what took place during the course of the day, with 'near quotes' of statements I can remember.

The other Coastal RF vessel I visited is *Haldorson*. *Haldorson* is located in Lovund, an island close to my hometown; hence I was able to combine fieldwork and holidays. We made several appointments but it is impossible to control all the aspects involved in fisheries: the weather conditions made it difficult to reach Lovund due to blizzards; and when I got there in the summer of 2009 the vessel could not fish since the landing site was closed. Hence, the skipper, showed me the gear and his vessel and explained how the RF work is done.

The fieldwork on *Haldorson* started with a guided tour where the skipper showed me the vessel, the RF equipment and his boat house. We sat outside for a couple of hours, and I conducted a semi-structured interview, where all the questions were related to the RF. While we did the interview, I used a note book and took careful notes. Later I transferred these notes to the computer, and I added some of my impressions and observations. This is exemplified below, where the impressions and observations are within square brackets.

Fieldnotes Haldorson, 21 June 2009

Why did you want to participate in the Reference Fleet?
Skipper: We said yes because we thought it sounded interesting. Exciting to see the result. We are sceptical of the research on coastal cod. They regulate it so hard. We want them to look more closely at the knowledge and the research on coastal cod.

[I wanted him to say something more about why he is part of the Reference Fleet, elaborate, explain…But his answer was very concise: the coastal cod is the main reason for why he wants to be a part. He keeps returning to the coastal cod during the interview especially an area called 'Henningsværboksen']

Key informants	Number of Interviews	Participatory observation
Oddson: The skipper and one fisher	A large number of semi-structured and informal interviews, as well as discussion and conversations about the RF	Three days on board *Oddson* fishing in the coastal area of Vadsø
Haldorson: The skipper	A large number of semi-structured and informal interviews, as well as discussion and conversations about the RF. We have also had several telephone conversations.	One-day visit to Lovund,

Table 5: Fieldwork with the Coastal RF

The ICES

The ICES was as far as I was able to follow the traces from the RF within the heterogeneous network of fisheries management. This is the place I ended up as I followed the data trail left by the fish that I had watched as it was hauled onto the decks of the RF vessels. As mentioned in chapter 1, the ICES is the formal advisory body where scientists from the countries that own the different stocks meet every year to give advice on TACs. The ICES is a large organization which gives objective advice on numerous stocks for its clients, which are the member countries who own the different fish stocks. The advice is given by the Advisory Committee (ACOM), and is based on reports from expert working groups. The reports from expert groups are also peer reviewed by other chosen groups which are composed of scientists who do not originate from a nation with a strong interest in the stocks that are assessed. As an international organ, it constitutes the advisory bodies from all the member countries. In Norway, this role is played by the IMR. As a part of my fieldwork, I followed the RF data to one of the numerous expert working groups, the Arctic Fisheries Working Group (AFWG).

Following the assessment undertaken by the AFWG was an obvious choice to me, since the most important species in the Norwegian fisheries are assessed by this group. There are many fish stocks[19] being assessed and a lot of sub-group meetings going on simultaneously, and I decided that the best way to make sense of what goes on during ICES stock assessment was to follow one stock. I chose cod for several reasons: I have seen the RF sample the cod; the political and economic importance of cod; and the controversy about the Norwegian coastal cod[20], which is in critical condition (ICES 2008b). All types of scientist from a variety of countries are gathered here, and the main language is English. Some of the Russian scientists needed an interpreter, but in general the communication took place in English or Norwegian when I was observing. The 'stock responsible' for each stock is central here, and so are the statisticians. Their work however is done to a large degree before they come to the ICES (gathering and cleaning up the data, as well as assessing the stocks). What I could observe was the presentation of the data and methods used, and the negotiations between the different stock owners, such as Norway and Russia. During the meetings in the sub-groups I just observed. The scientists were extremely busy and stressed; hence there was little time for interviews or other inquiries and I spent time with them in the coffee breaks and for meals. Hence, I was at the observation end of the participatory observation scale here, while in other arenas I participated more than I observed. Mostly, I followed the material traces of the RF data. Taking notes was easy in this setting as we were mostly gathered around a table. Everybody had their laptop in front of them, including me. Hence, I could make notes directly in Microsoft Word. I made detailed notes about the practices, the discussions and conversations at the meeting. Some of these notes have quite a personal character, where I write down what I do not understand, what I have to follow up on later and my impressions. An example of this is provided below, where the notes were written in Norwegian and I have translated them into English:

[19] For assessment purposes, the RF provides data for the NEA cod, the coastal cod, saithe, haddock, two species of redfish and Greenland halibut (IMR 2011) Please see the ICES report from 2008 for an extensive review.

[20] While the management of the NEA cod is quite successful, with a well functioning assessment system and the stock status is well within precautionary approach criteria (ICES 2008b: 24-26), this is not the case with the Norwegian coastal cod. This stock has been continuously decreasing since 1994, and is described as in a critical condition. Consequently, ICES has recommended zero catch since 2004 (ICES 2008b: 38).

Field notes ICES, day 3
Cod: subgroup meeting evaluation stock recruitment models. They all seem to know each other from earlier. They are presenting the different models, their functions and parameters. It seems like the goal is to find one common model. NB! The ecosystem processes are of special interest here. They are going to write the first chapter ever in ICES 2008 where ecosystem is included: Check final result!

Other field notes are direct transcriptions of what was said, discussed or presented, often with a comment to myself in the margins. In the example below the notes were taken in English, the language used to communicate in plenary sessions, while my comments to myself are in Norwegian:

Field notes ICES, day 5
Plenum presentation from cod subgroup meeting [using PowerPoint] We agreed that we would make a hybrid: producing best result according to Sam. This makes this working group the first to implement climate in recruitment prediction. The PowerPoint slide states: 2008 430 000 t + 10 % 473 000 t. [Original text in Norwegian] GET THE DOCUMENT FROM BJARTE ABOUT THE 10% rule. NB: look for the stock summary in the ICES reports.

The AFWG was as far at it was possible for me to find any signals from the RF; hence, this is the last arena for knowledge production visited during my fieldwork.

Key informants	**Participatory observation**
Kjell Nedreaas, Asgeir Aglen and Harald Gjøsæter	Ten days, mostly observing

Table 6: Fieldwork at the ICES with the AFWG.

The RF annual meetings

I met most of the RF fishers several times at the annual meetings where I observed, participated and talked to them during the coffee breaks. Once a year, the IMR opens its doors for the fishers involved with the RF to meet with IMR scientists who work with the RF or with other issues. Here, the fishers and the scientists spend a couple days together with a tight schedule filled with both formal work-related tasks and more informal coffee breaks, lunches and a dinner. They talk about management issues and regulations, and evaluate the RF in general. The Offshore RF, which was established first, has its meeting in the autumn after the TACs advice from ICES is given. Hence, the TAC advice is often a central theme, together with how much of the research quota is set aside for the RF. The Coastal RF annual meeting is held before Christmas, which is before the TACs are set. At this time of year, most of the Coastal RF have finished their fisheries and they have time to leave the sea and come to the IMR. One of the important tasks of the Coastal RF is to provide the IMR with information about the NEA cod in general and the coastal cod in particular, and this fishery starts in January.

I have not followed the data to these meetings. However, they have been important in order to observe the interaction between the two epistemic cultures studied[21]. The annual meetings have been what Geertz would call a ‘cultural window’ (Geertz 1973) since they have provided me with an insight into what goes on in the meetings between fishers and scientists. I attended two meetings with the Offshore RF, in the autumn of 2005 and 2009, and four with the Coastal RF; in December 2006, 2007, 2008 and 2009. In addition to the formal interaction in and between the groups, there is always a conference dinner which is very informal.

After participating in several of these meetings, my experience is that the Coastal and Offshore RF share most aspects. However, there are some differences between the two groups at the annual meeting. For instance, at the Offshore RF annual meeting the vessel owners are present, and sometimes they bring one of the crew members who does the actual sampling. Hence, the data samplers are often not there. At the Coastal RF meeting, everybody present does the actual data collection, hence their concerns seem at times to be related to more practical issues than the vessel owners from the Offshore RF.

[21] Epistemic cultures are cultures of creating and warranting knowledge. Knorr Cetina (1999) defines it as: ‘Those sets of practices, arrangements, and mechanisms bound together by necessity, affinity and historical coincidence that, in a given area of professional expertise, make up how we know what we know.’

Mostly, I observed closely and took notes during these meetings. Since the schedule is tight, there was little time for face-to-face interviews. I administered questionnaires during the 2009 Coastal RF and Offshore RF annual meetings, where most of the fishers present answered all the questions. An extract from my field diary is presented below:

> The IMR scientists ask the RF fishers to voice any concerns or worries and so on
>
> - More visits!
> - Remember to check the weather report before you come [laugh, look at each other]

I always introduced myself and my reason for being at these meetings. At the last meetings at which I was present, in 2009, I also presented my findings so far. The annual meetings have been a platform giving me easy access to most of the fishers, and they have provided me with the opportunity to listen to discussions and conversations between fishers and scientists, as well as to administer questionnaires.

Key informants	**Number of Interviews**	**Participatory observation**
Kjell Nedreaas, Abjørn Borge, Irene Huse, and importantly, most of the RF fishers	A large number of informal interviews based on the annual meetings themes, as well as discussion and conversations about the RF. Questionnaires handed out to all the fishers present at both the Offshore RF and Coastal RF annual meeting in 2009	Offshore RF: two annual meetings over two days Coastal RF: three annual meetings of two days each

Table 7: Fieldwork with the RF annual meetings.

Maps of the Locations Visited

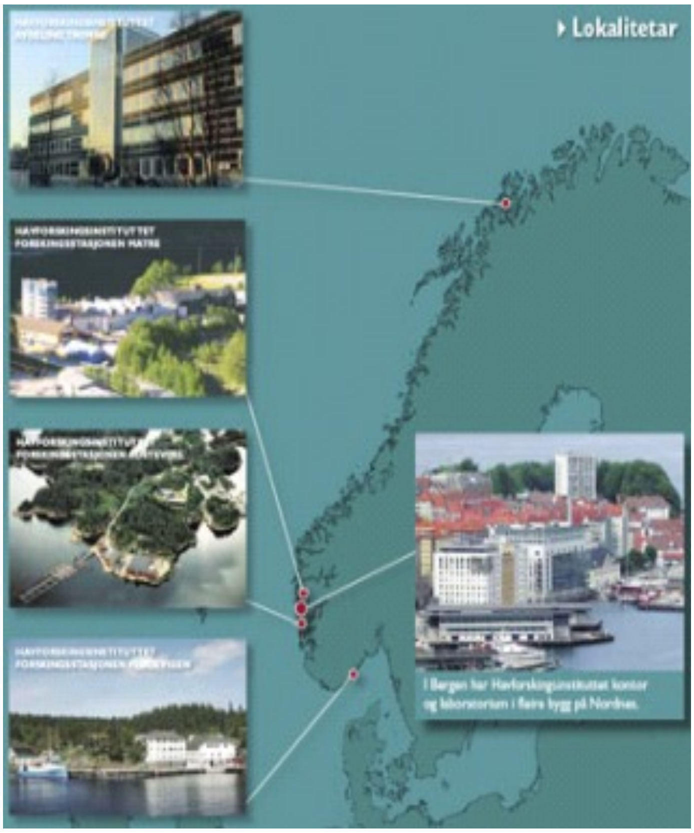


Figure 5: Map of the IMR facilities and locations (from IMR website homepage). I did fieldwork in Bergen, which is the location with its picture on the right side. The map to the right shows Denmark (from Wikipedia.org). The red dot marks Copenhagen, where the ICES headquarters is located.

Figure 6: The Coastal RF (IMR 2007a). As the map shows, the Coastal RF vessels are located along the entire Norwegian coast, from Varanger to Oslo.

Figure 7: The Offshore RF (IMR 2007a). As the map shows, the vessels are registered mainly in the south-west and the north. The fishing takes place in the high seas, often far away from where they are registered.

Notes on Doing Anthropological Fieldwork

Fieldwork as a method has been central to defining modern social anthropology as a discipline. In anthropology, including the STS tradition in 'laboratory studies', fieldwork is considered the main tool or technique. The methods used by a scientist can be described as the techniques used to collect and analyse data, while the methodology used refers to a discussion of how research is done (Blaikie 2000). Doing fieldwork, the anthropologist investigates thoroughly the social environment, preferably by being present for a long period of time. Malinowski is considered as the first to set the standards for how to do fieldwork, with his detailed account in the book *Argonauts of the Western Pacific* (see, for instance, Jenkins 1994). He kept a painstakingly meticulous record of the social behavior of those studied (Garbett 1970). To quote Malinowski,

> the goal of ethnographic fieldwork is to grasp the native's point of view, his relation to life, to realize his version of his world (Malinowsky 1932[1987]: 25).

Malinowski argued that the main method should be participatory observation. I have followed his advice, as this allows me to study the work in the different sites as a cultural practice. Participatory observation is not one single method; rather, it is practised in a variety of ways (Blaikie 2000). The researcher can immerse herself in the life of people who are studied to different degrees, ranging from total participation to simple observation, something in between or a combination of these methods. Importantly, the scientists are also understood as natives in this study. This focus on details is also found in ANT, and in the most myopic parts of my dissertation, I will follow their recommendations with regard to detailed accounts. According to a contemporary scientist (Callon (1986), an actor is an entity, human or not, that acts. Callon also underlines the importance of symmetry:

> Instead of imposing a preestablished grid of analyses upon (the entities and their relationships mobilized by actors in discussion) the observer follows the actors in order to identify the manner in which these define and associate the different elements by which they build and explain their world, whether it be social or natural (Callon 1986: 201).

Here, I adopt this position in order to follow the network of fisheries management and the RF as a new platform for data collection. This has been my main method, as I have followed one specific actor through the fisheries management network: the fish data collected by the RF. I follow how an object of knowledge is constructed, from being a fish as an organism to a fish as a knowledge object. I have followed its traces, and observed how the fishers fish and collect data and what the scientists do with the data. This has also taken me to conferences and meetings; I have participated in 'punching' the data and carried out a number of interviews. Using this method, I gained an insight into most of the activities related to the RF data. I conducted interviews with people I met during this process, i.e., the scientists at the FDG and the fishers.

According to Blom (1989), the description of culture is a question of establishing representations, or translations from one cultural system of expressions to another. Furthermore, he states that in a scientific context such translation depends on the access to a meta-language or a model that describes the given forms of expression of manifestations that can be compared in a system of different manifestations (Blom 1989). Hence, my representation of reality depends on the choices I make with regard to theories, models and language. I have tried to tell stories, histories and ethnographies that combine in a *thick description* of the world (Geertz 1973). It is important to notice that my aim is not to describe or analyse the scientific models used by the IMR or the ICES in the advisory process. On the same note, I do not aim to describe fishers' practices or methods in general. The purpose of the descriptions is to give a thick description of the practices related to the RF, and how these are related to the other practices of those studied.

While participatory observation, the key method in anthropological fieldwork, is central, other techniques such as interviews and document reviews are also part of my tool kit in the field. A further description about the interviews realized is presented in the next section.

Doing Interviews

According to Bråten (2002), the interview is a method that has developed along with shorter periods of fieldwork. Structured and unstructured interviews are methods that can lead to relevant and reliable data in a relatively short time. During my fieldwork, interviews were conducted with persons who were related to the process of data collection in some way. These interviews vary in character, from rather unstructured conversation to structured interviews where I follow a prepared interview guide.

During most of my fieldwork I used semi-structured interviews. In the beginning, this was also a way to make my informants talk about the issues they found relevant, and to find out how they talk about the RF using their own vocabulary. I tried to avoid letting my own theoretical ideas and assumptions guide my questions, and kept what I would call a passive profile during the actual fieldwork. Hence, I entered the field with an open mind, with the aim of understanding what the RF is from an emic perspective. The questions I prepared before starting fieldwork were very open-ended. Hence, the responses were often extensive.

Based on my informants' answers, and a better understanding of what the RF is, I returned to the field to get answers to more concrete questions. Since I could return to the field at any time during the process of writing my thesis, I went back with more structured interviews. These interviews took place during the annual meetings, after making appointmens or by mail or phone. This has given me the opportunity to make connections between ethnography and theory – doing analysis – in a reflexive solitude with my own personal focus, and then go back into the field again. All my questions have evolved around getting answers to aspects related to the RF: the knowledge production, the cooperation between fishers and scientists and how both groups understand and relate to this in practice.

Following the different steps of the process of data collection gave me the opportunity to conduct relaxed and in-depth interviews in a setting in which they (the interviewees) felt comfortable (i.e., on the vessel or in their work place), and I gained an insight into the physical and practical challenges involved in the data collection. Moreover, I could see the correlation between what the scientists and the fishers say they do and what they actually do. Many of the questions I asked during the conversations/interviews came up due to incidents during the participatory observation. For instance, situations that came up during the reading of the RF schedules at the IMR, or on the boats while the fishers were fishing, led me to ask questions, or the informants to tell me about the RF, which none of us had prepared for.

Instead of audio recording I made detailed notes throughout my fieldwork. Audio recordings are impractical on boats, but could have been used in other settings. I made notes and kept a diary because I find that many people are uneasy and hold back when being recorded, but also because I am uneasy around these tools. Most importantly though, I find that this is the best way for me to work since I get information complementary to what is said. My notes include information such as gestures, tone of voice and a lot of 'near-quotes' (Law 2004). However, I realize that this is also a limitation. For instance, it could have been interesting to re-check my interpretations of what was said. The notes I took are interpretations that I made at the moment of the interview.

What I Did and How I Did It

Most of my material was gained from participatory observation and questions or conversation in this context. Hence, I made field notes during conversations that turned into semi-structured interviews. At what point these conversations turned into interviews – and vice versa – can be difficult to differentiate, especially for the period when I was employed by IMR. Hence, one can say that I had numerous interviews and conversations with the IMR scientists. In-depth interviews are interviews where questions are asked without a given pattern and are loosely structured (Partapuoli and Nielsen 2006). At the IMR, I conducted sixteen in-depth and issue-focused interviews with scientists, and twelve in other settings and with people related to the RF directly or indirectly. These are defined as such since they were scheduled interviews, or we explicitly agreed that the given conversation was an interview. In general, the notes taken in the field are either written on paper or directly to computer, depending on the context. Mostly, I transferred the handwritten notes to my computer later, at home. Here, I added reflections, what I aimed to get out of them, what to remember and what to follow up. Some of my notes are still in a handwritten form, and I use the same technique of writing in the margins if I have any comments or observations. Even if it is a lot of work transferring the notes to computer, I find that it was worth it. During fieldwork for my master's degrees, I learnt that such handwritten notes can be hard to understand when one returns from the field, especially if there is a mixture of languages.

I have conducted several in-depth and issue focused interviews with the fishers as well. My visit onboard the Coastal RF vessel *Oddson* can best be described as a three-day continuous interview that changed form depending on the context (fishing, eating, taking care of the gear, travelling between sites) with both the skipper Odd and his co-worker, Knut. When I visited the Coastal RF vessel *Haldorson*, it was in port. Hence, the interview took place at the harbour, outside the boat house. The skipper's brothers are also fishers, and they were present for the first hour of the interview. I visited one of the Offshore RF vessels, MS *Geir*, for ten days as a part of a different project.

Any social situation displays various dimensions, and can be understood from different theoretical perspectives. Garbett describes a social situation as 'a temporally and spatially bounded series of events abstracted by the observer from the on-going flow of social life' (Garbett 1970: 215). Large parts of my raw material are drawn from social situations which I observed or participated in during my time at the IMR, onboard the vessels and at the ICES. This includes conversations, arguments, jokes, fishing, sampling, data entering and similar situations. I had the opportunity to take part in and observe everyday events in this site, and I was invited to several of the FDG parties, i.e., their Christmas party and a social internal workshop over two days. The same is not the case with regard to the fishers. This is an arena that is difficult to access due to practical issues such as money, time and space. At the IMR, I think it is safe to say that I immersed myself totally in their epistemic culture and became one of them, producing scientific knowledge. As mentioned, I was paid for doing some of the data punching for the IMR. I am even listed as a member of the FDG on the IMR website: www.imr.no. The major difference between my fieldwork at the IMR and with the fishers is that the participatory aspects were limited with the fishers. More participation was simply not possible due to a variety of reasons, such as my lack of skills, time and place as well as the method I chose with regard to following the actor. My main actor was the data produced by the RF, and I followed this closely throughout my fieldwork. Following the data took me more or less directly to the IMR and the FDG, since this is where the data is 'cleaned up', a procedure that takes a lot of time. Hence, I spent most of my time at the IMR.

The degree of participation affects the type of information to which I had access in the field. At the IMR, the conversation often evolved around the task of entering the data from the RF fishers. Since I was trained to do this task, we could share experiences and discuss the data. This sometimes revealed attitudes and led to spontaneous information I never would have discovered or asked about otherwise. On the boats the situation was a bit different. I never passed the stage of being a visitor or a novice. Still, I had the chance to share glimpses – snapshots – of their daily lives. Being onboard the boats was interesting and we could share the joy of a large catch or a huge fish over a meal, or when travelling between sites.

The formal fieldwork period was undertaken between October 2007 and June 2008. However, it is safe to say that this period can be extended both back and forth in time, since I have followed all the annual meetings and kept in touch with both fishers and scientists through e-mails, text messages and phone calls. When I have had any doubts or questions, the IMR scientists and RF fishers have been very approachable and helpful.

Expectations and Experiences

Even though I tried to keep an open mind during fieldwork, I must admit that I had some expectations about what I would find, and about the groups studied. Sometimes I found that these expectations coincided with what I found, but often, I had to spend considerable time working out what was 'off'. However, to understand what you do not understand is important in order to find new insight about the field studied:

> When you have understood that something is 'off', you can focus your attention on that which is 'off'. (Nielsen 1996: 154. My translation)

For instance, I did not expect to find that the FDG would be so genuinely interested in fisheries as a practice: some of the staff have worked as fishers and most of them enjoy fishing in their spare time, and they spend quite some time at sea during the research trips. Actually, I expected to find 'armchair biologists', based on what I have read and learnt about fisheries scientists, i.e., that:

> Many new fisheries scientists were trained as statisticians rather than as biologist … They knew numbers – not fish. (Rose, 2007: 450. As cited by Kolding 2009 in lecture)

Hence, I had to face some data that did not fit my expectations, and change some of my initial hypotheses (Prior 2003b). While the above quote does not fit the IMR research group I studied, this may be a fitting description of other research groups and advisory bodies.

From my social science training I am constantly trying to look for my main actor, which is the RF data, and for patterns in the wealth of information I have to handle. Also, my informants are expecting me to behave in a certain way. Since I am trained in both social and natural scientific methods and theories, I know how a good natural scientist should act. And, the natural scientists seem to have some ideas about how a good social scientist should act. For instance, I was questioned about the lack of an audio recording device at the IMR. I know that for the FDG my work seemed to be disorganized, not standardized and hence 'bad science'. Sometimes this caused me some stress. The first time I met a group from the FDG was at a conference in Arendal. I had not started the fieldwork yet, and they did not know about my background as a social scientist. During lunch, it became clear that they did not understand my type of work as science. One of the scientists was talking about a project in which he is working with an anthropologist, and one of the FDG members asked him:

How is it to work with anthropologists? Can you understand anything they say? Are they hopeless or what?

As the person continued to put anthropology as a science down, I was really dreading the moment where I had to tell them that I was one of the 'social science people'. However, it ended up being a funny story and a source for jokes: the cat was out of the bag, in a way. The FDG has been very inclusive and showed a lot of interest in my work from the first day at the IMR.

During my fieldwork I tried to behave as a PhD student does in the field: I simply wanted to be a good scientist. But what does it entail to be a good scientist? Different cultures have different answers, and even within the same culture there is no single answer to this. This is also true when it comes to science. I found that I was enacting different realities and sometimes I got confused. My casual job at the IMR gave me access to study, observe and participate in the scientists' work, but it also added more complexity to my role dilemma. This may also have been an issue for the groups studied. This is further addressed below.

The IMR: The Others or My Colleagues?

I conducted my fieldwork at several sites, some familiar, some unfamiliar. In anthropology, a central idea is that the study of a foreign culture can give important and different insights since one is taken out of what is familiar and 'everything' is new: food, smells, norms, clothes, social organization and so on (Hylland Eriksen 1993). From my first meeting with the IMR, I felt at home. I constantly reminded myself of the fact that I am studying this 'tribe' within the 'nation' of IMR known as the 'Fishery Dynamics Group' as a foreign culture, as 'the others'. Still, I feel more like their colleague than an outsider; they treat me as one of them and also speak in a language I understand when it comes to their knowledge production. My academic training is important, but also my gender and skills have been important with regard to feeling 'in place'.

The fact that I feel like one of 'the others' that I am studying has been a constant source of concern to me in many aspects; in particular since the fishers in the Coastal RF obviously look at me as one of the scientists from the IMR. However, I decided to embrace this role and dive into my fieldwork and participate more or less completely in the reality of this 'tribe' of fisheries scientists, the Fishery Dynamics Group (FDG). I am grateful to find support for this in anthropology and in guidelines about 'participatory observation'. Even if there is a possible conflict between participation and observation, this is not one single method, as it is practised in a variety of ways (2000). The correct description of my method is to say that throughout my fieldwork the degree of participation and observation varied depending on the context.

Doing fieldwork with the fishers was quite a change of context. The fishers never seemed to care about my attempt to act as a good social scientist. My impression is that the fishers categorized me as a scientist, and as a part of the IMR. I always emphasized that I am an employee of the Norwegian College of Fishery Science, studying the RF as part of my PhD thesis. Still, they expected me to be familiar with the IMR's theories and tools, and asked me questions that an IMR scientist would know. I felt as if I disappointed them every time I had to confess that I do not know how to 'read' otoliths, estimate stocks or know the specific regulations of a given stock. It is necessary to underline that I do not think that this is based on the work I did for the IMR, since this never was an issue when I met fishers. I think I was put in the same category as 'all' scientists, independent of the specific academic training.

How To Express the Anthropological Experience?

It is important to reflect on a key feature when using anthropology as a method: the body of the researcher is the main tool, hence there are some natural limitations with regard to what can be experienced. For instance, one has to be a woman to experience menstruation and a man to experience prostate cancer. Even if the fishers and scientists studied shared their experiences with me, there will always be some aspects that are missing since they are not fully aware of all the levels of experiences or they may not be able to communicate their experiences fully (Bruner 1986).

> Every anthropological fieldworker would readily acknowledge that the accepted genres of anthropological expression – our fieldnotes, diaries, lectures, and professional publications – do not capture the richness or the complexity of our lived experience in the field. There are inevitable gaps between reality, experience, and expressions, and the tension among them constitutes a key problematic in the anthropology of experience (Bruner 1986: 7).

In my fieldwork, my main lack of experience became most obvious with regard to fishers' activities. This is mainly due to my lack of skills. Of course, I have interviewed, observed, and participated to the greatest degree possible and my informants have described and explained their experiences. Still, there are some issues with regard to communicating both my own experiences and others, since these will always be subjective and some experiences become naturalized, or 'black boxed'. In addition, it is important to reflect on contexts and experiences where the researcher is 'at home' and the practices are, or become, embedded. In the following, I will reflect on how this may affect the validity and reliability of my findings.

Earlier, I did extensive fieldwork in Mexico, in a small scale fisheries context, for my master's thesis and for a book on fisheries and poverty (Salas et al. 2011). Even though I am familiar with doing fieldwork, it has been interesting to do this in my native country of Norway. While doing fieldwork in an unfamiliar context makes it easier to question and reflect on 'everything' it also makes it harder to know when something is 'off'. During fieldwork for this dissertation, I have been, or felt, 'at home' during large periods of time. While I grew up in an industrial town, both my parents grew up in the traditional fisher-peasant context, and my father was a fisherman (both offshore and coastal) for several years. The fisheries, its history and management have often been discussed at home and we know a lot of fishers. I am therefore familiar with a lot of the issues and the general context of the Norwegian fisheries, even if it is not 'home' as such. So, some of the arenas I study here have been very familiar and hence difficult to question, and some became very familiar during fieldwork.

Importantly, being aware of such 'traps' makes it possible to reflect on them. Let me give an example from fieldwork: Everybody that has used a computer and a computer program may have experienced how the position of the buttons, the icons of a program and the embedded logic becomes embodied. After a while, it is not necessary to think any more, and the fingers find the buttons automatically and make the moves even before you know it: you embody the knowledge. While I was punching the RF data for the FDG, this was happening to me. According to Knorr Cetina (1999), the experienced body can embody information and can become a silent part of the research machinery. The embodied or tacit knowledge can actually replace conscious communication and reflection. As my body became a part of the RF knowledge production, it became a black box. However, I made careful notes about every step in the process.

Gender is another issue that can influence both what experiences my informants have chosen to share with me, and how they share it. Both epistemic cultures studied are traditionally dominated by males. I am a woman, and this has probably affected the information I got from my informants. I am not really sure in what way my data would have differed, other than creating some space problems and giggling on board the vessels. It is also difficult to point to what is related to gender and what is related to how I have connected at a personal level with my informants. I can only state that everybody I have been in touch with has been very friendly and helpful.

For any social situation, there is frequently more than one cultural perspective. Both qualitative and quantitative data can be minded for a given result. Personal perception, gender, education and position in a community will always affect the process of collecting and analysing data. The postmodernists point at methodological and epistemological problems related to the scientists' position, choice of analytical objects and analytical language (Bjelland 1994), and Geertz argues for a move towards a greater self consciousness about modes of representation. It is always important to ask how, by whom and for whom the social and cultural reality has been established (Geertz 1973: 19). To be able to write this thesis, I had to generate some analytical and empirical limitations that I believe valid. To some degree, the reality presented in this paper will be a reflection of my own constructions, and my interests do not necessarily coincide with the interests of the cultures studied. Hence, it is a unit of analysis defined by the observer: me. An example of a social situation where I define the unit of analysis is the annual meetings. This is an event that takes place for two days at the IMR, with formal and informal interaction at the meeting venue, at the hotel and during breaks and meals. To me, it was important to follow the informal and formal events, as well as the preparation before the fishers come to the IMR. For those studied, the situation may take place only during the formal presentations (Garbett 1970). As underlined by Geertz, anthropology is hermeneutic (Geertz 1973). Hence, I have aimed to give a broad account of my methods and the choices made. This is done in order to provide readers with a sufficient foundation to understand my interpretations and hence also assess the reliability and validity of this dissertation. I understand method as a means to help produce realities. Realities are made and remade through enactments, and these enactments are also based on already existing enactments (Law 2004). My point here is that this dissertation is not an objective representation of reality. I will here use quotations, theories and models that correspond with my understanding of the RF. I will use thick description and quotes from my fieldwork to give authority and validity to my claims.

Sometimes during fieldwork I have been tired, frustrated and sea sick. In general, however, doing fieldwork has been easy – at least compared with writing up the case study and figuring out what it all means, which has been quite a challenge. Over the last two years I have spent much time in my office deciding what to include and exclude and how to make sense of it all, and sometimes I have popped back to the field to check and follow up issues. I have met scientists and fishers who have been open and friendly, making access to the field and information effortless. They have also been very interested in the result, although the scientists may have been a bit nervous about it. For instance, members of the FDG group have asked me if this dissertation would generate some controversies in the media, and they have sometimes asked me about how I will present them. Notably, they have invited and encouraged me to participate and present my material at the annual meetings but also at several international conferences with them, without having any idea of the result of my study of them. The FDG truly is a brave tribe of scientists.

In order to investigate my research question, I will next present the empirical material from this fieldwork. In chapters 4, 5 and 6 I will pay close attention to all the practices that take place within the RF, focusing on the knowledge production and authorization processes.

Chapter 4

Studying the Reference Fleet's Practices as I Follow the Fish

The Fisheries Dynamic Group at the IMR

When I first arrived to the IMR I had no prior knowledge about what goes on within these walls. I knew that this is the place where they – scientists like marine biologists and oceanographers – gather all the information that has to do with fisheries management. The IMR consists of several buildings and several groups, such as the bottom-fish group, the pelagic group and, of course, the group of particular importance to me: the Fisheries Dynamic Group (FDG), since this is the group that is responsible for the Reference Fleet (RF) project. At the IMR, I wanted to study the scientists' practices in general, but my main aim was to find the traces of the RF's knowledge production.

Science as a Livelihood

The FDG consists of different categories of people. Some have doctorates, some have master's degrees, some are marine biologists, and others are trained in statistics or have a totally different background. Even so, they seem to work on very similar or the same tasks when it comes to the RF data.

In total, there are twenty-five people at the IMR working with the RF[22]. Huse and Borge are the two persons at the FDG who are responsible for the RF in general. Although Huse is in charge of the Coastal RF and Borge the Offshore RF, they update each other all the time and work closely together. The FDG scientists visit each other's offices, especially those who work closely with the RF. They update each other on the fishers' activities, and they keep in touch with the RF fishers through e-mail, phone calls and visits. In addition, they discuss obstacles they encounter with the punching of the RF data. I soon learnt that while the Coastal RF fishers send in a lot of handwritten paper forms by post, the Offshore RF fishers fill in spreadsheets which they send by satellite to a computer located in the corner of the FDG coffee room, which has the necessary program. On a regular basis, Huse checks her mail and email to see if the Coastal RF fishers have sent her some information, while Borge checks the mail and the computer in the corner of the coffee room. Each vessel has a contact person at the FDG, referred to as their mentor. The mentor is responsible for keeping in touch and takes care of the data collected from the vessel. From the coffee table, I registered that the

[22] According to the budget presented at the Offshore RF annual meeting in 2009.

mentors sometimes get the data directly from the fishers, and sometimes they pick it up from Huse's or Borge's office.

Although a large part of their work today takes place within their offices at the IMR, the scientists talk a lot about the annual surveys. During the surveys, they leave their offices and go out to sea. People from all the IMR research groups join these scientific surveys, including the FDG scientists. These surveys are popular among the IMR employees. The surveys are well paid and the IMR scientists seem to enjoy these trips both on a personal and a professional level. What is characteristic with the Norwegian research vessels is that the crew has experience from the fisheries, while other countries like Germany and the USA tend to use the navy (Schwach 2000). Hence, Norwegian fisheries management is made at sea (Schwach 2000). According to Schwach, both the surveys and the social and professional community that is generated here are important to the IMR scientists. Also, the surveys are central for spawning ideas and solving problems (Schwach 2000). This is an important part of their culture and also seems to define this specific group of scientists. Importantly, the FDG members always seem to surround themselves with papers filled with numbers and figures, and they always – always – have a laptop wherever they go.

What a Discovery: Fish Are Otoliths!

At the IMR, I did not see fish but I did see tons of paper; articles, regulations, and something that caught my eye in particular – the forms that the Coastal RF send in to the FDG. From a glimpse at these forms, I could see that the fishers write down the different species they catch, what gear they use and where they fish. I was trying to figure out how to find any order in all the data and interaction that is taking place at the IMR, and I asked Huse countless questions about what I could see in her office and what I could not understand from their conversations.

In Huse's office, her desk and shelves are filled with these Coastal RF forms, neatly filed for each vessel. Patiently, Huse explains that these forms are important for the traceability of the *otolith*. Fisheries scientists want to know how old the fish is when it is caught, but how can scientists and fishers, or how can anybody, know how old a fish is when it is caught? How is it possible to know how old fish are, when it is impossible to ask the fish itself how old it is? On the IMR homepage, this is clearly explained. The answer is that there are some bony structures inside a fish's head that can tell us how old it is. These bony structures are otoliths, and they have age rings, like trees, that can tell us the age of each fish. Nature is truly an amazing thing! Scientists wonder how old a fish is, and the fish, even if it cannot speak, can provide the scientists with this information through these otoliths which can be picked out of each fish's head. According to Huse, otolith sampling is one of the most important tasks for the RF fishers.

Where are the otoliths collected by the RF fishers, these amazing little bony structures that can tell us how old the fish caught is? I ask Huse, and she points to the right corner of her desk, where she has some boxes piled up. Each box has a name on it, which corresponds to a RF vessel. The box is filled with little brown envelopes with a number on, and inside each envelope, there they are! Small, grey-white little bony bits that are collected by the RF fishers and sent to the IMR: I am left dazzled. And these are not all of them, since some of the vessels send the otoliths directly to their mentor at the FDG. The otoliths collected by the sea-going vessels are also sent here in glass boxes. There are so many of them, and I still do not understand how this can tell fish age: even if, as I explained above, they have rings, I cannot see any rings or marks on them. Huse explains that there are only a few IMR scientists that can read them. They break the otoliths in two and read the rings with a microscope.

I look at all the otoliths and I make an important decision: I will hold on to these bony structures that are so precious to scientists. I will not lose them from my sight and I will go wherever they take me. Hence, I set out to follow these as far as they take me. This turns out to be quite a journey, since there are several arenas for knowledge production that are involved in the process.

Even after several months at the FDG, I was confused with regard to who works with what because some scientists working with other subgroups at the IMR also popped by from time to time to talk about data, species or papers they are presenting. Also, some of these have 'hours' attached to the RF project. From my position at the coffee table I could see that the scientists were doing a lot of different work. The work related to the RF is mostly organized around the otoliths and the forms which the fishers send in. In a steady stream, the FDG receives completed forms and otoliths from the RF. When I visited the scientists in their offices, they always seemed to be entering data, or checking data, on their laptops. The tasks related to the RF are only part of what the FDG does. The FDG scientists also write scientific articles which they aim to publish in peer-review journals. E-mails are written to institutions and people; either to answer questions and requests, or to ask somebody – such as a fisher or other scientists – about something. Abstracts are written and discussed between offices at the FDG's own premises, and sometimes they cooperate with scientists that are part of another research group at the IMR, different institutions and a variety of countries. The abstracts are typically sent by mail to the organizers of conferences where they present their findings. The subject of the FDG papers is always fish. They write about fish in one way or another and different people are specialists in different species or aspects of fish.

There are a lot of strange and unfamiliar things going on, and some of these I will come back to later, like the annual meetings, but for now, I will stick to my decision to hold on to the otolith. So, how does the RF collect the otoliths? Is this a task they do while they are fishing, and are they doing it at sea or onboard the vessels? These are just some of the questions I want to find an answer to. It is time to follow the otolith out at sea, or more precisely; I am tracing the otolith back to the fish head.

Picture 2: The office of a FDG scientist filled with files with forms (in the black files) and otoliths (white boxes) from the Coastal RF

Following the Otolith at Sea

In this section, I describe my experiences on two Coastal RF vessels, *Oddson* and *Haldorson*; and the Offshore RF vessel MS *Geir*. I was really excited about going to sea, since this is where fishers' knowledge is produced and their epistemic culture enacted: a complex, contextualized body of knowledge that has been excluded in modern resource management – until now? Again, the otoliths are given special attention. If I can see how the fishers extract them from the fish heads we have reached the beginning of the fish's journey as data since this is where it all starts: out at sea.

The Coastal RF

In the north of Norway, where the Coastal RF vessels I visited during fieldwork are located, the coastal seascape is a mix of open waters off a rocky coast, with small bays, fjords and islands. These features make access difficult for the IMRs research vessels. Hence, the Coastal RF provides them with important information when they sample fish which involves collecting otoliths, and measuring the weight and length of different species from the coastal areas.

The annual cycle of the coastal fishers, as any fishers, is driven by different fish species and their patterns. While some of the species migrate for spawning or feeding, other species are located in the same waters all year round. Haddock, saithe and herring are important species that migrate to the north and are targeted by the fishers there (Maurstad 2004: 279). However, the Northeast Arctic (NEA) cod is the cornerstone of this group in terms of livelihood. In addition to the NEA cod, small local fish stocks known as coastal cod live in different fjords. Each of the vessels included in the Coastal RF and its geographical distribution is presented below (and see Figures 5, 6 and 7, 'Maps of the locations visited').

Oddson

The IMR scientists enjoy visiting the RF vessels, and they often talk about these trips around the coffee table. Many of the scientists want to visit 'their' fishers more often, but their workload at the IMR does not allow it. During my fieldwork before Christmas 2007, all visits to the vessels were postponed, since they were waiting for new contracts. Still, one vessel, *Oddson*, is given special importance. This is mainly due to its location (see Figure 8). According to Huse,

> It is crucial to make sure Oddson collects otoliths … we need to visit him and make sure that he will deliver [data] when the cod starts.

Huse explains that the main concern is to make sure *Oddson* delivers otoliths when the cod fishery starts again after Christmas. During the early spring, *Oddson* fishes mainly for cod, while the winter months are dedicated to the catch red king crab and halibut. Huse wants to make sure that he is ready for the cod. She decides to visit *Oddson*, and she agrees to let me come along. I land in Vadsø a cold November evening with crunchy snow and crisp air. *Oddson* is berthed in the harbour, and it is the only boat there. Huse has already arrived, and is inside with the two fishers. 'Per' is the skipper and 'Ola' is his cousin and crew member. We chat for a while, and Per explains that the most important fisheries are the cod, the halibut and the red king crab. Hence, their activities are organized around the life cycle of these. We all go to bed early since we will leave the harbour about four o'clock in the morning.

In the following, I describe some of the practices onboard and interactions that took place between Huse and the crew on *Oddson*. The haddock and red king crab fisheries provide the frame for this experience where I combine participating and observing.

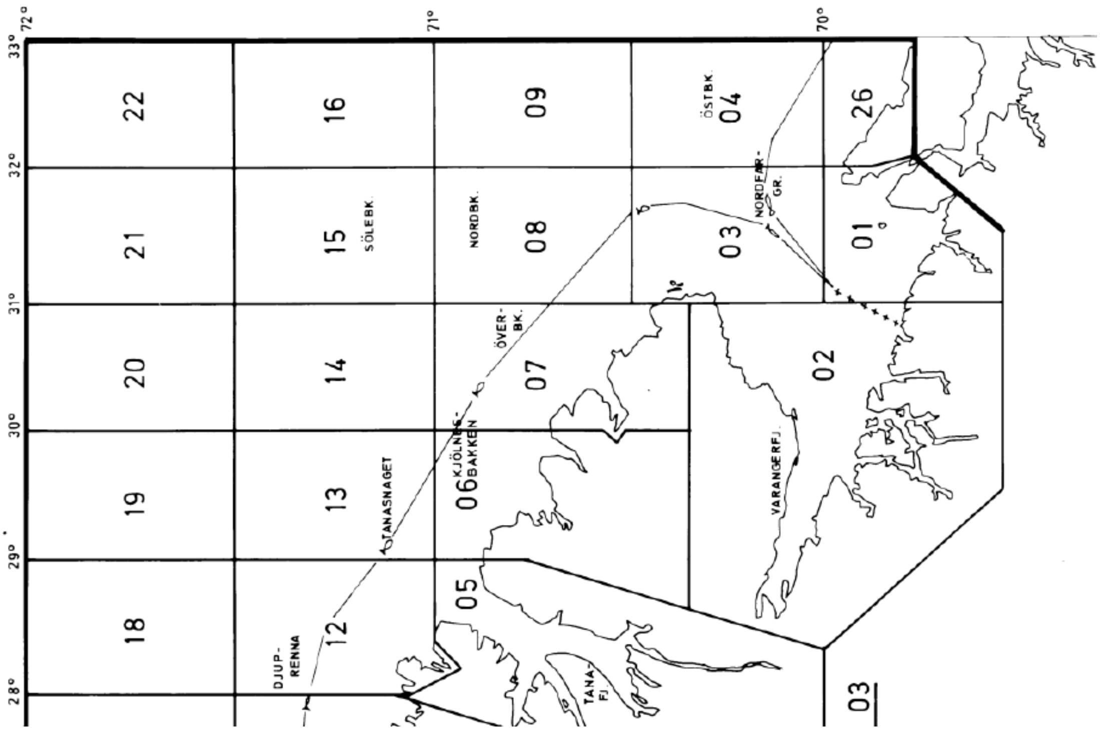


Figure 8: Part of Finnmark where *Oddson* is fishing. Coastal map: Finnmark, from the IMR Manual (IMR 2006)

Hunting halibut – and counting them

Huse and I wake up around six o'clock in the morning as the engine changes its sound when it is cut back by 'Per'. We have reached the gillnets they placed here a couple of days ago. We get up to discover that it is a beautiful sunny day.

There is a lot of equipment both on deck and inside. In the steering house there are several screens, different radios and a large number of buttons. Per points out the GPS, the echo sounder, the radar and a computer. This fits well with Maurstad's observation that 'most full time fishermen now operate fully equipped vessels with modern technology' (Maurstad 2004: 280). Per and Ola have already picked up the buoy marking the position of the halibut nets, and a machine starts hauling the nets onboard. I am as dazzled by everything going on here – what to do when and where – as I was during my first weeks at the IMR. Huse, on the other hand, seems to be at home: she seems to be used to the equipment and the organization onboard a fishing vessel.

We are all excited to see what comes up from the deep black sea when they start pulling in the nets. This day, the gillnets are filled with red king crabs. They come on board and the hauling machine takes them through a loop, and their long spiky legs are squashed, but without breaking. It is as if the red king crabs' legs are made of some sort of rubbery material, since their shape returns to normal afterwards. Per is watching the catch that comes up, making sure it goes through the net hauler. Ola starts to disentangle the crab from the net, one after another: there are heaps of them, big and small, male and female. Then, the gillnet continues its journey to a clearing device which piles it up neatly so it is ready for the sea again. However, due to the crabs, the net is piling up behind Ola. Huse is helping, and I jump in too, despite my clumsiness. Ola gets more impatient as there is no halibut and a lot of not-at-all-cooperative crabs that have to be removed. As part of the RF job, the fishers should count the by-catch, and they gather the crabs in a pile in the middle of the boat. Ola explained:

> Normally, we just throw the crab directly overboard since there is no space for it. But since Huse is here to demonstrate to us how to fill out the forms, we must find a place for it on board and count it later.

According to the regulations, the red king crab has to be caught by traps. Hence, all the crabs caught in gillnets must be thrown overboard, preferably alive. Since it is almost impossible to negotiate them out from the nets alive, it seems less cruel to just kill them quickly. We take up net after net. After each net, the fishers must clear it and prepare it in order to get the same nets back in the sea again. There is no time to count the crabs in between their work with the gillnets. The pile of crabs is growing, and I can see Ola's point about the lack of space in order to count the by-catch for the RF.

I am getting really cold from working with the wet nets and crabs, and I am glad when we have to move the boat to get to the location where the next sets of nets are. I can take a break and get warm in the steering house whenever I feel like it. For the fishers, there are no breaks if the rhythm of the work does not allow it. First they must do what is needed before they can make food or have a cup of coffee. When the chores are done at the first location, Per goes into the steering house while Ola makes coffee downstairs. We can see 'Grense Jakobs elv', the border river between Russia and Norway. The radio is on, and it is mostly Russian voices that break the silence. They show me the electronic maps, where we are and where we are going. Per and Ola are what a Norwegian would refer to as ‘typical northerners’. They are friendly, helpful and if I ask a question, they answer in short sentences; there is very little small talk.

At the next location, the same process takes place, and at the third, which is the last location for gillnets, the same. The pile of crabs gets bigger and we have not seen one halibut. According to Per, this has been a bad season:

> It has been this way every time we go out. Only crab. The nets are full of crab and no halibut.

Suddenly, Per gets excited. There is a huge halibut in the gillnet, too big for their standard equipment. Per and Ola work hard to get it on board, Per giving brief orders to Ola in a mix of Norwegian and Sami[23]. The halibut is 220 cm long and weighs over 200 kg. Per tells some of the other fishers on the radio about the catch. Now, Huse is eager to show them how to take out the otolith. We start to talk about the age of the fish.

> Huse: Do you have the equipment from the IMR?
> Per: Yes, I have it. You [meaning IMR] gave it to me.

The Coastal RF vessels are all given a set of equipment, and according to the 2009 instructions, every Coastal RF vessel should have: writing equipment, writing base, forms (Station, Sampling and Length forms), plastic length measuring device, envelopes for otoliths, tweezers, bags for stomach samples, knife, measuring board and a counting device. In addition, some of the vessels may have a weighting scale and a dictaphone (IMR 2009b).

They hang the halibut on a cord in the ‘corner’ of the boat. Later, both Per and Huse look for the otoliths in the giant haddock head lying on a table on deck. Neither of them can find it: the head is big and the otoliths are small.

[23] The Sami are the indigenous people who inhabit parts of far northern Sweden, Norway, Finland and the Kola peninsula of Russia, as well as the border area between south and middle Sweden and Norway.

Picture 3: Fishing with *Oddson.* The by-catch of red king crabs in front. The IMR scientist Huse with a measuring device.

The day is far from over, and the crab cages are waiting before they can take care of the halibut. The red king crab is the target species, and any other fish in the mix become by-catch. In order to catch crabs, they use traps. Still, the fishers seem to have the same organization regardless of the target species, where Per is in charge of finding the fishing places, finding the buoy that marks the location of their gear and getting it out of the sea. Ola then takes the catch out of the nets or traps, makes sure the equipment is ok and stores it safely until it goes back in the sea again where Per decides that Ola should let it go. At the same time, the organization is not fixed, as the two fishers interact and interchange tasks. The one thing that seems to be done exclusively by Per is the steering of the boat and deciding where to set the gear.

Training the fishers in data collection

The main reason for Huse's trip is to show Per and Ola how to collect the otoliths and fill in the forms, so *Oddson* is prepared for the cod season. The first night on board Huse prepared herself with a measuring board in plastic and a knife. She wants to demonstrate how the fish can become data in the most effective way so that it does not take to much time out of the fishers' day. Eagerly, Huse tells me how she is going to show them how the counting and measuring can be done quickly, using a plastic measuring board and a knife.

Huse**:** If I could only show him how effectively this could be done so he can be prepared for the cod … I need to find out what motivates him.

The problem, however, is that there are no fish in the gillnets, so she does not get a chance to do the planned demonstration. Huse's frustration also grows as the only catch that comes up is crab. There is not even one fish with otoliths that can be taken out and sent as a sample to the IMR. Between the locations, she talks with Per and Ola. Huse makes suggestions with regard to how they can organize in order to integrate the collection of data for the RF within their fishing activities.

We return to the IMR with one form, where the one halibut and several hundred crabs are registered. I must admit that I am a bit disappointed: I did not see a single otolith, and neither Huse nor Per could find this little magical 'chip' inside the giant halibut's head that can tell us how old the fish is. So, due to the lack of fish I did not get the chance to observe how *Oddson* collects otoliths. Maybe I would have more luck with the next Coastal RF vessel? This is where we jump next, to my field trip to Lovund to visit the Coastal RF vessel *Haldorson*.

Haldorson

Haldorson is the only Coastal RF vessel located in Helgeland. ''Stig' is the skipper, and we have made several appointments for me to come and visit him, however, the weather conditions have made it difficult. He lives in Lovund, one of the many islands scattered around this part of the Norwegian coast (see map below).

Stig fishes together with a friend, and they joined the Coastal RF in 2005. He did not apply for it, but was asked by the IMR to join the project. According to Stig, they receive a great deal of information and reports from the IMR:

It is very interesting to be a part of this and see complicated research. You have to be a scientist to understand it, you know.

Picture 4: The RF vessel *Haldorson*.

Stig talks with the FDG two to three times a year. He would like them to come more often, and to have more direct contact with the scientists working at the IMR in general. According to Stig, sampling the otoliths and filling out the forms is quite straightforward, and does not demand a lot of re-organization. He has a large dock with a huge boat house where he can take out the otoliths and weigh and measure a sample of the catch without too much fuss. Here, he can write down the information that the IMR asks for in the paper forms, such as the area where he fishes and what gear he uses. He explains that he finds it interesting to learn more about what scientists do, and he takes this as an opportunity for Helgeland, the geographical region in which he fishes, to get more attention on fisheries issues. Stig is concerned with how factors other than fishing affect the fish stocks, and he mentions pollution and temperature. Stig is particularly interested in the coastal cod, which is considered a threatened species. The day that I am visiting *Haldorson* it would have been perfect to go out fishing, since the weather is really nice. However, none of the vessels are fishing since the processing plants are closed. Stig's gill nets are lying in the sun on his dock, neat and tidy, next to the boat. Hence, I do not get the chance to go out fishing with him, but he shows me his vessel and demonstrates what he does. So, I still have not had the chance to see how the fishers find the otolith; to observe the moment when the fish comes out of the sea, and how the fishers take the otolith out of its head.

Even though I did not observe this myself, Huse has told me that *Haldorson* delivers otolith samples and forms continuously. Back at the IMR, I find Stig's schedules and envelopes filled with otoliths from the coastal cod and NEA cod from the coast of Helgeland.

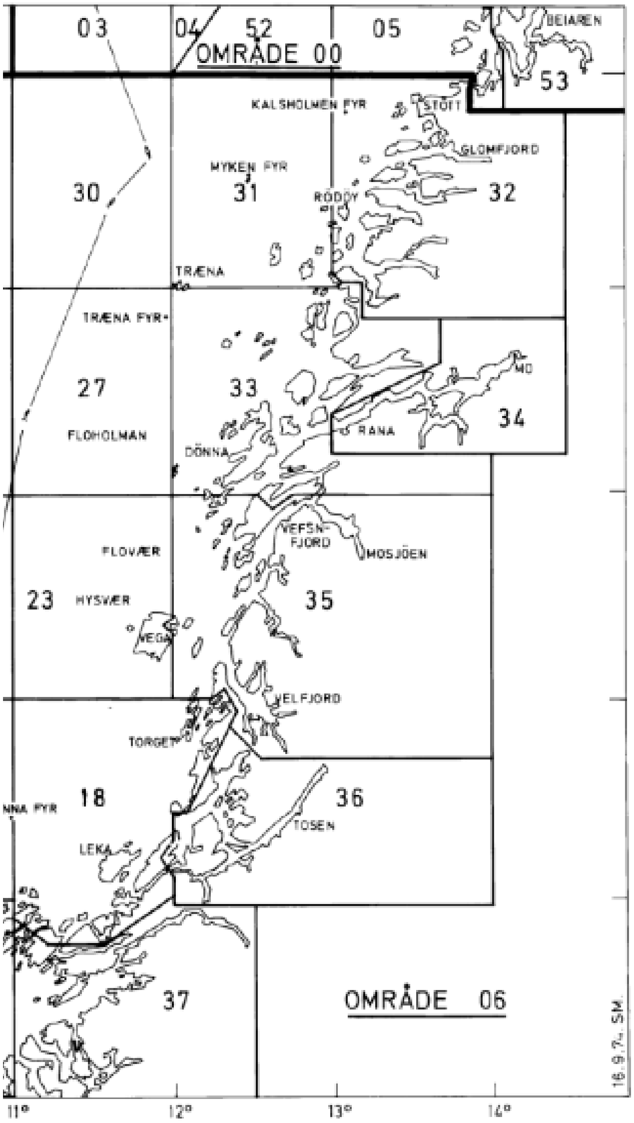


Figure 9: Map of Helgeland. *Haldorson* is located in Lovund, close to Træna (area 33), System 2 Statistical region, Coastal map 6: Nordland (IMR 2006)

I am getting impatient: I want to see the otolith and observe as a RF fisher collects it from its head, but despite visiting two Coastal RF vessels I have had no luck so far. It is as if nature itself is making sure that I cannot watch this: the lack of catch when I visited *Oddson*, and the weather conditions that prevented me from going to Lovund several times, and; when I finally got there the landing sites were closed. Uncertainty about the catch is intrinsic in fisheries, and this is also a challenge that the FDG scientists have to face when working with the fishers. However, I am not giving up, because I am sure that the fishers do collect the otoliths from the fish heads. I have seen the proof myself at the IMR, where the bony structures are gathered. The lacking piece in the puzzle is the actual fish: I want to see the fish, which swims around with its birth certificate in its head, and I want to observe the fisher picking it out.

Now, I will see if my luck changes as I leave the coastal areas and follow the fish to the high seas. So, let us take a look at what goes on within the Offshore RF, before the otoliths again take me to the IMR.

Visiting the Offshore RF

In order to follow the practices of the Offshore RF, I must be prepared to be at sea for quite a while, since their trips typically last four to five weeks before they change crew. However, I got the chance to take a ten-day trip on the Offshore RF vessel *Geir*, when it participated in a project with the Norwegian College of Fisheries Science, as described in chapter 3.

The MS Geir

A coastguard vessel, *Chieftan*, transports us from Tromsø to MS *Geir*'s location. It is a long journey which takes about 20 hours. It is like a miracle that we find the MS *Geir* since the sea is immense, it is pitch dark outside and the sun will not appear again for a couple of months. Thanks to the GPS we do find them. Over the next ten days I learn a lot about what goes on onboard a seagoing vessel, as well as how they relate to the RF. The most important data from the Offshore RF is age and length data from cod and haddock.

MS *Geir* is registered in Ålesund, which is in the west of Norway (See Figure 10 below). In order to reach the fishing locations, the fishers travel all the way up the coast and then go towards Bjørnøya. MS *Geir* fishes in the North Sea, somewhere between Bjørnøya and Tromsø (see map below). This is far away from everything, and if something happens, they basically rely on themselves. They have their own medical equipment with them and the boat has a hospital cabin. This is the cabin I use during the trip. MS *Geir* only uses lines to fish, and targets different species, such as cod, Greenland halibut, haddock, wolfish, redfish and tusk, but the skipper consider the Greenland halibut and the cod as the most important ones.

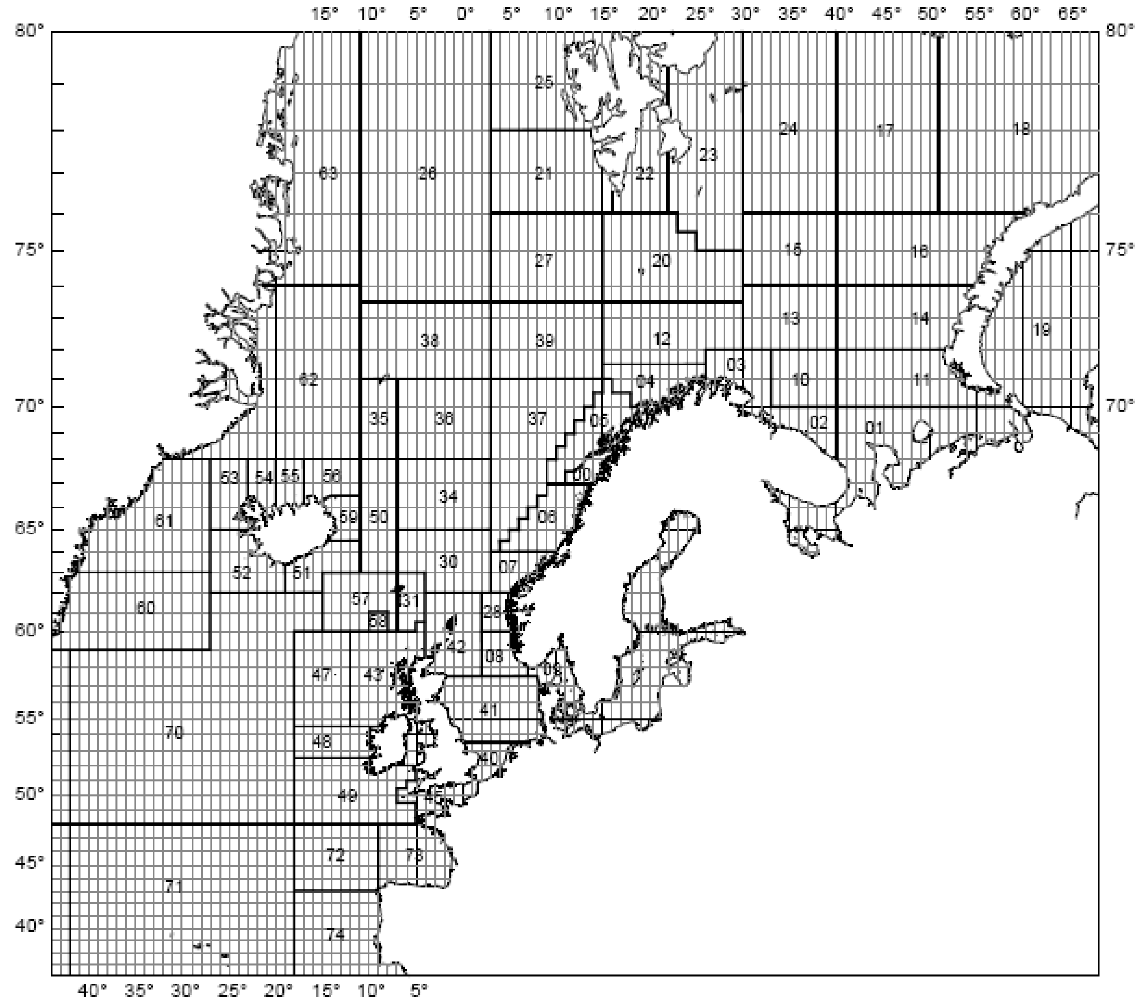


Figure 10: Map of Norway and Svalbard (IMR 2006). During my fieldwork, we were fishing in areas 12 and 20. System 2, statistical area. Ålesund, which is the hometown of the owners, is located in area 28.

The organization of the daily work onboard *Geir*

As mentioned above, I am doing fieldwork onboard MS *Geir* in combination with sampling for another project. Therefore, I spend a lot of time on the bridge together with the skipper. Here, there are several cameras where we can watch what happens in different places on board MS *Geir*. My plan is to observe the fishers onboard and the knowledge production for the RF in between the shifts. Now, I will introduce the general context at MS *Geir*, before looking into the knowledge production for the RF, where I hope to see the otolith collection. MS *Geir* looks impressive in the sea, like a floating 38 m-long factory. In total, they are thirteen men on MS *Geir* during this trip. The different tasks are divided between the fishers in each shift and there is a rotation so everybody gets to do everything. MS *Geir* can be divided into three work stations or posts for the fishers where they work in turn: the split, the trunk and the factory. These are all located on the main deck. Below, I will describe the organization of the boat and fishers as I follow the fish's journey in the boat from when it comes out of the sea until it is frozen.

The split: This is the area where the lines are stored when they are not used for fishing. Before letting the long lines into the water, each angle must be checked in the split. The fishers examine each hook, checking that that the metal is not bent and that the knot is intact. Usually, there are two fishers on this task. It is a noisy place and the work is repetitative. From here, the lines are sent on to the automatic angler machine, where squid, mackerel, or saithe is used as bait

Picture 5: The split

The trunk: A special feature of MS *Geir* is that it has a 'moon-pool'. This is a huge hole in the middle of the boat with a lot of equipment around it, and a line coming up from the sea. Hence, the fishers are working indoors most of the time, safe from weather and waves. Here, one fisher is 'receiving' the long line. The fish comes in as a steady stream, one by one, up from the sea, or more precisely, from the moon-pool. Each fish is de-angled by a special machine before it ends up in the metal arrangement. Quite often the fish falls off as it reaches the equipment and the fisher must try to get it with the 'long hook'. With the moon-pool, this is easy since the fish is trapped here. All the fish with swim-bladders are floating in the moon pool, while those without, such as the halibut and the blue wolfish, put up a fight and try to escape. If the fishery is good this is a busy post, and if not, the fishers complain that it is boring.

Picture 6: The Trunk

In the trunk I feel somehow close to nature, close to the ecosystem. It is a messy, bloody and noisy spot. The by-catch – such as undersized fish, skate and crabs – is mostly thrown out, but some of the skate is thrown in a tray by the fishers' feet. They collect them for another project at the IMR. The catch – mainly cod, haddock and some blue ling – are cut to bleed out. The fisher throws the bleeding fish in two different trays, sorted by species, which lead to two large trays. When the trays are full, a fisher pushes a button in the roof, and the trays are lifted automatically and turned around and the fish end up on the other 'side' of the boat, the *factory*.

Picture 7: The moon-pool. Fisher is standing in the trunk, looking down into the moon-pool

The factory: In the *factory* the fish are left in another, larger, tray with cold water, which fills up with fish from the moon-pool side every now and then. The fish are left to bleed out for a while, and then they move on to a conveyor belt where the fishers are waiting. The fish then go one by one through a fixed system which typically involves five fishers and a heading and gutting machine, splitting machine, filleting machine and skinning machine. After being processed, the fish is frozen. One or two of the fishers place the cod neatly in trays before it is frozen, while the haddock is sent on to a different line of production. The skin is removed and the fillets are cut very neatly by hand by one fisher, then packed and frozen in boxes by another fisher. The *factory* is somehow different from the other two stations. It is clean, even if there is a lot of mess from the gutting, since the heads and the guts are kept apart from the fish. The guts are sent directly to the sea, where the seagulls are waiting for a meal. I can see the seagulls from the bridge, and they circle around the hole where all the by-product is pored into the sea at all times.

The factory is dominated by aluminium tables, trays, transport lines, machines and water. In a way it is cold and sterile, and seems a world a part from the messy and bloody scene on the other side of the boat where fish come up and their moths are ripped off by the de-hooker while they are gasping for oxygen and sometimes their stomachs are pushing their way out through their mouths.

Picture 8: The factory. Fisher is filleting saithe.

On the Bridge

During the shifts for the NCFS project, I have to stay on the bridge. There are several cameras in different places on board MS *Geir*, such as in the trunk, the split and the factory, and the screens are on the bridge. Here, I can chat with the skipper and follow some of the fishers on the screens. 'Harald' and 'Knut', skipper and mate, keep a close eye on what goes on with the position of the lines in the moon pool, if the fish is falling off the hooks, and give some orders over the calling system. What Maurstad (2004) refers to as the vertical knowledge dimension of fishers – how to find fish – is here related to where the captain decides to set the lines, and what bait to use. Both Harald and Knut talk a lot on the phone with the other vessels in the area. They try to get some information about the fishing conditions, and in return they give some information about their own fishing luck. However, they keep this information close:

> Harald**:** This information is like the code to my bank account. I can't just give it to anybody.

The fishers have no say in where the lines are set. The decision is taken by the captain, and during this trip Harald proved to be a very skilled fish catcher. He had already finished the boat's regular quota, and all the fish was the research quota from the NCFS. Harald was trained by his father, together with his brother. Together, they now run the company. Knut, the mate, is the elder son of his brother, and Harald is now mentoring him. In addition, both have been trained in the formal system that certifies skippers in Norway.

The fishers' work shifts and so do the skippers. This is an operation that runs 24 hours in a never ending circle. When the lines are baited and Harald has found a place where he wants to set it, the line is deployed from the boat. When all the hooks are in the sea, they go back to where they started and begin hauling the line. Hauling the gear back in takes about 20 hours, and then the same process starts over again.

Picture 9: The bridge

Finally: Otoliths in Fish Heads

So, how is MS *Geir* organized in order to collect data for the RF? Two of the fishers in the crew are responsible for collecting the data, Jacob and Joseph. In order to follow the data, I ask if I can follow them when they do the work for the RF. Since we all have other jobs to do as well on the ship, it is not that easy to coordinate, but Jacob willingly agrees to take the otolith samples during my free shift[24].

On board this huge vessel, it seems to me that only a few adjustments are necessary in order to make it a laboratory, where fish comes as a continuous stream of material for both the RF sampling and the freezers.

> Jacob**:** Last year we sent in 1200 otolith samples [this involves weighing and measuring each fish in order to get the catch at length and age data]. What's important to us is the otholits because they count 10 times the fish-tests. That's what gives us the quotas. We [MS *Geir*] have an ongoing competition with *Atlantic* [another boat in the Offshore RF] where the goal is to collect the most [otoliths]. We [MS *Geir*] won last year [he laughs].

In the *factory*, Jacob and Joseph cooperate to collect the otoliths. Joseph picks up a cod from a

[24] 5 December 2008.

tray filled with both cod and haddock, and makes a deep cut in its head. Now, Jacob uses his tweezers to pick out two little white bony things from the head. Finally I get to observe a fisher take out the otolith from a fish head! This is a big moment for me. I picture this setting like a painting where the frames are made of guts, blood, slimy fish parts, aluminium trays and the strong smell of fish as well as numerous fishers doing different tasks along a conveyor belt. Inside the frames, I see two fishers: one looking like a scientist in a laboratory with clean clothes and he holds a pair of tweezers which he uses to pick out the two otoliths from each head; the other looking like a fisher, holding the fish head so that the cut is open and the otoliths are visible. I have travelled far, from the IMR and along the rocky coastal landscape, and then out to the high seas to find the actual *fish* that carries the otolith inside its head. To Jacob and Joseph, however, this is just another day of doing routine work. MS *Geir* is a vessel that works well and delivers the raw data continuously. The data collection is very organized and effective. According to both Jacob and Harald, this is because it is the same people collecting the data and they are familiar with the procedures and follow the routines.

In addition to the otolith data, the Offshore RF fishers register a lot of information in the spreadsheets and the forms that the IMR gives them. According to Jacob, he sends in one file for each trip to the FDG. Here, he registers information such as where they have been fishing, the standing time and what type of gear they have used. Other Offshore RF vessels send in several files from each trip. These spreadsheets are sent to the ‘corner computer’ at the IMR.

Picture 10: Doing the otolith sampling onboard *Geir*

Back at the IMR: Flooded with Information

Back at the FDG offices, the schedules keep coming in from the Coastal RF and Offshore RF vessels. At the IMR, the scientists are flooded with information from all their different knowledge platforms. The RF is only one of several sources, and the FDG has a lot of work to do with organizing the information that comes in, and placing it in the IMRs data bank. In addition to the otoliths and the forms, the RF fishers also send detailed descriptions from the fisheries by mail, and share their experienced based knowledge through e-mails, phone calls and visits, in addition to the forms and the spreadsheets. If the fish is fat, what it has been feeding on, if it is hard to find, bundled together or spread out, are examples of such information that the fishers add.

A lot of the information from the fishers seems to be excluded in the process of producing data at the IMR. Actually, a large part of the work that is done at the IMR is organized around cleaning up the knowledge produced by the RF fishers from raw data to data, which entails the exclusion of a lot of information. From my position at the coffee table, I note that three major seasons seem to dominate the FDG annual cycle: the annual meeting with the Offshore RF vessels which is held in September and with Coastal RF in December; as well as the ICES working group meetings in spring. These events are all related to the data production and stock assessment.

Even if I am impatiently waiting to follow the otoliths to their next destination, the otoliths themselves have no hurry. As the Regulatory Chain illustrates, the IMR collects data continuously and then bring these data to the ICES in order to do the stock assessment and give TAC advice. A lot of work has to be done with the otoliths and the forms and spreadsheets that come together with them from the RF vessels. Hence, as the otoliths are waiting with discipline to be read by the otolith readers, and the forms to be transferred to computer by numerous scientists, I have to settle down at the FDG coffee table, studying this group of scientists as they go on with their daily routines. Maybe I can get some more information about these forms that seem to flood the FDG?

Three Windows for Studying the RF Practices

Getting access to people and to study what the scientists are doing is getting more difficult after a couple of months of fieldwork. As Christmas is approaching, there is a lot of activity at the IMR, and the FDG scientists spend most of their time in their office, working and communicating through e-mail and phone calls, and there are numerous meetings. Three ‘windows’ generate opportunities for me to study, or more precisely experience, what FDG does with the data from the RF fishers. The first chance I have to get a really close glimpse of what the forms that follow the otoliths are and what the scientists do with the forms, is when a new FDG scientist is trained in handling the Coastal RF data using Reg-Fisk, which is a computer program which becomes central in the following. Then, the FDG hires me to handle the data because they are short of people, which gives me a personal experience of how to punch the RF data. In addition, Huse starts the 'Wednesday meetings', and for me this is a lucky opening to study a social situation where the scientists gather to enter data and talk about the RF.

Reg-Fisk

Huse is training a new employee so he can handle the data collected by the fishers. To my surprise, Huse suggests that I learn it too, so I can understand what happens with the RF data. Hence, my method changes slightly as the degree of participation increases. I am going to learn how to plot the RF data into the computer program the IMR uses, the Reg-Fisk program.

All three of us are gathered in the only empty office at the FDG premises. We have a pile of the handwritten forms mentioned above from the Coastal RF in front of us. First of all, we get a copy of the IMR's 'Manual for Sampling of Fish and Crustaceans' (IMR 2006), which is called 'the bible' by the scientists. I take a quick look through it, and I see a large number of codes for the official fish names as well as for the fishing gear. There is a lot of new information about stuff I have never heard of before. This is the manual where all the codes that are available to scientists to describe reality are found. I will soon discover that without this book one is certainly lost in the world of Reg-Fisk. A central element here is the computer program called Reg-Fisk and before we can do anything, Huse has to arrange for us to get a laptop with this program installed. A couple of clicks, a USB pen and we have access to a central actor in the network of fisheries management.

At the FDG office, Huse starts explaining and demonstrating the process in detail, and I just know that this is an important moment. I concentrate; I have a pen and paper, ready to take notes of the procedure. Huse demonstrates how Reg-Fisk consists of several spreadsheets[25], the Fishing Station Form (S form), the Frequency of length Form (U form) and the Sampling Form (T form) (see Figures 17–21 in chapter 5). In addition to the schedules we will fill in here, Huse explains that there is a V form, where information from the otoliths is entered on Reg-Fisk by the otolith readers; and a W form for stomach samples. Importantly, the raw data from the Coastal RF has to be prepared for the Reg-Fisk programme. Based on

[25] The impatient reader can take a look at the forms in chapter 5.

Huse's explanations, this means that the *raw data* must be turned into a form that this program can process. However, Reg-Fisk only speaks 'lingua matematica', and only after going through a process of giving the raw data a code can it be fed into Reg-Fisk. This means that only quantitative data is accepted by Reg-Fisk. 'Everything' needs a code, a number that corresponds to it, and hence all the raw data is translated into a number. In general, a spreadsheet can be described as a tool that arrays, relates, creates, juxtaposes and simplifies numbers.' (Law 2004). Apparently, this is what Reg-Fisk does. Reg-Fisk is an important actor at the IMR, and later I will describe in detail what role it plays and what it does. For now, it suffices to say that Reg-Fisk transforms 'raw data' into data.

What we are supposed to do is to fill in the data that the fishers have registered on paper in a standardized format according to Reg-Fisk. Even if the idea itself is simple, I am left dazzled. We have the tools but lack the skills and experience to understand what we are supposed to do. At this stage of my fieldwork, most of what is said and done is like Greek to me. I am totally lost when the scientists talk about the forms using their short-names (S, T and U schemes) and I don't remember what type of information is supposed to be in each scheme or row. With time however, this will change since the FDG hires me to enter the information from the forms into Reg-Fisk – to punch data – based on the training I received here.

Punching the Forms before 1 March

The first day of March is an important date for the IMR. All the data from the Norwegian fisheries has to be handed in to the National Data Centre where they are going through a quality check, before it is placed on the IMR's 'data bank'. The first of March is the deadline for handing in the data. All the data that travel to ICES has to go through this quality check. The RF data is just one of the sources that contribute to the IMR's data bank. In general, additional work must be done to these data before they are placed on the IMR data bank. All the data that comes into the IMR must be checked by scientists and then be tested at the National Data Centre. So, producing knowledge at the IMR is time consuming in general, and depends on a lot of work.

Huse is worried because nothing has been done with the Coastal RF data for quite a while due to some organizational issues, and the forms have been piling up. Some of the scientists who work with the RF project belong to other thematic research groups and therefore their offices are in different locations. In the weeks before Christmas, Huse wants to make sure that the data from the Coastal RF is ready for the first of March. Hence, she contacts all the casual workers on the RF and asks them to work by email. At the first

‘Wednesday meeting’, which are further introduced below, she stated:

> All available hands should punch! (Wednesday meeting the 9th of January 2007)

Now, I realized that even if the otoliths are key, these are the actual material traces of the fish caught by the fishers and transported to the IMR, they cannot travel alone. It is crucial that the otoliths come together with some information, which is the function of the forms the RF vessels complete. These forms make the otoliths traceable. Hence, just collecting the otoliths from the fish head is not enough. These forms are filled in by the fishers and must be checked by the FDG scientists. The Coastal RF forms require more work than the Offshore RF spreadsheets since these are paper versions. Hence, the scientists must transfer the data to computer spreadsheets, and this is time consuming. The data from the Offshore RF must also be checked before it becomes a part of the IMR’s data bank, but since they come to the IMR as spreadsheets, this is easier.

As the 1 March deadline for the ICES data became imminent, Huse realized that they need more people in order to get the Coastal RF forms translated into Reg-Fisk. This registration is tedious work, time consuming and some knowledge and skills are needed in order to do it. This is a major part of the FDG’s work, and it is done continuously as the forms come in. Or, more precisely, it should be done continuously. Since the RF is what is known as ‘a new knowledge platform’ and a new task for the scientists, some organizational aspects were still not in place during my fieldwork. A lot of the schedules had been piling up, and Huse was stressed about getting the punching up to date, and getting the routines in order. she asked me if I could help them out with some of the data punching. Hence, I immersed myself in the FDG life, at least for a short period of time. Importantly, I was happy to have a reason for knocking on their doors and being in their way during this busy period. Also, this gave me a chance to get an insight in what they are doing with the data up close, and they remember to inform me about meetings and what is going on since I am part of their staff.

Now, the FDG trained me so I came to understand their culture and therefore obsession with numbers. I went through what anthropologists would call ‘cultural adaptation’ or ‘training’. I adapted to the social, technical and ideological ways of the FDG scientists’ as well as their intellectual dimension of culture.

Wednesday Meetings

The third and the last window for studying the RF practices came when the Wednesday meetings were introduced by Huse. She decided to start a ‘punching group’ when she realized that the data from the RF was just piling up as paper forms on her desk. All the data from the Coastal RF must be entered into Reg-Fisk in order to be useful for the IMR, and the FDG is too far behind on the data punching to be able to present something for the fishers during the annual meeting in December.

The kick-off meeting for the punching group takes place in October 2007. I attend together with three other scientists. These are all familiar faces from the FDG. During this first meeting, the only issue is how to get the data registered in time for the annual meeting with the Coastal RF in December. Huse wants as many from ‘the punching group’ as possible to come. The ‘punching group’ consists of people from the IMR who have hours in their budget connected to the RF project. It is decided that Wednesdays will be used as a ‘workshop day’ for punching the RF data. Importantly, this is used for developing a system with regard to how to manage all the RF data, especially from the Coastal RF since they deliver handwritten forms which must be transferred to Reg-Fisk. The Wednesday meeting is not a permanent arrangement, but the meetings take place during most of my fieldwork. There is a lot of e-mail activity going on in order to organize these meetings since people are busy. During my field work, they take place on any day of the week and at different times, but they keep their name: Wednesday meeting.

What becomes obvious during the Wednesday meetings is that there are some general problems that arise in transferring the data recorded by the fishers to the Reg-Fisk program. All the data that is punched is placed on the IMR’s ‘common computer area’, so everybody has access to it. In order to maintain communication and distribute the task of punching the data from the different vessels, the scientists are responsible for a couple of vessels each. The responsibility entails punching of the raw data and checking the data, as well as keeping in touch with the fishers by mail, phone calls and visits. During the Wednesday meetings it becomes obvious to me that fishers and scientists do not share the same logic when it comes to fishing. Some issues are so commonsensical for the fishers that they do not see the point of writing it down on the forms.

Huse: The fishers think that their choice of gear is logical – what is normal for them to use – so they [fishers] don't understand why we [scientists] are having problems.

Different people show up at these Wednesday meetings. Some are familiar faces from the FDG offices, and others are new to me. Getting a venue is sometimes difficult, and the meetings are held in different buildings that belong to the IMR or the Fisheries Directorate. Technology is always an issue. Huse needs to connect the laptop in order to show progress, schedules or changes that need to be made in the routines with the video projector. Some are more impatient than others while we wait. Coffee is an important companion at this hour, especially since we are waiting. During this time, which often takes about 30 minutes, people gossip, talk about their research and trips at sea, plan get-togethers and so on. With time, the procedures for punching the Coastal RF data become more standardized and the questions and problems discussed at the Wednesday meetings are fewer.

So far, I have followed the otoliths. First, I discovered them in the IMR scientists' offices, then I followed them back to the sea where fishers collect them from fish heads, and then back to the IMR. In addition, the forms, or the otolith identification papers that ensure their traceability, have become very familiar to me as I am hired to plot them myself in order for the RF data to be ready for the 1st of March deadline. In the next section, the otoliths travel from the IMR to the ICES, and this is where the actual stock assessment is done. Now, without more ado, I will jump to my fieldwork at the ICES. Below, I will describe some of the scientific practices that took place during the Artic Fishery Working Group (AFWG), keeping an eye on the otolith data collected by the RF.

The ICES and the Arctic Fisheries Working Group

The assessments of the different fish stocks take place in annual meetings of the assessment working groups. Each of these working groups is responsible for the collection and combination of various data sets, to assess a range of stocks and provide a first draft of advice for each stock. During my fieldwork, I attended the annual assessment of the AFWG. I am looking for the RF data at this specific place since I know that this is where they are converted so that they can be part of the data base which the AFWG uses to give advice about the quota size. But I was also curious about the scientific practices in more general terms.

The ICES offices are located in a tall, old building close to a canal in Copenhagen, Denmark. I have travelled here together with several scientists from the IMR. They are here to develop unbiased, non-political advice together with the other stock owners about the North East Atlantic Fisheries (see ICES webpage, www.ices.dk). In order to be allowed in, Nedreaas, who is the head of the Fisheries Dynamic Group which is responsible for the RF, has sent in the necessary information a couple of months ago, and I have the status of an observer. For the next ten days we all share most meals and many hours at the ICES offices.

The AFWG is held in quite a large room, with the tables in the shape of an 'E'. People are chatting, and the great majority of them are men. Many seem to know each other already, and some are new and here as trainees. I find a place that gives me a good overview of the room. The people from the IMR seem to be scattered around, and so are the Russian scientists. Later I find out that people are seated together according to fish stocks.

There is so much information going back and forth, and I am pleased to have a strategy: Follow the RF data, and more specifically, the RF data related to the cod.

The Subgroup Cod Meetings

The days at ICES are filled with meetings for the scientists. Different groups of people work with different stocks and it is quite confusing since some meetings are in the programme, some are announced spontaneously, and people go back and forth between different rooms. Everybody is very busy, and I try to stay out of their way.

The cod group has its meetings in a small room, where the Russian and Norwegian scientists gather to discuss what models to use and what data to include. The same is done for other stocks in other rooms. I am a bit overwhelmed, and it is obvious to me that to follow their conversation, it is necessary to know more about two central data sources, the Virtual Population Analysis (VPA) and the Catch per Unit of Effort (CPUE).

Getting a grip on the VPA is central in order to understand scientists' epistemic culture: the existence of virtual fish stocks whose behaviour and number of fish can be defined and characterized mathematically (Roepstorff 1988; Roepstorff 2003). First then, let me describe what the CPUE is before I turn to the VPA.

Catch per Unit of Effort (CPUE)

According to the Organization for Economic Co-operation and Development (OECD), the CPUE is a ratio that can be defined as

> the total catch divided by the total amount of effort used to harvest the catch (OECD 1998)

This is a ratio that typically is used to eliminate the temporal and regional trends in the abundance of fish stocks (Morgan and Burgess 2008). The 'unit of effort' portion of the measure refers to the time specific gear is used, and can be measured according to the number of vessels, vessel-days, gillnet or long-line sets, and the trawling or gillnet hours (Morgan and Burgess 2008).

There are both some drawbacks and some benefits with the use of CPUE for stock assessment. CPUE data can help reduce uncertainty with assessment, if the stock trajectory is consistent and the management plans are stable (Rice 1999). However, CPUE data is not considered reliable when a stock is declining (Rice 1999). The problem is knowing if a stock is declining, and if the science is wrong, the consequences can be devastating. The fisheries crisis described in chapter 1 is a classic example of this, and the case of the Newfoundland cod collapse in 1992 in particular (see for instance Hutchings and Myers 1994). Because of the dangers with using CPUE, some texts suggest that assessments should avoid the use of CPUE as a tuning index (Rice 1999). One of the IMR scientists explained to me that the CPUE is an index that is used in several statistical assessments, including the assessment of NEA cod and saithe. However, there are some issues that must to be considered when using CPUE in models. A number of factors that can affect the CPUE when using data from the fleet must be taken into account, i.e., any change in the fishing gear and hence efficiency, the weather pattern and the captains' and crews' skills. The collapse of the North Atlantic cod in Canada taught fisheries scientists some hard lessons with regard to the potential bias in CPUE data. Thus, the CPUE is well established and those working with these indexes are well aware of the pitfalls that these indexes can lead to if they are used uncritically.

CPUE data can be obtained from the forms completed by the RF fishers and sent in regularly. However, I could not find any traces of the CPUE data at the ICES[26]. For now, then, we will leave the CPUE data and return to the otoliths' journey.

Virtual Population Analysis (VPA)

The VPA is a commonly used model for the analysis of fished populations (Lassen and Medley 2001). The VPA does not by itself specify how many individuals can be caught to

[26] I did look for the CPUE from the RF in different places and at different times. How this search took place, and how I know for certain that CPUE data from the RF is excluded, is further described in chapter 5.

meet a given objective, nor does it predict the future. The assumption is that with a good picture of the past and present population dynamics, it is possible to make the forecast needed to assess management options, such as TAC (Jennings et al. 2001). What the VPA does is to explain the *past* (Jennings et al. 2001). Simply put, the VPA attempts to put numbers on the total amount of fish in a stock and follow their destiny through their life span. The existence of a virtual stock creates a well-defined community of fish that is visible from a hypothetical point of view and hence, in theory, countable (Roepstorff 2003). The 'natural development' of fish must then be taken into consideration. This includes migration patterns, growth and mortality with no human intervention in their life cycle. The assumptions are that we know how fish grow, how many enter a fishery and the rate at which they die naturally. In theory, then, fisheries biologists know everything about fish stocks, and the only variable left is death due to fishing. The information of fishing mortality is obtained from landing statistics from the fisheries. One can say that the surveys tell the scientists how much fish there *is* in the sea at the time of the survey, while the landing statistics tell the scientists how much fish is taken out.

There are numerous VPA techniques; they vary in the way they use data and fit the model rather than in the form of the model itself. At the ICES, the scientists use a version called the extended survivor analysis, or XSA, according to the FDG scientists. This is 'A VPA with no catch errors tuned with age-specific Catch per Unit of Effort (CPUE) indices' (Lassen and Medley 2001: VIII).

Of course, making these assumptions is only possible because scientists believe that it is possible to define the dangers and risks of overfishing in a scientific manner (Hauge 2008; Hauge 2010). The main parameter used is the biomass of mature fish. This gives science the possibility to translate questions about TAC into how many mature fish are necessary in order to safeguard the state of fish for the future. This issue is 'immensely complex, as only a very small, and highly variable, fraction of fish survives to become mature, even in the absence of fishing' (Hauge 2008: article 3 page 7. See also Hauge 2010). Based on the assumption about how many mature fish are needed, the fisheries scientists have set a scientifically based threshold, which requires a 'quantifiable relationship between the mature stock and recruitment. Recruitment refers to the number of fish at a certain age, the age when it starts to get caught by fishermen' (Hauge 2008: article 3, page 7). In the case of the NEA cod, the recruitment is related to the number of three-year-old cod.

For now, what is necessary to keep in mind is that the VPA is the model the ICES uses for analysing fished populations, and that it needs age data about fish. Hence, the otoliths are key data sources in general to the VPA which is used in order to set a TAC.

Discussing Models and Data

Over the ten days when I observe the scientists and their practices, I realize that they spend a lot of time discussing what data they should include in the models, and hence which should be excluded. A main task for the AFWG is to make sure that the data that is put into the VPA model is of high quality and that as much uncertainty as possible is removed. Including new data is done only after a process of checking its quality, the continuity of the data series and if the data fits the existing framework. Some of the discussion and processes with regard to which data should be included and which model to use for stock assessment, is described below. According to the IMR scientist Subbey, the most used recruitment model between the years of 1985 to 1998 is RCT3. He asks the group:

> Which recruitment model should we use instead? We can choose between at least five recruitment models in the AFWG domain. The main question is: could we do better than business as usual?

Subbey explains that they want to include data on the climate in the models, since this is important for the recruitment of cod. This is not an easy task, it seems, and the scientists discuss back and forth.

The subgroup for cod evaluates the stock recruitment models over several days. In addition, some of the scientists want to include some new inputs, while others want to keep a conservative line. They are discussing back and forth about whether it is possible to include data on the climate. 'Petter' argues:

> It is more recognized that climate has an effect on cod and the whole ecosystem.

They all seem to agree with this, but there is a concern about the access to this type of data. A Russian scientist asks:

If you want to include climate data such as temperature, we must be sure that we can get such data every year. Are you sure that we have access to this? We have to think about the continuity of the data.

As far as I can tell, those who argue in favour of including this new data manage to assure those with concerns that this is not a problem. The scientists all seem to agree that climate data is important, but they do not agree on whether to include it in the models or not, or how to include it in their models. What is certain is that change is difficult within this framework. Later, the result is presented in a plenary session:

We agreed that we would make a hybrid, and chose the one producing the best result (…). This makes this working group the first to implement climate in recruitment prediction!

The inclusion of climate data in the TAC machine is obviously a big issue for the scientists. After the presentation, Petter explains that this is a 'small revolution':

This is the first time that a Working Group is including climate factors, so I am really pleased. To me, it is not important if they use my model, what's important is that they include the climate. It has never happened before!

I am surprised that it is so difficult to add new data to the models, especially since everybody seems to agree on the importance that climate has for the recruitment of fish. Importantly, this is data collected by scientists, which makes me wonder even more about why it is so difficult to include or exclude these data. I ask Petter why it is so difficult to include new data when it is collected by scientists:

Why? Conservationism. Business as usual!

According to several of the AFWG scientists, this conservationism is also related to the importance of continuity.

The climate data is not the only data they discuss. Over the ten days that the meeting lasts, there are numerous discussions about which data to include or exclude. The different data is inspected and evaluated by the experts over and over again. The issue of which model to use – the RC3T or not – and which data to use or not, are discussed and evaluated several times during the subgroup cod meetings. This is a complex and time consuming process.

Show Me the Otoliths: From Fish to Otolith to Numbers

Now, I want to *see* the data produced by the RF. I am curious to see if fish and their birth certificate can travel from the sea to the ICES.

During a coffee break, I go over to the IMR scientist who works with cod, Asgeir Aglen. He is very busy, but he takes the time to show me what I want to see. Aglen opens up a data file with a table where the age samples from the different sampling platforms for the cod are presented. The messy and slimy fish from the sea has ended up as a number in a table with data used for stock assessment.

SUMMARY SAMPLES WITH AGE					
By season:					
	1	2	3	4	Total
Amigo (Port Sampling Programme)	96	49	12	18	175
Kystvakt (Coast Guard)	27	13	16	6	62
Overvåking (Surveys)	4	0	0	5	9
Referanseflåte (Reference Fleet)	44	41	29	73	187
Total	171	103	57	102	433
Average no. of fish measured per sample:	44.3				
Total catch by season:					
1	2	3	4	Total	
106102	48857	13590	31259	199809	

Table 8: Age samples from the different platforms: *Amigo* (hired vessel with IMR scientists, generally referred to as 'the port sampling programme'), the coast guard, surveys and, of special importance here, the Reference Fleet. The numbers are in tons, based on the total landings from the Norwegian catches. The table is courtesy of Asgeir Aglen, but the translations in parentheses are mine.

The table shows the different platforms that the data – the otoliths – comes from: *Amigo* (a vessel the IMR hires for the 'Port Sampling Program'[27]), the coast guard, surveys and the RF. Aglen explains that there is a difference in the size of each sample, and from *Amigo* there are 60 samples in each (from 60 cod), while those from the RF contain 20. From this, one can tell that the total of 187 samples, with otoliths from 20 cod in each, taken by the RF fishers over the year (season 1–4) is used in the stock assessment and mixed with data from the other knowledge platforms. This is one of several tables Aglen has made from the data sets based on data collected by the IMR. There are numerous spreadsheets with numerous tables on each spreadsheet that Aglen opens up, and all of them are related to the otoliths. In the table below, the RF collected some of the samples from different areas and in different quarters. In the spreadsheet, I can find the same type of tables going back to 1984. However, I only know for sure that the RF otoliths are in this last table from 2007.

Year		**2007**				
Qu./Area	**03**	**04**	**00**	**05**	**06-07**	**Total**
1	8797	19575	15638	30371	4863	**79244**
2	10727	13988	2804	3456	1396	**32370**
3	1279	811	546	562	423	**3621**
4	2377	960	352	685	314	**4688**
Total	**23180**	**35334**	**19339**	**35073**	**6997**	**119923**

Table 9: Total catches of cod (coastal cod and NEA cod) divided into areas and quarters inside the 12 n.mile zone from the Russian border to 62 degrees N.

These tables were the last glimpse I had of the data collected by the RF at the ICES, before it was mixed together with the other otolith numbers. From here, the RF is part of all the 'at age' information which is used in the VPA model; catch at age, weight at age, length at age. It is impossible to distinguish at a later stage, but they do have a say in setting 2008 TAC advice. What is important is that we have found the otoliths, as virtual representations of fish, collected by the RF fishers here at the ICES.

RF Otoliths Are Included: A Big Revolution!

The tables and statements presented above are proof that the RF data is used in stock assessment at the ICES. It is difficult to spot the RF data. Their traces can be seen in glimpses before they are mixed together with all the other traces of fish from a number of knowledge platforms. Now, they can be used in the VPA as age and length keys, and they can represent the fish as colours and numbers in graphs and models.

[27] The Port Sampling Programme was cancelled in 2009.

After following the AFWG meetings, I know that the scientists disagree and have different views on which models to use, what data to include and exclude based on numerous assumptions and criteria with regard to all the species that are estimated here.

From the subgroup meetings I know that the VPA is a central model for stock assessment, and that scientists are very careful about what information to include in the assessment. Even the inclusion of data from pure scientific surveys done by scientists, such as data on climate factors, is considered a 'small revolution'. Still, the RF fishers manage to collect data in a way that is accepted by the very critical TAC machine, where scientists scrutinize data before they include or exclude them.

As described by, for instance, Nielsen (2008), fisheries management makes a strict division between scientific knowledge and other knowledges, and the data used in the VPA is scrutinized also when produced by traditional knowledge arenas such as surveys. In light of the small revolution described above, this must be considered a big revolution. Maybe this is a new paradigm where fishers are included in knowledge production for fisheries management? I have high hopes for the RF.

Now, I can say with certainty that the scientists at the IMR in Bergen, Norway, are organizing a project – the RF – where fishers are included in knowledge production for stock assessment.

How to Make Sense of the RF? Learning To Swim in a Sea of Data

I have faithfully followed the otolith from one arena to the other, from the vessels to the IMR, and from the IMR to the ICES. Even if I only have seen fish out at sea when the fishers catch the fish, I have actually followed the fish to all these places, with the help of the otolith. These bony structures seem to be what keeps the network of arenas together. The IMR is flooded with fish even if they are invisible – all you can see are otoliths, paper forms and spreadsheets from the RF (and several other sources like the coast guard and surveys). After spending months following the RF knowledge production, I have learnt a lot about what goes on in the different arenas. I have visited the vessels, where the fishers work as typical fishers, catching fish and landing it, and importantly, the fishers produce otoliths for stock assessment. I have seen it myself, how the fishers collect the fishes' 'birth certificate', the otoliths, together with their length and a lot of other information that they register in the forms. This is sent to the IMR, where everything is stored in the scientists' offices or laptops, before they travel as numbers to the ICES. At the ICES, the 'TAC machine' accepts the otoliths collected by the RF. But we should also keep in mind that the RF affects the system. As we have seen, new data generates new discussions, disagreements and uncertainties even when generated by scientists themselves.

I am starting to understand some of the complex interactions and making sense of the practices within the RF. As the seasickness I experienced in the beginning of my fieldwork is letting go, I feel safer, more experienced and I can dive into the details of what I have just explored as well as looking for other 'stuff' that goes on between these walls. I am getting more familiar with the IMR, the FDG and the RF practices, I can navigate like the fisher at sea between the IMR and the vessels, and as I am learning how to use the scientists' tools (computer, Reg-Fisk and the manual), I feel like I am swimming as a fish in the sea of data from the RF.

I may not need the otolith as my 'life jacket' anymore, which gives me more freedom to travel wherever I would like to within these data streams and different networks of practices and cooperation at within and between the fishers and scientists. However, I do not want to let go of the otolith just yet. There are still some issues that need to be clarified. While the otoliths are key, I am also starting to understand they are worthless without the forms that the RF fishers fill in. What can be included and excluded is to a large degree framed by Reg-Fisk. Mainly, the FDG scientists punch data from the paper forms handed in by the Coastal RF into Reg-Fisk, and they clean up the spreadsheets from the Offshore RF. When the otolith readers read the fishes' age, the forms give them an identity, where each fish comes from and how it was caught; it is like their passport, really. Without their passport, the otoliths cannot cross the boundary and be included in the stock assessment. Like an immigrant without identification papers, it will not be allowed in and will not become an immutable mobile that can jump from one spreadsheet to another, and be a number in a table or a pretty colour in a figure or table. It is fascinating how it is possible to follow the otoliths' journey all the way from the vessels to the IMR and the ICES, back and forth: from fish to otoliths and then as numbers in spreadsheets and models.

Let me dwell on what I just said: from the fish, which is an organism, to the otolith which is an object, to numbers which are signs? This is exactly what Latour argues is impossible: it is not possible to travel directly from an object to words and from the referent to a sign (Latour 1999: 40). So, how can the RF data do this? How can fish make such jumps from the real world to a spreadsheet? According to Latour, one needs go to the field and follow carefully what happens with the data collected at each stage: how fishers take samples of fish and how the otoliths become their guarantors; how the FDG scientists handle the otoliths and transform them into numbers that can travel to the ICES.

We must take a closer look at what is necessary in order for knowledge to become relevant and hence put to work. I have moved too hastily between these arenas for knowledge production, and I will follow Latour's advice about returning to the field. In the next chapter, I will first follow the otoliths and then the CPUE. But this time, I will not miss any of the jumps made by the fish as it is transformed from fish as an organism, to raw data, and finally data.

Chapter 5

Making Data Circulate

In chapter 4, we became familiar with how fishers collect otolith samples, and also saw that they ended up as data in Reg-Fisk spreadsheets. Still, *exactly* how this transformation occurred, from slimy catch to well-ordered data, slipped my attention. Hence, I found that things had moved too fast. How can otoliths become loyal representations of fish? How can fish make the jump from the sea into being numbers in a spreadsheet? In this chapter I will try to make things slow down in order to take a closer look at exactly how the RF fishers are included in knowledge production for stock assessment purposes.

According to my findings, there are two main types of data that the IMR looks for and RF is contributing to; namely the age data and Catch per Unit of Effort (CPUE) data. In this chapter, I confine the argument to these two types of data, both of which are used for stock assessment purposes. Even if the knowledge chains that are related to stock assessments are my main focus, this dissertation is not limited to these two data types, as we will see in chapter 6.

The main issue in this chapter is how the RF fishers are included in knowledge production and what is necessary to allow such participation. In order to examine this issue, I will follow all the steps that are undertaken in order to make data traces that can serve as loyal representations of fish stocks, and how fishers get to be included in this work. This is going to be a meticulously and extremely detailed, and perhaps boring, description at times. This is nevertheless necessary in order to find out how fish can be transformed into numbers that can be used in scientific assessment models.

Otoliths as Loyal Representations of Fish

In the following, we shall revisit the vessels and see what is done with the otoliths in order to make them loyal representations of fish. One important document must be introduced before the process that takes place at the vessels is presented in detail; the IMR's general guidelines for the collection of otoliths. These guidelines also explain the importance of the forms that are filled out by the fishers in addition to collecting the otoliths.

Importantly, the otoliths cannot travel by themselves. The RF fishers must provide the otolith with its 'full scientific identity', and what this means is further explained in the section about 'ensuring traceability: the forms'. What we should note here is that the traceability of each otolith from each fish is important. An identity seems to be key in order for the otoliths to become part of the NEA cod stock assessment. Another central issue is that otoliths should be removed from a *sample* of the catch. Sampling is defined by the IMR as '[T]he number of specimens of a species extracted from a catch for closer examination, e.g. individual sampling' (IMR 2006). This sample should represent the catch, using 'common sense', according to information given to fishers during the annual meetings. So, in order to give a fish its full scientific identity following IMR guidelines, the fishers must set apart a sample of their catch from which they take the otoliths, and register the date, serial number, vessel and species in several forms. These forms are presented in Figures 17 to 21. What is necessary to keep in mind for now is that fishers collect the otoliths and that they fill in some forms in order to ensure their traceability. While all of the Offshore RF vessels have an electronic device, a 'FishMeter', that can weigh and measure the fish and store this information in a standard data format (Øvredal and Totland 2002), the Coastal RF vessels use traditional scales and a plastic length-measuring device.

The IMR's procedures for providing otoliths with an identity are described in general terms above, and below I will relate this to how fishers organize and perform this task. So, now, we will leave the laboratory and go out to sea again.

The Otoliths Collected by the Offshore RF

When I visited the Offshore RF vessel MS *Geir*, I followed the data collection the fishers do for the RF. The collection of data for the RF is done in the factory section of the vessel, which is described in chapter 4, where I meet the two fishers who are mainly responsible for the RF data collection. These two take care of all the sampling done for the RF on this trip. In the factory all the by-catch has already been removed and only the target species are allowed to enter this space. These fish start their voyage within the factory in a large tray filled with cold water. Here, they spend a couple of hours bleeding out in a tray filled with water. Then, the tray is emptied on a conveyor belt by one of the fishers, and several fishers are waiting for the fish to come down the belt, standing at different posts. Actually, the main difference from any other factory is that we are on a boat on the high seas.

One important tool used by the fishers, which is found in all the Offshore RF vessels, must be presented before we turn to the sampling of otoliths; the FishMeter. Like the counting device I used onboard MS *Geir* to count fish with floppy mouths (see chapter 2, Tables 1 and 2), the FishMeter is an inscription device.

The FishMeter

The FishMeter is an electronic length-measuring board that consists of a display unit and a measuring board that is waterproof and can operate in a harsh environment. All measurements are recorded with a serial number, which gives each fish a unique identity, which is in line with the traceability underlined in the IMR's guidelines presented above. Furthermore:

> The FishMeter can be interfaced with two other instruments via serial ports. It is an efficient tool for sampling fish lengths, weights and biological data, speeding up sampling, improving accuracy and, most importantly, storing the data in a standard computer format (Øvredal and Totland 2002: 326).

The serial ports are used to connect the electronic weight to the FishMeter, and the weight can be registered by a function key (Øvredal and Totland 2002). The FishMeter and the electronic weight are connected to a PC running software called Scantrol Fishmeter. This equipment is expensive, and each set which includes the measuring board, the display, the cables, magnets etc. costs about 90,000 NOK[28]. Importantly, the data registered in Scantrol FishMeter is compatible with IMR's own program for counting fish, Reg-Fisk. This simplifies the otherwise time-consuming process of registering data for stock assessment (Øvredal and Totland 2002).

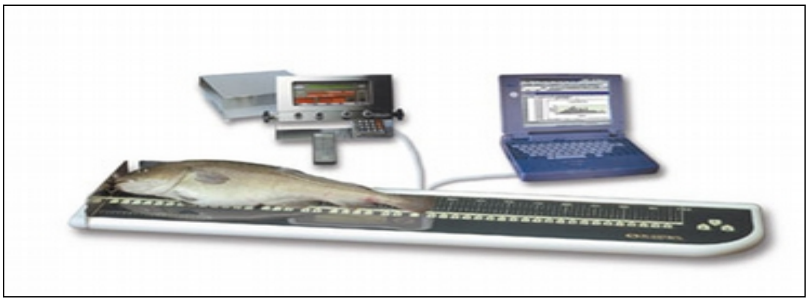


Figure 11: The electronic FishMeter (Scantrol) and electronic scales (Marel)[29]

[28] The price in January 2010 was 92,691 NOK, less 15% for the IMR: personal communication by phone. Scantrol, 21.01.2010.

[29] Image from http://www.imr.no/temasider/redskap_og_teknologi/teknologi/vekter_og_malebrett/vekter_og_malebrett/nb-no

The Offshore RF: From Fish to Otolith

As described in chapter 4, the Offshore RF fishers are organized into different groups with different tasks where their work is quite specialized. In order to collect data for the RF, the organization in MS *Geir's* factory is changed slightly as the fish will not only be caught, but also sampled. With just a few adjustments the factory has turned into a small laboratory. Now, the fishers are using the FishMeter measuring board together with electronic scales. The FishMeter is put on top of the assembly belt where all the fish passes, and some of this fish – a sample – is placed on top of the device. In an office directly above the factory there is a PC with the software that is needed, including satellite communication. Jacob has put on different clothes. He usually wears the typical orange waterproofs when he fishes, while he puts on a grey overall for the RF work. In his hands he has the equipment necessary to take the samples and fill in the forms: a pair of tweezers and a glass box with small numbered pockets. He takes care of the sampling without really touching the fish. Joseph keeps his orange overall on since he is doing the 'dirty work' of cutting and grabbing the bloody and slimy fish. While the RF sampling takes place, the other fishers keep working with the rest of the fish in the factory, and the sampled fish simply re-enter the normal loop when the sampling is done.

Fieldnotes: collecting RF data: Measuring

The fish leaves the tray of water and travels down to the extra station where the electronic measuring device is placed on top of the assembly belt. Here, one of the fishers uses the FishMeter to measure 50 cod (and 50 haddock) and sends them on the belt where Joseph leads them into an aluminium tray, separating them from the rest of the fish, making a loop in the system. Most of the fishes slide down the belt without going through the RF data collection process. This fish never gets an identity as it simply travels down the belt to be gutted by a fisher and then the cutting machine where another fisher is waiting for it. (05.12.2008)


Picture 11: Fisher using the fishmeter

It is fascinating to watch how the factory is transformed into a kind of a laboratory. The fishers who use the FishMeter are used to this task, and with a trained eye one takes out the fish in different sizes that they are going to sample. The FishMeter makes a little sound when each fish is registered. This is difficult to hear since it is quite noisy in the factory; however, a little light from the FishMeter tells him that the length and species (which he must register in the FishMeter) is registered with a serial number. Now, each cod and haddock is taken to an aluminium tray where Jacob and Joseph are waiting.

Fieldnotes: collecting RF data: Collecting the otoliths and weighing
Joseph is ready with a large knife. He grabs each fish in the eyes and with experienced hands, he makes a deep cut in the cod's head. Jacob is ready with tweezers and a special glass box with small pockets, and while Joseph holds the cut open, Jacob picks out the otholiths, two in each head, from the fish. Then he places the otholiths from each fish in the special glass collector. Each fish gets one pocket; hence two otoliths are placed here. (05.12.2008)

Picture 12: Otoliths in cod head.

Picture 13: Otolith is moved from cod head to glassbox

This is it! This is the moment when the fish changes from a normal fish: from now on it is more than a cod caught in the untamed North Sea; it has become a representative for the NEA cod stock. Importantly, since the otolith now represents the fish which represent the NEA cod stock, the fish can go back to being a part of MS *Geir's* catch. The otolith, however, can travel on, representing the fish.

Fieldnotes: collecting RF data: Collecting the Otoliths and weighing
After the otolith is taken out, the fish is weighed on the electronic scale by Joseph. The two fishers do this with each cod, and when each of the 50 pockets has two otoliths, he marks the box and finds another one for the haddock. Afterwards, the fish they sampled is mixed in with all the other haddock and the cod in the tray that is normally used during production for gutting. From here they travel with the rest of the fish – gutting, cutting and filleting – all the way to the freezers. (05.12.2008)

It is impossible to see, but the weight of the fish is sent automatically to the FishMeter, and registered together with the serial number and the measurement for each fish. This facilitates the process since the weight and length can be transferred directly into Reg-Fisk, in the same way as during the scientific surveys. Each pocket in the glass box is marked and Jacob makes sure that the numbers all correspond with each fish. During this process, Jacob underlines several times how important it is to make sure that each set of otoliths has the correct corresponding weight and length.

Fieldnotes: collecting RF data: The Forms

From the factory floor, Jacob takes the two boxes up some stairs in the other corner of the factory. Here, they have an office with a computer and this is where they register the information. His hands and clothes are clean since he did not really touch the fish. He leaves the two boxes of otoliths, one from haddock and one from cod, in the sink. Jacob explains that the FishMeter is connected to this PC, and the information, such as serial number, weight and length, is transferred automatically to the computer. He gets the data required for the forms from the bridge, where all the information is registered in their own computer: i.e., location, standing time for the gear and the gear used. From the laptop, they send the information as numbers on spreadsheets to the IMR's computer, where an IMR scientist opens the files and copies into the Reg-Fisk program installed on their PC or laptop. Jacob explains that he will fill in the forms on the PC afterwards. Now, he must change and help the other fishers. (05.12.2008)

Picture 14: The office above the factiry with the PC set up with the software to receive the data from FishMeter, and send it to the IMR

From this PC, MS *Geir* sends all the RF data collected in one file with for each trip. Other Offshore RF vessels send several files. The otoliths themselves are sent by mail to the IMR, and end up in the offices of the FDG scientists. I have seen them myself, piling up on their desks.

The otoliths are sent from MS *Geir* and all the other Offshore RF vessels as a steady flow of data into the IMR. So, the glass boxes come in the mail, while the forms are sent as email from the vessels. In the coffee room, the 'corner computer' is receiving all of these forms as spreadsheets in Reg-Fisk. The Table below (Table 11) shows how many otoliths of the different fish species were collected using different gear types by the Offshore RF in 2008. As one of the auto liner vessels (Table 11), MS *Geir* collected some of the 8116 otoliths.

Gear	Total N^o	Greenland Halibut	Haddock	Ling	Saithe	Beaked redfish	Cod	Redfish
Gillnets	**2489**		**300**	**68**	**517**		**1464**	**140**
Auto Line	**8116**		**3722**	**264**	**120**		**2987**	**1023**
Purse seiner	**760**		**60**		**460**		**240**	
Trawl	**5148**	**60**	**1539**		**1520**	**40**	**1329**	**660**
Seine	**460**				**460**			

Table 10: Otoliths collected by the Offshore RF in 2008 by gear. This table was presented at the 2009 annual meeting.

At the IMR, I found the otolith samples from MS *Geir* in the office of one of the IMR scientists who 'reads' otoliths. He works with the RF vessels and is the mentor to several of them, but he is not a mentor to MS *Geir*. All the Offshore RF vessels send in the otoliths and here, these tangible, bony structures from the fish heads end up in the offices of the 'age readers'.

We will come back to what happens to the otoliths at the IMR later. First, however, we need to visit the Coastal RF vessels to understand how they participate in making translation chains.

Picture 15: Otoliths from *Geir* in a FDG scientist's office

The Otoliths Collected by the Coastal RF Vessels

On the Coastal RF vessels, the fishers also collect otoliths and follow the IMR's procedures as described in the handbooks' guidelines in order to ensure their traceability. However, due to a number of practical issues, the process differs from what goes on in the Offshore RF vessels.

The coastal vessels typically have a crew of two who take care of all the tasks that have to be done in order to fish: getting to the location, deciding where and when to set the gear and how, taking up the gear and taking care of the catch and by-catch, then making the gear ready for the sea again and finding new locations. This is related to the knowledge dimensions described by Maurstad (2004),who divides their knowledge into a vertical and a horizontal dimension: how to travel to the field, where to find fish as well as how and when to catch fish. After the fishing is done, they have to travel to a landing site and sell their catch. In between all this, they must cook, make coffee and, importantly, collect data for the RF. So, while the Offshore RF fishers operate within a large organization with quite specialized tasks, the Coastal RF fisher is truly a 'Jack of all trades' (Maurstad 2004).

Space is an issue with regard to data collection on the Coastal RF vessels. The vessel's area is used effectively, making room for all the machines and gear the fishers need to fish and store their catch. This leaves little room for other artefacts such as weights and scales. Also, the electronic devices from IMR need protection from the wind and waves in order to be accurate. The Coastal RF vessels cannot offer this environment outside since there is little protection. Hence, most of the Coastal RF vessels have to weigh and measure each fish and then subsequently register this manually in the paper version of the forms[30]. This is actually how the IMR scientists registered data before they had access to the FishMeter. It is an extremely time-consuming procedure (Øvredal and Totland 2002).

To do the sampling, the Coastal RF have their own instructions. The procedures for collecting cod otoliths are described in the instructions fishers get from the IMR:

> In stations where up to 50 fish are measured, otoliths are taken from 20 of these fish. (The 20 fishes should be randomly chosen from the 50 fish measured!). Mark the otolith bags (the small brown envelopes) from 1 to 20, and write down the length, weight and the fish gender (♀ for female fish and ♂ for male fish). Place the otoliths in the otolith bag (one bag for each fish). When you have done this, gather the bags and mark the pile with the name of the vessel, the species and date. (IMR 2009b: my translation).

In order to follow the instructions, each vessel gets paper versions of the forms, plastic measuring devices, special otolith envelopes, tweezers and a knife, to mention some of the equipment. In comparison with the Offshore RF, the lack of an electronic FishMeter is the most important difference with regard to data collection. Accordingly, the Coastal RF fishers have to spend a lot of time filling in the paper forms that make the otoliths traceable.

Below, I will describe how the Coastal RF vessels are organized to cope with these instructions.

The Coastal RF Vessels: Collecting Otoliths and Filling in Forms

The Coastal RF vessel I visited in Finnmark is a typical Coastal RF vessel with regard to space and organization on board. As described earlier, Huse was there to find out why they do not deliver data to the IMR. However, the fishing was bad, and the only catch during this trip was one big halibut and an enormous amount of red king crab as by-catch in the gill nets as well as in the tramps. This meant that there was no fish to sample from, hence I could not observe how the sampling is done, and Huse could not show them how to do it properly either. Between the fishing locations, Huse spoke with the skipper, Per, and his crew member, Ola. She made suggestions with regard to how they can organize their work and the vessel in

[30] The Coastal RF fishers are currently (from approximately 2009) trained in using the computer program Reg-Fisk themselves. However, during my fieldwork, most of the fishers filled in the schedules by hand, and just one or two of them had started 'playing' with the program.

order to integrate the collection of data for the RF in between their fishing activities.

Importantly, they have to separate the fish that is sampled from the normal catch according to IMR's definition of sampling. This is sometimes difficult because of the practical conditions on board these smaller vessels and all the other tasks that have to be done during a fishing operation. How this can be organized onboard is described in the field notes below.

A Coastal RF vessel in Finnmark, 13 November 2007

Huse proposes that when the fish comes onboard the boat they take out a part of the catch, and then weigh it, throw it on the plastic device for measuring and mark the plastic with a knife, take the otholiths and then throw the fish, like a cod, back in the pile.

Huse demonstrates with imaginary fish while she marks the measures on the plastic board and counts what they would earn: *'10 Krones, 20 Krones, 30 Krones, 40 Krones'*...

Per interrupts her: '*But we don't have a scale here, so we have to do it on land before we land [deliver] the fish*'.

In light of this, it is more practical for the RF fishers onboard this vessel to do the sampling – remove the otoliths and weigh and measure the fish – on land. This is the case for many of the Coastal RF vessels, according to information from fishers during the annual meetings. This complicates the sampling since it is important to keep these fish separated from the others until all the necessary information is registered in the forms. In addition, the landing site is far from this vessel's home port, complicating the process further. When we arrived at the landing site late at night in November 2007, both fishers where cold and tired after two long days at sea. When there are numerous boats that want to deliver their catches, there is little time for taking care of this type of task at the landing sites.

While the Coastal RF vessel in Finnmark had some challenges with the sampling, the other Coastal RF fisher I visited in Nordland delivers data on a regular basis. The skipper, Stig, explains to me what type of work they do for the RF:

We take samples of the coastal cod and the cod. This includes measuring and weighing the fish and taking the otoliths. We take 20 samples every 14 days with otoliths and length measurements of 60 fish every week. Also, we measure and weigh anglerfish. The catch statistics is done every day.

The workload does not bother Stig, and according to him, it is unproblematic to do the sampling.

The two Coastal RF vessels visited are comparable with each other. They have the same equipment in order to take the samples for the RF, and the boats' organization seems very similar. However, Stig has a large boathouse on land, where he berths his vessel. Here, he has a lot of space for taking care of his gear and the catch. Inside, he has manual scales and a measuring device which he uses for data sampling. After fishing, he brings the fish he is sampling here, and removes the otolith, measures and weighs the fish and fills this in on the paper forms. Then, he delivers the catch at the landing site which is nearby.

Picture 16: *Haldorson,* boat house

Picture 17: *Haldorson,* interior of boat house with scale

Per is not the only one of the Coastal RF fishers that find it difficult to follow the instructions for data collection. During the Coastal RF annual meeting in 2007, several of the fishers expressed some frustration. One fisher said:

> We don't have either a computer or a weight. We are drifting around the coast in different places, so it would be ok to have a weight. The way it is now, we have to take the catch in and out of the boat.

At the same meeting, yet another fisher stated that:

> The RF is a lot of work: first fishing, all the crabs [by-catch] and the cod and then the bloody marine research [RF work]…

According to the RF fishers, collecting the otoliths in itself is quick and easy. While removing the otoliths is considered straightforward by the fishers, they find it very time consuming to make sure that they are traceable according to the IMRs guidelines. This involves weighing and measuring, and then registering this information in the IMR's forms. At the annual meetings, many of the fishers say that it is difficult to make notes because their hands are freezing and the environment is so wet. While the Offshore RF vessels' crews have several designated roles, i.e., a skipper, a third officer, a steward and an engineer in addition to the numerous fishers that divide the tasks and work in shifts, the Coastal RF fishers must do everything themselves. In addition, the Coastal RF fishers do all their work outside and the weather conditions can sometimes limit the research work they can do, as they have to work in snow and rain and sometimes cope with large waves that hit the vessel.

The fisher has numerous chores that have to be handled onboard which demand his attention before the RF sampling can be done. The Coastal RF fishers must be organized as effectively as possible to weigh and measure the fish sampled and then fill the information in on the schedules. If the Coastal RF fishers could use an electronic scale this would make it easier for both fishers and scientists, since data is transferred directly into Reg-Fisk. But these scales would in most cases be exposed to water and wind, which makes the electronic scales unstable. Such challenges and possible solutions for installing electronic devices onboard the Coastal RF vessels are often discussed around the coffee table at the FDG.

From the Coastal RF to the IMR

The otoliths are sent from the Coastal RF fishers to the IMR regularly by most of the vessels. Some of the Coastal RF fishers find the RF sampling easy and just a matter of making new routines while others have more problems finding the time to do the RF sampling. In general, the Coastal RF fishers find it time consuming to collect data according to scientific standards and procedures, since the fish has to taken out of their normal production line before it is returned and melts together with the rest of the catch that the fishers sell.

At the Coastal RF annual meeting, the otoliths are an important topic. The FDG scientists keep reminding the Coastal RF fishers about the importance of filling out the forms correctly through email, phone calls and at the annual meetings. Some of the otoliths from the Coastal RF samples arrive at the IMR without the information necessary for their traceability. Sometimes, the brown little envelopes come without any information about which vessel they come from, and sometimes the envelope is empty if the fisher has forgotten to seal it. Also, some of the otoliths from the Coastal RF often travel without the weight and the length of the fish. Since the otolith sampling is time consuming and requires more space and time, these are sometimes left inside the fish head and never travel to the IMR. However, with experience, the Coastal RF fishers are becoming quite effective otolith samplers, a process that has been interesting to follow. As Figure 12 below shows, the Coastal RF fishers collected 411 otoliths in 2006, and in 2009 they collected 2000 otolith samples.

Kystreferanseflåten

	Antall			
	2006	**2007**	**2008**	**2009***
Lengdemålinger	2 185	13 406	11 645	16 000
Otolitter	411	966	1 450	2 000

Figure 12: Data gathered by the Coastal RF from 2006 to 2009: otoliths (*otolitter*) and length measurements (*lengdemålinger*). The asterisk, 2009*, is added since the numbers are until October. Courtesy of Halvor Godøy.

The otolith readers have a special interest in the samples collected by the Coastal RF fishers, since they catch a mixture of NEA cod and the endangered Coastal Cod. The importance of the location from which the otoliths are caught is underlined by all the FDG scientists during this annual meeting. Nedreaas explained why:

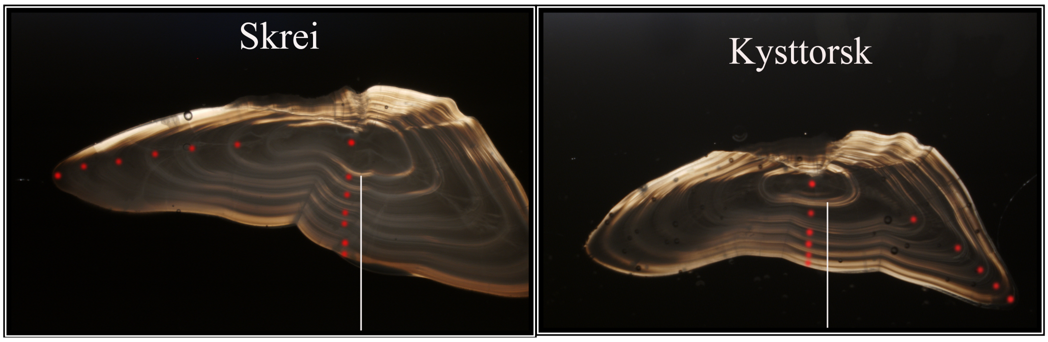
> From the fisheries we get the sales note, but this information is not accurate enough. Often, the area filled in here is where the fish is landed, which can be far away from where the fish is caught. It is crucial that we get this information from the Coastal RF since they provide us with data from areas where we [with surveys] do not have access.

While the IMR has limited access to the rocky coastal area due to the gear and vessels they use, this is where the Coastal RF vessels operate. Hence, the Coastal RF fishers provide them with valuable samples. Using the microscope, the otolith readers can tell the coastal and NEA cod apart and produce nice figures like those below.

In sum, the scientists dedicate a lot of time in order to make sure that the otoliths sampled can remain loyal representations to the fish. And of course, the fishers are doing a lot of work in order to follow the instructions from the FDG.

Haldorson			***Odd Yngve***		
Date	**Coastal Cod**	**NEA Cod**	Date	**Coastal Cod**	**NEA Cod**
28.03.2008	21	8	03.01.2008	2	18

Figure 13: Otoliths from the Coastal RF, read and analysed for the 2008 annual meeting. The fishers looked at this in the microscope and the scientists demonstrated the difference. Just a few samples were ready for the annual meeting, where the Coastal Cod and the NEA Cod has been differentiated. Later, all the otoliths were read and placed in the IMR data bank.



Picture 18: Otoliths from the NEA cod (Skrei) and the Coastal cod (Kysttorsk). Picture Curtesy of Harald Senneset

Back to the IMR: Putting Otoliths into Words

From the vessels, the otoliths travel as they are, as hard bony parts representing fish and they all end up at the IMR. Huse, as well as some of the other scientists at the FDG, has piles of the boxes filled with little brown envelopes and glass boxes in her office. All the otoliths collected by the RF and other arenas for data collection are stored at the IMR. Actually, a large amount has been collected by scientists since the early twentieth century, and they still store them, in case new methods can make it possible to get even more information from the otoliths (IMR 2010d).

We already know that the fish sampled by the RF are a part of the NEA cod stock assessment, represented by the otoliths. More specifically, the otoliths are a part of the VPA. Now, I focus on how the otoliths are transformed from an object to a number, which is the fish's age. In order to make this transformation from bony structure to number, the IMR has a lot of tools which make it possible to 'read' the otolith. So, in addition to checking the forms from the Offshore RF and punching the handwritten forms from the Coastal RF, the otoliths they send in must be 'read'.

How the 'reading' is done is where we go next. I then turn to the forms filled in by the RF fishers, which I have mentioned several times – below I introduce them properly. The otoliths cannot travel alone; they have to come with 'identification papers' which include the S and T forms and the marked envelopes. This is important since the scientists must be able to trace each otolith back to the fish head it came from, and in order to make this possible, the RF fills in the forms provided by the IMR.

Reading Otoliths at the IMR

The 'reading' of the otoliths is an important and time consuming task at the IMR. The RF fishers contribute a constant flow of these to the FDG, especially the Offshore RF which sends them in glass boxes and gets quotas in return[31]. From the FDG, they are redistributed to the IMR's otolith readers. Here, all the otoliths are read and the fish's age is determined and the coastal cod is distinguished from the NEA cod. It is obvious that this is considered an important task at the IMR. The large amount of otoliths is one clue and the extra payment the fishers get is another indication. In addition, reading each otolith is time consuming, and the otoliths are always an issue at the annual meetings. As described earlier, I can find the otoliths at the ICES as numbers.

Obviously then, somewhere during its voyage from the fish head to the ICES, it must have been transformed from a thing to something very different than an object: language. As numbers in a spreadsheet, the fish – represented by otoliths – can become combinable with all the other information that goes into the VPA. These are the numbers we can later find as age keys within the strict ICES framework.

From Bony Structures to Numbers: from Hardware to Software

At the IMR, the age readers are located in different departments, and at the FDG I see the piles of otoliths and I talk with the 'readers'. Some have their offices at the FDG and others work elsewhere. Each fish species has different people reading them, since it is a very specialized task. For instance, 'Ida' 'reads' haddock, while 'Kim' 'reads' cod. Both of them 'read' otoliths from the the Coastal RF and the Offshore RF, which are stored in Huse and Borge's offices. Maybe you have noticed that I refer to the otolith reading with quotation marks. This is because I find referring to the aging of fish as reading a bit misleading. In order to 'read' them, one needs a lot of training, a microscope and other tools. During my fieldwork, I never learnt how to do the reading myself, but I have interviewed some of the FDG scientists about the process, and this is described below.

According to scientific theories on otolith reading, aging the fish is possible because the fish's age and growth history are encoded in the microstructure of the organs (Bermejo 2007; Jones 2000). The growth pattern continues throughout the fish's lifetime, creating growth pattern in the otoliths. Hence, according to theory it is possible to make a correlation between the number of opaque or translucent rings and fish age (Campana 2001). However, it is not possible just to 'read' the otoliths as they are when they are taken out from the fish's head. Otoliths must be manipulated in order to make the rings visible. Even when the rings are made visible, an untrained eye cannot read them. The reader must undergo training in

[31] This is further described in the following chapter.

order to interpret what he/she sees when looking at the otolith. This is difficult and only a handful of people are qualified to do it.

Just after Christmas in 2008, a course was arranged at the IMR for new age-readers. Some of the scientists that participated at the course work at the FDG, and I was allowed to observe, take pictures and ask questions as the trainees practised. The course is important, because one needs to learn how to interpret what they see when they look at an otolith. According to one of the age readers, those that have years of experience of 'reading' teach the new ones. Each species has one person who is responsible for the 'reading'. The idea behind this is that if a mistake is made, or new science is developed, there is a systematic error, since it is the same person making the mistakes (personal communication, Stian). The otolith reader remains a trainee for a couple of years, and must check the reading with the 'otolith responsible'. Uncertainties are quite common, but as the 'reader' becomes more experienced, he/she seems to become more confident. The comments from the new trainees exemplify this. For instance, soon after the 2008 course, Ida stated that

> It is difficult. It is difficult to be sure. You know, you have false lines sometimes … And it is so hard on your eyes!

As time went by, their statements changed. When I visited Ida in her office in 2009, she showed me again how she 'reads' the otolith. With experience, the nature of her comments has changed, expressing certainty. For instance, she showed me an otolith under her microscope and stated:

> This is a typical line, look!

Some of the species can be 'read' from photographs, like the red fish. The cod otolith, however, needs shadow from a special angle in order for someone to 'read' the lines. I have observed how Ida read the otoliths and this is described below, mixed together with the IMR's guidelines for how to read otoliths.

First of all, Ida has to break or cut the otolith in two to see its lines: '*Break the otolith* *in two at the centre with your fingers (half of the nucleus in each part)*' (IMR 2006: 34) Then, Ida places one half into something that resembles chewing gum so it remains still and in a good position for the light: '*One half is stuck by its sharp end into plasticine or another material that is suitable for mounting. Observe the broken plane under the microscope with light coming in from the side horizontally.*' (IMR 2006: 34). Then, Ida uses a pencil to manipulate the shadow: '*Use a stick (e.g. pencil) to shadow the surface (the broken plane). The light will be refracted in the otolith towards the objective.*'(IMR 2006: 34).

Ida invited me to try it myself, and it is quite difficult, just as Ida experienced when she first started. According to Ida, it becomes quite easy after a while. As I watched the otolith through the microscope, I could see the lines, which resemble the age-rings in trees (see Picture 19). However, it can be quite difficult to distinguish the lines from one another, and there are also false lines: if the line is not complete all the way around the otolith, it is false. The handbook states that '*The hyaline zones (winter zones, narrow) will be light and the opaque zones (summer zones, wide) will be dark*' (IMR 2006: 34). Again, this becomes easier with experience, according to Kim and Ida. Concentration is vital in order to do the counting, and the age readers follow a set of rules for how they should be interpreted:

> Count the number of summer zones to determine the age of the specimen (AGE). In the first year of spawning and the subsequent spawning years, the summer zones will be narrower. The number of these zones should be recorded (SPAWNING ZONES) and the age of fish at first spawning (SPAWNING AGE) (IMR 2006: 34).

When reading the cod otoliths, it is also necessary to give each a code according to what type it is according to how the reader interprets the otoliths, from one to three:

> For cod one must decide the type of otolith (TYPE). (…) Legibility 1: Age determined with ordinary degree of certainty 2: Uncertain age determination 3: Illegible or missing otoliths (IMR 2006: 35).

When Ida 'reads' the otolith from one of the Coastal RF vessels, she notes all this information on the brown envelope, and later she punches it into the otolith files, the V forms (see figure 14 below). Some of the otolith readers also work with the RF and they both read and plot the otoliths, like Ida. Other IMR scientists get the information from an otolith reader and then punch it into a V form. One of the FDG scientists explained the process:

> The otoliths that come in are sent to the readers for the different species, and then they are registered in a file for otoliths. When they are read, I get them back for plotting [into the V form]. (E-mail communication, 18 of January 2010).

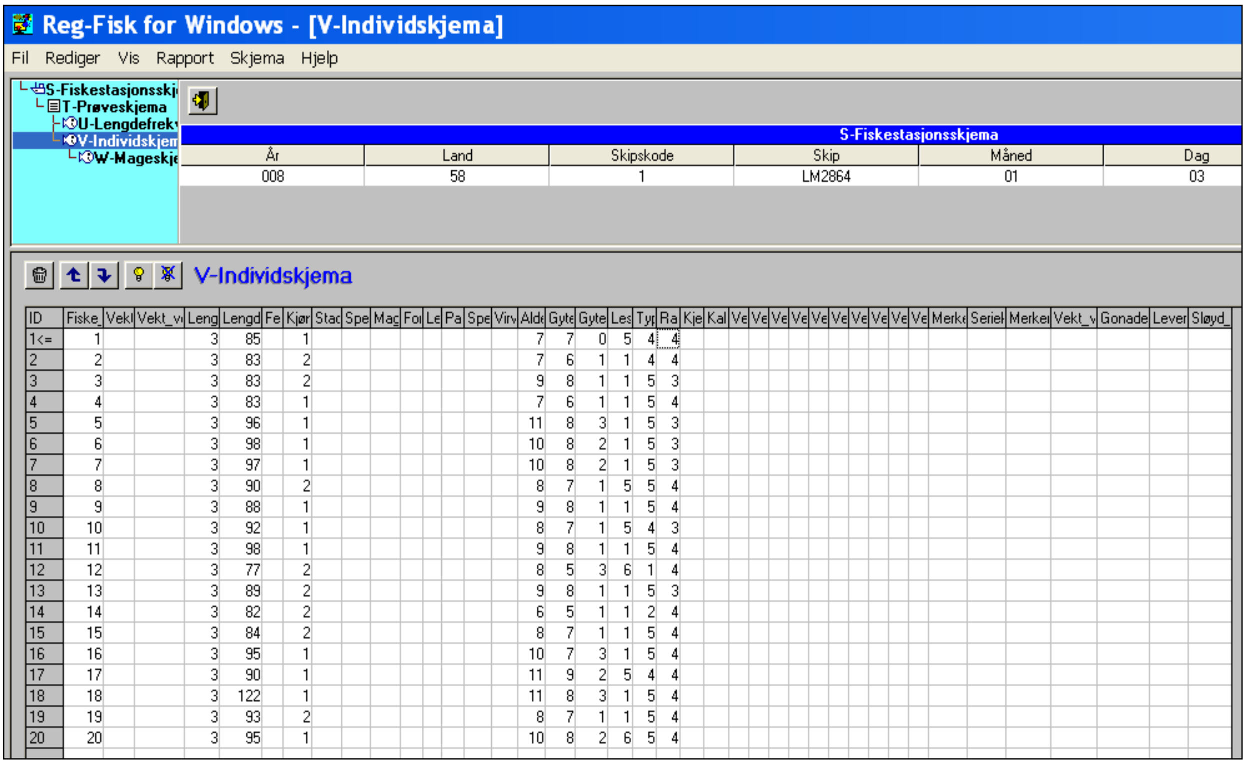
Picture 19: An age reader at work

So now, when the individual otolith is read, it can be plotted into the **V-form** (see Figure 14 below). Here, all the information that the scientists can read out from each otolith is registered, i.e., the fish age and how easy it was to read.

Once the 'age reader' fills in the V form, the otolith itself can be put aside. This is the moment when we cross the sacred boundary that divides the world from discourse (Latour 1999: 64). But like Latour's soils samples, the fish has crossed this boundary several times already. The written number now replaces the otolith, which replaces the fish which represents the NEA cod. At each of these stages, it is

> A matter of *aligning* each stage with the ones that precede and follow it, so that, beginning with the last stage, one will be able to return to the first (Latour 1999: 64)

So how can the IMR scientists follow each stage of the transformation that is necessary to include this number in their spreadsheets called the 'V-form' in the Reg-Fisk universe? This is where the forms come in. They have played a small role in this dissertation up to now, but in reality, they are key to the otolith's success. The forms make sure that the otoliths are traceable, and that we can follow their pathway back and forth over and over again.



År	Land	Skipskode	Skip	Måned	Dag
008	58	1	LM2864	01	03

ID	Fiske_	Vekt	Vekt_v	Leng	Lengd	Fe	Kjør	Stad	Spe	Mag	Fo	Le	Pa	Spe	Virv	Alde	Gyte	Gyte	Les	Typ	Ra	Kje	Kal	Ve	Ve	Ve	Ve	Ve	Ve	Ve	Ve	Ve	Ve	Merke	Seriel	Merker	Vekt_v	Gonade	Lever	Sløyd_
1<=	1			3	85		1									7	7	0	5	4	4																			
2	2			3	83		2									7	6	1	1	4	4																			
3	3			3	83		2									9	8	1	1	5	3																			
4	4			3	83		1									7	6	1	1	5	4																			
5	5			3	96		1									11	8	3	1	5	3																			
6	6			3	98		1									10	8	2	1	5	3																			
7	7			3	97		1									10	8	2	1	5	3																			
8	8			3	90		2									8	7	1	5	5	4																			
9	9			3	88		1									9	8	1	1	5	4																			
10	10			3	92		1									8	7	1	5	4	3																			
11	11			3	98		1									9	8	1	1	5	4																			
12	12			3	77		2									8	5	3	6	1	4																			
13	13			3	89		2									9	8	1	1	5	3																			
14	14			3	82		2									6	5	1	1	2	4																			
15	15			3	84		2									8	7	1	1	5	4																			
16	16			3	95		1									10	7	3	1	5	4																			
17	17			3	90		1									11	9	2	5	4	4																			
18	18			3	122		1									11	8	3	1	5	4																			
19	19			3	93		2									8	7	1	1	5	4																			
20	20			3	95		1									10	8	2	6	5	4																			

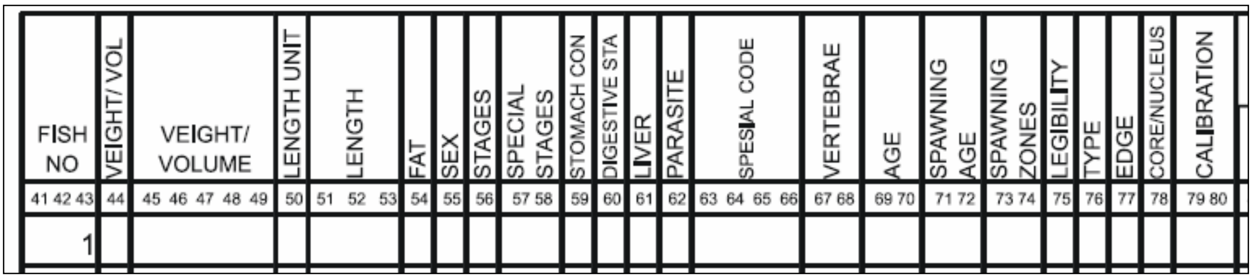


Figure 14: Reg-Fisk V form. The top figure (Reg-Fisk for Windows – [V-individskjema]) is how the otoliths look when they have been punched into Reg-Fisk after being read by an otolith reader and placed on the IMR's data bank. The bottom figure is a close up of an empty Reg-Fisk form in English, where the columns are enhanced. For instance, the first fish registered as 1 (FISH NO in the English version), is 85 cm (LENGTH in the English version) and is 7 years (AGE in the top figure).

Ensuring Traceability: The Forms

An important issue is that the numbers produced from the age reading must remain loyal representations of the fish caught by the fishers in the sea: It is crucial that the otolith samples from the RF come with an identity, and as stated in the 'bible':

> It is important that all samples have a unique identity, to ensure traceability. There must be a minimum of information along with each sample. This information may vary due to different sampling routines.

> Identity of a sample of otoliths in a station would be; date, serial number, vessel and species. When using sub-sample it is important that this information is part of the identity. In order to separate the individuals in a sample it is important that each envelope with otoliths is numbered (termed individual number). Information such as weight and length are important for the further analysis, but not for the identity. (IMR 2006: 9)

The RF fishers are trained at both giving otoliths such an identity and providing weight and length information. This training is followed up continuously, and is also an important issue at the annual meetings. For instance, Per Ågotnes comes by to inform the fishers about the otolith's importance at the IMR[32] and how to collect them according to IMR standards, at most annual meetings. He is an experienced 'reader', cod being his speciality. During the Coastal RF 2007 annual meeting Ågotnes reminded the fishers:

> The otoliths are very important to us. You are doing a very valuable job. But you *must* remember to write the species, the date and the vessel's name [on the envelope] before you send it to IMR.

If any of the otoliths come without their unique identity, they simply cannot be used in stock assessment.

Now, it is time to give the forms the attention they deserve, in order to understand what they are and the practices that are arranged around them. When the practices related to the forms are thoroughly described, we will know more about how fish can cross the divide between the world and discourse. We will also have an idea about what type of knowledge can be included in the knowledge machinery in place for stock assessment.

The S and T Forms: Providing Otoliths with a Unique Identity

Both the Coastal RF and the Offshore RF vessels send in forms that must travel together with the otoliths. These forms are called Station and Sampling Forms, and the FDG scientists always used their 'nickname': S (Station) and T (sampling) forms. In addition to the S and T forms, the Length Frequency Form, nicknamed U form, is important since this is where the length of the fish is registered. The U form information is not necessary to ensure its

[32] He was present in 2005, 2006, 2007 and 2008 but not in 2009.

traceability, but can be used for other types of analysis, and the U form will only be mentioned here. The **S, T** and **U** forms are designed by the IMR in order to enable accurate and selective representations in a manner that makes a specific relationship visible between fish and otoliths. However, what information is registered in each form can be confusing for an inexperienced person, like a fisher, an anthropologist or a novice scientist.

The **S** and **T** forms (see Figure 15) can be understood as providing each fish – each otolith – with a passport, which gives it access to a number of places whose borders are guarded by the strict rules of scientific methodology:

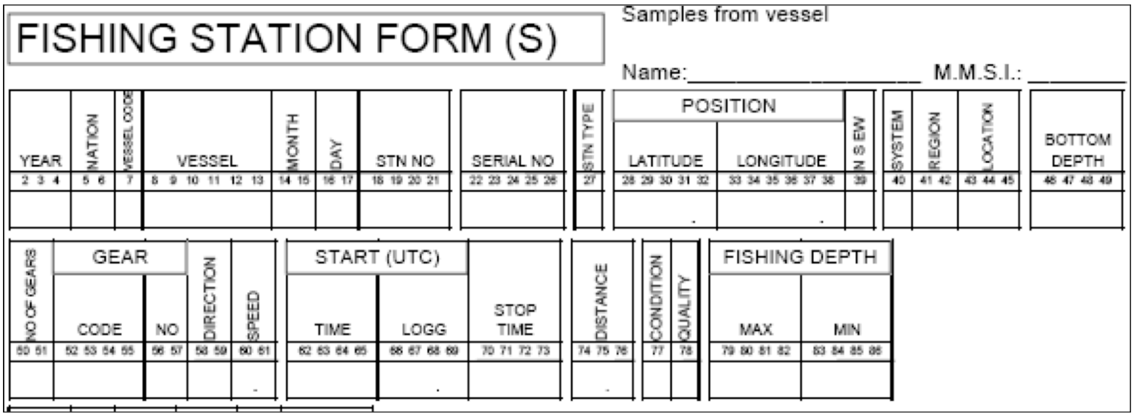
> Identity of a sample of otoliths in a station would be; date, serial number, vessel and species. (…) (IMR 2006: 9).

In the **S** form the serial number is registered, as well as data about how and where the fish was caught, i.e. the position, standing time and gear used. In the **T** form, the type of samples that have been taken is registered, i.e., otoliths, length and weight. Figure 15 below is a copy of the S and T forms from the IMR manual. It shows how the forms appear in Reg-Fisk before the information is filled in by the fishers or the scientist.

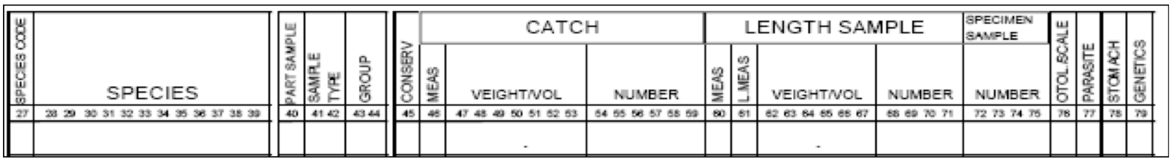
As already mentioned in my descriptions of visits to the vessels, there are some differences between the Offshore RF and Coastal RF in the process of filling in the forms that ensure the traceability of the otoliths. While the Offshore RF plot these forms directly into Reg-Fisk spreadsheets and send them by e-mail to the IMR, the Coastal RF register the information by hand in a paper version. The paper forms from the Coastal RF are then punched into Reg-Fisk by the FDG scientists, and the Reg-Fisk files from the Offshore RF are also checked carefully at the IMR. The RF fishers register their sampled fish in the forms, and importantly, the samples and the S and T forms are attached to each other through a serial number:

> The series number is used to uniquely identify the sampling station and is particularly necessary when sampling is undertaken on board fishing vessels, at factories, etc. The series number has five digits, of which the first denotes which department is responsible for the sample (e.g., Aquaculture, Fish Capture, Marine Environment, or Resources) (IMR 2006: 7).

The RF data is also denoted by a serial number which indicates that it is collected by the RF. The combination of year and serial number is a ‘unique identifier’ (IMR 2006: 48). Hence, any IMR scientist can include or exclude the RF data thanks to its identification number. Below, I will describe the processes that the form requires in detail, starting with the practices related to the Offshore RF forms.


FISHING STATION FORM (S)
Samples from vessel
Name:__________________ M.M.S.I.: ________
YEAR 2 3 4 | NATION 5 6 | VESSEL CODE 7 | VESSEL 8 9 10 11 12 13 | MONTH 14 15 | DAY 16 17 | STN NO 18 19 20 21 | SERIAL NO 22 23 24 25 26 | STN TYPE 27 | POSITION: LATITUDE 28 29 30 31 32, LONGITUDE 33 34 35 36 37 38 | N S EW 39 | SYSTEM 40 | REGION 41 42 | LOCATION 43 44 45 | BOTTOM DEPTH 46 47 48 49
NO OF GEARS 50 51 | GEAR: CODE 52 53 54 55, NO 56 57 | DIRECTION 58 59 | SPEED 60 61 | START (UTC): TIME 62 63 64 65, LOGG 66 67 68 69 | STOP TIME 70 71 72 73 | DISTANCE 74 75 76 | CONDITION 77 | QUALITY 78 | FISHING DEPTH: MAX 79 80 81 82, MIN 83 84 85 86

The Station form (S form): This form provides the otolith with a date and an ‘address’. The ‘address’ is the geographical area, a region and a location, where the fish was caught according to the statistical maps used by the IMR.


SPECIES CODE 27 | SPECIES 28 29 30 31 32 33 34 35 36 37 38 39 | PART SAMPLE 40 | SAMPLE TYPE 41 42 | GROUP 43 44 | CONSERV 45 | CATCH: MEAS 46, VEIGHT/VOL 47 48 49 50 51 52 53, NUMBER 54 55 56 57 58 59 | LENGTH SAMPLE: MEAS 60, L MEAS 61, VEIGHT/VOL 62 63 64 65 66 67, NUMBER 68 69 70 71 | SPECIMEN SAMPLE: NUMBER 72 73 74 75 | OTOL SCALE 76 | PARASITE 77 | STOMACH 78 | GENETICS 79

The Sampling form (T form): The species from which the otolith comes from is registered in the T form, i.e., cod. The serial number is also registered here. This information is crucial in order for the otoliths to be good enough to count as loyal representatives for fish. The serial number is a ‘*[U]nique identifier within a year, but not between years. A unique identifier for a sample is obtained by combining serial number and year*’ (IMR 2006: 9). Different departments at the IMR have responsibility for these serial numbers, and at the FDG, they are handed out by Borge. According to the IMR handbook (2006: 48) the Offshore RF data is given serial numbers from 86000 to 95999 and the Coastal RF data is given numbers from 27000 to 36999.

Figure 15: Reg-Fisk S and T forms with a summarized description of what information they have. The Offshore RF plots the information directly into Reg-Fisk, and some of the information is registered automatically from the FishMeter, such as weight and length.

The Offshore RF forms

The Offshore RF vessels send the spreadsheets as email to the IMR. The FDG has a computer in a corner next to the coffee table which receives all the files from the vessels. Here, the FDG scientists Borge and another IMR scientist who is a specialists on Reg-Fisk check the incoming files and make sure that all the data is received and that the system is working. From this computer, the files are sent automatically by e-mail to the FDG scientist in charge of the specific vessel.

The IMR scientist Vedholm is in charge of the Offshore RF vessel MS *Geir*, hence he checks the data registered by Jacob. Vedholm explains:

> After I have received the file (I get one from each fishing trip), I copy it to Reg-Fisk on my PC. [I] run the correction program. When the file has been corrected, it is copied to the common area [IMR's files for the annual material and for payment]. (Email, 18th of January 2010)

According to Vedholm and other FDG scientists, there are always some mistakes made in the process of punching the data. Mostly, the fishers forget to fill in some of the columns, and this is checked and filled in by the FDG scientists. Some of the Offshore RF fishers have already provided the otoliths with a series number, and sometimes this number is plotted by the FDG scientists.

In light of the above, ensuring the traceability of otoliths collected by the Offshore RF is quite straightforward. Nevertheless, I know that the FDG scientists spend a lot of time working with these forms, since I have studied their practices. However, what mainly takes time with regard to the forms from the RF is what has to be done to the Coastal RF forms. As described in the following, it takes a lot of work to ensure that the Coastal RF otoliths are traceable.

The Coastal RF forms

The forms that travel together with the otoliths to the IMR from the Coastal RF are paper versions that are filled in by hand by the fishers (see Figure 16 below). The Coastal RF fishers register information on the S and T forms by hand and send these continuously by mail to the IMR. Each Coastal RF vessel has its own folder at the IMR, where the forms are filed. At the

IMR, this information must be punched into Reg-Fisk by the FDG scientists. This is an important – and time consuming – difference between the Offshore RF and the Coastal RF:

> Vedholm: The difference between the data [from the Coastal RF and the Offshore RF] is that the sea going vessels send us a file that is punched. From the Coastal RF, the data must be punched. (Email, 18th of January 2010)

Hence, making sure that the otoliths are traceable entails some extra work in comparison with the Offshore RF otoliths which already travel quite easily into the IMR's data flow. At the FDG, they refer to the unchecked forms from the RF as 'raw data'.

In the following, I will point to the specific challenges with the S and T forms for both the fishers and scientists. From my visits to the Coastal RF vessels and talking to the Coastal RF fishers at the annual meetings, I know that some of the information the FDG want is quite straightforward for them to fill in, while some of it is more challenging. Since I was hired to punch the forms from the Coastal RF, I have detailed knowledge about the challenges that both the Coastal RF fishers and the FDG scientists encounter to ensure the otoliths' traceability. In order to fill in the schedules, some choices must be made, and there are some practical obstacles both for fishers and scientists in this process of creating data from the RF. It is important to keep in mind that the Reg-Fisk and the forms are all made for standardized scientific surveys, which does not necessarily correspond with the reality of fishers.

In order to describe this thoroughly, the Coastal RF vessels must be revisited and then we follow the forms to the IMR where the FDG scientists plot them into the Reg-Fisk files installed in their computers. However, let me first describe the already mentioned 'bible' – the 'Manual for Sampling of Fish and Crustaceans' – in more detail since the FDG scientists rely heavily on this in order to do the punching of the forms.

SKJEMA TIL REGISTRERING AV FANGST OG BIFANGST FOR KYSTREFERANSEFLÅTEN

FARTØYETS NAVN:	KALLESIGNAL:	REG. MERKE:	STØRSTE LENGDE:
SKIPPER:	**ADRESSE:**		

FANGSTDATO	Mnd	Dato	Mnd	Dato	Mnd	Dato
OMRÅDE/ LOKASJON	Omr	Lok	Omr	Lok	Omr	Lok
POSISJON	’N	E	’N	’E	’N	’E
REDSKAP (antall/ maskevidde)						
FISKEDYP						
STÅTID						

TOTAL FANGST & BIFANGST AV FISK (KG. RUND VEKT, ANTALL, UTKAST ANTALL) OG SKALLDYR (ANTALL)

	Fangst kg	Fangst antall	Utkast antall	Fangst Kg	Fangst antall	Utkast antall	Fangst kg	Fangst antall	Utkast antall
TORSK									
HYSE									
SEI									
BREIFLABB									
ANDRE ARTER									

Figure 16: S and T Forms, blank version of the paper form used by the Coastal RF.

The Bible: Coding the Data according to Standard Form

The 'Manual for Sampling of Fish and Crustaceans' is an important tool for the FDG when plotting the Coastal RF data. It is cheerfully referred to as 'the bible' by the FDG scientists, since 'everything', all the information that is punched into Reg-Fisk, must be done according the guidelines and codes in the manual:

> This manual describes the procedures used in sampling of fish and crustaceans by the Institute of Marine Research (IMR), Bergen in sampling of fish and crustaceans. It includes the field sampling and the entering of data into electronic media. The objective of the manual is to ensure that the biological material related to fish and crustaceans which is collected on board research vessels, contracted vessels, coast guard vessels, fishing vessels, as well as in factories and laboratories after landing, are sampled in a uniform manner according to specifications given here (IMR 2006: 2).

It is evident to me why the FDG members call it the 'bible': This is the holy book in terms of data registration since this is where the whole ethos is found: where to register what, which codes to use and where to find other information. In the manual, some important procedures are described, such as how to do the sampling of fish and crustaceans according to simple, pre-determined steps. Also, the manual describes how to do the 'coding and filling of forms' in order to fill in the standard forms correctly. This is important, since the forms from the Coastal RF vessels come to the IMR as handwritten schedules, hence the FDG scientists must code the data and fill them into the standard Reg-Fisk forms according to the manual. In short, the bible contains the descriptions of the action sequences that the IMR scientists – and the fishers – should follow (Callon 2002).

The Scientists' First Meeting with the Coastal RF Forms

The Wednesday meetings, described in chapter 4, gave me the opportunity to study how the FDG scientists do the punching of the Coastal RF forms. Here, I can observe how the scientists work with the RF data. Actually, I observed when some of the FDG scientists were trying to punch the handwritten Coastal RF forms for the first time.

Even though the FDG scientists all have used Reg-Fisk for many years with the data from other sources such as surveys, this seems to be different somehow and they do not know how to start. 'Mary', who is an experienced 'puncher', is trying to interpret the data from the paper schedule in front of her that corresponds to Reg-Fisk S and T forms. This is her first meeting with the Coastal RF handwritten forms. Before we went to the meeting, 'Astrid' explained to me that she is glad to have Mary in our group, because she is very good at the punching: she is very familiar with the Reg-Fisk program, and does the punching quickly.

> **Fieldnotes (01.10.08):**
> Mary asks Astrid: *How do I read this?*
> She is referring to the schedules filled with handwritten numbers handed in by one of the CRF vessels. Astrid is looking at it together with her (the s-schedule), and explains: *This [number] is half a mesh. That is the same as '*stolpelengde*'. We need to look it up somewhere.*
> They both look it up on the internet, and find rules for how to convert measurements.

Even experienced scientists find it difficult to plot the data from the fishers into Reg-Fisk, at least to begin with. Mary explains:

> **Fieldnotes (01.10.08):**
> The data from the Coastal RF is raw data. This is new to us, and it is important that we get it right. When we are on surveys, the researchers are placed in the lab [in the vessels] and we measure with an electronic device [FishMeter] that converts all the data directly into Reg-Fisk. Also, the gear used is standard gear.

Some of the schedules in front of us have stains of fish blood and guts, and they smell funny; and it seems logical to consider the fomrs as 'raw' in comparison to the clean and tidy numbers on a computer spreadsheet.

Different problems that the punchers encounter are discussed at these meetings. Quite often, the scientists have doubts about gear codes or other aspects, like the area, that are important to them. The issue of gear codes is repeated at most of the meetings. Astrid says that she will ask the fishers at the annual meeting (Coastal RF annual meeting in 2007) to fill out the gear codes themselves, so we don't have to do so much detective work. 'The bible' provides the scientists with all the necessary information such as codes for the different gear types and the standard names for fish. If the procedures described in the manual are not followed, or there is no code for an item, Reg-Fisk does not accept it. This can sometimes be tricky, since the fishers' way of fishing often does not follow the standardized universe of Reg-Fisk, which is made for collecting data from scientific surveys. These issues and obstacles are also related to the use of CPUE data, which will be thoroughly described later.

So, scientists with experience of using Reg-Fisk encounter problems when plotting the Coastal RF forms. This is comforting for those of us that are new to this, like myself.
Some of the issues we encountered when first filling out an S form and a T form together with Huse is described below. Now, I will describe how the Coastal RF handwritten forms are filled in by the FDG scientists according to the uniform standard required by Reg-Fisk and some of the challenges this gives scientists.

Punching in Action: Translating Coastal RF 'Raw Data' into Data

In order to describe some of the challenges with punching the Coastal RF data – translating it from raw data to data – I will give some examples from my own experiences as a puncher. This is going to be a meticulously detailed description. This is necessary in order to give an impression of all the work that is behind each otolith that has been transformed from raw data to data. In addition, this is an introduction to Reg-Fisk which choreographs the flow of information from the sea to the IMR's data bank. Also, these forms show how a lot of information travels to the IMR in addition to the otoliths. Hence, the information in the forms is related both to otoliths and other 'stuff'.

Being a 'Novice Puncher'

As described in chapter 4, Huse is teaching a new FDG scientist and me how to punch the Coastal RF forms. We are in her office, with a Coastal RF form in front of us, a copy each of 'the bible' and laptop with Reg-Fisk installed. First of all, Huse makes us work with the S form (see Figure 16 above for an example of the S form):

Fieldnotes (01.10.08)
S form: In the field where it says 'gear', the fisher has written 65/63. This does not mean anything either to me or the FDG apprentice. To Irene however, this says a lot. She explains that the first number [65] is the number of gillnets, the other [63] is mesh size. Irene looks in the handbook, looking for the code that is used to translate this type of gillnet into a 'language' that Reg-Fisk understands. At page 97 in the "bible" she finds the table for gear codes. Here, the codes for different gear such trawls, Danish purse seines, gillnets and traps etc. are gathered

This sounds simple. Huse finds the code for gillnets in general: 40. However, this should be specified as either bottom or floating gillnets. So which gillnet did this vessel use? Somehow, Huse knows that the fisher has been using haddock gillnets, which is a bottom fish, hence we plot a code for bottom gillnets: 41. But Reg-Fisk wants more information: it wants us to specify what type of net has been used – monofilament, nylon, etc. – and it also wants to know the mesh size. We are all looking through the 'bible' to find a code that corresponds to mesh size 63 under bottom gillnets, but we cannot find it. After looking in the bible and some discussion, Huse figures out that the fisher is giving us the *stolpelenge* which is another measurement used by fishers. The FDG apprentice knows these terms since he used to be a skipper; to me however, it is a new term. This is different from the mesh size, since this is the whole length of the mesh, Huse explains to me. She does the maths, and finds that if the *stolpelengde* is 63, then the mesh size is 130. Accordingly, we have to find a code under bottom gillnets that corresponds to 130 mesh size. It is a lot of work in order to translate just one little piece of information from the Coastal RF handwritten schedules to a standardized code in the Reg-Fisk forms.

Another Coastal RF vessel has written something just next to the numbers for gear codes: '250/8.25 OMF'. I do not know what 'OMF' means so I ask Huse for help. She explains that this is '*omfar*', another measurement used by some fishers.

Fieldnotes (01.10.08):
Huse has a table for converting '*omfar*': 0.627 x 8.25=0.076 metres =76 mm. According to Huse this gives us the *stolpelengde* for 8.25 *omfar*. We are not done yet: *Stolpelengde* is half a mesh size, so we have to convert this to mesh size: 76 x 2= 152.

Now, we now the mesh size, but we need to know if the fisher used bottom gillnets or what? Huse looks at what type of fish he has delivered from the T form; this is mostly haddock and cod, so, according to Huse, we can be quite sure that we are looking for bottom gillnet codes.

Fieldnotes (01.10.08):
I look in the bible for a code that can translate bottom gillnets with 152 mesh size, but there is is no code for 152. Then, I look for 150, but there is no code for this mesh size either. I find the code for half mesh size 76 mm. Now, I encounter a new problem: this code is for gillnets made of monofilament. What did this fisher use: monofilament, nylon or something else?

The whole process is really frustrating. In order to translate the Coastal RF forms into Reg-Fisk codes, a lot of work must be done. Sometimes we have to convert the measurements fishers traditionally use, and sometimes there is no code for the specific mesh size they use. In addition, it should be specified if the fisher uses a monofilament gillnet or something else, which is information we do not have. Hence, in order to find it out, it is sometimes necessary to call the fisher. We continue to punch the information from the schedules filled out by the Coastal RF fisher for the S form: the radio signal, the date of catch, the area and location, the fishing dept and time.

Soon I learn that a challenge with the data from some of the boats is that they use the traditional fishermen's measures of '*omfar*' and '*favner*' that must be converted into modern measurements such as mesh size and metres, respectively, on which the Reg-Fisk data program is based. In addition, I cannot find some of the gear the fishers have recorded using in the schedule. I ask the other scientists, but they do not know either. They seem as puzzled as I am. Mary explains that this information is very different from what they are used to from the research vessels: the time that the fishing gear has been in the water and the fishing gear is registered automatically and is standardized. As described above, this process is quite similar to how the Offshore RF vessels fill in the forms.

Later, we turn to the information in the T form, or the Sampling form (see Figure 16). This is where the name of the species of the fish is registered. Hence, filling out the T form means registering all the fish caught and registered by the fisher in the schedule. Two pieces of information are of particular importance when filling out the T form: (1) catch and by-catch and (2) if any samples have been taken. First, it is important to register the fish that is landed, and the by-catch, the fish that is thrown out for some reason. The species names have to be filled in according to what are considered as 'valid species names' in 'the bible' (IMR 2006 table four, page 92). While some of the forms from the Coastal RF fishers are filled with fish names, some of the forms have only a few. Huse explains that this depends on where the fishers are fishing and what gear they use. Filling out the T forms is quite straightforward, but can be time consuming if there is a lot of different species registered as catch or by-catch. It is important to 'tell' Reg-Fisk what language is used to register the fish names, i.e., Latin, Norwegian or English. In addition, one must learn the standardized names for fish, and know when to use the name in plural or singular, since Reg-Fisk only accepts a given standard version of the name.

If the fisher has taken otolith samples, as well as any other samples such as length and weight, this is registered in the T form:

> Part number is usually 1, since the standard procedure is to take one sample of each species at each station. If several samples (part samples) are taken, they are given consecutive part numbers and each part number is assigned a line on the T-form. When only the length frequency is measured, it is called sample type 10. When individual sampling for age, weight, maturity etc. is carried out it is called sample type 20 or 21 (IMR 2006: 9-10)

The specific information from the age samples is filled in by the otolith readers who have been trained to read the otoliths and fill in the required information. There are several procedures for how the sampling and preparing of age material, age estimation and quality assurance should be done, and most of these are species-specific (IMR 2006: 3). This information is thoroughly described in the 'Manual for Age Estimation of Fish'.

The serial number for each form is crucial, as already mentioned. For the RF vessels, Borge provides the punchers with serial numbers which uniquely identify the sampling station, which is

> particularly necessary when sampling is undertaken on board fishing vessels, at factories, etc. The series number has five digits, of which the first denotes which department is responsible for the sample (e.g.,

Aquaculture, Fish Capture, Marine Environment, or Resources) (IMR 2006: 7).

At the beginning, all of the codes and the field for codes were quite meaningless to me. However, it is becoming obvious that the Reg-Fisk, with its corresponding Manual or bible, is a data program that has a lot in common with the VPA: it is picky, and accepts only quantitative data that is fed to it in a certain way or in codes. Reg-Fisk is an important tool for the FDG scientists, and a lot of time is spent on transfering the information on forms handed in by the Coastal RF into Reg-Fisk.

Plotting Coastal RF Forms: An example from a puncher's everyday work

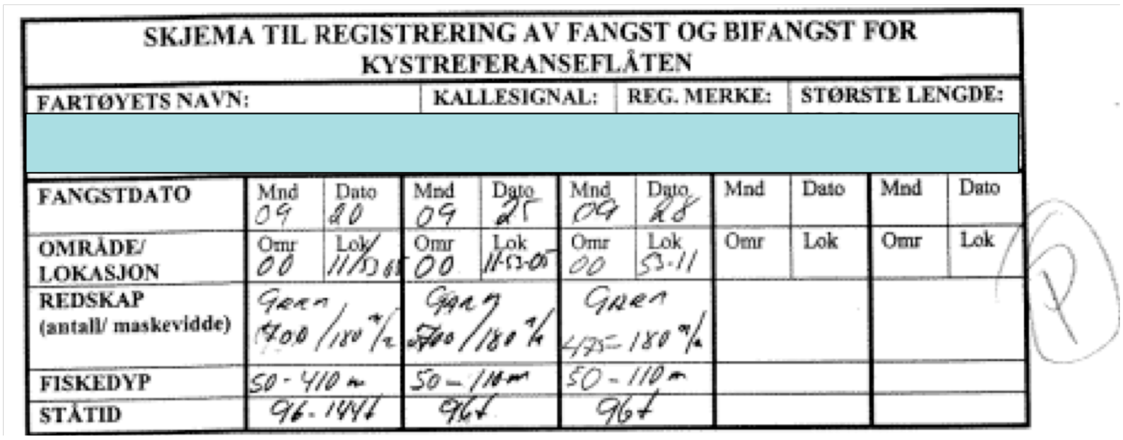
Now then, let us jump to my time as a 'puncher' for the FDG. Based on my experience plotting the data as well as observing the FDG scientists doing the plotting, I know that scientists meet some practical obstacles that must be overcome, and some choices must be made in order to transform the schedules into Reg-Fisk. Below, I will describe how Reg-Fisk works in detail, in the context where I had become more experienced in punching the forms. Even as a fairly experienced plotter, translating raw data into data takes time. However, for now I am familiar with the different measurements such as '*favner*' and '*omfar*', and can concentrate on the punching of data.

This section is based on the punching of handwritten S and T forms from one of the Coastal RF vessels. The vessel's identity is made anonymous, according to the agreement between the IMR and the RF fishers. I will refer to it as 'Coastal RF vessel X'. 'Coastal RF vessel X' is considered a 'good boat' by the FDG since it delivers raw data continuously. It is also a good example of the problems the scientists can meet as they do the punching, with regard to the practical obstacles they encounter with integrating the fishers' data into Reg-Fisk. The paper forms correspond with the standard spreadsheet version – Reg-Fisk – used during surveys and by the Offshore RF, as Figure 17 below demonstrates. This is the form that I will refer to in the following.

It looks easy and straightforward just to fill in the information from the paper form to the Reg-Fisk file, or use the 'bible' to transfer the information that needs a code into a code. Well, in theory, it is. In practice however, there are some quite specific and interesting challenges with transferring the Coastal RF forms to the IMR's spreadsheets since fishers' practices differ quite a lot from the practices of standardized surveys.

The S form

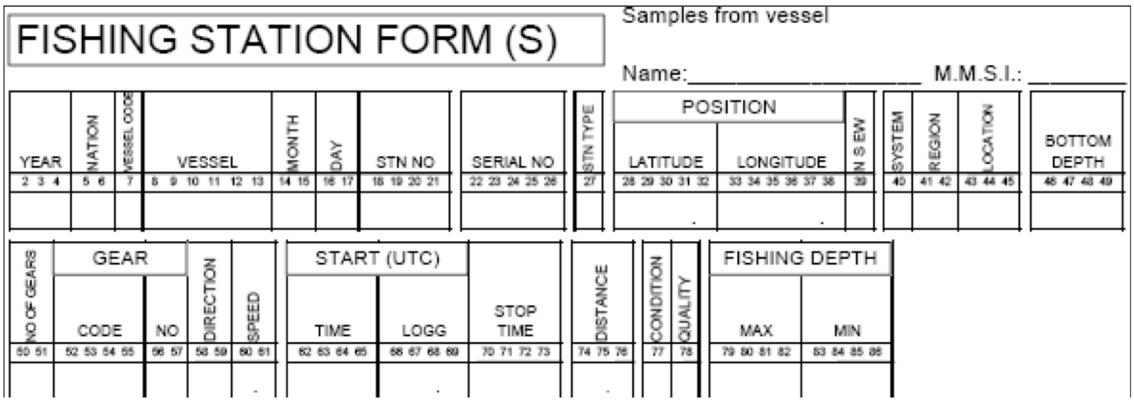
As I am getting some experience with the punching, I know how to organize my desk. I have the form next to my right hand, the laptop in front of me with the Reg-Fisk program open, and the ‘bible’ is ready for use in order to find the code necessary in order to transfer the handwritten information to the spreadsheet. Even if the IMR considers ‘Coastal RF vessel X’ to be a ‘good Coastal RF vessel’ since it delivers a lot of data, it is a tiresome vessel to punch since I have to use ‘the bible’ a lot. This is because it keeps changing gear every day and fishing at different depths. Like many of the Coastal RF vessels, X often uses a mix of gears, depth and times, which is difficult to fit into the Reg-Fisk universe.



SKJEMA TIL REGISTRERING AV FANGST OG BIFANGST FOR KYSTREFERANSEFLÅTEN

FARTØYETS NAVN:	KALLESIGNAL:	REG. MERKE:	STØRSTE LENGDE:

FANGSTDATO	Mnd 09	Dato 20	Mnd 09	Dato 25	Mnd 09	Dato 28	Mnd	Dato	Mnd	Dato
OMRÅDE/ LOKASJON	Omr 00	Lok 11/13 65	Omr 00	Lok 11-13-05	Omr 00	Lok 53-11	Omr	Lok	Omr	Lok
REDSKAP (antall/ maskevidde)	Garn 400/180 m/m		Garn 500/180 m/m		Garn 475=180 m/m					
FISKEDYP	50 - 410 m		50 - 110 m		50 - 110 m					
STÅTID	96 - 144t		96t		96t					



FISHING STATION FORM (S)

Samples from vessel

Name:________ M.M.S.I.: ________

YEAR	NATION	VESSEL CODE	VESSEL	MONTH	DAY	STN NO	SERIAL NO	STN TYPE	POSITION LATITUDE	POSITION LONGITUDE	N S EW	SYSTEM	REGION	LOCATION	BOTTOM DEPTH
2 3 4	5 6	7	8 9 10 11 12 13	14 15	16 17	18 19 20 21	22 23 24 25 26	27	28 29 30 31 32	33 34 35 36 37 38	39	40	41 42	43 44 45	46 47 48 49

NO OF GEARS	GEAR CODE	GEAR NO	DIRECTION	SPEED	START (UTC) TIME	START (UTC) LOGG	STOP TIME	DISTANCE	CONDITION	QUALITY	FISHING DEPTH MAX	FISHING DEPTH MIN
50 51	52 53 54 55	56 57	58 59	60 61	62 63 64 65	66 67 68 69	70 71 72 73	74 75 76	77	78	79 80 81 82	83 84 85 86

Figure 17: The top form is a copy of a handwritten S form, handed in by ‘Coastal RF vessel X’. The handwritten and circled ‘p’ is added by me to register this form as punched. The bottom form is a copy of the corresponding Reg-Fisk file into which I am transferring the ‘raw data’ into data.

First of all, it is important to give the form a serial number. This is not written in the paper form, but is given to the puncher by Borge. Then, one can start punching the paper form into Reg-Fisk. The first row, labelled ‘Fangstdato’, is the *date*, which is easy with this form: I just punch in the dates ‘20.09.2008’, ‘25.09.2008’ and ‘28.09.2008’. Sometimes, the fishers have registered two days of fishing, which is related to the standing time, an issue to which I will return below. The second row, 'Område/Lokasjon' means 'Area/Location'. The registration of one area and one location is based on statistical maps. These are the maps used in the previous chapters to show the location of the vessels I visited during fieldwork. Hence, for the assessment of fisheries, a special set of maps have been made, which are referred to as a 'system for geographical region' (IMR 2006: page 40 and 131). As you can see from this form, he has been fishing in different areas the same day:

Fieldnotes 10.12.08, Form from 20–28 September
The 'CRF vessel X' has fished in the same area according to this S form: area 00 for all the different dates registered here. However, the location varies, and they are multiple. He has registered three locations: '11-53-05' on 20 September, '11-53-05' on 25 September and '53-11' on 28 September.

Fishers' actions are not organized around these statistical maps, like surveys, and often they fish in two of the statistical areas. That is how fishing is done in reality; fishers fish where they believe they will find fish. But my problem is that Reg-Fisk only accepts one area code, since there are only four digits available, as the above copy of the empty Reg-Fisk file shows (digits16–21 in the form above). So, how do I register this information in Reg-Fisk, whose material reality only accepts one area? I ask one of the FDG scientists, who tells me to find out which area is mostly used, or just choose an area and stick with it. Hence, I choose to punch the first number that dominates all this vessel's S forms: 11. In the surveys where fisheries-independent data is collected this is standard and the samplings are done according to the map, and there are also set stations where samples are taken every year in order to ensure the standardization of data[33]. The Coastal RF fishers do not seem to care much about the statistical areas that have been made in order to register where fish is caught.

'Redskap' is the next row and means gear. This is a recurring issue when plotting Coastal RF forms. With this particular form, 'Coastal RF vessel X'has used a 700 gillnet links with 180 mm mesh size. I have to look for a code for this in the 'bible'. On other days, 'Coastal RF vessel X' has registered a gill net of 240 mm of some sort, and this does not have a code in the bible. I asked X's mentor what to do when there is no code for the gear:

[33] For the most important surveys,, see IMRs webpage (IMR 2010c)

Chose a code and stick to it, or use 4110 code [unspecified bottom gillnet]. It's important because if somebody wants to check the length frequency of this fish when using different gear, then it must be accurate and valid.

In this S form the gear information is straightforward, since I can simply punch in the code for 180 mm gillnets. In other forms I have punched, 'Coastal RF vessel X' has used a mix of gear, where the mesh size differs between 93 and 96 millimetres. The problem is that Reg-Fisk only accepts one type of gear. Since Reg-Fisk, and hence the 'bible', is made for registering data from surveys, there are only codes for the standard gear used during such surveys. Fishers, however, want to find as much fish as possible with the gear they have at hand: hence, they may use a mix of gear based on what they have available and what they think is effective. When I ask the FDG scientists for help, they all underline that it is very important to be consistent. Every time 'Coastal RF vessel X' or any of the other vessels for which I punch forms changes gear, I look for it in the 'bible'. If it is not there, I use the 'unspecified' code, 4110.

The following column states 'fiskedyp': fishing depth. As one can see from the above example, this varies quite a bit from day to day. There are three rows for punching the depth in Reg-Fisk, the minimum and the maximum depth, and the mean depth. Hence, all I have to do is plot in the information, and then I have to calculate what the mean depth is. Since the depth varies from day to day, I must do the calculations for each day. Some of the fishers use fathoms instead of metres, and then this must be converted into the metric system used in Reg-Fisk.

The last column to plot in the S form is 'ståtid', which directly translated means standing time, but it is more common to refer to this as 'effort'. The effort aspect is quite tricky to punch into Reg-Fisk with 'Coastal RF vessel X. Sometimes he leaves the gear in the water for more than 99 hours, such as on 20 September, where he has written 96–144 hours. There is no way to fit that into Reg-Fisk since there are only two digits available for standing time. Again, I call one of the more experienced FDG punchers, and the solution is to plot the maximum standing time: 99 hours. Figure 18 (below) is an example of how the S form looks when it has been integrated with all the other S forms in Reg-Fisk.

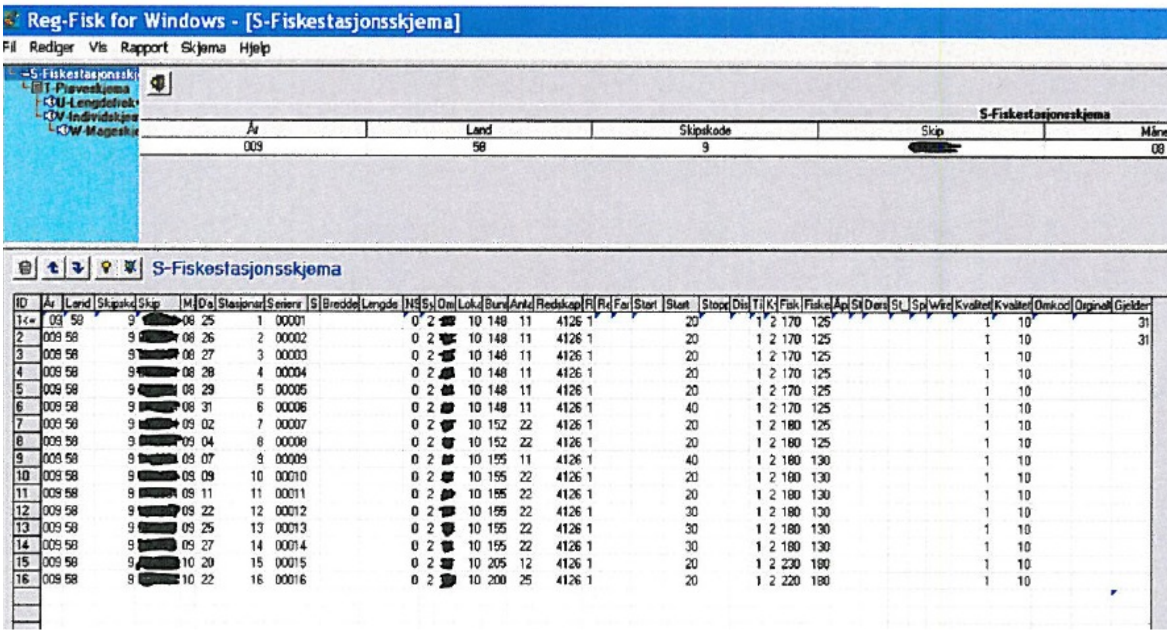
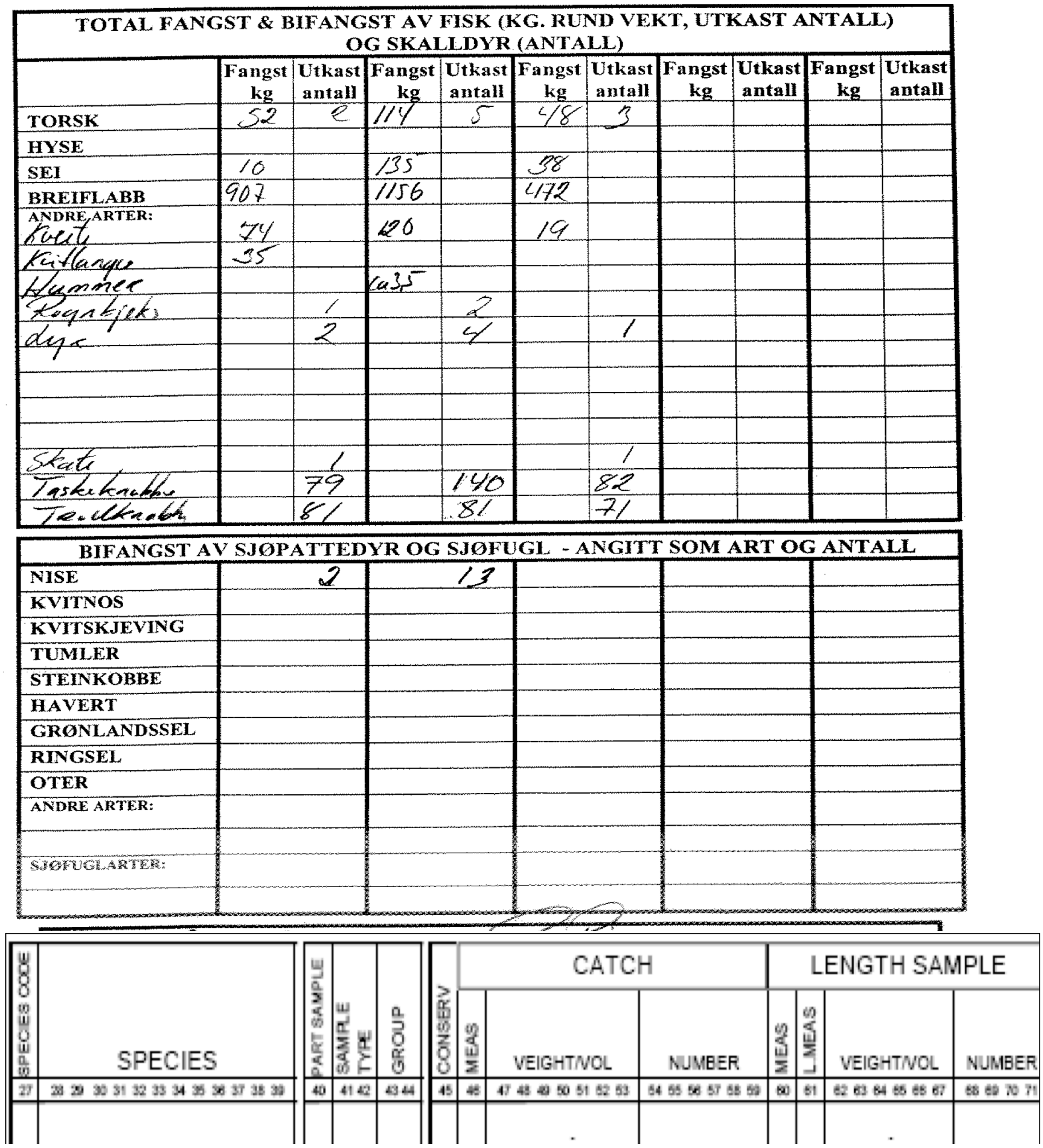


Figure 18: Several S forms in Reg-Fisk. This is how the S forms look when they are punched into Reg-Fisk.

The T form

The T form is where the catch and by-catch is registered, and how much the fishers caught (see Figure 19 below). In the T form handed in by ‘Coastal RF vessel X’, it looks quite straightforward: as one can see from the figure, he has caught a number of species, including cod, saithe, angler fish, halibut, ling, female lumpfish, and pollack, and some of these species are registered as by-catch as well. At the bottom he has added three species which are by-catch only: skates, edible crab and deep sea king crab. Whatever the fishers can sell is considered catch. The other ‘stuff’ is by-catch, which normally is thrown back into the sea.



TOTAL FANGST & BIFANGST AV FISK (KG. RUND VEKT, UTKAST ANTALL) OG SKALLDYR (ANTALL)	Fangst kg	Utkast antall	Fangst kg	Utkast antall	Fangst kg	Utkast antall	Fangst kg	Utkast antall	Fangst kg	Utkast antall
TORSK	52	2	114	5	48	3				
HYSE										
SEI	10		135		38					
BREIFLABB	907		1156		472					
ANDRE ARTER: Kveite	74		120		19					
Kvitlange	35									
Hummer			ca35							
Rognkjeks		1		2						
[illegible]		2		4		1				
Skate		1				1				
Taskekrabbe		79		140		82				
Trollkrabbe		81		81		71				

BIFANGST AV SJØPATTEDYR OG SJØFUGL - ANGITT SOM ART OG ANTALL					
NISE	2	13			
KVITNOS					
KVITSKJEVING					
TUMLER					
STEINKOBBE					
HAVERT					
GRØNLANDSSEL					
RINGSEL					
OTER					
ANDRE ARTER:					
SJØFUGLARTER:					

SPECIES CODE	SPECIES	PART SAMPLE	SAMPLE TYPE	GROUP	CONSERV	CATCH MEAS	CATCH VEIGHT/VOL	CATCH NUMBER	LENGTH SAMPLE MEAS	LENGTH SAMPLE L.MEAS	LENGTH SAMPLE VEIGHT/VOL	LENGTH SAMPLE NUMBER
27	28 29 30 31 32 33 34 35 36 37 38 39	40	41 42	43 44	45	46	47 48 49 50 51 52 53	54 55 56 57 58 59	60	61	62 63 64 65 66 67	68 69 70 71

Figure 19: Reg-Fisk T form. This T form is the paper copy filled in by hand by a CRF vessel, the form below is the corresponding Reg-Fisk file T form into which I punch the data. The fish is registered in kilograms of weight. This T form corresponds with the above S form, for 20–28 September. If the CRF take otolith samples these are put in an envelope that is marked, and this is registered by the puncher, plotting 2 (in columb 76 otol/scale in the below form).

Plotting this information into Reg-Fisk is not as straightforward, since there are a lot of codes I must use in order to make the program understand. In addition, Reg-Fisk wants to know a lot of things about the catch, such as if it is frozen or fresh fish. Most of this information is given to Reg-Fisk as codes, which one can find in the 'bible'. The electronic T form is based on abbreviations, so it is easier to follow the digits. Hence, I will refer to the column number (T + number) as it appears in the 'Reg-Fisk T form' in Figure 19 (above), so it is possible to follow how the information in the paper forms is registered in the Reg-Fisk spreadsheet[34].

The first information I must give Reg-Fisk when punching a T form is that I am using Norwegian names, instead of for instance Latin names. The code for Norwegian names is 2, so I punch 2 in column T27 for the species code. Then I register the species registered by 'Coastal RF vessel X' by name in the field for species, T28-39, which delimits the characters in the species name to 12 letters. I have to check exactly how the names should be written, since they must be valid species names:

> Valid species names are found in Table 4 of the annex (p. 92). The list is based on the NODC (National Oceanographic Data Center, US Department of Commerce) taxonomic list. If the species name does not take all the twelve positions additional remarks may be added, e.g., marking a catch for a special purpose or designating sub-species or special groups of a species. Such a remark should be separated from the species name using an apostrophe („). (IMR 2006: 9)

There are two main categories for the catch, which should be filled in T40; catch is coded 1, while by-catch is coded 2. The group column, T43–44, is related to the by-catch and catch information (T3). If the samples are taken from the catch then it is registered with the code 23, while by catch is coded as 26. The conservation of the fish is registered in column T45, and with the Coastal RF it is always fresh, which has the code 1. The measurement (T46) is where the catch is registered in kilograms or tons, and the by-catch is counted (registered in column T54–59). The different species that are caught are registered in kilograms or tonnes. Tonnes is coded as 5 in Reg-Fisk, this is better because then you don't have to add so many zeros[35]. If the fish has been measured, the method used to measure it must be described in column T62. How to measure the different species is thoroughly described in 'the bible', and must be coded according to its guidelines with different letters. The most common code I register when I am punching is the letter 'E', which means that the

[34] In the version of the handbook I used as I did the punching, these digits are different since it is a more current and Norwegian version. The handbook I have used here is an internet version from 2006 which was more practical since it is in English and since it is digitalized. What is important is that it is possible to follow the punching in detail here.

[35] As I first started punching, I was told that I could choose between tons and kilograms. Later, this was changed to make sure that no mistakes where made when using Reg-fisk later, making kilograms the standard.

fish has been measured ‘from snout to the end of tail when in natural position’ (IMR 2006: 112). In this particular form, no measurements have been registered.

Finally, in the bottom part of the form, there is a special section for the by-catch of marine mammals and sea birds. As mentioned above, this is coded 2 in T3. This information is quite sensitive in the fisheries context since there are some controversies both with regard to birds and mammals as by-catch. In this particular form, the fisher has caught two harbour porpoises on 20 September and thirteen on 25 September.

In addition, I must check if the Coastal RF fishers have taken some samples such as our main character here, the otoliths, or length measurements. This is written on a different form by the fishers, and it is important to register this in the T form where it says ‘Otol/Scalet’ (T76):

> The otolith/scale space should be filled in if the individual sampling includes age reading (scale readings coded as 1 and otolith readings as 2) (IMR 2006: 10).

Actually, none of the forms I have punched have had otoliths samples, only length samples which are punched in the U Forms. Hence, I ask one of the FDG scientists, about the procedure, and he explains that if otoliths have been sampled this is registered by the otolith reader, who also may be punching Coastal RF forms. Let me remind you that these forms, the S and T forms as well as the V form where the otoliths are registered, are all linked to each other through the serial number which is registered in the S form.

After all the information is registered in both the S and T form, I can run a test-program to check if there are any errors in the plotting. This program is a part of the Reg-Fisk set up on my computer. If any mistakes are made, even the most minuscule one like a comma, it is not accepted. Reg-Fisk does not allow any information that does not follow the standard codes and procedures to remain in its spreadsheets. For instance, the local fish names all have to be translated into standard names that fit Reg-Fisk. Reg-Fisk only accepts them as they are written in the ‘bible’. Most of the time a couple of errors are detected by the system which must be corrected, such as an extra comma or a misspelled name.

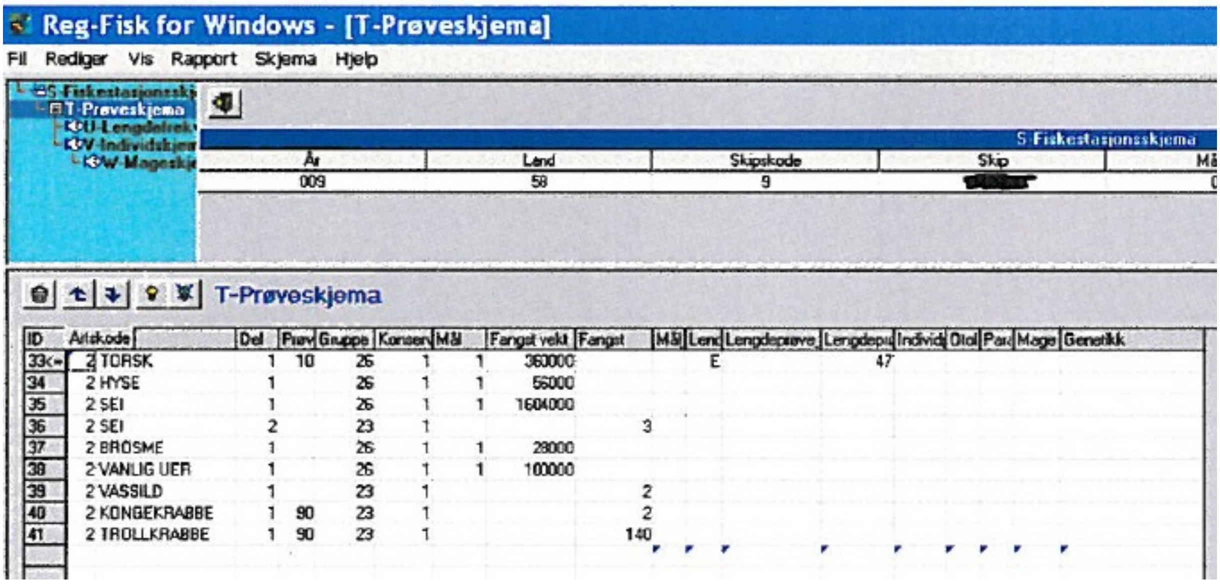


Figure 20: How T forms look in Reg-Fisk when the punching is done. This is an example from a different form, courtesy of the IMR

My body as a 'black boxed instrument'

When I first started to work with the forms and Reg-Fisk, I found it hard to understand. This is related to how different cultures have different ways of coming to grips with the physical and socio-political dimension of the world. I see the numbers. I understand that they are trying to count fish – how much there is at present, how much there were last year and importantly – how much can be taken out next year. What is hidden to me when I first start the plotting is how the numbers can represent the fish stocks and why the gear information and standing time must be so accurate. I find it hard to accept that the otoliths can be 'read' as well. As pointed out by Chagnon (1997 [1968]), most of the world of the observed natives

> is ontologically real in the sense that an outsider from a different culture can 'see' and document it in a fashion that can be verified by other observers. But much of it is hidden in the mind of the observed natives, whose cultural traditions, meanings and assumptions infuse it with spirits, project into it meanings and view it in a way that the outsider can discover only by learning the language and, through language, the intellectual dimension of culture (Chagnon 1997 [1968]: 45).

In this case, the observed natives are the FDG. I find some comfort in one of the basic principles in anthropology, that

> No matter how confused or absurd the circumstances and activities of [the tribe] might appear, the ideal observer retains [her] faith that some kind of a systematic, ordered account is attainable (Latour and Woolgar 1986: 43).

This turns out to be true with regard to my relationship to the RF data and Reg-Fisk. With time, the logic of the system became evident. I started to share the FDG scientist's ontology of fish. With time I learn the most important codes that are repeated often and the pages where the different information I needed could be found in the 'bible'. So, with experience, I did the plotting more effectively. Also, the information in the forms and the corresponding codes in Reg-Fisk became logical, even natural, to me.

Everybody who has used a computer and a computer program – be it games, spreadsheets, or text programs – may have experienced how the place of the buttons and the icons of a program becomes embodied. After a while, it is not necessary to think any more, and the fingers find the buttons automatically and make the moves even before you know it: you embody the knowledge. According to Knorr Cetina, the experienced body can embody information and can become a silent part of the research machinery. The embodied or tacit knowledge can actually replace conscious communication and reflection (Knorr Cetina 1999). While I was plotting the RF for the FDG, this was happening to me.

However, I took careful notes in the process. I noticed that I was starting to make some choices automatically. For instance, sometimes the information from fishers cannot be translated since there are no codes for them, and I had to make choices:

Fieldnotes 10.12.08

First: Should I include or exclude the given information? If I exclude it, nothing more is done with the information. The fishers sometimes make notes on the forms with regard to different issues or observations, or they register fish making distinctions that are impossible to make in Reg-Fisk. For instance, 'CRF vessel X' sometimes registers Lumpsuckers (*Cyclopterus lumpus*) making a distinction between the female and the male. More often though, the standing time and gear is creating problems. I can choose to exclude the gear information if I don't know it, or I can include it. Importantly, if I choose to include the information, I have to make other choices:

Second: What type of code would correspond best to the true information (gillnet, mesh size, time, and type of redfish)? Hence I must chose to either register the information as either as unknown (code 4110) or the code that is closest to the information.

The choices made become automatic after a few forms, and the Reg-Fisk system becomes logical: information is included or excluded without reflection, and traces melt into the background and become invisible, even for the person making the choices. Some choices are made without any reflection, such as choosing unspecified gear codes, and '99 hours' for any standing time over two digits i.e., over 100 hours.

What was hidden in the mind of the observed natives – the scientists – is becoming my world view too. After a while, my fingers tend to do the work without any effort, and the process of translating slimy fish into numbers that fit Reg-Fisk is now naturalized and embedded in my body and sometimes mind, it seems. I make careful notes about every step in the process, as my body becomes a part of the RF knowledge production, and turns into a black box.

Excluding and including

While plotting the Coastal RF forms, I notice that some of them come with accounts and reports outside the columns and rows. They make handwritten notes about weather conditions or maybe they have seen something they rarely see. Mostly, this is information that cannot be registered in Reg-Fisk since there no codes available to translate this information. Hence, one can say that some of the otoliths come with some of the local context, including descriptions of the weather and the catch and by-catch which came out of the sea together with this particular fish; difficulties with the gear; or if the fish is standing at a normal depth or maybe deeper.

The FDG really appreciates this, and motivates the fishers to write this type of information on the schedules. One of the fishers, Johan Inge Misund, makes very detailed descriptions. The 'contemplations from the field' as Misund calls them, are very thorough and rich in context. He also makes a relationship between the number of the registration and the notes he makes, so that the scientists know which data belongs to each description. Below is an example from his 'contemplations from the winter herring in 2009' (January 2009):

> [Serial number]: We have anchored up in Harstad. Producing as best we can. (…) The herring is very fat. If we do not wash the factory frequently, big lumps of fat are gathering. (…) The weather has not been too good while we have been still producing. The main part of the fleet has moved further south. We have gone out through Andfjorden, around Andenes, moved along the coast SW. We are moving more or less continuously through herring between 'Anda lighthouse' and 'Floholman'. Some places dense with high layer, other places deeper, denser and not so high.

During the 2008 Offshore RF annual meeting, several of the FDG said explicitly that they want the fishers to continue making such descriptions since they appreciate it. They also said that such descriptions are important in order to understand the data. However, none of these descriptions can travel on within Reg-Fisk. There are simply no codes to translate them. There are many simplifications that make the fisheries biologists able to handle 'reality'. The schedules handed in by the fishers are also simplifications, giving options for what the fishers should register from 'out there'. Sometimes the fishers make room for some additional information on the form, they can write with small letters or use abbreviations, but Reg-fisk only accepts that which has a code. Let me underline that the scientists know that the limited codes do not correspond to the complex reality of ecosystems.

The forms from the Coastal RF fishers I work with are sometimes stained with blood and guts and even smell funny. In a way, it is as if the local context from the vessels has travelled here together with the otoliths. After I have punched the forms, however, I can put them back in their files in Huse's office. The forms and the otoliths travel on in Reg-Fisk, and if necessary we can go back to the files and find the actual forms or the actual otolith, and see who collected the data. When all the forms from both the Coastal RF and the Offshore RF vessels are punched into Reg-Fisk and checked by the scientists, the otoliths can travel as V forms, attached to the S and T forms through their unique serial number.

Before any of the data produced at the IMR, including the RF data, can travel to ICES, it is controlled by the National Data Centre. Now, the otoliths which have the necessary identification papers, as provided by the forms, have jumped the gap from an object to language. As numbers in Reg-Fisk spreadsheet, the RF data now travels lightly to the National Data Centre, where a scientist, Hestenes, receives the data. I asked Hestenes what he does to the RF data:

> I am just tidying up the data. They send it [the Reg-Fisk files] to me, and I go through them to check if everything is correct. (…) The program that they [the FDG] learn to use is not accurate enough.

According to the FDG, the Offshore RF and Coastal RF data is integrated into the larger database where information from all other information platforms is gathered, the IMR's data bank.

So, after the data has been through this cleaning process by the FDG scientists and the National Data Centre, it is placed in IMR's data bank, where it is available for anyone who wants it (see Figure 21 below). Here, the RF data is 'cleaned up' and corrected, hence, more choices are made and become invisible as they are placed on the IMR data bank. As we know from the visit to the ICES, the data that has been checked by the National Data Centre can be picked up – or not – by the different scientists responsible for different stocks.

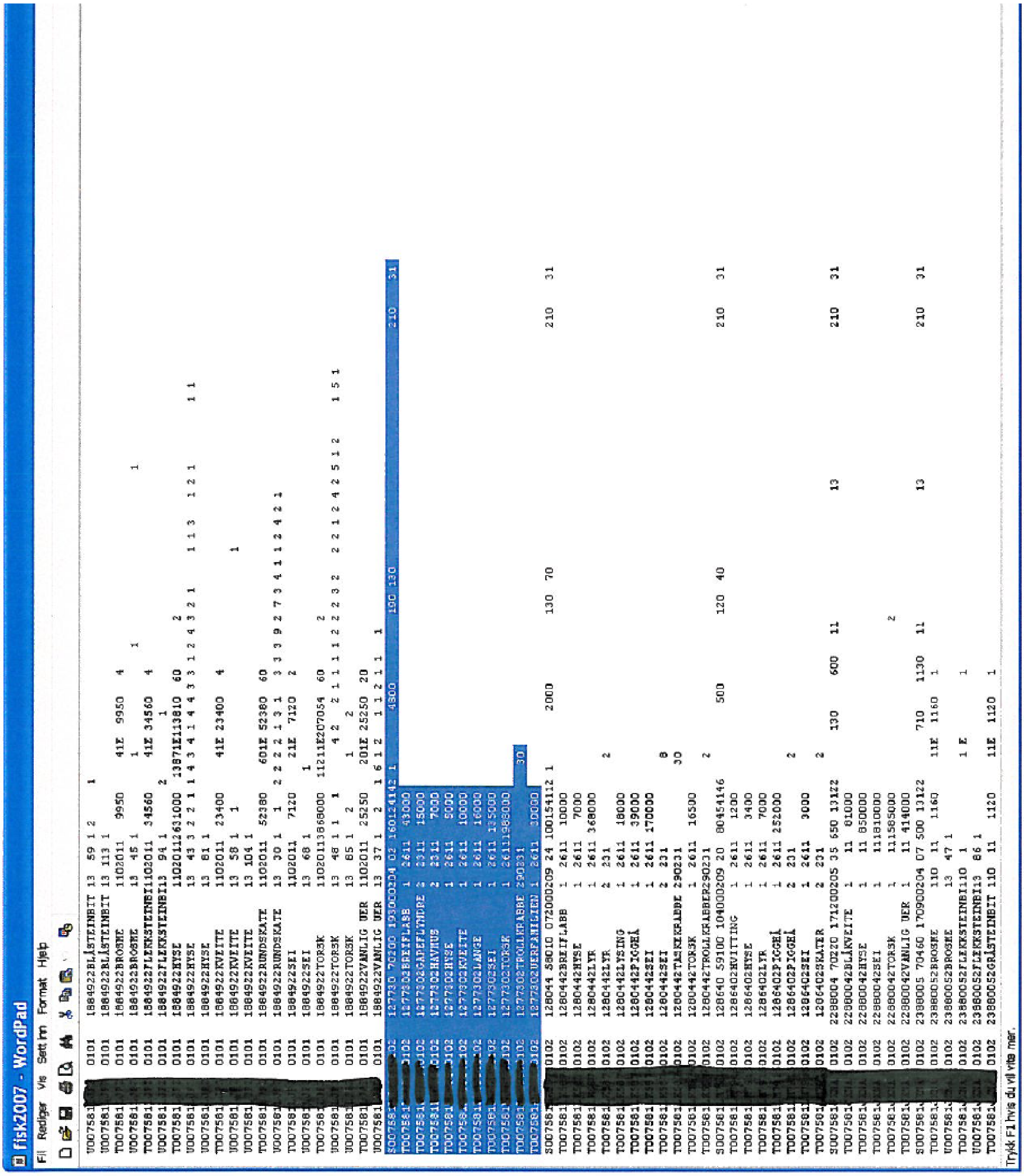


Figure 21: A sample from the total annual material from the IMR's data bank. The RF data is mixed in here after it is checked by Hestenes at the National Data Centre. The serial numbers inform the scientists about the data's identity: where it came from. Ship Codes are classified as requested by the FDG since the identity of the data collected by the RF vessel is classified. RF data marked in blue. Ship codes are removed for anonymity.

A Successful Chain of Transformation: From Otoliths to Otoliths*

The punching of the data can be quite an overwhelming experience, especially with all the codes. Now, in this jungle of transformation processes, it is crucial to remain focused on the issue at hand: how fish can jump from being an organism in the sea, to becoming represented by bony structures and finally, how they end up as numbers in the data bank.

Let me summarize the chain of transformations that makes it possible for fish to be a part of stock assessment as 'catch at age'. Some of the fish is sampled, taken out of the normal harvest chain, and the otoliths are taken out and given a 'passport', an identity that ensures their traceability. The fish then travels to the IMR. Or, more precisely, the fish never leaves the boat and goes to the IMR itself. Since fishers follow the IMR's instructions for data collection, the fish traces can move easily to the IMR. The otoliths travel as biological samples that can tell the scientists the fish age, and the corresponding forms follow them in order to give them the necessary identity. Importantly, the fishers depend on a number of tools and training to be able to this. The FishMeter, the electronic scales and the computer software is costly, and the fishers are followed up continuously through visits, phone calls, emails and meetings. In addition, the fishers are paid for doing these tasks and following the IMR's instructions.

So, one can ask: How far are we from the sea and fishers' practices? We are close, since the fishers are at sea fishing, and this is where they do the sampling. At the same time, we are far away from fishers' practices since now, the fish, the sea and the context stay behind, while the otoliths and the forms travel on to the IMR as raw data. Sometimes, the Coastal RF forms and the otoliths take the sea – or parts of it – with them to the IMR: they can bring some of the smell; and sometimes they are stained with fish blood and guts.

The efforts made by the RF fishers are not enough to make the data *combinable* with the other data that is gathered at the IMR. At the IMR, the Coastal RF forms are punched and the Offshore RF forms are checked. In the case of the Coastal RF otoliths, the information from the S and T forms must be translated from raw data into data. The forms filled in by the Coastal RF fishers often contain some information that cannot be translated into Reg-Fisk. This can be notes on the weather, if the fish is fatty or has a lot of lice or other information. Even though the scientists appreciate the notes and find the additional information interesting, it will not become part of Reg-Fisk. Since there is no way to make a lot of the information combinable, they are left behind when the 'raw data' becomes data. The plotting of the RF data teaches me that precision and robustness are important issues in the methods used by the

FDG scientists. The options that are available on Reg-Fisk must be limited and still give the information that is needed to say something about the actor that it should represent. There are a limited number of codes in the 'bible', and these are all based on the scientific surveys. With Reg-Fisk, the fish is represented by the otoliths, which is now a number on the V Form and are given an identity with the S and T forms filled in by the fishers and later punched or just checked by the IMR scientists.

So, we can ask again: are we far from the sea? Near in one sense, since one find fish as numbers in the Reg-Fisk forms in the laptop. Even if one cannot see the fish or smell their guts here in the laboratory, they are present as entire fish stocks thanks to their traces from a sample of the stock. At the IMR, the otoliths are translated into numbers, when they are read by an 'age reader' and this is plotted into a V form. In addition, the handwritten S and T forms which arrive at the IMR as raw data, the S and T form information, are translated into data in Reg-Fisk at the FDG. The S and T forms give the otolith a 'passport': where it comes from (area/location) and how it is was caught (gear).

In the end, all the forms represent the fish that fishers once fished, which now gives information about the fish, as codes in Reg-Fisk. The fishers are producing both semiotic and corporal traces of the fish, such as the numbers on a schedule or a data file and the otoliths. Actually, the major product of the RF is text, or numbers, and it is not cheap: the budget was approximately 50 million NOK in 2007 and 44 million NOK in 2008[36].

So, fishers make traces with inscription devices that can travel to the IMR, while the context and the fish remain mainly in the same place. From the IMR's data bank, the files are sent into the National Data Centre, where they are checked again. Since this is done with all the data that comes in to the IMR, there are two rounds of inscriptions that are specific for the RF data: fishers sampling otoliths and making them traceable by filling in a corresponding S and T form, and scientists who punches the paper forms into Reg-Fisk or checks the already punched Reg-Fisk files[37].

Once the data is re-inscribed into Reg-Fisk, the fishers' inscriptions can travel very easily to any laboratory, computer, e-mail or spreadsheet. Now, this data is still referred to as otoliths, however, it has become something else: together with the S and T forms it has become a circulating reference that can travel everywhere. Importantly, we can follow its path back to the vessel where it came from, the area where it was caught and the gear used to catch

[36] The RF is financed mainly through quotas, hence the price of the fish varies from year to year. This explains the difference here, according to Kjell during the 2009 annual meeting.
[37] The RF and the Coast Guard data share some aspects, however. This is further addressed in chapter 7.

it. The bony structure which is the otolith itself is left behind at the IMR, and in Reg-Fisk we can find the otolith data as number. It is important to notice that the otoliths as numbers are very different from otoliths as bony structures, and to demarcate this, I will refer to them as otoliths*.

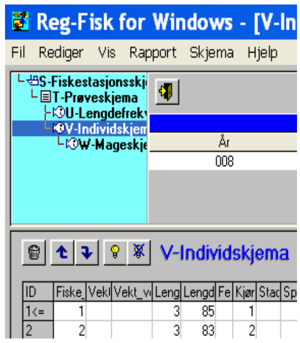
1: fish as organism: **X tonnes**	**Fish as otolith:** **X kilos**	**Fish as data:** **0 grams**
		

Figure 22: A successful circulating reference. The transformation of fish as an organism to a format fit for science: from fish, to otolith to data, or otoliths*.

The Flow Interrupted: CPUE

As we know, the otoliths collected by the RF are used in order to assess fisheries. Not all of them, but a large quantity, make it to the ICES. A large number of fish jump the gap from object to number, from fish to otolith, and from otolith to otolith*. In light of this, we can say that the IMR has succeeded in training the fishers so they can participate in making effective representations that are loyal to the fish caught in the sea; and we also know that it is not easy to succeed, as the Reg-Fisk has a demanding framework.

However, there is an enormous amount of information from the RF, in addition to the otoliths, that has a potential use for scientists. When all the information in the S, T and V forms is punched into Reg-Fisk, it is combinable with all the other material in the IMR's data bank. In this state, there are almost unlimited possibilities for how the RF data could be used, now and in the future. As described in the previous chapter, I only managed to find the otolith data at the ICES, so what happens to all of the other data? For instance, CPUE data (Catch per Unit of Effort, as described in chapter 4) can be obtained from the forms that the RF hands in regularly. From my fieldwork with the AFWG at ICES, I know that the CPUE data is central to stock assessment. However, I could not find any traces of the RF CPUE data at the ICES, as illustrated by Table 12 below, from the AFWG.

XSA name	TISVPA name	Name	Place	Season	Age	Years
Fleet 09	Fleet1	Russian trawl CPUE	Total area	All year	9 - 11	1985 - 2007
Fleet 15	Fleet2	Joint bottom trawl survey	Barents Sea	Feb - Mar	3 - 8	1981 - 2008
Fleet 16	Fleet3	Joint acoustic survey	Barents Sea+Lofoten	Feb - Mar	3 - 9	1985 - 2008
Fleet 18	Fleet4	Russian bottom trawl surv.	Total area	Oct - Dec	3 - 9	1994 - 2007

Table 11: CPUE data used, from the AFWG of the (ICES 2008b: 128). The traditional knowledge platform for CPUE data is the research cruises, even if other sources are sometimes included, like the Russian trawl series demonstrated here.

This section is mainly guided by one question: why is the CPUE data from RF not used in the assessment of fish stock at the AFWG? The pace in the dissertation changes here, as I have to rely on the explanations given to me by my informants, hence there will be many quotations from interviews rather than descriptions in the following.

Why the RF CPUE Data Is Not Included

We know now that the type of data that is collected by the RF fishers and accepted by the ICES is the data that describe their catches, i.e., length, weight and age. This can be summarized into the otolith data and its 'identification papers' (other data is also included, such as species identification and is further described in chapter 6). The CPUE data, which are supposed to describe the stocks as it is considered proportional to changes in stock abundance if the data cover the stock properly and the effort is standardized, is not. Even if I am still thrilled about the otoliths travelling all the way from the fish caught by fishers to the ICES models, I wonder why so much of the fishers' information is excluded. In the following, different scientists at the IMR explain why the CPUE from the RF is not used. Based on my fieldwork, including interviews and participant observation, I have made two categories for the reasons scientists give for excluding the data from the assessment; the representativeness of data and the amount of data available to scientists. Both of these categories are related to a third issue which affects if and how the RF data is used, namely trust. The role of trust will be further discussed in chapter 6. While I use the CPUE data as an example, I argue that these categories can be used at a more general level as well with regard to the exclusion of RF data.

Representative Data

In general, scientific claims to truth are tied to methodological standards, and the same is true for statistical models such as the VPA: Following procedure is key in order to make robust data that can be used for stock assessment. Hence, in order for scientists to use the RF data, they must trust that these are collected according to the scientific standards. However, there are some challenges with regard to using the RF data, according to the scientists I have talked to, and I will point to these below.

With regard to the use of CPUE data, Nedreaas explained:

> Why can we not include data from the Norwegian trawl [which includes the Offshore RF]? Well, we [AFWG] have said that there are three-four reasons for this: First, for the most important commercial stocks, ICES considers that they possess other abundance series that better reflect the stock abundance, i.e. scientific surveys designed for the purpose. Second, lack of effort standardization, e.g., there was a period when the Norwegian trawlers began using double and triple trawls without reporting when they were using one or the other. Third, lack of spatial and temporal coverage… you understand that the trawlers have not been everywhere, and the question arises if their data, which is assumed to describe their catch composition very well, also reflects changes in the total stock. (…), and furthermore, if the CPUE rather reflects the fish aggregations than the stock abundance, i.e. due to the schooling and shoaling behavior of the fish. (E-mail 12th of September 2011)

Summing up Nedreaas's reasoning, there are at least two main motives for not including the Norwegian Fleet: the gear, and hence the *effort* is not constant; and the *area* trawled is not representative enough. Nedreaas also explained that:

> For instance, the fishers can catch the same amount of fish from year to year, but this is due to more effort and not that the stock size remains constant. Hence, it is important to have knowledge about the vessels and their equipment. (Interview 16.12. 2009)

This is related to a core principle in science: the data must be representative. Nedreaas also added that:

For the stocks managed with high accuracy, such as the NEA cod, the CPUE data are very often not accepted by the ICES. Nevertheless, in lack of better data series as indicators for stock changes from year to year, CPUE data are used and will be used when the above concerns are taken into account, and no better alternatives exist. CPUE data are today e.g. used in the ICES stock assessments of our two saithe stocks, and will for other less important commercial, and not so data rich stocks, be the only abundance indicator. (E-mail 12th of September 2011)

Huse is one of the scientists who has worked closely both with the RF fishers and the data. Her arguments are similar to Nedreaas:

The main problem with the RF data is that it does not cover enough with regard to the gear and the area distribution: (…) there are too few individuals [fishers] who hand in samples. A methodical sampling programme should cover more boats. (…) The index (and hence the catches) are dependent on factors such as the time of the year and the day, the moon face etc. etc. (…) But, we [IMR] can never get enough data, remember this. (Email, 22.01.2010)

The same type of statement is made by the IMR scientist Gjøsæter. According to him, some scientists are reluctant to use the RF data:

From the statisticians, there is criticism raised based on the large number of samples from few vessels, while there should be fewer samples from more vessels. Questions can be asked with regard to whether the sampling holds a scientific standard: Is it random and representative? (Email, 01.12.2009)

Again, the scientific standards must be followed in order for the RF data to be good enough to be accepted. When one of the FDG scientists oriented the fishers about the importance of RF data for the latest stock assessments during the 2009 Offshore RF meeting, he pointed to both the cost and the above issue of the large number of samples. The 2009 summary from the Offshore RF annual meeting states that

> Arild mentioned the cost-value of the samples collected by the RF vessels compared with the other vessels. From an isolated viewpoint, these samples are a lot more expensive than the samples we get from other vessels. In some cases, too much fish is measured. (IMR 2009c)

However, it is not enough that every single one of the fishers in the RF makes sure that all the scientific standards are followed. There are some additional issues that must be taken into consideration, such as the number of vessels and samples in relation to the rest of the fleet. So, using commercial CPUE data is difficult in stock assessment independent of the quality of the data, simply because fishers fish to find fish, not to count fish.

Another issue to keep in mind is that the RF is a young project in a scientific perspective. The Offshore RF was established in 2000 and the Coastal RF in 2005 and since then fishers' have received a lot of training and experience. Of course, the quality of the RF data has improved over the years, and this is also underlined by Nedreaas. With experience, fishers are becoming better and more experienced data collectors. The quality of their samples and the forms are improving, and the amount of data is growing (see, for instance, Figure 12 which shows the increase in otoliths collected by the Coastal RF). In addition, some changes have been made in order to improve the quality of the data the fishers collect, since the RF was first established in 2000. The contracts with each vessel are now for four years, while they used to be for one year at a time.

(…) with four-year contracts, we get to know each other better (…) we can remove such…what ever the reason, for mistakes [in the data collection]. (Interview 16.12. 2009)

In sum, making sure the data is representative takes a lot of work. It is crucial to eliminate subjectivity, and strict methodological procedures and painstakingly thorough note keeping are necessary (Law 2004: 29). As Huse says, one needs 'God-like qualities' to be able to produce good data about fish stocks:

> To give a good picture of what is taken out of the sea [fisheries related death] you really have to be a perfect God, sit in heaven and zap randomly down on fish catches and get data back that can be raised back to the area, vessel group, gear, time period etc. that one wishes to say something about. And, if one samples correctly, it can, in theory, be enough. With a random sample from each unit one should [be able to] say something about it. But, with some more samples the precision increases and one will get a better covering of the fisheries. (Email, 22.01.2010)

One aim of fisheries science is to make definite statements that correspond to definite realities: that fish stocks can be counted. This seems to be difficult to correlate with fishers' reality: They do not relate to the statistical areas plotted on the coast and the EEZ; they use the gear they find most effective and they fish when and where they believe the fish can be caught. Hence, to make independent data, the scientific surveys are important:

> Nedreaas**:** The scientific surveys are central, since they are a very good support in order for us to be more precise with regard to the stock situation. (…) An index from a survey is totally independent and then you can say something about the mortality from one year to another (Interview 16.12.2010)

Hence, as is often done in science, some data is rejected, since it is not considered good enough: the CPUE data from the RF is not included, in order to deal with uncertainty. Much of the information that is sent to the IMR from the RF vessels is never used.

The IMR: Flooded with information

When I was at the ICES during the AFGW meeting in 2007, some of the scientists – including the IMR scientists – had never heard about the RF. Several times I had to explain what the RF is and that they collect data for the IMR. Hence, I was left with the impression that the existence of this data is not 'common knowledge' at the IMR[38].

During the 2009 Offshore RF annual meeting, I discussed the issue of lack of communication of the RF data with one of the FDG scientists, Borge. He expressed that it is important to establish a more direct contact between the fishers and the stock responsible. This is one of the aspects which could improve the actual use of the RF data. This also seems to be the impression of scientists working in research groups other than the FDG. For instance, one IMR scientist explained that

> Often, those who could make use of the data [from the RF] work in different research groups, so it [the RF data] is not communicated to them.

Hence, one reason why the RF data is not used can be related to the organizational structure at the IMR; here, the scientists are flooded with inscriptions which can be an organizational challenge (This is also described by Latour 1987). This is also reflected in the obstacles I met as I tried to get an overview of how the IMR uses the RF data. At the IMR, different scientists work with different species and base their research on different data. There are nineteen thematic research groups working with different responsibilities and fish stocks. In addition, numerous projects that are organized independent of these research groups may also use the RF data. In order to gain an overview of IMR's use of the RF data I contacted all the groups. Very few of them could give any information about their use of the RF data, and most of them suggested that I contacted the FDG. When I interviewed Harald Gjøsæter, who leads the bottom-fish research group, about the IMR's general use of the RF data, he explained:

> It is difficult to say something about the use of the RF data in general, since it varies from one year to another and between gear types and areas (…). (Email 01.12.2009).

[38] This was my impression during fieldwork. Since the Port Sampling Program was cancelled, however, my *impression* is that this has changed since the IMR scientists depend to a larger degree on the RF otoliths.

So, the eighteen thematic research groups may or may not use some of the data, including CPUE, produced by the RF, for one or several fish stocks. Any scientist at the IMR with access to their data bank can include or exclude the RF material in their analysis and assessments. The serial numbers give the material an identity and tell the scientist where the material comes from: i.e., the annual surveys, the coast guard, the Port Sampling Programme or the RF.

To sum up, there are some issues with using the RF. Scientists are worried that the fishers' data can have a bias, since they have an economic interest in the end product, i.e., the quotas. Also, some believe that the quality of this data is not good enough since fishers may be lazy. As noted, this is also related to whom the IMR trust as data collectors. I will discuss how trust affects the relationship between fishers and scientists in the following chapter. Here, I will just underline that there seems to be a difference with regard to who trusts the data from the RF: those who work closely with the fishers' state that they do trust the data, while other research groups at the IMR as well as internationally have a higher level of distrust towards this type of data. Hence, the RF data is trusted 'locally', while it is met with more scepticism elsewhere, which has an impact on the degree to which that data is used.

Reg-Fisk's Standardized Universe Meets Fishers' Reality

The issues that the IMR scientists' points to, in the quotes above, such as trustworthiness and representativeness, have also been discussed at several of the Wednesday meetings I attended. Another typical concern at these meetings is how to plot the Coastal RF fishers' gear and standing time into Reg-Fisk appropriately; both of these are important components of CPUE data. The options available in Reg-Fisk do not fit very well with the forms that come in from the Coastal RF vessels.

Above, the punching of the S and T forms is thoroughly described, and as mentioned above, there are some challenges with fitting the data from fishers into Reg-Fisk's standardized universe. While scientists use standard gear for their surveys, which has a code in the bible, fishers will use the gear that they believe is most effective or to which they have access at that moment. The FDG scientists who do the punching, myself included, meet the same obstacles over and over again: the fishers use a mix of gear (i.e., gillnets with different mesh sizes) and they use different gear from the surveys (different mesh sizes). For some of the gear there are simply no codes available in Reg-Fisk, and with regard to mixing gear, there is no way to register this in Reg-Fisk. Hence, the scientists complain about the lack of adequate gear codes, since the gear codes available only reflect the scientific gear and not fishers' gear. This is because Reg-Fisk is made for surveys. However, something must be written down on the schedules in order for the information to enter the IMR's data bank, and choices must be made. During the Wednesday meetings, how to tackle these challenges is frequently discussed. The agreement is that the punchers either register the data according to the code that is closest to the fisher's gear, or as 'unknown'. So, it is almost impossible to make Reg-Fisk reflect the complex reality of how fishers actually fish, due to the material limitations – the lack of codes or digits – in Reg-Fisk.

Even if the CPUE data is not used in stock assessment, the FDG scientists are working hard to register this data in Reg-Fisk. Given the time spent on these forms at the IMR, this data is important to them: the FDG scientists really want to get as much accurate information about the gear and the standing time as possible. Despite their efforts, it is very difficult to follow the CPUE data back and forth, from the fishers' vessels, to their handwritten forms and finally in Reg-Fisk.

CPUE: A Broken Chain of Translation

The RF data is produced by the fishers and comes to the IMR as mobile samples, representing fish. At the IMR, the FDG makes sure that these samples are made stable and combinable with the rest of their data, as the fishers' samples are inscribed for the second and third time. Now, it can, in principle, be mixed and combined with all the other data placed on IMRs data bank. In light of the above, it is certain that not all the RF data can flow into the regular stream of data that is used by the IMR for stock assessment. Actually, the otoliths seem to be the exception[39].

All the data that is used by scientists is scrutinized in order to make sure it is trustworthy: since some scientific standards should be followed in order to protect research from distortions and make proper science (Holm 2003; Law 2004; Nowotny et al. 2001). At the IMR and the ICES, the quality of the data is always questioned independent of the source. Some of the scientifically produced data is also excluded, as I discovered at the AFWG meeting at the ICES (see chapter 4). Still, scientists seem to trust the data more when it is produced by themselves or other scientists, as this statement from Nedreaas exemplifies:

> When it is our own people [from IMR who collected the data] then all this slides more directly through. (16.12.2010)

[39] Let me remind you that this is related to the cod assessment.

When it comes to CPUE data, there are some risks with using fishers' data *because* of fishers' experience based knowledge for finding and catching fish. With regard to the use of CPUE data in general, Huse warns:

> There can be changes that makes the CPUE poor [data], like what happened in Canada, where we did not see the changes soon enough.(…) in catch data [fisheries dependent data], where the sampling is not by chance and rather, one goes where one hears, or believes, that there is fish, then there can be huge errors. (Email, 22.01.2010)
> .

The CPUE data is important to the models, and at the same time, there are some risks with using it. The effort ratio seems to be one of the most important thresholds with regard to using data from the fisheries, and hence the RF. Hence, at the IMR, they seem to minimize this risk by using CPUE data from a source where they know that the effort is the same from year to year.

When I asked Huse about the challenges with using RF data, she sums it up as follows:

> Even if all the data from the RF are 100% trustworthy – everything is registered and sent in – there is a problem with both the coverage (they fish where the fish is, we do not know if the area without fish gets bigger or smaller) and we [IMR] cannot decide where they should fish to cover the whole area. Also, we cannot decide that we need data from seasons when they normally do not fish. (…) Data from passive gear [i.e. gillnet] is not easy to use for CPUE. In addition, you get an extra level that can give a bias: a high level of individuality and little coordination of the sampling between the vessels, there can be huge differences which it takes years to adjust. Training is essential! And there can hardly be enough! And fishers fish to get money and to survive, not to produce data. (Email, 22.01.2010)

The RF is a new relationship that presents scientists, who decide whether to include or exclude any data, with some questions: can they be sure that the fishers follow the scientific standards, and can they trust the data collected by fishers? Is the data representative for the fleet? These issues are important for scientists, as their epistemic culture is founded on Merton's ideas of science as autonomous. At the IMR, the epistemic culture is built on a vision of science as knowledge that has to be disentangled and autonomous from the social in order to give unbiased advice. Hence, they are worried that the fishers' interests, i.e., getting larger quotas, could influence their data collection.

The scientists who work closely with the RF seem to trust the RF data more than those that do not, as mentioned above. Some of the IMR scientists are very sceptical of including fishers in the knowledge production, and want to maintain the strict boundaries between science and other forms of knowledge. This is my impression from doing fieldwork at the IMR, which is also supported by statements that are vague, but representative for parts of the scientific community in general. This impression is also supported by other scientists, as the quote below examplifies

> Many [scientists] are against the RF internally. Hence, it is uncertain if it will remain in its present form. It is expensive and the quality of the data is bad.

In addition to the amount of data that is collected at the IMR, which poses an organizational challenge, there are other issues which I have pointed to above.

The RF is a new knowledge platform, and it is a challenge to make sure that the data is trusted and that all the scientists at the IMR know about their existence. In their encounter with the scientific rules that guard science from non-science, the RF fishers' work as data producers for the TAC machine fails with regard to CPUE data.

How the RF Fishers Are Included: A Preliminary Answer

In this chapter I have presented a relentless mass of empirical material. This has been necessary not only because the devil is in the details, but also because this has been the only possibility for getting answers to my research questions. As we have seen, it is by way of representational chains that the fish stocks can be transported, as knowledge and management objects, from the Barents Sea to Copenhagen. It required a lot of work, skills and a number of clever material devices in order to make sure that these chains remained stable and allowed the production of valid representations of the cod caught in the Barents Sea. It is through the chain described in Figure 23 (below) that the ICES scientists can construct, in their computers in Copenhagen, a model fish that corresponds to the real fish stock in the Barents Sea. Following the transformations from stage one to ten (Figure 23 below), we started in the Barents Sea and ended in Copenhagen. This process began with treating the catch as a sample of the stock. Through the translation chain we have traced, this sample was gradually transformed from a large and slimy mass of flesh and bone, into a light, compact and combinable information package, tailored to fit with the format and quality requirements set up by the assessment community. If any of the steps described above fails, the link between the model fish in Copenhagen and the real one in the Barents Sea is threatened, and the quality of the assessment and the soundness of the advice are compromised. If the otolith arrives at the IMR without a unique identity, or any other procedure fails, the chain is broken. Sometimes this happens. For instance, the otolith can fall out of its envelope where the identification markers, name and vessel name are registered. Without this information, it can no longer serve as a representative of the fish stocks and must be discarded. A number of other things can also break the relationship between the model fish and the real fish. Age reading, for instance, is a vulnerable operation. Age reading involves quite a bit of interpretation and there are several examples of age readers getting the age wrong. As one scientist stated, 'an otolith will never be given the same age when read twice'. When the chain of representation is broken, the model fish no longer represents the real fish. Despite such problems, or rather, exactly because such problems are predicted so that appropriate counter measures can be taken, the otolith chain, the purpose of which is to represent the age structure of a given stock, is quite successful.

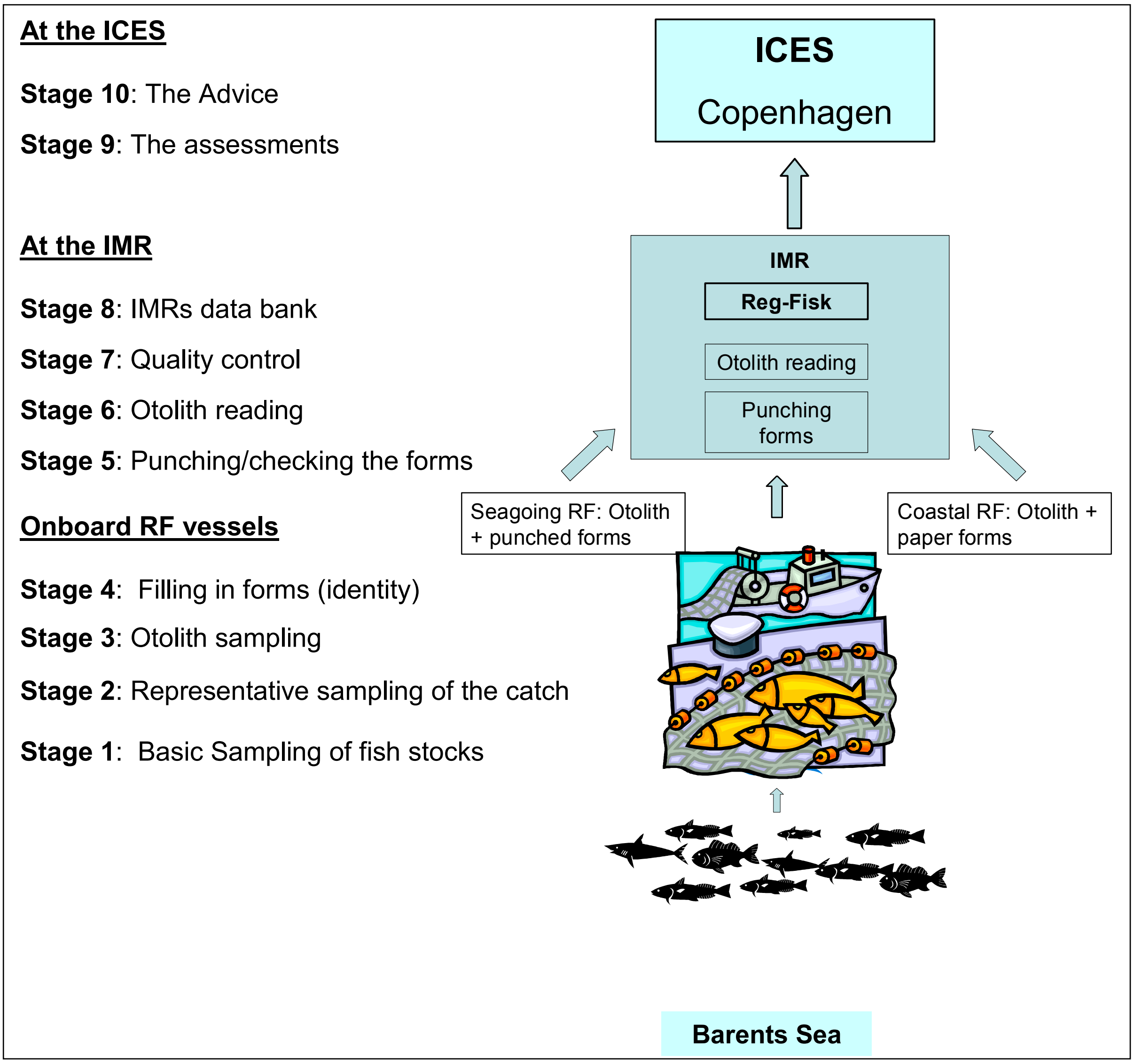


Figure 23: Knowledge chain 1: How otoliths can travel from the Barents Sea to the IMR.

The question we now must address is what exactly is achieved by using commercial fishing vessels as platforms and including fishers in the data collection. What kind of knowledge is it that the fishers, through their participation in the RF, contribute? Is this knowledge different in any way from the type of knowledge normally relied on?

The first thing we can note in answering these questions is that it does not seem likely that the RF will allow the fishers to contribute experience based knowledge, at least if this refers to some kind of pre-existing knowledge the fishers had before they entered the RF. As we have seen in the previous description, the RF fishers get to work on data collection that is completely designed and controlled by scientists. Whereas RF fishers are included in knowledge provision for management purposes, the knowledge they provide is scientific through and through, and has little to do with the fishers' normal experiences.

While this may be a bit disappointing, it should not come as much of a surprise. As I mentioned in chapter 2, the fish stock, the main management object featured in modern fisheries resource management, is an eminently scientific construction. It becomes visible and manageable only through complex representational chains of the kind described in Figure 23, and is made possible through the types of scientific instrumentation described in detail throughout this chapter. That the fishers, without access to such a machinery, already would have knowledge about it of a kind that could be directly collected and plugged in, is not particularly realistic. A more interesting question is whether the utilization of the RF allows such representational chains to perform better. This can be addressed by comparing the way the RF works with the other data platforms that are in operation.

The RF is one of four data collection platforms, as portrayed in Table 13 below. These are, besides the RF, the Port Sampling Programme, the annual surveys, and the coast guard. Hence, the RF does not represent something entirely new. Instead, it is a new way of doing well established tasks, and it comes in addition to other ways of collecting data from the Barents Sea. In the following, we shall look into how the RF as a data platform differs from the traditional data platforms.

Data Platform	**Otolith**	**CPUE**	**Geographic distribution**	**Time**	**Comments**
RF	Yes	Yes (not used)	Whole coast and spread in high seas	Continuously	Fishers fish and sample their catch: 34 vessels
Port Sampling Programme	Yes	No	Lofoten to Varanger (statistical areas in Nordland, Troms and Finnmark	Continuously	Scientists: Samples from 300 vessels of approx 30,000 fish (annually)
Coast Guard	Yes	No	North and South	Continuously	Trained personnel: 15 vessels taking samples from a number of vessels. 1900 otoliths (2008)
Surveys	Yes	Yes	Standardized	Standardized	Scientists sample catch from surveys

Table 12: The contributions from different sampling platforms. The geographical distribution is here related to the statistical areas. Note that the Port Sampling Programme has been cancelled, leaving the RF as the main platform for otolith data from commercial catches.

We can identify several examples where the utilization of the RF as platform and fishers as data collectors is slightly different. To some extent, these variations concern how to make sure that the difficulties of having to do data collection on board fishing vessels and in combination with fishing do not compromise the quality of the data. For instance, scientists are pre-trained and motivated by their professional responsibility for data collection, while fishers must be trained to follow a protocol and must be motivated by other means. The data collected by the coast guard, surveys and port sampling arenas are collected by crew that has this as their main task. Fishers, on the other hand, are doing this in addition to their work as fishers. Moreover, the coast guard and port sampling programmes sample catches from other vessels, while the surveys and the RF fishers sample their own catches.

In addition to such variations, however, there are at least two aspects of the RF platform that make substantial differences to the quality of the data. The first, as noted in the table, concerns the fact that the age data from the RF has a different distribution in time and space from the age data collected from the other platforms. From the Port Sampling Platform, age sampling could be taken from landing sites along the whole coast. With a single collection point, however, the time window for each sample site was narrow. In addition, the collection at landing sites meant that the geographical location of the age samples was imprecise. With the coast guard platform, the geographical distribution of sampling was dependent on the coast guard’s cruise programme, which is largely planned for surveillance purposes. In comparison with both of these platforms, the distribution of sampling in space and time is better with the RF platform. According to the IMR, the RF data

> enables the IMR to allocate commercial catch sampling resources in time and space in a sound statistical way [and] leads to improved and continuous biological sampling by area and season, and thus improves sampling protocols (IMR 2007a: 10).

In addition, the RF provides the IMR with continuous information about species and data from species and areas that are rarely covered by research vessels. This includes near-coast fish populations and deepwater species (IMR 2007a: 10).

The second example of the RF making a substantial difference concerns the CPUE data. In the scientific surveys, the conventional source of CPUE data, the gear used, the standing time, depth and speed is kept unchanged over years. Also, the exact location of the CPUE series is strictly programmed and kept constant. In the case of RF, this cannot be done. Or rather, fishers could standardize their effort, but not in combination with normal fishing, which is a requirement. Instead, as we have noted, the approach here is to try to measure the actual fishing effort the vessels deploy, and use this as a basis for calculating the unit effort. This difference in the basic approach means that the RF fishers need to undertake operations that are not required for research cruises. Whereas the protocols for measuring the relevant dimensions of the catch are the same, the RF fishers need protocols for collecting data on gear type and deployment. Since the Coastal RF often uses a mixture of gear, these protocols become complex and tricky to follow. It also follows that it is difficult to ensure that such protocols are understood the same way across the RF fleet. This means that it is uncertain whether the CPUE measurements are comparable across vessels and over time. In the case of CPUE data, the traditional knowledge platform is the research cruises, even if other sources are sometimes included[40].

The point here is that compared with the other knowledge platforms, it is difficult to see how the RF works by different principles. To the extent that fishers follow the scientific procedures, the chains of knowledge production can be extended, and data made to flow effortlessly from the vessels towards the IMR in Bergen and the ICES in Copenhagen. This means that fishers are not bringing new data as such: they are bringing more of the same into stock assessment; the RF includes fishers in the production of the already established knowledge chains and within the RF framework; and the fishers are employed to do laboratory work.

In one way, the RF vessels are no longer just fishing vessels. They have also become minimalist laboratories, traceable within the grid of coordinates imposed by the ICES. With the aid of sampling protocols, tweezers, T and S forms, the FishMeter, computer networks, envelopes, glass boxes and so on, the IMR has expanded the boundary of the laboratory to include the fishing grounds. The RF vessels have become a scientific data collection instrument; and the RF fishers have been transformed into laboratory employees. The success of the otolith chain comes exactly because the laboratory has been extended all the way to the Barents Sea. This network is working not because the RF has somehow opened up for fishers' knowledge produced outside the laboratory. On the contrary, it works since it takes charge even before the catch enters the vessel and keeps it tightly under control all the way to Copenhagen. This can happen only to the extent the RF fishers transport the laboratory out to sea when they go fishing. When the representational chain is not working, as in the case of the CPUE data, this is only because such networks have not (yet) been extended far and solidly enough. In both cases, the condition for success is the same: that the laboratory reaches all the

[40] For instance, as portrayed in table 12, a Russian trawl series CPUE data was used according to the AFWG report in 2008: (ICES 2008b)

way. The boundary for fishers' inclusion is still drawn where the laboratory's network ends. For the CPUE data, the IMR has only half succeeded in extending the laboratory towards the site where it must be in order to capture relevant data.

So far, we can conclude that the RF has allowed fishers to become involved in the process of providing knowledge for management. We can note that the RF gives the fishers fairly mundane roles and responsibilities as knowledge providers. As we have seen, fishers are still excluded from the more important areas in the interpretation and authorization of data. While the RF fishers are allowed to perform data collection tasks according to given protocols, they have not been invited to contribute to the development or testing of these protocols. The fishers can collect otoliths, but they do not get to read them. Fishers may participate in the production of data, but are still excluded from interpreting these data. While it takes considerable amounts of effort and ingenuity, there are no insurmountable problems in training fishers to collect information about the catch and the gear deployment. With the RF, fishers have been enabled to contribute to the production of data utilized for management purposes.

Chapter 6

Working the Boundary?

In the previous chapter, the main concern was to describe and understand how data is made to flow, from the vessels to the IMR and from the IMR to the ICES, in order to understand how fishers are included in the knowledge production for stock assessments. In this chapter, I will broaden my scope to make more of the knowledge production activities that take place within the RF visible. The otolith will remain a central object but it will not be so much in the spotlight. The focus is on how the data that circulate between fishers and scientists connect the fishers and scientists and generate opportunities where they can meet as co-experts, at least informally, and how knowledge functions other than data collection are becoming within reach of the RF fishers. I will focus more on the authorization aspect necessary for the expert role, and how the RF relates to this. Hence, I will lift my gaze and investigate whether there have been any changes in the traditional boundaries between fishers and scientists with the establishment of the RF.

Fishers and scientists interact and produce knowledge in a number of settings throughout the distributed network that constitutes the RF. Scientists visit the fishers onboard their vessels and share meals and discuss the problems of catching and counting fish. Such issues also come up in the fishers' and scientists' communications through e-mails and phone calls. However, there is one arena that stands out as the most important one when it comes to boundary processes. This is the RF annual meeting. A lot of the material I draw on for this discussion comes from the annual meetings since they have provided me with a rich and easily accessible arena for studying the RF boundary work. Nevertheless, the chapter is not restricted to that, and I will address boundary negotiations wherever they occur.

First, I will present what goes on during the RF annual meeting. This has a descriptive character and is an important backdrop to how fishers and scientists communicate and cooperate within a framework where the traditional boundaries between fishers and scientists are somewhat blurred. While I will expand my view beyond the otolith and the NEA stock assessments, I will address how the annual meeting is an arena where the success of the RF in terms of the NEA cod assessments is presented as well as the potential for improvement. Then, I turn to whether, to what extent, and how, the RF can be seen as a rudimentary expert body: is the expert role within reach with the establishment of the RF?

The RF: An Arena to Meet and Interact

Every year the IMR invites all the RF fishers to an annual meeting, one for the Offshore RF in the autumn, and one for the Coastal RF in December. For two busy days, the fishers travel from their home towns to participate in the annual meeting at the IMR. Not all of them have the chance to come each year, due to circumstances such as weather and time. Also, the fishers that have not taken their quotas mostly prioritize fishing instead of going to the IMR. The annual meetings are important events at the IMR and the FDG spend a lot of time planning and organizing them. The programme is always tight from the early morning to the afternoon, with numerous issues addressed and discussed by fishers and scientists. The social component of the meeting is important, and the coffee breaks and lunches are always longer than scheduled. This is also an informal setting, where people talk, make jokes and share stories. The 'conference dinner' is an important part of the social interchange, where the participants typically talk about some of their shared experiences and how the RF has improved their relationship.

At the annual meetings where I have been present, from 2005 to 2009, both fishers and scientists underline how much they appreciate these annual events where the two groups meet, interact and share their ideas and experiences from the fisheries. Fishers and scientists can ask metaphysical questions with regard to its existence: What have we achieved? Is the RF producing something new? Is the work we are doing worthwhile? How can we improve the RF? What are our respective roles? How can we contribute, given our differences? This is an arena for scientists and fishers to meet, summarize and legitimize the RF as a useful and important project. Below, I will describe some of the interactions that take place during the formal settings of the annual meetings.

Opening up the IMR

> Nedreaas: The RF is [important] to get an insight into each other's reality and understanding. We need cooperation and trust. (…) These are ideas that should have seen light earlier.

Nedreaas made this statement during the 2008 annual meeting with the Coastal RF, and he has made similar comments at all the RF annual meetings. In 2007, for instance, he underlined that

Nedreaas: [the RF] should be a vibrant cooperation! Don't go around thinking that the IMR knows more than you. You have many good questions, so please, do not hold them back (Coastal RF annual meeting 18.12.2007).

The same message is given to fishers in more or less the same manner at all the annual meetings and by different scientists. Comments as exemplified by these above reflect a change in the relationship between fishers and scientists that has come about with the RF. Several of the RF fishers have told me that the RF has changed their relationship with the IMR. One of the Coastal RF fishers explained that the RF has 'opened up' the IMR to fishers

Some years ago, the IMR was closed to the fishers

An Offshore RF fisher reported the same experience with the RF:

20 years ago, this was unthinkable! Imagine, today we can come to the IMR and the scientists are interested in what we have to say: they listen and say that 'we must take a note on this'. This could never have happened before [the RF].

Within the traditional management landscape, there are few, or maybe no, arenas for such cooperation. Or, as the fishers expressed it above: the IMR has been closed to fishers.

The stories narrated here at the annual meeting are familiar to most fishers and scientists. This is the official mythology of the Norwegian fisheries management. The genesis of the IMR is narrated in large together with the logic behind the stock assessment process: the why and how of fisheries management as performed by the IMR is central:

Nedreaas: In 1900 the Board of Fisheries [IMR] was established, and in 1906 the fisheries directorate.(…). The IMR's main tasks are research and advice about the ecosystem, and the research goal is to give advice to the public.

Nedreaas narrates IMR's history from it was established up to present. All the 'big men' of the IMR: How the Norwegian scientist Georg Ossian Sars (1937-1927), who is considered as the founder of Norwegian marine biology, set out to investigate the life history of the cod and found important cod banks in the 1860s–1870s; the role of Johan Hjort, the undisputed leader in marine science in Norway from the 1890s; the work realized by Rollefsen and Devold who were the second generation of scientists to run the IMR after World War II. How the relationship between scientists, fishers and fish has changed over the years is also described, Nedreaas underlines how there used to be a strong cooperative relationship between these two groups in Norway before the 1970s: focus was on increasing the catches through development of new equipment, finding fish and new fishing grounds. This is exemplified by the research done by many of IMR's 'practical men', or 'big men' as I refer to them above. The link between how fishers and scientists relations used to be before the 1970s and the present RF is underlined in these presentations. The role of the RF within the IMR's 'universe' is also described:

Nedreaas**:** The Reference Fleet is the largest project that we have here at the IMR, and it gives us good data on species composition, length, weight, age and by-catch and time series with regards to effort. (CRF 2007 annual meeting)

Picture 20: The Coastal RF annual meeting in 2009

An important part of the annual meetings is to present the data produced by the RF: the number of logbooks, the number of otoliths collected and different ways that the RF data is used or could be used. The number of otoliths collected by the RF fishers is always given emphasis, and the scientists always address the growing number of otoliths that succeeds in becoming a circulating reference. As stated by Nedreaas:

> We want more otoliths because that is what really goes into our models.

The annual meeting is an important collective arena where the IMR invests a lot of time, effort and money in order to produce and maintain a system for the RF knowledge flows into the IMR.

Below, I present how the annual meetings are used as an arena for scientists to school fishers in science, and fishers to address challenges and issues that arise from their perspective.

Learning Science: How to Make References Circulate

Much of the time at the annual meetings is organized around the coordination and standardization of data, and making sure that the quality of the data is as good as possible. The annual meeting is also an opportunity for scientists to train fishers and to motivate them for data production, where the software program Reg-Fisk and its correspondent manual have been key issues. As described in chapter 5, there is a lot of information that never enters the flow of data, and some of the data enters but is never used. The annual meetings are an arena where fishers can learn about what constitutes science and why some data is included while other data is excluded.

There are always discussions related to challenges with the RF data: the problems fishers have out at sea, as well as the problems scientists have at the IMR. For instance, at the 2007 Coastal RF annual meeting, Huse went through all the problems that the scientists at the IMR encounter with the translating the data handed in by the fishers into Reg-Fisk spreadsheets:

> Sometimes it takes some real detective work! Please write down the month in letters, not the number of the month, since the format is strange (…) if you want to write several sentences, just use the space necessary.

The CPUE data is an example of data from the RF that scientists hesitate to put to work. Huse explained the problem of using CPUE[41] data collected by the RF to the fishers at the 2009 annual meeting:

> Huse: Why are scientists so sceptical towards using CPUE data [from the RF]? We all remember the Canadian case (…). One big catch can give systematic error – bias – in our data.

With the standardized data from scientific surveys, this is different. The IMR scientist Nedreaas explained:

[41] The problem of bias in the CPUE data was key in the the Canadian North Sea cod collapse in the 1990s: the overestimation of the spawning stock biomass and underestimation of fish mortality was partly caused by biased commercial CPUE data ((Holm and Nielsen 2004) See also(ACFM 2001)

> The surveys are a CPUE series, but you know, the effort is constant from year to year. Since the effort is constant, the variations we see can be understood as variations in the stocks [and not efficiency or effort].

The annual meetings are also used as an opportunity to train the fishers on Reg-Fisk. As described in chapter 5, there are some issues with translating the gear fishers' use into Reg-Fisk codes. While the Offshore RF vessels are supported by electronic devices that transfer the data directly to a spreadsheet, the Coastal RF has to write the data manually on paper forms. Accordingly, there are some additional concerns with the Coastal RF data. The FDG's long term goal is to teach all the fishers how to use Reg-Fisk and plot the data themselves since this would take a lot of workload off the FDG scientists. Huse explained to the Coastal RF fishers that the data needs to be standardized for Reg-Fisk, and that it even if what gear they use is logical to them, it is not for the scientists sitting in their offices punching the data. Nedreaas elaborated on this:

> Take a look in the manual that you have all been given, which is filled with codes. That's our bible. [Lot of laughs from the fishers] (2007 Coastal RF annual meeting)

Regardless of how the data comes to the IMR, as spreadsheets or hand-written forms, the RF fishers must learn the relationship between Reg-Fisk and the way they collect data. Several of the fishers also complain that it is difficult to fill in the schedules, especially when the weather is bad. Some of the fishers are having a hard time with Reg-Fisk, like one of the Coastal RF fishers who expresses his frustration with the work and all the procedures as follows

> First of all I must say that it is inspiring that you [the IMR] are interested in what we are doing. **But** [fishers laugh]… I have tried to do the punching myself, and I found it really hard to begin with. Also, when it comes to weighing the samples that we measure, I tried to do it, but it is too elaborate when you are alone. (Coastal RF annual meeting, 2009).

The FDG scientists find the Reg-Fisk system logical and meaningful, since it is related to their practices. However, it is challenging to translate fishers' reality into codes. Fishers, on the other hand, have a hard time understanding the logic behind Reg-Fisk[42] and 'the bible'. The standardized and systematic approach to fisheries, which they know as the wild and uncontrollable reality out there at sea, is unfamiliar to them. To the fishers, this Reg-Fisk universe filled with codes and standardized gear lacks meaning. One of the Coastal RF fishers' commented:

> You should condense this bible as you call it, down to what is necessary for the given boat. Then it will be less complicated and less scary than that huge thing. (Coastal RF annual meeting 2007)

All the tools and devices that are necessary in order to do the data collection for the RF is another topic that is repeated at the annual meetings. The Offshore RF vessels and a few of the Coastal RF have the electronic measuring board 'FishMeter' and an electronic weight installed. The fishers have had some problems using these devices which are developed for scientific use, i.e., condensation. There are also some comments about how the cooperation between fishers and scientists could be improved. For instance, one Coastal RF fisher stated that

> In my opinion, we get too few visits. *And*, if you are coming, do take a look at the weather report [all fishers laugh]. The last time, the person came and we couldn't go out because of bad weather and what's the point of us ogling at each other on land? (Coastal RF annual meeting 2007)

The FDG scientists agree in general that there should be more time for visiting the fishers and going out fishing. The FDG scientists really enjoy these visits, which can be related to how Norwegian fisheries science was practiced from its establishment around 1800 (Schwach

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[42] According to Nedreaas, a new registration software is under development which amongst other things will be more self-explained with more data storage opportunities and less codes.

2000). At times, professors spent more time in the field than in the laboratory. Schwach (2000) describes how those working with marine science in Norway have always been 'practical men', and that surveys are an important part of the IMR scientists' culture, maybe more than in other nations.

Today, scientists may not spend as much time at sea as fishers, but their identity is rooted in the image of a scientist in the field, knowledgeable about the practical challenges and real fish as well as the model fish. The scientists I met at the IMR fit the image of the modern fishery scientists who spends a lot of time in his office or laboratory working with numbers rather than fish. But, the same scientists also have other practices where they go out to sea and work with real fish, which fits the image of the scientist as the explorer who leaves the laboratory to discover the world. While the scientists would like to go to sea more, their daily practices take place in their offices at the IMR. As Borge said at the 2009 Offshore RF annual meeting:

> We just have to admit the fact: the administrative aspects with the RF are unfortunately taking too much time.

Over the years, from when I first attended the annual meeting in 2005 to the last time I participated in 2009, less and less time is spent on system maintenance as fishers are getting more experienced with both the equipment and doing the sampling. As the fishers are getting more experienced, there are fewer problems with the use of the equipment. In 2009 the FDG noted contentedly that fishers' use of this equipment was working immaculately. With time, the fishers are getting more skilled at doing the sampling and the scientists are looking for ways to include more data from the RF vessels.

The RF as a Rudimentary Expert Body

In the following, I will take a more analytical role in order to understand the RF in light of my research questions. How fishers are included in the knowledge production remains a key issue, as in chapters 4 and 5, but now the scope is broader and includes other issues than the NEA cod assessments. Fisheries management is made up of numerous tasks outside the TAC advice on key species like the NEA cod. Quota regulations are central tools to regulate fisheries, but there are also other regulation measures parallel to these, like minimum landing size, minimum mesh size, gear restrictions, discard regulations, closed areas and closed seasons (Hauge 2008). The ICES and the IMR provide advice for some of these management instruments, but not necessarily on an annual basis (Hauge 2008). As we shall see below, there is a variety of examples of how fishers' knowledge is put to work within the RF framework when we look to areas that are not defined as strictly by the ICES annual circle depicted by the Regulatory Chain. I will now address how the RF can be understood as an important change in the IMR's priorities and practices compared with the Regulatory Chain organization and how room is made for fishers' experience based knowledge. It is time to investigate all the other messy interactions and interchanges of knowledge that occur within the RF.

I cannot think of a better way to set the stage for how the RF opens up more knowledge functions than the PowerPoint slide below[43] (Figure 24). It was presented by Borge at the 2007 Coastal RF annual meeting, and is what can be called a summary of how the RF affects fisheries management:

- Better data from commercial catch the whole season
- Unusual species
- By-catch and discard
- Coastal cod
- Marine mammals and sea birds
- Testing of new technology
- Easy access to special samples
- Generate a common understanding between fisher-scientist

(CRF 2007 annual meeting)

Figure 24: Powerpoint slide from the CRF 2007 annual meeting.

While two bullet points, 'better data from commercial catches' and 'easy access to special samples', are typical of scientists' practices, the other issues are closely related to fishers' practices and position for making observations and sampling. At the annual meeting setting, the RF fishers are invited to 'the table', much like in peer reviews. They participate in the discussion of how data is collected, what data is collected, what type of data is missing and the reliability of the data and advice given and so on. Hence, other knowledge functions may be available for the RF fishers than is allowed for so far.

Hybrid Delegates: Being at the Right Time and Place

According to Latour (1987), the scientific process depends on effective and reliable delegates

[43] These issues are also underlined by the IMR in publications and information pamphlets (see, for instance, IMR 2007).

that can collect reliable data which can return to the centre of calculation. Holm (2003) addresses the difference in how 'orthodox' scientists and FEK researchers use delegates, since the key strategy of the latter is to rely on fishers as naturally occurring observers as their delegates:

> Instead of constructing and equipping new delegates (…), FEK researchers want to use as delegates people who have already been out there and made such observations in pursuit of non-scientific projects (Holm 2003: 15).

As we shall see below, the IMR uses a mix of these two strategies, as they use naturally occurring observers which, with scientific training and follow ups, makes the RF fishers capable delegates for the IMR.

The importance of the RF as IMR 'delegates' (Latour 1987) out in the field is a central issue when fishers and scientists meet. Science always wants more and better data, and giving good advice about fisheries management is also related to access to data; being in a position to take samples or make observations at the right time and place. Of course, this is central to the rationale behind the establishment of the RF. With the RF, the IMR has a direct 'channel' to the fishers, and in the IMR's own words,

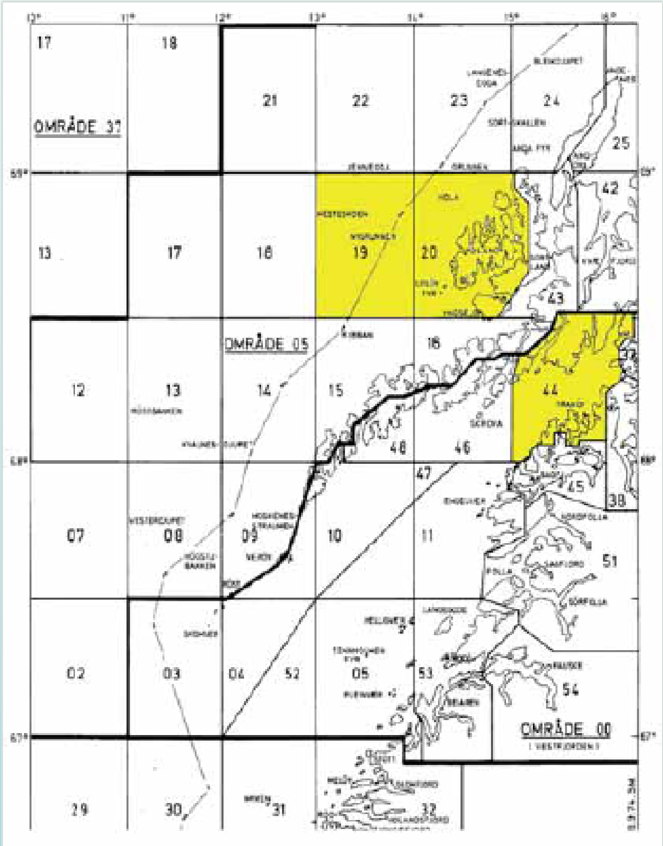
> [T]he IMR has access to data from the vessel monitoring system (satellite tracking) operated by the Norwegian Directorate of Fisheries. The Reference Fleet may also be requested to make specific observations and collect urgently needed data. The Reference Fleet makes it possible for the IMR to be in the right place at the right time. (IMR 2007a: 8).

With the RF, the IMR has established a framework that makes it possible for scientists to know where the RF fishers are fishing. The offshore RF vessels are tracked by satellite, hence the IMR knows which vessel is in the position to take the necessary samples. Only a few of the Coastal RF is tracked by satellite, but the IMR can easily contact them with e-mails or by phone; they do not venture as far away as the Offshore RF so it is easier to know their whereabouts. With the RF, fishers are recognized as observers. They are out there at sea in a favourable situation in order to make observations.

During my fieldwork, different authorities and advisory bodies contacted the IMR in order to get such urgent data to give advice on issues as diverse as the level of poison in fish[44] and the by-catch of sea birds[45]. But being at the right time and place seems to be particularly important with regard to the coastal cod which is mixed in with the NEA cod, since the former is considered endangered while the latter is a main target species. While the coastal areas are often inaccessible for the larger vessels typically used during surveys, this is where the Coastal RF vessels navigate on a daily basis. As Figure 25 below demonstrates, the IMR considers such contributions from the RF very valuable. In addition, the fishers' organizations often complain that the IMR is not present at the right time and place. Hence, the IMR's access to such data addresses an important issue that is hampering fishers' trust in the IMR's advice.

[44] See, for instance this link in the reference list (FHF 2009)
[45] See, for instance, the NINA project: (NINA 2009)

TO BE AT THE RIGHT PLACE AT THE RIGHT TIME –
THE REFERENCE FLEET MAKES IT POSSIBLE!



Urgent sampling of otoliths (and genetics) for determining cod type, e.g., on a specific day and in a specific area, how much of the cod catch is coastal cod.

MS Leirvåg Junior

Date	Area	NEA cod	Coastal cod
10.01.06	0519	3	10
21.01.06	0520	16	4
27.01.06	0520	15	5
Sum		34	19

MS Nimrod

Date	Area	NEA cod	Coastal cod
09.01.06	0044	2	30

Figure 25: To be at the right place at the right time: The RF makes it possible (IMR 2007a)

I will now provide an example of how fishers, as naturally occurring observers, are useful and hybrid delegates that can report back to the IMR in ways that make their knowledge data. Importantly, this demonstrates how the RF provides a framework that makes knowledge flows between fishers and scientists possible. The IMR is interested in how species, introduced or otherwise, spread in time and space. Often, fishers do not communicate such findings to the IMR, and even if they do their observations may not be done in a manner that allows the IMR to register their observations. Since fishers do not take care of the specimens and they do not take pictures, it is difficult to do the taxonomy with certainty. With the RF, fishers' observations about new species in the area where they fish, which is essential to the IMR, can be authorized as more than anecdotes. The RF vessels have been given a digital camera for such incidents, the RF fishers are trained in registering such observations according to the IMR's protocol, and they know where to send such information. In addition, the FDG scientists visit the RF vessels regularly, and during these trips, the fishers and scientists discuss what they see. Also, fishers get feedback from the scientists with regard to what they have found and if it was the first time it has been registered in the area. Below, I will present two examples from fieldwork where fishers' knowledge was allowed to flow into the IMR and become a part of different knowledge functions for the management process. These exemplify what Holm (2003) labels 'translation chain 2, FEK as data', where fishers are considered capable observers.

During fieldwork, fishers reported several times to the IMR about unusual species and other observations, and once this happened when the FDG scientist Huse was visiting a Coastal RF vessel located close to Tromsø. Even though I did not travel with Huse to visit the RF fisher, I could follow their findings closely from the IMR, since I could follow the e-mail communication between two FDG scientists about their observations. Huse sent Bjelland an e-mail from the Coastal RF boat with a photograph of a fish that is a stranger in these northern waters, asking him what species they had caught. Taxonomy is one of the main working areas for Bjelland, and he is convinced that the fish on the picture is a John Dory (*Zeus faber*). According to Bjelland, fishers in the north have claimed to have seen these fish now and again; however, it has never been registered before in any scientific database. Since Huse was out there with the fishers, she could show the fishers exactly how the IMR wants the fishers to collect data about new species. This finding of John Dory is the northernmost registration of this species, and since it was registered according to scientific procedures, Bjelland could add it to any database like the 'Fishbase' or biodiversity database in Norway, where it can become a red dot on a map.

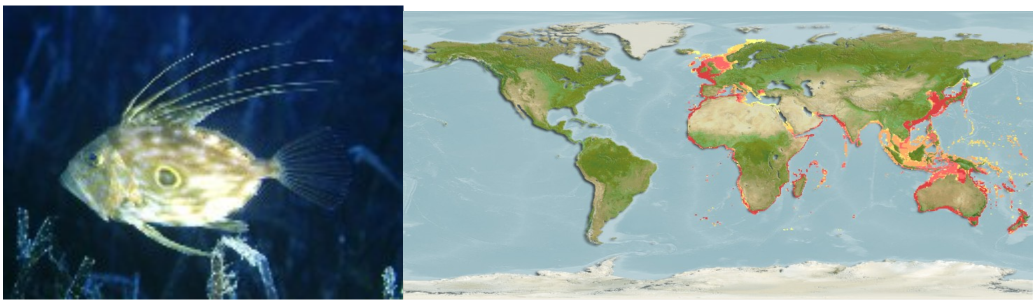


Figure 26: A John Dory and the Fishbase.org map of its distribution (Fishbase 2008b).

Another example of how the fishers contribute important information about species distribution is the registration of shark in the north. Bjelland is responsible for one of the the Coastal RF vessels located close to Bodø in the north of Norway. After one of his visits to the vessel, he came back with lots of pictures of a shark they had caught. He explained that they had scrutinized the shark together in order to find out exactly which species it was: a bluntnose sixgill shark (*Hexanchus griseus*). As with the John Dory, this was the northernmost registered exemplar.

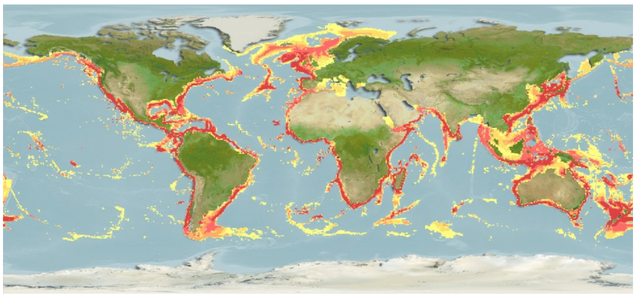



Figure 27: A bluntnose sixgill shark and the Fishbase.org map of its distribution (Fishbase 2008a)

In the examples mentioned above, fishers are natural observers with better access to certain knowledge objects than scientists since they are out at sea regularly and as an embedded part of their work. With the training they receive from the IMR, they also become 'hybrid delegates' for the centre of calculation. With reference to my first research question, I can say that fishers also participate here in the data collection function, working with science. While the RF follows the scientific protocols for how to register such samples, it is still of a different character than collecting otolith samples. This is because otolith sampling is a task based entirely on science and stock assessment, while how species spread and observations of unusual species is closer to fishers' practices and inquiries, and the knowledge object is also accessible for fishers' experience based knowledge. While scientific training and protocols are still important, fishers have more autonomy in this type of sampling. Hence, in these examples, fishers seem somehow closer to the expert role than in the NEA cod otolith sampling.

Now, I will turn to how scientists are using the RF as an arena for extended peer reviews, and hence how fishers have access to more knowledge functions than data collection.

Extended Peer Reviews: Changes in Stock Trends

During both Offshore RF and the Coastal RF meetings, fishers inform the IMR about changes they have observed in commercial fish stocks or by-catch. Fishers' interactions with the fish stocks puts them in the right place at the right time when it comes to changes in trends, while scientific models can often be slow. Fishers spend most of their days at sea, and based on experience and observation, they can get an impression of changes in stock trends before the IMR. Throughout the year, fishers also communicate with the IMR by phone and e-mails so the FDG scientists are often already aware about their observations and sometimes they invite the person responsible for the given stock. Below, I will use two examples where scientists are asking fishers to contribute with their experience based knowledge, since their data is falling short. First, I describe how the IMR scientist Kristin Helle uses fishers to make sense of the landing data on ling, then I turn to how the IMR scientists Harald Gjøsæter invites fishers to comment on the state of the saithe stock.

Some stocks that the IMR is managing are not targeted by surveys on a regular basis, i.e., tusk (*Brosme bromse*) and ling (*Molva molva*)[46]. Here, I will focus on the ling stocks which have been estimated through catch statistics since 1971, and the RF has been used for collecting data since 2001. During the 2009 annual meeting, the IMR scientist Kristin Helle addressed some issues with the official landing statistics with regard to the state of ling, in particular with the Offshore RF. According to Kristin, it was the RF fishers who first pointed out that the historical CPUE data were incomplete and doubtful, and based on their comments, she went over them. During this annual meeting, Kristin demonstrated how the landing of ling has been very stable from 1996 to 2008. However, in 2006 she found a decline in the landings from the longline fleet, which she could not explain and invited the RF fishers to find an explanation. She also found a decline in the number days fishers spent fishing this year (see Figure 28).

[46] See, for instance, (FKD 2009)

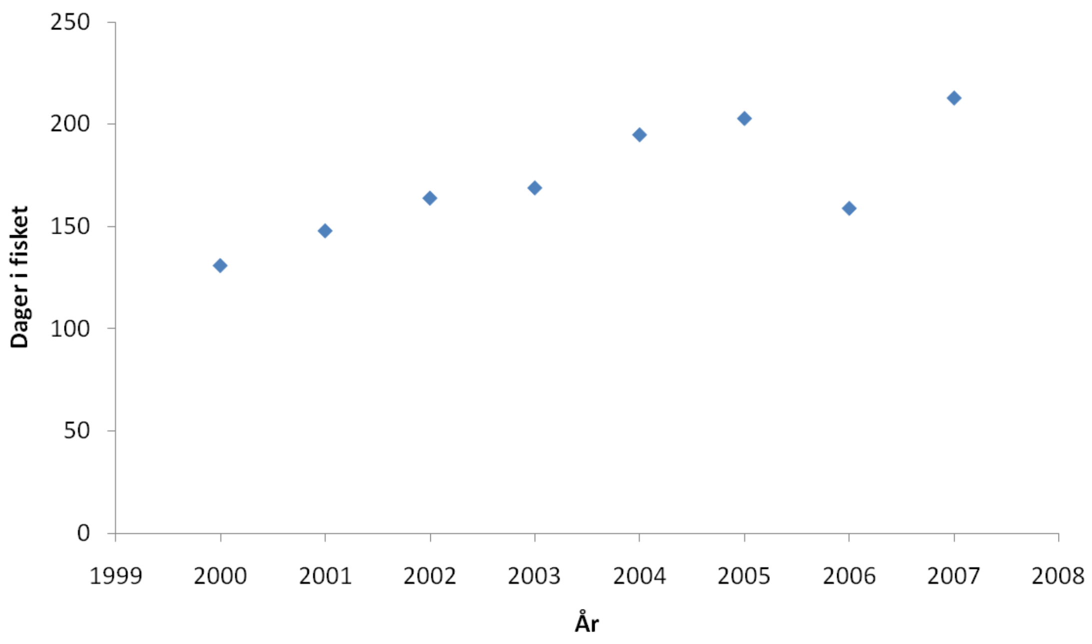


Figure 28: Ling fishery and the number of days fishing. The year is on the horizontal axis and the number of days fishing on the vertical axis. Note the drop in 2006.

Helle: the historical data is jumping all over the place so I do not trust them. Do you [the fishers] have any ideas or explanations?

The fishers discussed what the reasons could be, and found that in the period of time when the landing statistic was low, fishers targeted cod and haddock in the Barents Sea. Hence, the landings were low because the fishers preferred to catch other species, not because the stock was in decline, according to the RF fishers. The fishers' feedback was highly appreciated by Kristin, and she found their explanation valid[47]. Hence, with regard to the ling stock, fishers are used as peers, to check and discuss the scientific findings. Based on the joint effort of the IMR scientist Kristin and the RF fishers as well as other stakeholders, this data contributed to the removal of ling from the official Red List in 2010[48] (Artsdatabanken 2010).

In 2009, Harald Gjøseter, who is the leader of the bottom fish group at the IMR, was invited to discuss the state of the saithe. While fishers are often portrayed as opportunistic with regard to TACs, always arguing for higher quotas, this case demonstrates that the

[47] As Helle specified in an email, the "estimates are jumping around here because the data they are based on is way to small" (29.08.2011).
[48] More information about the red listing of ling can be found in 'Fiskebåtmagasinet' (2009)

opposite can be the case as well. With regard to saithe, it is scientists who argue that the stock is healthy and thriving, and both the Coastal and Offshore RF fishers are voicing a growing concern. The fishers are worried because they get very little saithe as catch or by-catch, and they see alarmingly few juveniles. Gjøsæter opened with several questions:

> Is the saithe there? Is it in decline? Is it difficult to catch when it is spread in the high seas feeding on herring? I don't know: what are you [the fishers] thinking? I would really like your view on this.

Gjøsæter invited the RF fishers to a discussion with the following questions:

> Why is there such a huge difference between what we, the stock responsible can find out about the saithe, and what the fishers see?

Gjøsæter speculated out load on the question he just posed to the fishers:

> Maybe this is because of regional differences. The decline is much bigger in Finnmark [north] than in the south. This provides an explanation in part. The estimation of the stock is resting on two legs: surveys and landings. (…) The saithe may not be as available along the coast anymore; this is a probable scenario since it follows the herring to the high seas.

Based on this, the RF fishers and the scientists discussed the state of the saithe stock back and forth.

Typically, when fishers and scientists disagree about the state of the stock, for instance, such differences in opinion can be discounted as fishers' economic interest in a higher TAC. Therefore, the advice should be based on science only. However, several scientists are now arguing that fishers' and scientists' disagreement about the size of fish stocks cannot only be written off due to this (see, for instance, Degnbol, 2003, Hauge, 2008).

These two examples demonstrate that, with the RF, fishers are invited to the advice function, even if it is informal. In this setting, the RF fishers' data is in addition to scientists' data sets. Compared with their role as data collectors following IMR's protocols for otolith sampling, the RF fishers' level of responsibility and hence participation is increased. With the case of the ling, the fishers' data is authorized by Kristin. Their observations and concerns with the saithe stock, however, is not, even if it is appreciated by the IMR scientists. They regard such feedback from fishers as important 'hints' about how the different stocks are doing. Hence, scientists can be warned early if it seems as if the scientists' 'model fish' clashes with fishers' 'real fish'. Even if this information is not used in the formal assessment as such, it is valuable information for scientists:

> Borge: It is like a snowball that starts rolling from the information that fishers gives us.

When fishers and scientists meet at the IMR, the knowledge of both groups, or epistemic cultures (Knorr Cetina 1999), is considered as a possible part of the puzzle that fisheries management is. This, then, is a place where there are less disputes over credibility, and hence who has the legitimate power to represent this part of the universe referred to as fisheries management (Gieryn 1999: 34). Accordingly, boundary work is less necessary since both fishers and scientists can work together; at least at times.

The Issue of Authorization

The RF is an arena that allows fishers to have an expert like role at the advice stage. Based on the annual meeting, it is becoming clear that the RF fishers are contributing in areas where the boundaries between fishers and scientists are more flexible, i.e., the distribution of species and other observations, and stock trends for species that are not as data intensive and economically important as cod. As will be described in more detail below, the RF fishers registers unusual species, by-catches and discards, which also includes marine mammals and sea birds and testing of new technology, and these are all examples of how fishers have experience based knowledge that is relevant and can be tested for use in advice. As we see with the ling case, the RF fishers are used for peer reviews and their knowledge is found to be reliable and authorized. With the saithe case, fishers voice their disagreement and the stock responsible is listening to them. The RF is organized like the peer review processes we know from science: testing of knowledge to see if it is found sound, reliable and relevant. Fishers and scientists are co-working.

The above examples demonstrate how the IMR sometimes finds the RF's experience based knowledge reliable, tests it and then authorizes it for management purposes and it has an impact in the decision making process, together with science. However, we should also address *how* it is authorized. As we see, the fishers' own knowledge claims are found valid, but only after scientists' approval. As described in chapter 2, science fuses the authorization of knowledge and its validation through peer reviews. While the RF fishers' knowledge is sometimes included, it is important to note that fishers lack the authorization mechanisms for including their knowledge in the advice. So, while science maintains its autonomy, authorizing its own knowledge claim by peer review, this is obviously not the case for the fishers. Instead, for such knowledge, external authorization mechanisms – here the IMR – must be relied on.

Another example from fieldwork illustrates well the importance of authorization in mandated science. In 2005 Nedreaas made a presentation of how an assessment, and hence a TAC advice, would differ if the length and age (otolith) data collected by the RF had been excluded.

According to Nedreaas,

> Including the RF data, the TAC was set at 535,000 tons, while if the RF data [length and age data] had not been used, the TAC would have been lower, 508,000 tons, and most likely, with lower precision (Offshore RF annual meeting, 2005, and elaborated in an email, 12th of September 2011)

This was also illustrated with several figures at the 2009 annual meeting (see Figure 29 below). What the figure shows is the difference between the advices given (in black) and how the advice would be with the RF data excluded (in orange). Note that these figures are not a part of the ICES official assessment, but it is a sensitivity analysis based on Norwegian data alone.

In mandated science, the knowledge produced by fishers must be authorized in order for fishers to be a part of the expertise. In this case, the alternative data set is authorized to be included in the advisory process. If it had not been authorized, this knowledge production would take place outside the Regulatory Chain, and the RF data would not be included in advice. In the case of Figure 29, how the RF makes a difference is presented, and made visible by illustrative figures.

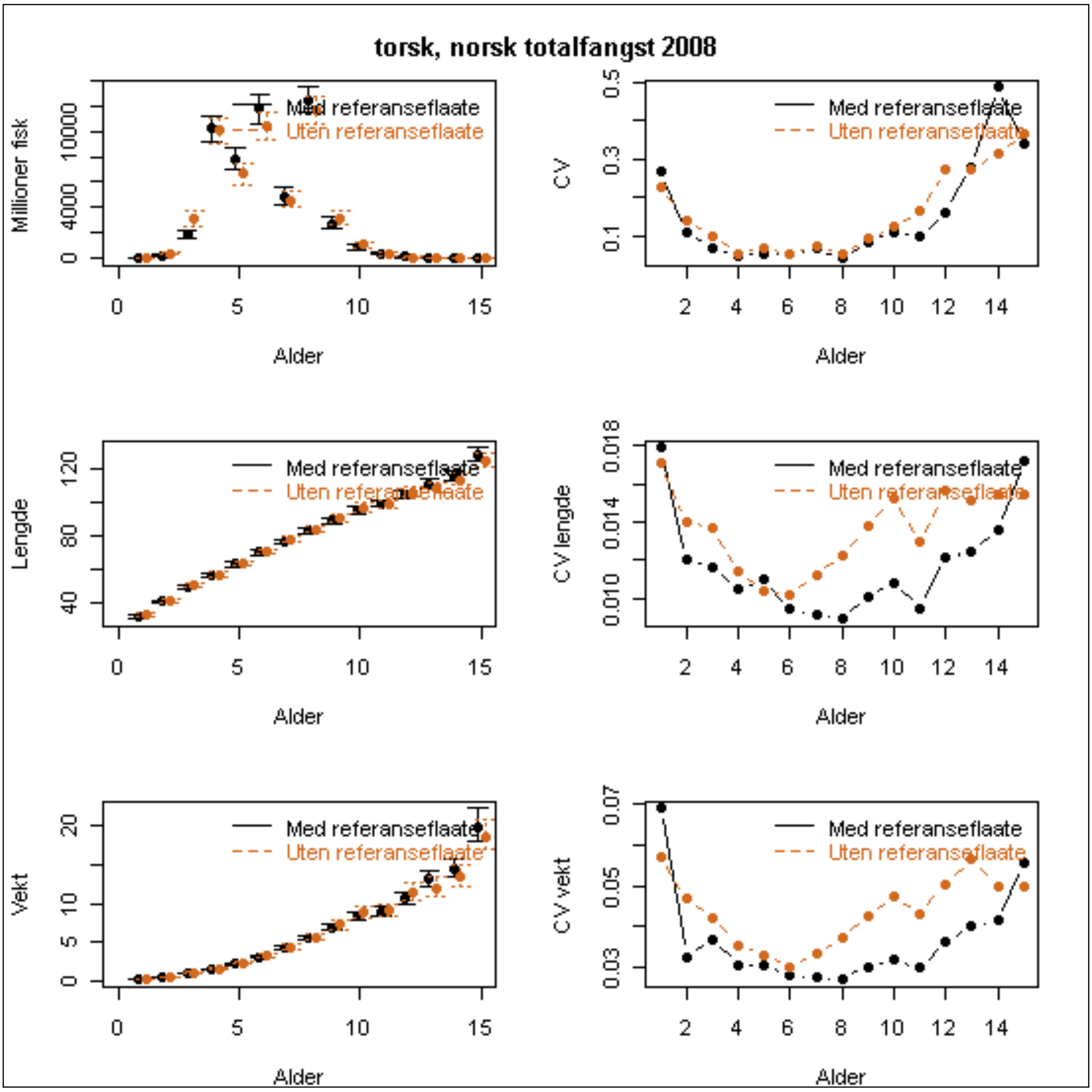


Figure 29: Total catch in Norway of cod, with and without the RF data. The black line is with the RF data included. 'Alder' means age, 'Vekt' means weight, while 'lengde' means length. Figure is courtesy of Kjell Nedreaas.

Fishers' Understanding of Science and vice versa

Based on the above, the RF is an arena where there is room to discuss what constitutes 'good science' and 'valid knowledge'. Fishers' knowledge is taken seriously and tested by science, and fishers are used as peers in scientific matters. This interchange has important implications for the relationship between fishers and scientists, and is related to the notion of boundary work. In the context of fisheries management, the boundaries between fishers and scientists become different and are maintained through relational processes of inclusion and exclusion. In the same way, these boundaries can be blurred as scientists and fishers meet through projects like the RF, which organizes their relations in different ways. This fits well with the idea from science studies that the boundaries are socially constructed and ties together the relationship between boundaries (Gieryn 1999) and heterogeneous network (Latour 1988).

Going Backstage

In the following, I will first look into how the RF is an arena that allows fishers and scientists access to each other's backstages. Then, I focus on how this affects fishers' and scientists' relations – how the RF is a turn from an understanding of fishers as ignorant or scientists as 'office rats'.

As demonstrated by, for example, Jasanoff (1987), Holm (2003) and Nielsen (2008), the legitimacy of advisory work depends on successful boundary work where science and politics are neatly separated (Gieryn 1999; Hilgartner 2000; Jasanoff 1987). In general, science makes strong boundaries between scientific knowledge production and other forms of knowledge, and fisheries science is a field where Merton is supposed to be followed to the letter. Holm[49] underlines how the politicized nature of fisheries science makes the importance of drawing a border between science and non-science even more important:

> Because it is so difficult to distinguish between science and politics within fisheries resource management, Mode-1 ideals [orthodox science] became all the more important. The invocation of Mode-1 science as a model for fishery science, in other words, is a crucial part of the boundary work (Gieryn 1999) within fishery science exactly because the distinction between nature and society within fishery resource management at the outset is so fuzzy (Holm 2003: 5)

With the RF, however, fishers are invited to scientists backstage on a regular basis. This is a result of the RF fishers learning science, and the RF as an arena where scientists demonstrate

[49] See also Nielsen (2008) which thoroughly describes how the boundary between science and politics is difficult to draw since management advice is such a politicized field.

to fishers that, backstage, they know that the model fish they perform frontstage is not always the same as the real fish. Below, I will give some examples of these boundary processes.

Since I have spent a lot of time with the scientists backstage at the IMR and the ICES in particular, I know that scientists are well aware of the complexity of fish stocks and the shortcomings of their models. However, as long as the IMR and the ICES maintain the clear-cut separation between frontstage and backstage performance of fish, fishers are only aware of scientists' belief in fish stocks as model fish. Several of the issues presented at the annual meetings are focused on demonstrating how the IMR scientists know that model fish stocks, which are the key management unit in TACs, are not the same as the complex and relational fish stock in the ecosystem (Hauge 2008). In 2009, the IMR scientist Sigurd Tjelmeland, who does not work directly with the RF, came to present the assessment of capelin. Tjelmeland explained the use of mathematical models to the RF fishers:

> a model is a simplification, and a model has to be so simple that we can adjust it to data and calculate uncertainty (…). We manage the model fish, which has catch in common with the real stock. With regards to capelin, we have absolute measures: the model fish is closer to the real fish.

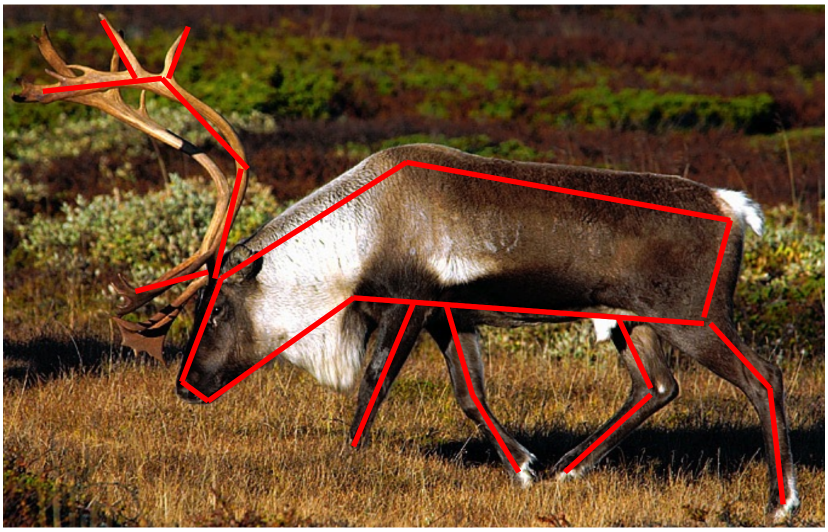


Figure 30: Reindeer as a model and real animal. From Tjelmeland's presentation in 2009.

In order to illustrate how the real fish and the model fish are not the same, Tjelmeland used the above picture of a reindeer (see Figure 30). His point is that even if the models are simplified versions of reality, like the red lines are a simplified version of a reindeer, still, they represent fish stocks.

In Tjelmeland's presentation, the model reindeer with its simplified red lines does not eliminate the hairy and softer image of the animal: fish can be understood as both a wild and complex animal and as a simplified model. This is yet another example of how the RF provides an arena where both fishers' and scientists' understanding of fish can be understood as valid instead of mutually exclusive.

Tjelmeland's presentation symbolizes and signalizes an important change from the traditional management system towards a frame where both fishers' and scientists' knowledge can be valuable. The models need some reality. As described above with the case of the saithe, fishers may also argue that the TAC set by scientists is too high. This generates a possibility for negotiations about what fish stocks are, rather than counter-knowledge production. Scientists' knowledge is not limited to understanding fish as model fish. When scientists acknowledge that for fish stocks can be more complicated than what their models can embrace, they are inviting fishers backstage. This is quite a change from their frontstage discourses, where these models are performed as true to reality. In this context, the IMR can be considered as quite controversial: they have invited fishers inside the traditionally rigorously guarded borders of science, contrary to the norms and rules that are so strict within fisheries science.

Gaining access to data that is true to reality instead of a glossy picture based on the official landing statistics is an issue that is addressed by several scientists. Scientists often complain that the data they work with is incorrect due to illegal, unregulated and unreported fishing. Hence, scientists do not trust the data based on fishers' official landings. Here, I treat the official landing data as fishers' frontstage performance. In the traditional landscape which defines fishers and scientists, the access to such 'true data' is well guarded by fishers: this is their backstage.

In most collaboratory research projects with fishers and scientists, the use of logbooks is common, and this is the case with the RF as well. For instance, the Offshore RF handed in 5777 electronic logbooks in 2008[50] . In the 'normal' data from fishers' logbooks as well as the official landing figures, fishers tend to register only data which match the official regulations in order not to incriminate themselves. However, I discovered something quite unusual about the RF logbooks: the data here do not necessarily correspond with the data that they register in the official logbooks. The RF fishers keep logbooks with registrations and forms that are

[50] This number was presented by Nedreaas at the Offshore RF annual meeting in 2009.

considered the property of the IMR. This means that the coast guard has no right to look into these, in contrast to all the other information onboard which the fishers should provide them. The RF fishers have a special arrangement to register everything they catch, even by-catches and illegal discards, in the forms they send in to the IMR. This is a trust based agreement which is often discussed at the annual meetings. Hence, the RF fishers give the scientists a glimpse into the some aspects of fishers' backstage activities, which they cannot normally share with scientists since it is incriminating. One IMR scientists explained that

> The official data are glossy pictures of reality. In the models, we use them as if they where true, giving a wrong assessment showing a decline in a given stock. This leads to a negative spiral since the fishers are given even more incentives to continue to cheat – they do not believe the scientists' advice – since they can see that there is more fish than the scientists' claim. The RF can break this, which I will call a vicious circle, since the data is based on trust.

Another backstage issue is that of by-catch, and the RF fishers also provide the IMR with by-catch data of sea birds and marine mammals. For instance, with regard to the harbour porpoise, the RF have provided the IMR with valuable data, especially the Coastal RF vessels. In 2006, the Coastal RF registered 149 harbour porpoises, 166 in 2007 and 176 in 2008. This information is found on the IMR's internet pages[51]. With regard to data on by-catch of both marine mammals and sea birds, the RF fishers have voiced some anxiety with regard to how these data will be used by the IMR. They fear this data can lead to some gear bans or excluding devices that would make their work more difficult. While NGOs like the WWF want to protect marine mammals, fishers typically want to diminish the number of seals and other marine mammals. The seal is very unpopular among fishers since they eat[52] a large portion of the cod stock and spread parasites[53]. With the RF, the IMR has access to fishers' practices and knowledge that is not presented on their frontstage due to the politicized context.

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[51]See internet link in reference list (IMR 2010a)

[52] According to estimates made by the ICES for the North Sea, grey seals alone consumed 4150 tons of cod in 1985 and 8344 tons in 2002. In 2002 the grey seal population tripled in size (21,000–68,000 individuals) and consumed 8344 tons (95% confidence intervals; 5028–14,941 tons (ICES 2008b).

[53] Some examples are from the local news (see, for instance, NRK 2010a; NRK 2010b)

Other 'glimpses' from fishers backstage are provided at the annual meetings when the fishers and scientists discuss the effort data, where the standing time registered by the RF fishers often goes over the legal standing time. The scientists also observe the fishers activities and practices when they visit them on the vessels, which can be important with regard to, for instance, technological creep. Some of the illegal practices that the fishers tend to turn to seem to be based on the lack of trust towards the TAC advice in general. This gives fishers an incentive to fish more since they believe that the fisheries can take a higher fishing effort. However, fishers also express frustration since they do not want to break the law, but often feel forced to do so due to a variety of practical obstacles. For instance, the new Fishery Law[54] which makes most discards illegal may be a good idea from a theoretical perspective, but in real life there may be some challenges due to, for instance, space for storing by-catch such as sharks, skates and crabs. In addition, it seems pointless to the fishers to bring by-catch which lacks a market to shore, since it can only be thrown away. The RF fishers gave several examples of how the regulations are impossible to follow in practice, and sometimes the regulations are very complex and difficult to understand.

With the RF, the IMR scientists can see that fishers sometimes do break the rules and throw out undersized fish, or leave their gear too long in the sea and so on. However, the reasons for this may become understandable, and fishers can be perceived as more than gain-seeking individuals.

Access to Uncertainty: How Does This Affect the Authority of Science?

Even if the experts – the IMR and the ICES scientists – agree about what makes up valid knowledge claims, this is challenged when it 'enters the stage' as advice of some sort. The consistency of the advice is crucial, and this involves excluding access to the backstage, not only for fishers but also for other competing scientific advisory bodies. And importantly, scientists are aware of this. A report about the role of the IMR states that

> The management authority has neither a wish nor a need for a competing advisory body for management within the same field [fisheries]. Considering all aspects, one wishes, with all the relevant aspects taken into consideration, the best expert advice. *Differences in advice will only contribute to unnecessarily complicate the political decision making process afterwards*. Internationally, the need for consistent advice for the

[54]The New Marine Act (FKD 2007-2008)

> North East Atlantic is solved as the ICES coordinates, evaluates and checks the quality of the collective scientific management effort of the marine, and hence the authoritative international expertise for management advice. (Gullestad 1996: my translation, emphasis added)

This is, as addressed in chapter 2, a strategy to ensure authoritative advice. If uncertainty – difference in advice – is expressed, the legitimacy of the advice can be challenged.
The IMR's authority in advisory matters is often challenged by fishers, and examples are readily available in the media. As the fishers' own newspaper *Fiskaren* reported:

> The news about the ICES scientists' quota recommendations were not well received (…). The fishers experience the opposite [of the quota advice] – that there is a lot of fish in the sea. (…) The two last years, the assessment by scientists been very different from the reality we experience at sea. (Fiskeribladetfiskaren 2005)

Such lack of trust in the advice given by scientists is common. Hence, the IMR's role as a centre of calculation is challenged, and the facts produced here are not accepted outside the laboratory (Latour 1987).

With the RF, the uncertainty of advice which is typically hidden on science's backstage is becoming even more evident for the RF fishers. This is related to how fishers are included when 'science is in the making' (Latour 1987) , rather than the 'ready made science' presented frontstage. As one fisher stated:

Kato: I am closer to the system, I am more aware about what is going on, what people in the business and the scientific environment are saying in general.

The RF is a case that makes it possible to investigate empirically what happens when fishers are trained in science and given access to all the negotiations and uncertainty on which advice is based. So, what happens when the RF fishers gain access to the uncertainty of advice: is science losing its authority?

In order to investigate if the legitimacy of fisheries management has changed with the establishment of the RF, I asked the RF fishers if they think that the legitimacy of fisheries management improved after the RF was established. The answer was predominantly positive. The majority of the fishers present at the Offshore RF and Coastal RF annual meetings in 2009 answered a questionnaire I had prepared about the RF. Out of the 28 RF fishers asked, 26 said yes. When I asked the fishers if they find the TACs more legitimate with the RF, 26 of 28 (total is 34) answered yes, and 2 RF fishers answered 'both yes and no'. In general, then, the fishers' evaluation of how the RF works is positive. The fishers also explained why they have an increased trust in the advice with the RF. First, they find that the data on which it is based improved when fishers contributed data on a wider range in terms of time and space, and the RF fishers find that the models used by the IMR are improved with the RF. Several of the RF fishers put across their renewed trust in the IMR as related to their own contributions (data from fishers). As one Offshore RF fisher puts it:

> Prestfjord: [the management is improved] because we [fishers] have participated in the sampling.

As mentioned above, the IMR is often criticized for 'not being at the right time and place', and with the RF sampling the fishers seem to trust the IMR's results as they are based on more representative data:

> Arctander: The picture the IMR gets of the stocks is more correct because the samples are taken at the best fishing places for the different species, and not random sampling based on pre-defined positions

The same type of comments are also made by the Coastal RF fishers. This fisher, for instance, find that the RF improves the advice because

Thor Arild: [with the Coastal RF] the IMR gets more data about the fish stock from the entire coast.

The RF fishers seem to find the figures with data from themselves, such as the data presented in Figure 29 above, more legitimate and as closer to the fish stocks they know from their experience. The fishers are showing this by nodding and making quiet comments like ‘yes’ and ‘this looks more correct’. Most of the RF fishers expressed that since the IMR now includes data collected from where fishers fish, not IMR’s predefined stations, their trust in the models is improved. This fits well with stakeholders’ participation theories, where the legitimacy of management is supposed to be improved when stakeholders are included (see, for instance, Wilson et al. 2003).

In addition, fishers express that they trust the advice more as they learn to understand how scientific models work, to understand the assumptions and logic behind the bio-economic models. As one of the Offshore RF fishers said during a break at the 2009 annual meeting

Before [I joined the RF], I could not understand why the scientists would get so happy when they got one fish in a trawl haul; they clapped their hands and said, ‘It is the same as last year!’

Other RF fishers made the same type of comments:

Snarsetværing: [I] get a better understanding for scientists’ working methods.

Nesejenta: When one works with the scientists for a couple of years, one learns to have faith in the work they do.

Skagøysund: Our views differ in some cases, but we have a better understanding of what the IMR is doing.

Finally, many of the RF fishers have explained that they trust scientists' advice more when they see that scientists are aware of the complex reality and do not relate to model fish only.

Enrolled in the Network?

With the inclusion of fishers in mundane tasks of data provision, they get to be educated in the mechanics of science. But training fishers in science this way and giving them access to science backstage can have important implications. From the above descriptions, fishers and scientists negotiations and the boundary work seems to be dominated by scientists. Obviously, there is a risk that the contributions from fishers are based on science premises. Have the fishers ended up being trapped in scientific practices and the framework of the Regulatory Chain? Is the RF framed in such a way that the fishers are no longer fishers, but transformed into 'little scientists'? This is not necessarily a problem, but we should at least be aware of this, if such a process is taking place.

As discussed in chapter 2, there are strands of FEK research that argue that fishers' knowledge is different from science, and that it should be protected from corruption by science (Agrawal 1995). From this perspective, the difference made by the RF is that it teaches fishers how to trust science, and hence to improve the power of the Regulatory Chains order. If we use ANT vocabulary, we could say that fishers are being translated; that they are enrolled and controlled by the network constituted by the Regulatory Chain.

Let me start by saying that, according to my findings, the RF fishers are far from being passive delegates for science. The RF is not just gathering data and answering IMR's questions. The RF gives the fishers access to science and all the powerful tools and methods that are key in producing knowledge chains. Hence, the RF is an arena that teaches fishers science and hence how to produce data sets that can empower them and give them a voice. During fieldwork, there were several examples of the RF fishers using science to test their hypothesis. In the following, I present one case that also demonstrates how fishers use their laboratory access to make stronger knowledge claims.

In Norway, fish farming is one of the most important industries, and this has caused some conflicts with other stakeholders, such as the coastal fishers (IMR 2007b; NRK 2006). In 2006, the local fishers in a community in the south-west of Norway contacted the press and started a public debate about the influence of the feed and feces from fish farms on saithe[55]. The fishers concern was that this salmon feed and feces, being eaten by the saithe, changes the quality of the saithe, making the fish fatty and inedible. In addition, some of the buyers in the south-west would not buy the saithe due to its smell and bad taste[56]. However, the fishers in the north disagreed, arguing that the best saithe is caught around the farms, since it is fatter and has a better taste. These statements from the fishers in the north were supported by the fish farmers[57]. One of the CRF fishers from the south-west contacted Nedreaas in order to ask if the IMR could help him with the case of the saithe. According to Nedreaas

> The CRF fisher contacted me because he wants the IMR to produce objective knowledge about the quality of the saithe that feeds around the fish farms. (Interview, 06.08.2007)

The IMR initiated a study, based in part on this discussion, resulting in a publication (IMR 2007b). The IMR found that there is a difference in quality between wild fish that has access to fish farm feed and other wild fish. The scientific report suggest that the saithe caught around the fish farms be treated as farmed fish, recommending that the fish is caught alive and then starved.

The RF provides the fishers, at least the RF fishers, with an open and easy communication channel by which they can communicate with science and test their knowledge. Regardless of the result of the study, the point is that the fishers know the value of a scientifically produced argument, and that the RF fishers have direct contact with scientists that can document what the fishers claim. Without such documentation, the fishers' statements would remain anecdotes. This example shows how the RF is giving fishers access to a laboratory: they are trained in the scientific methods and how to gather data that can be used to produce 'harder' facts. The RF has much in common with the case studies of Epstein (1996) and Wynne (1989b), as it shows that the public can mobilize abound particular issues and has the capacity to learn science (versus the deficit model) (see for instance Irwin and Michaels 2003). Also, the RF provides both the fishers and scientists with a new arena for

[55] See (Pelletssei 2009) for an overview .
[56] (NRK 2006).
[57] This was discussed in the news in Norway, both in 'NRK', in February, 2006, and in 'Nettavisen', February 2006. However, these interviews are not available on their webpages any longer.

communication. E-mail is an important form of communication within the RF, and the IMR finances the vessels' internet costs. Today, communication through e-mails requires little effort and there is a low threshold for using it. Hence, it is a smooth way to test each other's hypotheses and to keep in touch. During fieldwork, several scientists underlined to me how important it is to make room for fishers' knowledge with projects like the RF. According to one of the FDG scientists, the contact she has with fishers through the RF is invaluable:

> It is so nice to be in touch with reality. Typically, I get one mail from a boat, every day. A lot of the research groups only work with fish theoretically.

This illustrates how scientists also are constrained by the existing framework; it is not just that science is listening to society's call for more stakeholders participation, this call is also coming from within, as scientists are also looking for ways to open up the management process for other relevant inputs. This change is also reflected in the work realized by the RF. The RF establishes a common arena where fishers and scientists come together as a collective, they make alliances, which has the potential to reconstruct the boundary between them.

'IMR's People in the Field'– A Smooth Transition?

The examples I have described above are all positive with regard to how scientists view the inclusion of fishers in management and the establishment of the RF. To Nedreaas, the RF fishers are just as capable as the scientists; they are 'IMR's people in the field':

> Nedreaas: In my opinion, there should be no other difference [between the RF fishers and the scientists] other than them not being employed at the institute [IMR]. Hence, they are our people, the institute's people, out in the field. This is how I see it. They are data collectors for the IMR. (Interview 16.12.009)

However, it is also in order to point out that there is some resistance towards the RF at the IMR. From my fieldwork at the FDG I have the impression that the RF scientists and fishers have a good relationship that is based on trust. However, the trust between fishers and scientists generated by the RF is quite local within the IMR. I know from my meetings with fishers that they have had numerous experiences with scientists who are very critical of using fishers in management. Using fishers to collect data can be controversial, since some scientists argue that this is like letting 'the fox into the henhouse' (Jentoft et al. 1998). At times, it has been difficult to get statements from scientists that can give more substance to this discussion. The issue of mistrust between fishers and scientists can be difficult sometimes due to political aspects, and the potential for conflicts is high. This mistrust goes both ways. For instance, one of the key fishers in the creation process of the RF hinted about some resistance from both fishers and scientist towards the RF in general

> Well, we all had some confrontations

I asked Nedreaas, the leader of the FDG, about the trust issues between fishers and scientists, if the IMR's scientists trust the data collected by the RF. He answered:

> Now you are touching some fundamental issues… that of using fishers to collect data. And then there are such issues that still remain. (…) But I always say that a fisher will always meet himself in the door if he does not do it correctly. Because, if he only measures small fish, then we [scientists] will say that 'Oh look, here the fishing is too hard, or the mesh size is wrong', and so on, because in this area the fish is not growing up to a good size. Or, if he [the fisher] only measures the big fish, then we [scientists] will say 'Now we must slow down because there is no recruitment [to the fisheries].' (Interview 16.12.009)

So, based on my own impressions and Nedreaas's statements, there are some challenges with using data collected by fishers. Some scientists do not trust the fishers to collect data in an objective, standardized way following the rules, and believe that their bias – i.e., wanting larger quotas – undermines their ability to collect scientifically sound data.

If scientists do not trust fishers as data collectors is also related to why the CPUE data from the RF is excluded from stock assessment as described in chapter 5. In addition to the scepticism towards fishers as tactical samplers, there is also mistrust towards the fisher as a lazy data collector. Below, Nedreaas elaborates on the above question about trusting fishers for data collection:

> It is not just that the fishers are met with mistrust for being tactical, but they can also be mistrusted for being lazy. That he does not care about the data being representative or that he only reports half the catch just based on laziness. (…) We did discover that the fisher [did not follow the instructions], since we did not get any ling longer than one metre, but a large number of ling that was one metre: and this cannot be true to nature/reality, and then it turned out that they did not bother to push a button and add the necessary centimetres [using the FishMeter]. (…) This is an example of laziness; they did not take it seriously. Then, they are not following the instructions, and hence the contract. (Interview 16.12.009)

The FDG scientists who work closely with the RF fishers seem to trust the RF fishers as data collectors more than other scientists that do not have contact with the fishers. Most of the FDG scientists who work with the RF on a daily basis argue that the incriminating data the fishers send in to the IMR is a proof that fishers do not cheat or give scientists an idealized picture. One IMR scientist who works with the RF explained that he trusts the RF data since the RF fishers incriminate themselves:

> This is a good sign that we are getting true data. The usual data we get from the fisheries directorate, for example, logbooks and landings: here the rules are followed. Hence, the data is different from the reality.

My experience entering data for the IMR is the same: the fishers willingly give them information that could incriminate them, such as leaving the gear in the water too long or discarding undersized fish.

The RF generates trust between fishers and scientists. However, this seems to be a local phenomenon. While the FDG trusts the data collected by the RF, there is less trust in other research groups at the IMR. In addition, there seems to be a higher level of distrust towards fishers as data collectors at the international level. The EU, as well as the global fisheries management scene, tends to use observers on board vessels, rather than fishers, to take samples and collect data. This distrust also generates a boundary for the RF data since it must be accepted by the international community of scientists at the ICES. The scientists working closely with the RF sometimes have to defend the data produced by the RF. Nedreaas explained that

> [Scientists on an international scale] challenge us to document that this is data of good quality. And we have to relate to this all the time. But, when it is our own people [from IMR that collects data] then all this slides more directly through. (…) But, in my opinion, with good enough training, the only difference is that the person is not employed at the IMR. (Interview 16.12.009)

To sum up, there are some issues with using the RF that is related to the lack of trust that scientists have in using fishers as data collectors. As mentioned, scientists are worried that the fishers' data can have a bias, since they have an economic interest in the end product, i.e., the quotas. Also, there are some that believe that the quality of this data is not good enough since fishers may be lazy. In addition, there seem to be a difference with regard to who trusts the data from the RF: those that work closely with the fishers' state that they do trust the data, while other research groups at the IMR as well as internationally have a lower level of trust towards this type of data. Hence, the RF data is trusted 'locally', but met with more scepticism elsewhere, which has an impact on to the degree to which that data is put to work for management purposes.

From Fox to Colleague: The Expert Role within Reach?

In this chapter, my attention has been on the boundary work that takes place within the RF; how the fishers and scientists meet, how they interact and enact their relationships and invite each other backstage; and how they cross, at least at times, the (socially constructed) gap between them.

Now, we know more about what knowledge functions the RF fishers have access to, and it is obviously more than co-working with scientists for otolith sampling. As described above, fishers can voice their opinion and contribute with their own knowledge claims. RF fishers are used as capable observers and their access to data in time and space is highly valued. While much of the RF fishers knowledge is never authorized,, there are some very real changes as well. I have also described how the fishers and scientists invite each other backstage. When scientists demonstrate that they know that their models do not represent real fish and that fish stocks are much more complex than scientists enact frontstage, three important things happen. First, this generates room for both fishers' and scientists' world views; hence both groups can have valuable knowledge about fish stocks. Secondly, by allowing fishers backstage, scientists demonstrate to fishers that they also know about the 'real' fish out there, and that reality does not necessarily correspond with their models. Finally, fishers are becoming familiar with the power of a laboratory, and they are learning, at least potentially, about scientific assumptions and language which is important for generating effective communication. The RF fishers are learning about science; how science works, what the assumptions are, how and why standardization is so important and how and why it is necessary to do the meticulous registrations. Hence, science can become more than a closed hermeneutic circle where scientists define which questions to ask. Scientists are also invited to fishers' backstage. Importantly, in these backstage meetings, fishers and scientists generate trust and understanding of each other's practices. The fishers explicitly said that being part of the RF has improved their trust in science and the legitimacy of the advice.

The annual meetings are an institutionalized, almost ritualistic, arena for the fishers and scientists to negotiate the traditional boundaries that define scientists as experts while fishers' knowledge is excluded. Now, we can start to see how the RF also is an arena that makes it possible for fishers and scientists to communicate across the traditional boundaries as defined by the Regulatory Chain. The FDG is interested in opening up to include fishers in knowledge production and that the RF is more than an opportunity to use fishers for already established tasks and train them in science. The RF is an arena that generates so much more than the tangible data flows in and out from the IMR. In addition, fishers and scientists are re-negotiating the traditional map: within this framework fishers are no longer foxes and scientists are no longer office rats, as they can be colleagues with different but valuable knowledge. The expert role seems to be within reach for fishers as organized with the RF. In areas where the boundaries between fishers and scientists are more flexible, like distribution of species and other observations, and stock trends for species that are not as data intensive and economically important like cod, the RF is already using fishers in an expert-like role. In the next and final chapter, I will look further into whether and how the RF actually includes fishers in the knowledge production and the expertise for fisheries management.

Chapter 7

Bridging the Gap?

> Expertise has never before been so indispensible, while being simultaneously so hotly contested. The question of whose knowledge is to be recognized, translated and incorporated into action has been exacerbated under the pressure for democratization (Nowotny 2003: 151).

The starting point of this dissertation is the legitimacy problem that science faces. The importance of opening up decision making and establishing more participatory – and hence legitimate – processes is underlined by a rich body of literature (Fischer 2000; Liberatore and Funtowicz 2003; Nowotny 2003). While society in general puts great trust in science and advisory bodies, there are also calls for a more open and inclusive advisory process in line with good governance ideals. Such calls are now widely acknowledged by decision making authorities, and go together with increasing attention to notions like experience based knowledge and lay expertise (CEC 2007; Collins and Evans 2007; Prior 2003a). These discourses are raising important questions about how to re-organize advisory and decision making processes.

In order to address such issues, I have examined a practical project where the explicit purpose was to engage non-scientists in knowledge production for advice purposes, the RF. For the purpose of my thesis, the RF can be considered a social experiment in democratization of knowledge production. As indicated in the empirical chapters above, a great number of practical, technical, political, economic and institutional challenges were involved in establishing and running the RF. Whether and in what sense it can be counted as a success depends on the criteria employed, and the thesis has not been designed to perform such an evaluation[58]. In any case, the RF has now survived for over a decade. As we have seen, it does include fishers and it does contribute data that are used for stock assessment and advice. In one sense, then, the RF has demonstrated that it is possible to organize the knowledge production process in such a way that stakeholders can be included. With the establishment of the RF, fishers have been included in knowledge production for management purposes.

[58] An external evaluation of the RF that investigates some of these issues was realized in 2011, in which I participated (Bowering et al. 2011).

My examination needs to go beyond their inclusion as such, however. What I need to probe further into concerns the exact way the RF fishers have been included, what they contribute to the process, and what type of responsibilities they take on. Is the RF a project by which fishers get to perform minor tasks under scientific control, or is it an arena where they can mobilize their own experience based knowledge? Does the RF enable the fishers to get closer to the role of experts and advisors, or does it maintain a system where the scientists remain the eminent source of expertise?

How the RF Includes Fishers in Knowledge Production

As we now know, the RF does include fishers in knowledge production for advice. But exactly what is it that they are doing and what difference does it make? My findings are summarized in Figure 31 below.

How the RF fishers are included in knowledge production	Data Collection	Assessment	Advice
Working with science	X	0	0*
In addition to science	0	0	0
Responsible for	0	0	0

Figure 31: How the RF makes a difference. See text for a detailed explanation.

Before the establishment of the RF (and still for those fishers that are not part of it) fishers were largely excluded from knowledge production[59]. As illustrated in Figure 31 above, the most significant change brought about by the establishment of the RF is that the fishers have

[59] This figure illustrates what changes were brought about by the RF. Recall from chapter 1 that all fishers contribute data through their logbooks, referred to as fisheries dependent data. However, this only represents a minor contribution to knowledge production for management. The main purpose of collecting logbook data is catch and quota control. As mentioned in chapter 1, there have been some rather unfortunate and disastrous experiences where fisheries dependent data have led to bias in the assessment, which has led to less use of such data. The Canadian cod collapse is one such experience where the assessments showed a healthy stock while in reality it was in decline (see, for instance, (see for instance Hutchings and Myers 1994)

been included in data collection. The data collected by the fishers (species composition, length and otolith (age) data) are used for stock assessment and advice purposes. As we have seen, there is a steady flow of such data going from the RF vessels into the IMR in Bergen, and from there, in refined form, to the ICES where it is used as input in stock assessment models. Let me remind you that I have followed the NEA cod with particular care. For the many stocks that are assessed by the IMR at a national level only, the RF data (including the CPUE) may contribute more, dependent on the species.

While the fishers, through the establishment of RF, have been included in data collection, their involvement cannot be characterized as a very deep and responsible one. In Figure 31, this is reflected by the registration of fisher involvement here in the first row, in cooperation with scientists. The term ‘working with science’ can of course cover a range of possibilities, and this requires further specification. We note that the RF fishers are performing data collection; they are trusted to do it themselves. Nevertheless, in performing data collection, the RF fishers must follow standardized procedures and have very little influence on what data to collect and how to undertake this task. The role of the fishers is strictly limited to following protocols designed by IMR scientists. There are good reasons for this. Only as long as the RF fishers follow protocols can the otolith data be extracted, refined and made to flow into well established knowledge chains as one of several contributions to the IMR and the ICES. Furthermore, while the fishers do primary data collection, they do not get to participate in the transformation process where the samples (labelled otoliths) are turned into age data. To summarize then, the fishers’ role in data collection is similar to that of a technician or a research assistant, with little responsibility with regard to what data to collect and how to collect and interpret it. While the fishers are indeed working with science, the scientists have not given up much decision making power.

Turning next to the assessment function, I have not found traces that indicate that the RF fishers are included (second column in Figure 31). This stage of the knowledge production process takes place within the framework of the ICES, and is conducted during the AFWG meeting. As part of a highly esoteric and traditionally closed scientific procedure, only the designated scientists from the different national marine laboratories (like the IMR) are allowed to participate. The RF has not in any way changed this. When I observed the AFWG meeting, there were no fishers – or other stakeholders – contributing to the assessment in any way. This was not unexpected. First, the actual assessment, running the VPA models with data input, in part contributed by the RF, is itself an extremely technically complex operation. Even within the expert group that constitutes the AFWG, there are a select few who undertake the actual statistical modelling itself. Doing assessment requires years of specialized training in programming and statistical modelling. In short, the fishers don't have the skills. Second, the assessments are usually undertaken during the high season of the NEA cod fishery. The ICES and IMR scientists' work is organized in a yearly rhythm dictated by the Regulatory Chain, while fishers' practices are organized around the seasonal availability of the fish. While fishers' participation in the data collection stage is relatively unproblematic, then, it is hard to see how fishers could come into a position where they could participate in a meaningful way in the assessment process as this is undertaken today. In order to participate here, the fisher must have left the fishing vessel and made his way to the ICES in Copenhagen, the centre of calculation. The trickiest part of this journey would not be going to Copenhagen, even if the relevant event (the AFWG meeting) happens in the best fishing season and hence would be inconvenient and costly. In order to make a difference there, however, he would first have had to acquire the technical skills necessary. A more practical solution, perhaps, would be for the fishers, for instance through the Fishermen's Association, to hire a competent assessment scientist to represent them at the AFWG meeting. While this would meet this need, however, it would at the same time reintroduce in a slightly different way the same problem with which we started, namely the gap between fishers and scientists in knowledge production.

Finally, the RF does not offer an opportunity for fishers' participation at the advice stage for knowledge production either (Figure 31, third column). The basic reason is the same as for assessment, namely that the advisory function within the present management regime is explicitly reserved as an ICES responsibility[60], and the establishment of the RF does not in any way change that. Nevertheless, the annual meeting is an arena in which the RF fishers get to participate in discussions about the relevance of the data they have produced for the management of fish stocks. For instance, when the IMR scientists discuss the TAC advice with the RF fishers, this often falls in the same pattern as when the scientists discuss the data among themselves in the ICES. While the practices at the annual meeting cannot be qualified as a peer review, this is an arena that perhaps can be characterized as a rudimentary expert body. When the large, commercially important fish stocks are concerned, that is, the stocks at the centre of the 'TAC machine', to use Holm and Nielsen's (2004) terminology, the viewpoints and concerns voiced at the annual meeting have no access to relevant decision making arenas. For the marginal stocks, however, those for which there is little data, no

[60] In some cases, the IMR gets to take this role (See, for instance, Hauge 2008).

analytical assessment, and only weak management measures, the RF can sometimes be in a position to generate advice that may find an ear with the authorities. The ling and saithe examples from chapter 6 illustrate this. Here, I have described how fishers and scientists discussed the problems with the CPUE data on ling, and in the case of saithe, fishers could voice their concerns to scientists and deliberate on the reasons for discrepancy in fishers' experience based knowledge and scientists' models. While there are hence traces of fishers' participation in the advice function, this has an ad hoc character. Sometimes fishers' advice is found to be sound and reliable, sometimes it is ignored. There is thus a small opening created by the RF with regard to the advice function, noted by the asterisk in Figure 31. Nevertheless, it would be an exaggeration to say that RF represents a change in this respect.

In summary, then, the main difference the RF makes is to include fishers in data collection, in a subservient role. While there is a hint of inclusion with respect to advice, the fishers remain excluded from the assessment function. The fishers' involvement is low, as the RF fishers have no decision-making authority with regard to which data can be provided or how. To the extent the RF has succeeded in achieving the goals for which this project was established, it is because it actually involves fishers in knowledge production for advice. Nevertheless, this involvement is shallow, and does little to change the fundamental distribution of authority with regard to knowledge provision for fisheries management, which remains securely in the hands of the IMR and marine scientists.

While this may seem a bit disappointing, particularly in the light of the grand achievements claimed for the RF as the start of a new era (Bjordal 2003), one should not be too hasty in drawing conclusions. Given the starting point here, with the strong exclusion of fishers and other stakeholders from knowledge production within the management regime, the relatively small achievements of the RF have not come without a considerable and sustained struggle. What may seem like a small step for mankind, may be characterized as a giant leap for the fisherman.

Conditions for Including Fishers in Knowledge Production

The previous section addressed my first research question, namely how the RF fishers are included in knowledge production for resource management purposes. I found that this is mainly in data collection, working together with scientists in an arena that remains dominated by scientists. This already suggests the answer to my second research question, whether it is reasonable to say that fishers, through the RF, are getting to be experts. Since the RF to a large extent includes fishers in a system that remains controlled by scientists, there is little to suggest changes in the traditional distribution of cognitive authority. In order to address this more systematically, however, I will first answer my third research question: what are the conditions for the RF fishers' participation in the knowledge functions of the advisory process? In this section I approach this by investigating in more detail why fishers are included in some stages of knowledge production and not in others. While this does not address all aspects of my second research question – I return to other sides of this in the following sections – it allows me to consider in a more systematic way what the limits are for the inclusion of fishers in knowledge production under the current institutional framework. Later, I will discuss what fundamental institutional changes are needed in order to ensure fishers' participation in a more systematic manner.

What makes the inclusion of fishers in data collection relatively easy, at least compared with assessment and advice? The first thing one can note in order to answer this is that representational chains much like those the RF contributes to have been in place and working for a long time already. The RF is one of four data collection platforms. These include, in addition to the RF, the port sampling programme, the annual scientific surveys, and the coast guard (Table 13 in chapter 5). Most of the equipment and protocols employed for RF purposes were already developed and tested out in connection with these platforms. In some ways, the RF was not an innovation, but a variation on well established tasks. What was new was not so much the technology to extend the laboratory towards the fishing grounds, but fishers operating that technology.

The reason why it is relatively easy to include the RF fishers in data collection, then, is that there was a pre-established and well rehearsed network in place to achieve the inclusion of data from different data collection platforms. The translation chains needed to make data travel without distortion from the coast guard, ports and surveys and to the IMR were already in existence, as were the mechanisms to test and certify the data flowing through these channels. The RF fishers could, with some modifications, be attached to this network.

Still, of course, as described in the empirical chapters, the inclusion of fishers as part of these networks did not occur effortlessly, without problems, lots of sustained work and controversies. In order to ensure that the data collected by the RF fishers would be included in knowledge production, a number of practical challenges must be addressed. I have earlier described how the inclusion of the RF data does not mean that the IMR has opened itself up for knowledge produced outside the laboratory. On the contrary, the fishers' contribution depended on the expansion of the laboratory boundary. First, in order for any actor in the network to contribute data, access to a laboratory is required. In other words, the data must be collected following scientific protocol, using prescribed instrumentation, so that it is possible to follow the traces and check the data. Secondly, including fishers in such knowledge chains requires resources like time, relationship building, tools and money. It is crucial to provide any data collector with the necessary knowledge and detailed description of data, methods, underlying assumptions, simplifications and uncertainties (Hauge 2008). Third, for fishers to participate, it must be possible for them to combine the sampling activity with fishing activities. As long as the RF fishers can maintain their fishing practices and take the laboratory with them, they can serve as 'hybrid delegates' for the IMR. Even if all these requirements are met, it is still not certain that the laboratory boundaries can be extended and fishers included. I have demonstrated how the IMR scientists have put the otolith data, together with length and weight data to use for assessment, while CPUE data is left unused (e.g., regarding cod, haddock and pelagic species) in the IMR's data bank. In order for the data collected by fishers to be made to circulate within the network, the scientists in gatekeeper positions within the network must trust them. While such trust may be achieved by trying to meet the conditions suggested above, it is still not guaranteed. Extending the boundary of the laboratory to include fishers as data providers is hence a fragile achievement, requiring a lot of work in order to be accomplished and sustained.

While the inclusion of fishers in data collection is made possible because much of the practical apparatus for extending the laboratory was already in place, it is much harder to include fishers in the assessment. The annual assessments at the ICES require advanced training and skills in, for instance, statistical modelling as well as being present at the expert group meeting which takes place during the high season of the NEA cod fishery. The assessment function is located in a centre of calculation, far away from the sea. Moreover, such assessment has, within the current management regime, institutionalized boundaries established exactly with the aim of protecting science from non-science. While it is practically possible for fishers to combine laboratory and fishing practices, and institutionally possible to extend the laboratory to include fishers through appropriate instrumentation and strict instruction, this is much harder when it comes to assessment. Within the established regime, the role of the centre of calculation is to be a specialized knowledge platform that provides the coastal state with objective knowledge, unpolluted by political and economic interests. It is difficult to imagine how to open up this stage of knowledge production without a fundamental change of the system in place. Surely, including fishers in the assessment is practically possible, since fishers have the same mental capacity as scientists. But this would entail that fishers turned themselves into scientists or hired scientists to represent their interests. Put differently, in order to participate in assessment, fishers would have to be enrolled by the system and transform themselves into scientists. As we have seen, the RF fishers are still fishers, and they only comply with the terms of the laboratory as long as it is compatible with their fishing practices (chapter 5). If they were to engage in assessment, in contrast, they would have to give up being fishers, at least if they wanted to do it properly. Without that qualification, however, fishers' participation in the assessment function would only amount to a sort of 'silent observation' and it would, arguably, be more tokenistic than meaningful.

When it comes to the question of advice, we have seen that the RF does not really open the way for fishers' participation. Nevertheless, the potential for including fishers seems to be better for this knowledge function than for assessment. This potential becomes particularly visible during the RF annual meetings. While there are a lot of informal discussions here about the TAC advice, this is of course not an authorized arena where fishers have a real influence over the advice. As suggested in the previous section, I found that the annual meeting does not serve as an advisory function, but that there are instances where it approaches such a role for marginal stocks. As I have argued, the fishers, drawing on their hands-on experience of how science is done and their access to science's backstage through the RF, have been enabled to make more informed criticism of the assessment work and the scientific advice (chapter 6). Nevertheless, the potential for including fishers in the advice stage with RF remains largely unexploited. How this potential could be realized is further discussed below in relation to fishers as experts.

The RF and the Expert Role

Recall that in the context of mandated science I rely in a concept of expertise that comprises reliable knowledge as well as cognitive authority. While having reliable and relevant knowledge can be achieved through training, following courses or by practising a skill, authorization is achieved through the social processes of allocating cognitive authority to some person or groups. In the fisheries, under the established management regime, we already know that expertise in this sense is reserved firmly for the scientists, and remains the exclusive privilege of institutions like the IMR and ICES. The question I now want to address concerns whether the RF has made a difference or not with respect to this situation. Is it reasonable to say, given what we know about the inclusion of fishers in knowledge production through the RF, that the fishers can now be counted as experts?

As established above, the RF fishers definitely participate in data collection, but with little responsibility. Their tasks resemble that of a lab technician, who would hardly count as an expert. The total absence of fishers' participation in the assessment function indicates that fishers have no access to the expert role here either. This leaves the advice function. In the following, I discuss whether the RF has brought the fishers closer to the expert role in this respect.

As described in the empirical chapters (chapter 6 in particular), the RF provides an arena where the RF fishers are invited to participate, discuss and give their advice in certain matters. Especially the practices at the annual meetings shared some qualities with the peer review processes that take place at the ICES when the experts meet to discuss advice. As suggested above, the RF fishers were actually quite close to an expert role at times. For instance, when they participated in ad hoc advice about stocks like ling, the IMR asked the fishers for their views and comments. This shows that the RF is an arena where fishers, at least potentially, could participate in an advisory capacity. In practice, however, this capacity has not been developed systematically, and to the extent it manifests itself, it remains on an informal basis. For the RF fishers to become experts in a more formal sense, they would have had to be recognized as experts. While there is little doubt that the fishers, at least in some cases and for some types of issues, have a lot of relevant and credible knowledge, such knowledge under the current system is not asked for and not treated as expertise. The RF does not change that. Since the RF opens the way for fishers to participate in knowledge production, it is easy to jump to the conclusion that this makes them part of the expertise for fisheries management. Nevertheless, one must also look at how their participation relates to the dimensions that constitutes expertise – relevant knowledge and cognitive authority. Since the RF does not authorize fishers to give advice, the RF has not turned fishers into experts.

All the same, there are some practical ways that fishers, within the basic framework of the existing system, could have been brought somewhat closer to such a position. As I have argued, the RF has enabled fishers with capacities with regard to knowledge which they did not have before. We have seen that the RF fishers are becoming better commentators with regard to the scientific advice since they have practical experience of data collection and simultaneously they have been engaged in discussion with scientists about the uncertainties and quality of advice. With access to and insight into laboratory practices, fishers' critique can be pertinent and to the point, rather than irrelevant and easily dismissed. With better knowledge of how science works, they become better at spotting the weak points of the scientific advice.

While fishers have been enabled through the RF to discuss, criticize and improve advice, this capacity is not put to use, however. This could be changed if the fishers, in a formal and systematic way, were asked for their opinions and viewpoints with regard to the scientific advice for management purposes. Even if, in a European fisheries context, there are arenas that could have allowed for such inputs, these are underdeveloped and do not seem to serve this purpose.

In Norway, the advisory meeting for fisheries regulation is the main arena for providing stakeholder input and advice in fisheries management issues. In practice, however, the meeting does not work well as an arena for activating fishers' input with regard to knowledge issues. In part this is because of a timing issue; the meeting takes place at a time of the year (November) when the TAC decisions have already been made. Hence, it is too late to comment on the quality of knowledge and the advice on which the TAC is based. In part, the meeting itself, and the issues on which input from stakeholders are invited, are primarily organized with regard to the implementation of regulations in keeping with established quota limitations, not the scientific justification of those quota limitations themselves.

In the EU context, Regional Advisory Councils (RACs) have been established in order to include fishers in the advice function. Here, fishers and other stakeholders interact and give advice to the EU commission on fisheries issues, including questions of the quality of scientific assessments and advice (Wilson and Becker Jacobsen 2009). In contrast to the Norwegian situation, then, the RACs in the EU are specifically mandated to contribute to advice. According to Linke et al. (2011), however, they are not allowing for a real and strong stakeholder input. The basic problem, as with the case of the Norwegian advisory meeting for fisheries regulation, is that the timing of fishers' inclusion is wrong: Fishers have to be included earlier in the process, before the advice is decided.

These two examples, while surely not ideal arenas for securing fisher input with regard to advice, suggest that it could be possible to include fishers without fundamental challenges to the established regime. Since there is little or no tradition for including fishers in advice, however, it is important that the arena in question is carefully organized for the purpose. With reasonably modest adjustments, the EU RACs and the advisory meeting for fisheries regulation in Norway could become effective arenas for allowing fishers to contribute advice with regard to assessment and TAC setting. This would require better timing, and, in the Norwegian case, an explicit invitation to comment on the knowledge basis for resource management decisions.

This possibility is not unrealistic within the basic resource management regime of today. With such adjustments, fishers would come to be in a position to comment, criticize and suggest improvements with regard to the data, the assessment and the advice given. This would also represent a version of what Functowitz and Ravetz (1993) call 'extended peer review', a variation on the traditional scientific review institution in which both science and experience based knowledge are included, leading to better and more socially robust knowledge than the closed advisory system dominated by science alone. While this would bring fishers closer to being recognized and used as experts, it would not necessarily represent a challenge to the authority of IMR and ICES. At the same time, and exactly for this reason, it does not bode well for a radical change in the fishers' position in knowledge provision. While the fishers would get to comment on knowledge products generated by scientific institutions, they would still not be allowed responsibilities with regard to their production. Whether they could appropriately be labelled experts is also doubtful, since the cognitive authority would still rest with science.

Reversing the Burden of Proof

An important feature of modern fisheries management, as exemplified in practice by the Regulatory Chain, concerns the specific way responsibility for knowledge provision is organized. As we have seen, knowledge production for resource management purposes, in particular when it comes to TAC advice for the large commercial stocks, is organized in accordance with an orthodox model of science. In particular, this has meant that the stakeholders, which in the Norwegian fisheries context primarily implies commercial fishers, have not been drawn into knowledge provision or advice. Whereas the fishers through their associations have been generously invited to most other management functions, such an invitation has not been extended to include knowledge provision. On the contrary, knowledge provision remains almost exclusively the domain of scientific institutions; the IMR at the national and the ICES at the international level. With scientific expertise as an objective and autonomous knowledge provider, fishers have been effectively excluded.

This configuration with respect to knowledge is of course the starting point for the establishment of the RF as well as for me wanting to write a thesis about it. The RF itself is an attempt to bridge the gap between scientists and fishers as constituted by the established management regime. My thesis is an attempt to evaluate how that experiment and reform initiative has fared.

In the discussion so far, I have concentrated on exploring the merits of the RF without invoking the possibility of radical reform. That is, I have tried to address my research questions with reference to the possibilities of including fishers in knowledge production while staying within the boundaries of the established regime. I have concluded that, on the one hand, the RF represents a fairly modest and shallow inclusion of fishers in knowledge provision. On the other hand, this is a great achievement given the strong, institutionalized exclusion of fishers against which it is set. While this may be an interesting and valuable finding in its own right, it also suggests that there is little hope for substantial change without a more fundamental reconfiguration of the regime itself. This takes me to my fourth research question: If we wanted to extend fisher involvement in knowledge provision beyond that which is achieved through the RF, how could that be accomplished? The issues I address in this section concern what such an alternative regime, one in which fishers could take a strong position in knowledge production and advice, would look like. What would it take to get there? Is it realistic? Are there development trends that support such a regime change? How strong are they, and how far off might it be?

The established regime obviously does not represent the only possible way to organize fisheries management. It is the result of a contingent, historical development process, and can be changed when and if the necessary social resource can be mobilized in support of an alternative way. There are of course many different factors that must be included in order to give a comprehensive account of why fisheries management in Western Europe turned into a hierarchical system with a strict division between science and non-science. Let me here mention just two relevant factors. First, the knowledge structure within fisheries management originated and was institutionalized in a period (1950–1980) when the conventional model of science was taken for granted (Degnbol 2003; Holm and Nielsen 2004). Secondly, the establishment of the regime was highly controversial, among other things because it implied the closure of the fisheries commons (Hersoug 2005). In the midst of controversy, the legitimacy of management interventions was low, and the knowledge claims on which they were based easily came under attack. To secure them, they were provided by employing the best available social technology for knowledge production available at the time, namely science (Holm and Bjørkan 2011).

Today, this situation has changed. There are many calls for a change towards more decentred and open organizational structures, based on ideals like good governance (Funtowicz and Ravetz 1993; Irwin and Wynne 1996; Nowotny et al. 2001). Furthermore, the coastal state's role in marine resource management is no longer as controversial as it was; the fisheries common has, at least for the most important stocks, been closed and most stakeholder groups seem to accept that.

The movement towards an ecosystem approach to fisheries management (EAFM), involves a number of challenges to the established regime, including the way knowledge is mobilized for management purposes (Garcia 2003; Wilson 2009). Here, I assume that the EAFM can be understood, at least in part, as a sector-specific version of the general institutional and societal change processes indicated by concepts such as 'participatory democracy' and 'good governance' (Holm and Bjørkan 2011) .

Since the established management regime, with its particular configuration of knowledge provision for advice, can be seen as a result of a specific set of historical contingencies, it surely must be possible to imagine a different regime, one in which the fishers have a stronger position in knowledge provision. How would that look?

Figure 32 is one possible organizational solution. In this model, the fishers have basic responsibility for knowledge provision for management purposes. Hence, Figure 32 is a different way of illustrating how fishers could be 'responsible for' all three knowledge functions as portrayed in Figure 31. In practice, this can be implemented if the default situation is that all harvesting of marine resources is banned unless it is documented that it is sustainable, according to a set of criteria defining what this means. From such a starting point, anyone proposing to harvest a fishery resource can be made responsible for providing the required documentation. Such a model would entail a reversal of the burden of proof. While the coastal state today is responsible for knowledge provision and hence funding for resource management science, this responsibility would now fall on the fishers.

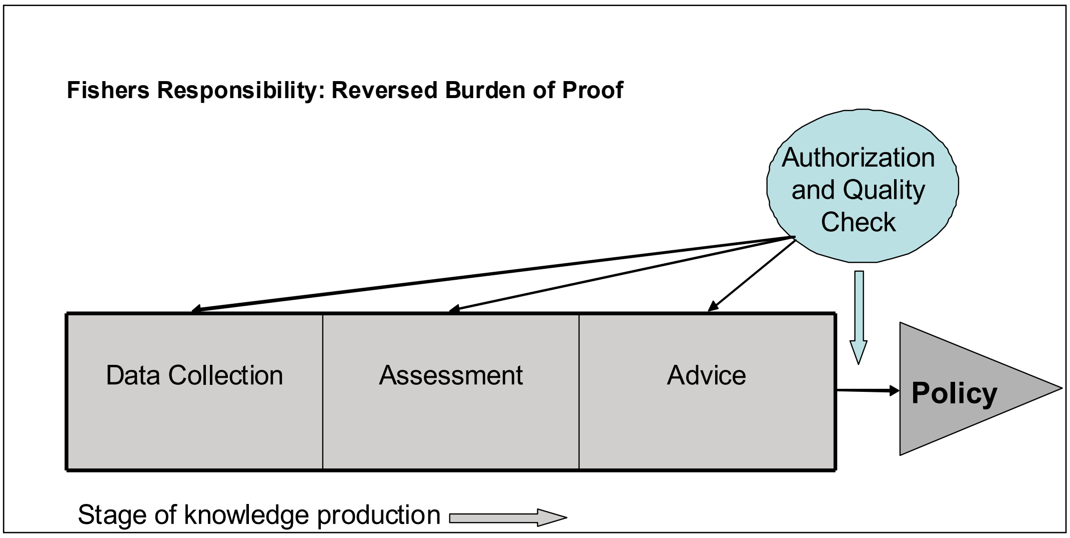

Figure 32: Reversed burden of proof.

How such a model would operate in practice depends on different things, among them which criteria are set for sustainable harvest, and what would count as valid documentation that this is likely to ensue. To keep things simple, we could imagine that most of the established criteria and documentation requirements remain as they are today, except for the basic one, that the fishers now had to take responsibility for knowledge provision.

At the outset, this would mean that the fishers would be in charge of all three stages of knowledge provision, that is; data collection, assessment and advice. Exactly how they would exercise that responsibility would depend on a number of things. Building on the RF experience, it is perhaps plausible that fishers would continue collecting data themselves. As within the RF, fishers could make the necessary adjustment to their vessels so that they could combine fishing with data collection. In the case of assessment, fishers could solve the task by hiring scientists to do the assessment on their behalf. Without doubt, within this scenario, fishers would reserve for themselves the task of formulating advice for themselves, possibly assisted by hired scientists to secure the technical argument.

A fundamental dilemma within this system would be whether and how the management authorities, who are supposed to set quotas and other regulations on the basis of advice generated in this way can trust that advice. This is a general problem: How can the result be trusted when those with an economic or political interest can influence the process (Collins and Evans 2007)? However, a reversal of the burden of proof does not entail that 'everything' should count as valid knowledge or that any advice produced by fishers should be authorized for policy. Some control function is required to solve this issue. In other words, some institution must be established to check that the knowledge is produced according to certain standards, and whether the advice is sound. It would be fairly easy to change the role of the IMR and the ICES to serve these functions. Instead of collecting data, performing assessments, giving advice and certifying data collection procedures, they could take the role of checking the quality of assessments and giving a second opinion on the merits of advice.

How realistic is this scenario? As judged from the basis of the established regime, it is of course highly unrealistic. One reason for this is simply that, because responsibility for knowledge provision under the current regime remains with the state, the appropriate arenas, instruments and skills required for the fishers to take on such a responsibility have not been developed. While this is of course an important barrier, it does not mean that it would be impossible in principle. At least, similar reversals of the responsibility for knowledge provision have been undertaken in other sectors in the form of environmental impact assessment. Some examples are aquaculture (Eidem 2009; OED 2011) and the development of windfarms and oil and gas fields (CBD 1992; FKD 2009; OED 2011; Tesli 2006). When looking at the institutional reforms taking place in the fisheries sector, such a shift in responsibility seems to become more plausible and within reach. In a number of EU political documents, like the EU's White Paper on Governance (COM 2001) and the Green Paper on fishery reform (COM 2009), a move towards good governance and the EAFM is suggested. In Norway, a reversal of the burden of proof was suggested as the principle for the new Marine Resources Act. In other parts of the world, such systems have also been developed for the fisheries. In New Zealand, for instance, quota holders hire their own scientists to do stock assessments additional to those of the national advisory body, and in some cases they actually do the assessments themselves (Hersoug 2002).

Reversing the burden of proof would be a radical institutional change. But would making fishers responsible for knowledge provision necessarily close the gap between science and fishers? Perhaps not completely. The important thing is that re-organizing the knowledge production this way would change the relationship between fishers and scientists. This is not because fishers' experience based knowledge would be turned into expertise by waving the wand of institutional change, but because fishers then could make alliances with science. As suggested by Irwin and Michel (2003), with their notion of 'ethno-epistemic communities', communities of lay people can form alliances with experts, using science as a potential source for support for their knowledge claims. Fishers and scientists could work together as a hybrid group or an assemblage with the production of knowledge, as they are already doing at times within the RF framework. This is a drastic change from the dichotomous relationship organized with the Regulatory Chain. Together with scientists, fishers could ask questions, provide knowledge and give advice and have a voice. In this sense, the gap would disappear since fishers and scientists would stand on the same side, looking to solve the same questions. Or rather, being responsible for knowledge provision, they could hire scientists to address their questions. In such a situation, it may well be that different questions could be asked. While there may still be a gap – after all, fishers and scientists have different cultures and practices – the gap would be different. Today, scientists, through the strong ties to the coastal state, have been granted cognitive authority to the exclusion of other knowledges, while fishers are left without valid knowledge and have no say in knowledge production. In a different regime, with different power constellations, the question of including fishers as experts may also change. We have already seen the contours of how this change in perspective works with the RF. In chapter 6, I describe how fishers and scientists are making alliances in the case of ling and saithe fisheries, and conflict with the aquaculture sector and how species spread. In these cases, fishers and scientists are standing on the same side of the boundary, they work in alliance to reach a consensus and a better understanding of the different knowledge objects.

As already suggested, there is a general shift away from the institutional solution which has been the basis for the fisheries management regime that still is in place (Irwin and Michaels 2003). That this regime is under pressure for modernization is quite obvious, as implied by the discourses on good governance and the ecosystem approach. The existence of the RF might even be taken as evidence that these sentiments are starting to gain stronger leverage in the fisheries sector. Several societal mechanisms drive such a change in the fisheries. New technological and organizational platforms are enabling stakeholders to participate in knowledge structures that earlier were reserved for science. For instance, the high level of education and access to technological tools like the internet, laptops and mobile phones has lowered the threshold for participation in knowledge production. As suggested by Irwin's 'Citizen Science' (Irwin 1995), modern society is characterized by people who are actively participating in knowledge production. An illustration of this is Wikipedia, the internet encyclopaedia that gives anybody, not just authorized experts, access to produce articles and definitions. This is a sharp contrast to the conventional encyclopaedia production where only a few authorized experts contribute. With Irwin (1995), we can perhaps say that fishers, at least in the Norwegian context, are turning into 'scientific citizens'. As portrayed in the empirical chapters, all the RF vessels, even the smaller ones, are fitted with computers and electronic equipment, and fishers are connected to the satellite system and use the internet on a daily basis; they have smartphones and they communicate through text messages and e-mails regularly with IMR scientists and PhD students like myself. Hence, there are general societal processes that support the involvement of the citizen in general. In the case of fishers, this process is boosted since fishers are already part of networks of alliances and hybrid groups, where they intermingle with fishery scientists and other social actors about shared concerns like the size of TACs, spreading of species and changes in stock trends. Taken together, the changes that are taking place today with political reforms and a more informed citizen with access to resources like computers and the internet, the move towards a reversal of the burden of proof seems more plausible than ever before. Even if a sector sometimes aims to protect itself against such societal processes of change, it will mostly generate a delay rather than halt the development (Holm and Bjørkan 2011).

While an EAFM in this sense can make it more legitimate – perhaps even self-evident – that fishers get access to and responsibility for management functions, it also involves recognition of groups other than fishers as legitimate stakeholders in marine resource management (Holm and Bjørkan 2011). Hence, the trend towards more participatory management as suggested by EAFM does not only mean that fishers will get more involved, but that this will also pertain to other stakeholder groups. Hence, the EAFM can give fisher stakeholders access to participate in management functions from which they have been excluded previously, and it also involves recognition of groups other than fishers as legitimate stakeholders. A consequence of this development is that the different interests of the different stakeholder groups must be considered, compared and evaluated. Hence, fishers may lose their privileged position as 'main consumers' of the knowledge produced by the IMR and the ICES. As Hart (2009) has suggested, fishers cannot in the future take for granted that the responsibility for management is entirely the job of the government. This means that fishers will also have to change their ideas about the basic distribution of management responsibilities and how to get in a position to control the knowledge production: 'it will be necessary for them to accept that they are responsible for their own future and that it is up to them to ensure that their activities are sustainable' (Hart 2009). However, stakeholders like fishers do not have traditions for doing or participating in knowledge production. As other interest groups are accepted as legitimate stakeholders, fishers become more vulnerable to changes in the way expertise and cognitive authority are distributed.

As the management scene is changing towards making room for a plurality of stakes and voices, it may be necessary for fishers to start taking on such burdens themselves in order to ensure their own stakes on the management stage. This would of course entail that they start preparing for the responsibilities and putting in the necessary resources such as time and costs that enable them to face these new challenges.

Taking the Experience Based Expert Seriously

Should we take the claims of FEK research and STS scientists seriously and include stakeholders like fishers, farmers or patients in the knowledge production for advice? Can stakeholders be experts? This thesis has shown that the answer to this question is yes. But fishers are not 'natural born scientists'. They may become experts, but this hinges on their participation at the appropriate stage of the knowledge production process, receiving the appropriate accessories and training, and that their advice is asked for and used when it is sound. The RF case shows that a laboratory and authorization is necessary, even when the knowledge objects are 'close' to fishers' practices.

From the expectation that fishers already are (experience based) experts – that they possess, merely through their experience as fishers, ready-made knowledge on a par with scientists – the RF case is somehow disappointing. Without the work that takes place in the laboratory, fishers' knowledge cannot cross the boundary between anecdote and expertise.

While I sympathize with those who have criticized the arrogant and disrespectful attitudes towards fishers' knowledge that scientists used to hold not long ago (Berkes, Folke, and Colding 1998; Johannes, Freeman, and Hamilton 2000; Neis and Felt 2000), this should not lead towards the reverse mistake, regarding fishers as mysteriously endowed with precise and reliable knowledge about the size and state of fish stocks. There might be a gap between fishers and scientists when it comes to knowledge, but this is not because fishers' knowledge must be understood as fundamentally different from scientists' knowledge. Faced with the refined system that expert advice depends on, I have to conclude that it is naïve to believe that fishers' experience based knowledge can be put to work as it is, when there are no institutions to verify that knowledge or arenas to authorize it.

In some cases, FEK researchers have taken upon themselves the task of testing the validity of fishers' knowledge claims (Holm 2003). These are interesting exercises, which have succeeded in demonstrating that sometimes fishers do have valid and useful knowledge. At the same time, however, they implicitly demonstrate that fishers' knowledge cannot be taken on face value in itself. As the FEK research itself shows, it takes scientists to refine it in such a way that it becomes recognizable as valid knowledge. In this way, FEK research in itself tends to reproduce in a slightly different way the very gap this research intended to overcome. This is problematic to the extent that the work undertaken by FEK researchers to transform fishers' knowledge into expertise is invisible (Holm 2003).

It would seem that the IMR scientists engaged with the RF fleet have one thing in common with (some) FEK researchers and (some) STS scientists. *They* are the experts, who authorize some of the knowledge lay people have. On the one hand, the work undertaken by these scientists makes lay people's potential as knowledge holders and experience based experts visible. In a way, then, it is the scientists who produce the notion of fishers and other lay people, be they sheep farmers or Aids patients, as experts. On the other hand, the work that has to be undertaken to achieve this reversal, is rendered invisible. This is a process that drastically under-communicates the fact that non-scientists still rely on scientists in order to have a voice – they have no real authority by themselves. Even if these are not conscious acts of domination, I agree with Haraway when she warns that there may be a serious danger of 'romanticizing and/or appropriating the vision of the less powerful while claiming to see from their position'(Haraway 2004: 87)[61].

[61] See also Bjørkan and Qvenild (2010)

If the translation processes that take place in the laboratory become transparent and explicit for both the stakeholders and others, such transformation processes are unproblematic (Holm 2003). Actually, the work done by FEK researchers' offers good examples of how such authorization systems can be set up and what procedures are required. Hence, the work that is done with experience based knowledge items in the laboratory in order to make them consistent, reliable and authorized should be made explicit and transparent. If we can liberate ourselves from the idea that there is some 'sacred' knowledge out there to which some (noble) groups of people have access, it becomes acceptable and legitimate that scientists make the effort to clean up knowledge (lay, experience based, fishers' and so on) in order to use it for advice of some sort.

Importantly, there is no inherent contradiction between fishers' experience based knowledge and the laboratory. Fishers and scientists have the same cognitive capabilities and they can acquire the same skills and use the same type of instruments (Latour 1987; Levi-Strauss 1966). Within such a perspective, we can draw on both fishers' and scientists' insights and experiences: 'there is no need to reject fishermen's knowledge, as orthodox science tends to, or to reject scientific knowledge, as FEK research sometimes pretends to, since both bring important things to the table' (Holm 2003: 26). With insight into science, fishers can produce relevant and critical questions, and voice their concerns and differences in opinion in a language that is difficult to dismiss since they are well funded. As many of the examples in chapter 6 demonstrate, the RF fishers work together with IMR scientists to document their knowledge so that it becomes more than anecdotal claims. With science on their side, fishers can document errors in the CPUE data for ling and how saithe living on fish farms feed has a different quality. And, with an institutionalized trust in fishers, scientists could ask fishers to participate at different levels and in different stages of the knowledge production process.

The calls for including fishers' expertise must be seen against the background of their near total exclusion from knowledge production within the established regime. Today, one can say that fisheries management is based on an institutionalized mistrust in fishers and their knowledge is defined as of no value. As a consequence, fishers are left with few options in order to have a voice when it comes to knowledge provision and advice. They must challenge the experts, produce 'counter-knowledge' and spend resources proving the obvious, that fishers do have experience based knowledge that is relevant for fisheries management, and that fisheries scientists can be wrong. This is a framework that generates a situation where fishers and scientists are standing on opposite sides of an institutionalized boundary with a huge gap between them.

As suggested above, if a different more decentralized advisory system is established, this dichotomous understanding of fishers as non-experts and scientists as experts may change. Then, fishers and scientists can make fluid sets of alliances, where knowledge flows between the two groups. Then, it also becomes more obvious that the question is not whether fishers have relevant knowledge. Of course they do. Rather, the question becomes whether and to what extent it is necessary for them to be experts. If fishers are responsible for the knowledge production, there would presumably be more focus on what is a practical division of tasks. Hence, if fishers are included from the outset, the question then turns into a more pragmatic one, based on how fishers choose to discharge their responsibilities, instead of insisting on fishers as experts. Assuming that fishers have chosen their career path based on their personal preferences, it is reasonable to picture a scenario where fishers hire scientists to do these tasks: scientists could work on a mandate from fishers.

Within the established system, science has a key role which makes it very easy to connect the idea of power and expertise together, and draw the conclusion that the power is tied to the command over knowledge. However, science works on mandate from the coastal state that has the real power. Putting fishers in charge of the knowledge production would surely entail a more distributed management system, even if ultimately of course, the coastal state would be the owner of the resource.

General Lessons from the RF

What lessons, then, can we draw from the RF with regard to expertise in general? Based on this case study, I agree with FEK researchers and STS scientists that stakeholders can and should be included, and their capacity for knowledge provision recognized and put to use.

The RF case demonstrates that fishers can be included in knowledge production, even in a setting where the basic institutional configuration provides extremely high barriers against such inclusion at the outset. If fishers are comparable to other lay people, and the knowledge structure in fisheries management is comparable to knowledge structures in other sectors, the same would presumably apply elsewhere. However, I have not found that the RF fishers have become experience based experts through the establishment of the RF. The reason for this is important and carries a general lesson. The RF case could not, indeed was not intended, to make experts out of fishers in any substantial sense. Instead, the RF project was carefully designed not to break too radically from the established order of things. Hence, it allowed fishers to take on minor knowledge functions, but reproduced and reinforced the established order, with science safely in control of knowledge for management.

Including fishers in knowledge production, and keeping within the established regime, turned out to require a lot of work, connecting them to the established data collection network as well as testing and authorizing the data. While fishers' knowledge is considered relevant and the relationship between fishers and scientists is improved (locally at least) the RF does not bridge the gap between them. This issue, however, looked quite different once we lifted this restriction, by assuming a shift in the burden of proof. When we start with a regime where the fishers take over responsibility for knowledge provision, the gap is no longer there, at least it is not as wide: the basis for cooperation between science and fishers is changed in a regime where fishers get to be responsible. While a centralized system like the one in place today creates a strict division between experts and non-experts, and hence a gap, reversing the burden of proof would change this situation. In the same way as there is in the current regime no gap between the coastal state and science, in the sense that science works on a mandate from the state, fishers and experts could make alliances. Hence, since the boundary excluding fishers' knowledge would disappear, the gap between them would close. There are a number of other problems generated in this scenario, of course, such as the distribution of power, increasing costs, the possibility of favouring larger, capital intensive techniques over smaller, traditional fishers, and so on. But the fundamental gap, where fishers and scientists are standing on different sides with a vast ocean between them since one has valid knowledge and the other has not, is fundamentally transformed.

Is it not strange that this question about knowledge, which is so knotty and complicated, becomes so different when we shift the attention to the basic institutional configuration and the question of who has responsibility for knowledge? In any case, a general lesson here is that knowledge questions should be addressed with such basic features in mind. Instead of asking why experience based knowledge is ignored when it is perfectly valid, the question should be: how can the knowledge production for advice be organized so that responsibility for knowledge is distributed in apprehensive and sound ways?

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