Complexities in keeping seals away from the catch – building 'seal-proof' fishing gear

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Abstract In 1990's an increasing grey seal population in the Baltic Sea started to cause economic losses to fishing. Several mitigation measures to the growing problem were introduced. Among them are hunting, compensations and technical solutions. This paper concentrates on the latter and more precisely it analyses a process that lead to introduction and spreading of 'a seal-proof pound net'. We follow the process by focusing equally on technical, ecological and social aspects. In other words, we take a symmetric approach to studying this process whereby fishermen, gear developers, seals, fish, fishing gear materials and the sea itself together with larger policies promoting sustainable fisheries played important roles. The gear developers faced various opponents and problems along the way, but the paper shows the necessity of such 'trials of strength' in technical development projects. We conclude that technical development projects can importantly help in achieving 'dynamic stability'. In this case it is achieved when 'a seal-proof pound net' brings income to fishermen in a way that protects seals and meets larger fishery policy goals of protection of wild salmon.

Introduction

The first signs of the recovery of the Baltic Sea grey seal population were detected in early 1990s. The annual counting of seals showed an increase in numbers (Harding and Härkönen 1999) and the coastal fishermen started to report more and more frequent encounters with the seals. The numbers of seal increased and seals started visiting fishing grounds in inner archipelago areas, which was a new pattern of behaviour for seals (Ylimaunu 2000). While the growing trend was welcomed by many, the fishermen soon became concerned. Why? Because the seals learned to take fish from their nets and break the nets. Consequently fishermen's catches were reduced and the broken nets increased the costs of fishing to the extent that 'the seal problem' has been mentioned as one the most difficult problems

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of coastal fishery in the Northern parts of the Baltic Sea, in Finland and Sweden (MoAF 2002; Broman 1998).

In the late 1990s, fishermen in Finland started to demand action from the state to mitigate the damage caused by the seals. They demanded control of the growth of the seal population and economic compensation for the losses (Varjopuro and Kettunen *forthcoming*). The authorities responded by allowing limited hunting of seals in 1997 and by compensating the losses in 2003, but neither of the measures have been very effective: the population of seals has continued to grow and the compensation was paid only for two years. Furthermore both measures are controversial. First, hunting of seals tests the limits of the recommendation concerning protection of seals adopted under the Convention on the Protection of the Marine Environment of the Baltic Sea the Baltic Sea (HELCOM) and the derogation rules provided in the EU Habitats Directive. Secondly, compensating for the damage that seals cause could be only temporary on the basis of the EU state aid regulation. (Similä et al. 2006.)

However, controlling the population of seals or compensating for the economic losses are not the only ways of solving the damage. In principle the damage can be prevented technically by deterring the seals away from the nets or by preventing the seals' access to fish caught in the nets. These methods have been tested and developed in Sweden and Finland, for example (Westerberg et al. 1999; Suuronen et al. 2004). Technical methods are preferable to compensation, because, if they work, they can *prevent* the damage and this provides a long-term solution to the problem. In addition, technical solutions are preferable to hunting; these solutions also aim at preventing the damage, but as a non-lethal method they seem to be politically much less controversial. For instance, WWF Finland has actively promoted development and the adoption of technical measures and compensation as a way to reduce the damage. Both measures are non-lethal.

In this paper we concentrate on one type of technical mitigation measure, namely modifications of a trap net, which has proven a promising approach. Gill nets are more common fishing gear in coastal fishing and, therefore, even if modifications of trap nets are promising, they provide only a partial solution regarding the whole coastal fishery in Finland. For the fishermen, solving the problem seems to be crucial for the continuation of their occupation. On the one hand, by its success, seal protection policy has become an important factor influencing the industry. On the other hand, fishermen's encounters with grey seals affect the general acceptability of their occupation: if many seals drown in their nets, this will act against nature conservation policy and they could even face public protests. These are some of the factors that make conditions for continuing coastal fishing a complex web of interdependences and fishermen have a critical need to stabilise this complexity. A crucial issue for coastal fishing is to balance profitability and acceptability. In other words, reducing seal-induced damage is positioned at an intersection of various policies and needs.

This article studies a process leading to development and spreading of a fishing gear, here called 'a seal-proof pound net', which could help reduce the amount of fish taken by seals from fishing gear and the physical damage to nets. We follow the process by focusing equally on technical, ecological and social aspects. In other words, we try to take a symmetric approach to studying this process. Usually technological development has been seen from the principle of asymmetry: i.e. society and social factors become relevant only in cases of failure or when technological development runs into obstacles. To better understand the technological processes a principle of symmetry (Latour 1987, 136) is needed.

Material in this paper is based on interviews with fishermen and others involved in developing 'seal-proof' pound net. We also use documents and scientific papers written by the gear developers (Suuronen *et al.* 2004; Kauppinen *et al.* 2004; Lehtonen and Suuronen 2004; Lunneryd *et al.* 2002; Lunneryd *et al.* 2003; Siira *et al.* 2003; and Siira *et al.* 2004).

Fishermen's interviews were conducted in two areas in two separate projects. One set of interviews consists of four fishermen and a representative from fisheries organisations. These were collected in 2003 and 2004 during a project that analysed activities related to seal/fishery interaction in one region in Western Finland. The other set consists of two qualitative (thematic) interviews with commercial fishermen who have participated in a salmon trap net development project and one interview with the leader of another project which started seal-proof trap net development. These interviews were conducted in 2004. The salmon trap net development project was conducted on the coast of the Bothnian Sea and had two aims, namely 1) to develop seal-proof trap nets and 2) to develop trap nets which could better be used for releasing part of the caught salmon (the 'wild' salmon, selected by size or other determinant). The project was conducted by fisheries biologists and technical personnel from the Finnish Game and Fisheries Research Institute together with the local commercial fishermen. Fishermen used different types of experimental trap nets during the fishing season and were paid for this effort. Fishermen also took part in discussions concerning the development of the trap nets.

In addition, three interviews with gear developers were conducted in 2005, one in Sweden and two in Finland. These interviews produced the crucial material for structuring our story, but the other material is necessary to really capture the events. The material is used in the paper to reconstruct the trajectory of events in the attempts to develop the 'seal-proof' pound net. In the section below, in which we concentrate on different aspects of developing the pound net, we structure our story in a series of 'trials of strength'. These trials emerge from the material as decisive moments. As the material is used to reconstruct the development, we do not use many direct quotations from the interviews.

The Pound Net

Fishing gear, which in this paper is a pound net used for salmon fishing, is the locus of the fishermen's 'seal problem'. In other words, that is exactly where the problem takes place. Seals also eat freely swimming fish in the sea, which is their 'natural' predation habit. This makes them a rival to fishermen from the resource allocation perspective, but the debate in Finland has so far mostly concentrated on the loss of catch directly from the nets.

The type of pound net used by fishermen in Finland in salmon fishery was developed in the 1960s (see figure 1). It was modified from older trap net models generally used in coastal fishing since the mid 19th century (Toivonen *et al.* 1991) to adapt to special environmental conditions and also to be compatible with the fishermen's fishing strategies. Regarding the latter point, one must note that in some areas in Finland the fishermen had to look for new fishing strategies when they were faced with dramatic environmental changes, namely pollution of rivers and nearshore waters and consecutive changes in fish stocks. Therefore, this technical change did not mean just an incremental change in the existing strategy, but was rather a part of overall change needed at that time (e.g. Österbottens fiskarförbund 1990). In fact, different modifications of the pound net were developed to suit different coastal regions in the Northern Baltic Sea, in Finland and Sweden.

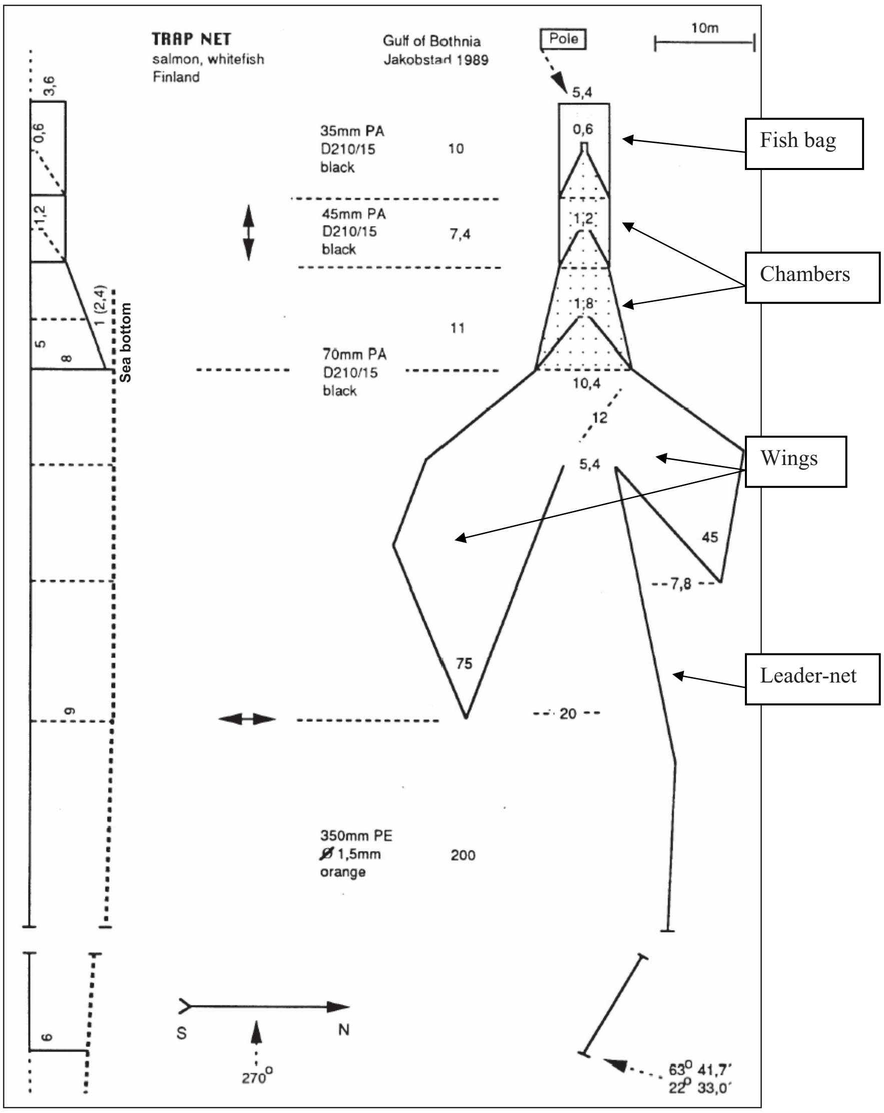

Figure 1. *A construction of a pound net from 1989 on the west coast of Finland (Toivonen et al. 2001).*

The pound net was used to catch salmon and whitefish. Units in the figure are in metres.

But before we describe the trials of strength, it is better to present the fishing gear that we argue has such a central role in more detail. The device is a pound net that is commonly used in Baltic salmon and whitefish fishing in the Northern Baltic Sea area. It is a pound net type of floating gear (see figure 1) with a leader net that guides fish into the wings and further through chambers to a fish bag. The catch is then generally collected from the fish bag, but some constructions of pound nets have a mesh size in wings and chambers that can also catch fish, so in this gear fishermen also check these parts. Fishermen use a small boat with which they move over the gear while collecting fish from it.

The leader net can be 400 metres long and several metres high. The height of the wings is usually around 10 metres and the construction gets lower towards the fish bag. The fish bag is usually about 3 metres wide and high and 5 metres long. Fishermen have built many kinds of models with large variations in the size and even shape of different parts. In practice the gear has to be built in the spot it is used and the gear therefore differs greatly in detail. Toivonen *et al.* (1991) studied the constructions of pound nets on the west coast of Finland in the late 1980s. Out of the 14 pound nets, 10 were asymmetric to maximise their endurance and ability to guide fish to the fish bag. The gear is set crosswise to the migration routes of the salmon that migrate in early summer from south to north. Locally the fishermen must know where the salmon usually swim.

At the start of the fishing season, the pound net is built in the sea with the help of a complex system of floats and anchors. Quite often the pound nets are located so that the topography of the sea bottom helps to direct fish towards the gear. The complex and large gear requires a lot of maintenance during the fishing season. For instance, the netting must be repaired and, because the shape and stability of the gear influences catching capacity, anchors need to be tightened up from time to time. Furthermore, algae and other dirt get stuck in the netting and depending on the place and the season's weather conditions the gear must be cleaned a couple of times during the season.

A pound net is stationary and in the models used before the emergence of the seal problem in the 1990s, the entrance and often even the roof were totally open for seals to enter. Furthermore, the material used in the netting was not very strong and, in fact, seals often just bite their way into the fish bag. From the seal's point of view, stationary fishing gear that posed no serious obstacles was an easy source of salmon. In fact, salmon is not the preferred fish of grey seals in general, but as an opportunistic predator they eat what is most easily available (Stenman and Pöyhönen 2005). A big fish like salmon caught in a pound net is an easy source of food. So, the types of pound net used from 1960s to 1990s were functioning adaptations to the environment in which seals were practically absent, but the gear proved to be extremely vulnerable in the environment in which seals were abundant.

To adapt to this new environment, fishermen needed new types of gear. The task for fishermen and in this case also the gear developers in research institutes was therefore to stop seals from taking fish from the gear and to make the gear strong enough. This paper focuses on the transition from the situation of seal's intervention in fishing activities to the one in which seal's intervention is prevented. We describe a development of adapting the fishing gear and related technology to work in new environment.

Development of Seal-proof Fishing Gear

Social scientists have studied technology from different perspectives, for instance from perspectives of evolutionary economics, social construction of technology and actor-network theory (Bruun and Hukkinen 2003; Sharif 2004). All the approaches have their strengths and as Bruun and Hukkinen (2003, 96) observe they are in fact complementary. This paper, however, studies the process whereby fishermen, gear developers, seals, fish, fishing gear materials and even the sea itself play important roles. In other words, the process involves many different heterogeneous elements. We find that the actor network theory proposed by Latour (especially 1987), Law (2002) and Law and Callon (1992) could provide conceptual tools to study associations and relationships between heterogeneous elements when they intermingle in (apparently) one process.

In this Chapter we describe the technical development of a 'seal-proof' pound net. We concentrate on different phases and innovations along the road from a pound net that was vulnerable to seals to the new 'seal-proof' pound net. We follow the gear developers closely enough to see the complexities, the uncertainties, the dead ends and the dissidents they had to face and identify the associations they had to create and maintain along the road. Many of the concepts used in our analysis were introduced in Latour (1987), Law (2002) and Law and Callon (1992).

We conceptualise a pound net as a machine or a complex technical device. Useful for our analysis of building machines are the approaches by Tim Ingold (2000) and Bruno Latour (1987). Below we first briefly describe those approaches and then concentrate on the efforts to develop a 'seal-proof' pound net in Sweden and Finland.

What is Involved in Building a Machine?

The functioning of fishing gear is the result of a complex interplay of technological knowledge, materials, seals, fish, the sea and human actors. Therefore, building such devices cannot be approached just as mechanical materialisation of a predefined plan in a process where human reason works upon inert substances. Because of the complex dynamic relationships between these various elements, making a 'seal-proof' pound net is better formulated as 'growing' of it from the old constructions through the active engagement of skilled human agents with the materials, but also through engagement with the sea, seals and salmon (Ingold 2000, 88). The present technical solutions to 'the seal-problem' are firmly based on more than a century old models of trap nets that later evolved to become a modern pound net and on to 'a seal-proof' pound net.

Knowledge about the environment is an important feature in our paper too. To a certain extent, we follow Tim Ingold's line of thinking. In his view, practical knowledge about the environment is a product of people's continuing involvement with their surroundings and their engagement with it: "...people develop their skills and sensitivities through histories of continuing involvement with human and non-human constituents of their environments. For it is by engaging with these manifold constituents that the world comes to be known by its inhabitants" (ibid, 10). He applies the same logic to building artefacts, which similarly involves engagement with material rather than just implementation of a predetermined blueprint.

Ingold conceptualises the making of an artefact in a very useful way, but besides engagement with various elements, more is needed to build a device that can be called a 'functioning seal-proof pound net'. Building devices is also a sequence of trials of strength that result in a complex device, parts of which are kept together. It is sometimes a less harmonious process that includes convincing others, winning dissidents' counter arguments and stabilising a collective of heterogeneous elements.

In order to develop a device, developers must convince enough people to get partners, facilities and funding. Convincing others requires establishing relations and alliances while the device is being built; it is difficult to convince anyone during the building process simply because the device does not yet exist in a form that could perform any tasks (Latour 1987, 11). It is, in fact, quite the contrary: technology developers can easily run into trouble if they demonstrate prototypes too early.

Supporters are needed and similarly the first users are needed to make the device more stable, but it is crucial to recognise that dissenters and trials are also needed to make the devices stable. As Latour (1987, 88-89) puts it, a list of trials defines the object, by saying what the object can and cannot do. The final construction then begins to take shape as a list of victories in the trials of strength initiated by the dissenters. In the end, what works becomes incorporated in the pound net. At first the parts are recognised only as their performance until they really become parts that can be identified as objects and even moved out of the network in which they were first formed. Construction of devices is ultimately a social process, which involves human agents as well as materials and natural elements (ibid, 29).

Law and Callon (1992) analysed a project that attempted (but failed) to develop a new combat aircraft in Britain in the Cold War years. Their approach allowed following a "co-evolution of what are usually distinguished as socio-technical context and socio-technical content" (ibid, 21). For that they used a network metaphor in a way that situated the technical development project in a global network and in a local network. This is a useful separation since the global network metaphor allows one to discuss an actor's relationship to its neighbours and the relationships between those neighbours, while the local network concentrates on "the development of an array of the heterogeneous set of bits and pieces that is necessary to the successful production of any working device" (ibid. 22). According to them, ideally the project manager has to successfully make the relationship between the both networks work to support the project goals, which can be a tremendous job and, as they show in their paper, is not always achieved.

What does building a seal-proof pound net look like from this perspective? Various elements have played important roles during the development of the gear by putting new modification of the pound net into trials (Latour 1987, 88-89) or by becoming supporters (ibid, 172). As it turned out and will be described below seals, fish and fishermen are dissidents posing counter arguments verbally or by their actions. The sea also sets certain limits to possible fishing gear. The non-human elements have the power to reveal the strengths and weaknesses of materials and technologies and make the trials decisive moments that provide information to technical developers.

In the following sections, we describe how the pound net was transformed into a device that does not give seals much chance to get fish from this gear. One must note that traditional pound net models provided plenty of opportunities for seals to catch fish from fish bag, chambers and even from the wings. Below we follow both Swedish and Finnish development projects. The reason why we follow both projects is that both countries work in close cooperation and exchange of experiences. Many of the innovations were first made in Sweden and then applied in Finland too. However, in Finland there have also been independent projects to develop own solutions and to adapt Swedish innovations to local conditions. There are at least two reasons why so many of the innovations were first made in Sweden. First, the problem started there earlier than in Finland and, secondly, the Swedish government agencies invested substantial resources in gear development from the early 1990s. First of all there was a major national project "Sälar & Fiske" (Seals & Fishery) and then in 2000, the Swedish Environment Protection Agency launched a national management plan to coordinate activities in solving the seal conflict. The plan also allocates national economic resources for that purpose.

Keeping Seals away from Catch

The grey seal initiated the most obvious and most important trials of strength, of course. The main task for the new gear was to keep seals away from the caught fish and even more: the ultimate goal phrased in an interview with a Swedish gear developer was "to make a pound net as unattractive to seals as possible".

Keeping seals away from the catch involved two steps that are described in the next two sections.

Closing the Fish Bag

The first attempts to make a pound net less vulnerable to seals were started with the "Sälar & Fiske project" in 1992. The project emphasised technical solutions. Project researchers tried using different acoustic deterrents (like playing killer whale sounds), but the most promising direction for technical development was gear modification, which started from the fish bag where the most evident damage occurred.

The very first idea was to build the fish bag using a strong material so that seals could not bite their way into it (see e.g. Kauppinen *et al.* 2004). In other words, the gear developers wanted to close the fish bag. One important result of the first studies was the discovery of a very strong fibre or "extra strong" as the gear developers described it (Suuronen et al. 2004, 2) called "Dyneema®" as a suitable material. This is an expensive but strong material. "Dyneema®" is a patented product (the patent is held by the Netherlands-based DSM Dyneema which invented the fibre), which created a problem regarding the price and availability of the material. The company had filed several patents to protect their product and also filed law suits against infringements.

Netting made of Dyneema was almost impregnable to seals. The finding reduced the physical damage on fish bags, but did not significantly reduce the amount of fish taken by the seals.

So why did the new material fail to reduce the loss of catch? It was simply because the seals, which used to simply break through the netting, now started to swim inside the fish bag to take a fish and then come out again. They used the same route as the salmon, but a clever animal like the seal finds its way out just as easily.

The next task for gear developers was to stop seals from entering the fish bag. The very simple solution was naturally to put a grating in the entrance of the fish bag. However the first prototypes made of solid metal bars did not work. The bars could not be too thick, because a thick bar would scare the fish away and it would become too heavy to be practical for use in sea conditions. A problem with thin bars was that seals could bend the bars quite easily. A breakthrough came with grating constructed of steel wire. This could be tightened to be stiff enough to prevent seals from going through and seals cannot bend such material. It therefore cut off the seals' entrance to the fish bag.

But the problem was still not solved. Dead and injured salmon were discovered inside the fish bags even though no seals had been inside. It was found that if the netting was loose, the seals could push the netting so far that they could bite the fish through the netting (from the sides and from the bottom) and could eat at least the soft parts of fish without breaking into the fish bag. The task of gear developers became even more complicated. Now they knew how to stop seals from entering the fish bag, but the seals could still damage the catch from the outside. The last task in 'closing the fish bag' tackled this problem.

The development of a Swedish 'push-up' fish bag started in 1999 from an idea to build a stable double-body fish bag. The idea came from a former fisherman in Sweden who had pondered the problem of 'closing the fish bag' since the mid 1990s. The innovation was to have two layers of netting (the outer made from "Dyneema®") and a firm, round construction. This construction is a sure way of keeping seals away from the catch, but it has a critical disadvantage: it is very heavy and practically impossible to handle in sea conditions. Because it was too heavy to be lifted from the sea, a device to help lifting was needed. The solution to this problem was to add inflatable air pontoons that would lift the fish bag. Now the heavy, but seal-proof fish bag could be used in sea conditions. The 'push-up' fish bag had the advantage of being easier to handle than the traditional fish bag that was lifted manually. The older construction was also more dangerous at sea because it was dragged into the boat, thus increasing the load of the boat and making it vulnerable to high waves. The 'push-up' fish bag, in contrast, operates so that the fishing boat floats freely at the side of the fish bag from which the fish drop to the boat (Figure 2). However, the strong material, a firm body and two air-pontoons make the 'push-up' fish bag a very expensive construction. The high costs of the solutions and how they were tackled will be discussed below.

Figure 2. *'A push-up pound net' lifted from the sea (photo Pekka Salmi 2005)*

In the Finnish gear development projects, the work concentrated on two main constructions of fish bag, both built from material that seals cannot break and with a grid at the entrance. One was the 'push-up' type developed in Sweden and the other was a prototype developed in Finland. The grid principle is similar in both constructions but the main difference is in the innovation of making the body of the fish bag strong enough to keep the seals outside and away from the catch. The other construction was a model first tested in Finland in 2003. This model is not very different from a 'traditional' rectangular fish bag (see Figure 1). The innovation of the new model was to make the traditional fish bag firm and strong to prevent seals from breaking into it and to prevent them from biting fish through the netting. Firmness in this "float-anchor pipe" model is achieved by attaching firm pipes in the corners of the fish bag. Tests showed that pipes are also needed along the long sides of the fish bag. The pipes give enough firmness to the fish bag and prevent seals from damaging the catch. The advantage of the solution is that it is considerably cheaper than the 'push-up' fish bag. However, the fishermen who tested the different constructions preferred the 'push-up' fish bag as it is much easier to use. In fact, the new 'float-anchor pipe' solution is very cumbersome in use, both in daily operations to collect fish and when the trap net is set up in the sea at the start of a fishing season. Furthermore, this fish bag has to be dragged into the boat like the traditional ones. This is hard work and dangerous in high waves.

Closing the fish bag is crucial for reducing the loss of catch, but of all parts of the pound net the fish bag is decisive regarding the other requirements of the new pound net, namely protecting the seals and wild salmon. If seals drown in a pound net, this almost always happens in the fish bag. This was a problem in early attempts to close the entrance with grating because small seals could squeeze themselves into the fish bag, but when the fish bag was submerged they could not always find their way out. Therefore, the grating must be a compromise between keeping small seals out and letting salmon swim in. Without this consideration, the grating could be wider so that it would provide only minimum disturbance to the salmon while keeping big seals out.

The other 'extra' capability required is the protection of salmon. This is achieved when a salmon released from the fish bag is unharmed and can survive. In the Finnish practice, the international needs to protect wild salmon, set in the Baltic Sea Salmon Action Plan (www.IBSFC.org), is implemented by releasing all salmon longer than 85 centimetres (MoAF 2004), because big salmon have been found to be the most able to reproduce. All salmon of this size must be released, as there is no reliable way to identify wild salmon from hatcheryborn. The material used in the netting of the fish bag and the fish bag's dimensions affect the damage on the scales of the salmon. Furthermore, the way salmon are taken from the fish bag and treated immediately afterwards also have an impact. This issue has been studied especially in Finland (Ikonen et al. 2002), where the protection of salmon is closely tied with the development of the 'seal-proof' pound net and the economic subsidy scheme (see below).

Reducing Loss of Catch in other Parts of the Trap

After the fish bag was closed from seals, they concentrated on catching the salmon swimming in the outer parts of the pound net before entering the fish bag. In fact, fish can spend a long time, even days, in the outer parts before they find their way into the fish bag. A salmon that is hesitant and swims in a closed area is easy prey to seals. In addition, many half-eaten salmon were found in the netting of wings and chambers in models that had a mesh size to catch salmon in the netting. An entangled salmon is a very easy catch for a seal. The task for gear developers was to discover ways to reduce the number of salmon taken by seals from outer parts of a trap net.

Entanglement of salmon in the netting of wings was thus one of the problems in the old models of pound nets. There were two possible solutions to this problem: either to make the mesh size very small or to make it very large. Both solutions were tested. Small mesh is an effective way to avoid salmon becoming entangled, but this solution also creates other problems. First of all, reducing the mesh size dramatically increases the amount of material needed and thus the expense of building such a pound net. Another problem with a small mesh is that it gets dirty very quickly, because algae become entangled more easily in small mesh netting. This reduces the gear's effectiveness in catching fish, because fish, especially whitefish, do not swim into too dark gear. Finally, small mesh gear catches smaller fish and more species that may become a problem especially in salmon fishery. However, there are technical solutions to separate small fish from legal size fish in the fish bag and this can even be done manually. After all, a pound net catches fish alive.

Large mesh was tested in Sweden starting in 2000 (see Lunneryd *et al.* 2003). The idea was to make wings from very large mesh netting that allows salmon to escape from the gear if a seal should attack. From a gear developer's perspective, this serves the final goal of developing 'seal-proof' pound net, namely it makes the pound net unattractive to seals as it was emphasised in an interview with a Swedish gear developer. In Sweden researchers have studied the effects of large mesh and found that seals are less abundant in areas where fishermen use pound nets with closed fish bags and large mesh in wings. Their conclusion is that this gear is unattractive to seals (Lunneryd *et al.* 2003). From a fisherman's point of view, a salmon that has escaped through large mesh is a lost catch, but the gear developers argue that fishermen should look at the long-term impact rather than the immediate loss of catch.

Changing mesh size is not the only way to prevent seals from catching salmon in the wings and chambers. Sharp corners in the wings and cambers of traditional pound nets are another area where seals could catch fish. Seals chase the fish to corners from where they cannot escape (Westerberg 2003). By creating rounder corners, the gear developers have been able to mitigate this problem (compare Figures 1 and 3).

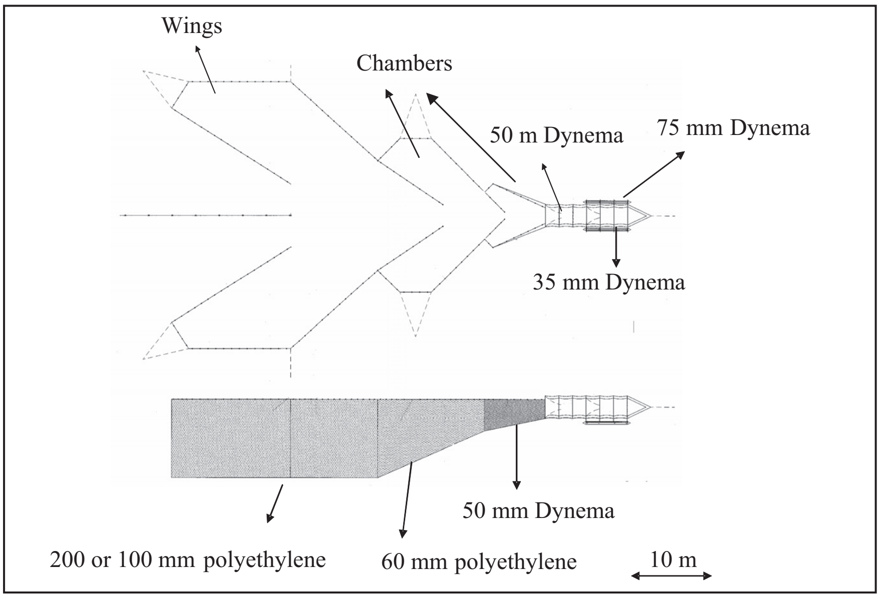

Figure 3. *A new pound net model with a closed fish bag ('push-up' pontoon trap) and round corners (compare to Figure 1). Source: Suuronen et al. 2004*

Monitoring to Highlight the Strengths and Weaknesses

Modifications of different parts of the fish bag, chambers and wings were produced on the basis of knowing or assuming behaviour of seals and fish and the technical possibilities of different materials or constructions. The ultimate tests of modifications were made in real conditions at the sea. Some aspects like durability of constructions and material were relatively easy to test. If damage occurred after a period of fishing, this is an indication that modifications have failed. However, the success in closing the fish bag or preventing seals from taking fish in other parts was much more complicated to study. Damaged fish in the fish bag or other parts was evidence of a seal's visit, but seals can also take the whole fish which leaves no traces whatsoever.

Modern technology was mobilised to help gear developers. There were at least three different uses of monitoring devices. Firstly, video cameras were attached to fish bags to monitor seals' behaviour at the entrance. There is some very clear footage from the Finnish tests showing seals turning away at the entrance – and salmon swimming in! (Lehtonen 2005). In Sweden even seals that are held in zoos were mobilised to highlight the strengths and weaknesses of new modification. Secondly, transmitters were attached to seals to monitor their movements in other parts of pound nets, especially the wings. These tests were conducted in Sweden. The results did show that in a pound net that prevented seals from entering the fish bag seals waited for salmon swimming in wings and caught them there (Westerberg 2003). Thirdly, in Sweden again, transmitters were used to study fish behaviour when approaching large mesh nets. This was related to testing the last step of gear development, namely the construction that allows fish to escape seals if attacked in the wings of a pound net. A crucial aspect in this was, of course, that such nets would keep the fish inside the gear and guide them towards the chambers and the fish bag when not attacked. The test showed that such nets, even if they allowed fish to swim through them, do have a guiding effect to fish that prefers to avoid obstacles (Lunneryd *et al.* 2002). Behaviour of the fish and seals showed how well the different materials and constructions performed, whereas modern monitoring technology was needed to provide this information to the gear developers.

How to Keep Pound Nets Catching Fish

One problem that gear developers faced while testing new technical solutions was to keep the pound net catching fish. Changes in construction of the gear affect how fish behave once they have entered the wings. The Swedish gear developer who was interviewed explained that the basic idea of a pound net is to guide salmon or other fish to the fish bag by gradually directing the fish to the next compartment of the gear. In other words, a salmon ends up in the fish bag as a result of a sequence of events. Firstly, the leader net (see the Figure 3) guides the fish towards the pound net. Then the salmon enters the wings of the pound net where it can swim quite freely in a big section of the gear. The chambers come next which finally lead the salmon to the fish bag. In fact, the salmon could swim out of the fish bag, if it found the entrance to it. The fish are reluctant to swim through small holes that lead to inner compartments, but the gear structure causes increasing stress on the fish and in its attempts to find a way out it finally swims to inner compartments that appear to be more spacious.

The basic idea of a pound net is a very old innovation made by fishermen. In developing the new construction, this understanding was just applied in new situation. For instance the inventor of a Swedish 'push-up trap', who was a fisherman himself, struggled with a problem of making the salmon enter the fish bag through a very narrow entrance. The entrance had to be narrow so that seals could be kept out with light grading. Finally one extra entrance was added between the chamber and the fish bag. This is a rather large entrance, but it still adds one more compartment to the sequence of compartments separated by increasingly narrow entrances.

The gear's ability to catch fish is naturally very important. Fishermen have generally been sceptical about the effectiveness of the new construction, but continued tests have gradually convinced them. The tests show that these new models, even though less effective compared to the old ones, are however more effective in areas where seals are abundant. And these are the areas where the old models became unfeasible after seals returned.

Keeping the pound net catching fish effectively poses a real dilemma to gear developers. On the one hand the pound net should keep seals away and this can be achieved by a heavy structure. On the other hand, a pound net should not disturb the fish. The development of catch in different constructions is naturally an indicator of the success of gear development. In addition, the gear developers used the same video camera technique to observe the behaviour of fish and seals.

With salmon, the dilemma was solved, but in whitefish fishery the problem is more serious. Whitefish are more timid than salmon when they detect obstacles. Therefore a pound net catching whitefish must be light, which poses a problem regarding the thickness of wires at the entrances, the mesh size and the material of the netting, as well as the shape of the gear in general. This problem is serious especially on the west coast of Finland, where whitefish are economically more important than salmon. So far this aspect has not been solved although progress has been achieved.

Enduring the Sea

Fishermen doubted also whether the new models could endure the harsh conditions of marine fishing. Fishermen were initially sceptical about the Swedish 'push-up trap' because it is based on the idea of inflatable pontoons that raise the fish bag above sea-level when the catch is collected. The fish bag is more than two metres high when lifted to the surface and looked very clumsy and vulnerable to the fishermen (see Figure 2). Tests of these new trap nets showed fishermen that the pontoon fish bag was no more vulnerable than the traditional model.

Strong and variable sea currents in coastal waters and waves are issues facing builders of large stationary fishing gear. Because the principle behind pound nets is to influence fish behaviour by their form, it is particularly important that the gear keeps its shape. For example, tests have shown that the grid that keeps seals out of the fish bag must be relatively stable: if it moves a lot, it scares the fish away. Stability of the gear is obtained by a complex system of anchors and floats based on knowledge dating back decades. In that respect the pound net has not changed much. In the pound nets studied in the 1980s, some pound nets had 28 anchors to keep them stable. Anchors of the long leader net are not included in this number (Toivonen *et al.* 1991). Interestingly, this system is not described in gear developers' interviews and reports. The system of anchors and floats has become a black box (Latour 1987, 81-82) that does not need to be studied like other parts of the pound nets, as the system has already been fairly stable for decades when older models were developed. It has become an object with the ability to move from network to network. Anchors and floats are discussed in one of the analysed reports, but only related to keeping the box-like shape of fish bag (Suuronen *et al.* 2004, 11).

The pound nets are always built where they are used. Local conditions like depth, shape of bottom and sea currents are the physical variables that have to be taken into account. Even more important is the movement of fish. Fishermen must have practical knowledge about the routes that fish take in their fishing grounds and build their pound nets accordingly. Along different parts of the coast, fishermen have built pound nets of different sizes and shapes. In the study of Toivonen et al. (1991 and see above) the 14 studied pound nets all had different shapes (10 were asymmetrical) and their total length varied from 210 to 475 metres. The height of the leader net also varied from 6 to 23 metres and some extended from surface to bottom while others did not reach the bottom.

Convincing the Dissident Fishermen

The last set of trials is about fishermen and overcoming their counter arguments. In 2003 the Finnish Game and Fisheries Research Institute conducted telephone interviews with commercial fishermen to study fishermen's conceptions about protection areas for seals (Salmi *et al.* 2005). The fishermen were asked how they have solved the seal problem in their fishing activities: most of the interviewees had changed their fishing methods or fishing areas. With regard to future actions, they preferred hunting to reduce the seal population and scaring the seals from the fishing gear. Only a minority referred to the development of seal-proof fishing gear as a solution to the problem. Other interviews also reveal the fishermen's scepticism towards the new technical solutions (Varjopuro and Kettunen forthcoming).

Fishermen's Counterarguments

An interesting side about fishermen's counter arguments is that they very seldom asserted that the new models could not keep seals away from the catch. Instead, fishermen argued that the gear did not catch fish or that it could not endure the sea. One crucial issue was the price. For instance, a 'push-up trap' can easily be twice the price of a traditional model, which is simply too much for many fishermen, especially considering the uncertainty of the gear's effectiveness in catching fish. This highlights the inherent complexity of fishing gear: there are always various tasks that the gear has to perform.

Why didn't the fishermen believe in gear development as a workable solution? One explanation is that the prospects for the development of seal-proof trap nets were not very good at the time of the interviews in 2004. There had been some earlier negative experiences with the new pound net models. For instance, an earlier version of 'the push-up' type pound net had been tested on the west coast of Finland with poor results: the gear did not catch fish very well. Behind the fishermen's scepticism was also the fact that gear developers mainly worked at government research institutes in Sweden and Finland. They were seen as outsiders by the coastal fishermen and in Finland in particular, the fishermen perceive the same institute as the main actor behind fishing restrictions. In other words, the researchers are accused of being more interested in the health of fish stocks than fisheries.

The fact that gear developers were seen as outsiders also became an issue during the tests that were conducted in collaboration with the government research institute and fishermen in Finland. This was seen in the pound net construction used in tests on the coast of the Bothnian Sea, when the gear developers tested trap nets used on the coast of the Bothnian Bay (a few hundred kilometres north of the Bothnian Sea), and refused to listen to the local fishermen who claimed that the gear had to be adapted to the area where it is used. Fishermen had long practical experience in the area, how fish behave there and the kind of technology which suits those circumstances. One fisherman interviewed stated that the fisheries' researchers listened to the fishermen's perspectives in the planning stage but then constructed the experimental pound nets with little consideration for the fishermen's suggestions. The attitude that the fishery researchers set aside fishermen's perspectives and knowledge reflects, according to the fisherman, wider marginalisation of commercial fishermen's interests and knowledge among the researchers and the institute they represent.

Another and quite important reason for not believing in the development of fishing gear to reduce the seal problem is that the technical development had concentrated on trap nets while most of the coastal fishermen used gill nets which are difficult to protect from the visiting seals (Salmi *et al.* 2005).

All and all, it is interesting that fishermen actually opposed this process that was definitely aimed at helping fishermen and it makes the case even more complex. In addition, the fishermen's role as dissenters is more a social phenomena in the traditional sociological sense. However, following Latour's line of thinking, all the trials on the way to a 'seal-proof' pound net were deeply social. Winning fishermen over to the gear developers' side was a result of various simultaneous developments. These included ergonomics, state subsidies, selective fishing and relationships between scientists and the local community.

Convincing by Tests and Promotion

In principle, the gear developers had answers to most of the fishermen's counter arguments. For instance, they could show that the gear caught fish and that it worked well in harsh conditions. Regarding the push-up trap, the developers could even show that it was much easier to use than the old models. It was also much more ergonomic and safer than the push-up trap and the alternative, the Finnish 'seal-proof' pound net. They had all these 'facts' to present to fishermen, but still had to convince the dissenters that they were not mere artefacts (see Latour 1987).

One point in trying to win the trials of strength initiated by fishermen is that gear developers – and fishery organisations that stepped onto the scene at later stages when many of the activities were merely concentrated on promoting the new solutions – must win the dissenters over to their side. In other words, they want fishermen to become end users of the devices, not just to win the arguments. The goal of convincing fishermen is then really to make them believers, not to convince others that dissenting fishermen are wrong. This affects the strategies for overcoming the counterarguments. While in scientific disputes it is often enough to isolate the dissenters from the rest of the academic society or from society in general so that they do not find support for their arguments (Latour 1987, 44), in the case of fishing gear development, this will not do. An artefact that is not used for fishing is not a fishing gear!

The gear developers' strategy was to get fishermen to test the gear in their own fishing and thus let the gear itself convince the fishermen. Tests therefore had a dual function: to provide information for gear developers and to promote the pound nets to their potential users.

The gear itself might convince fishermen about its practical capacities, but developers still had to get fishermen to test the gear. For this purpose gear developers needed to find allies who would provide funding. In practice, fishermen had to be paid to test the gear. In Sweden funds were made available from the national funds to compensate for damage caused by wildlife. In Finland, in addition to government agency funding, there was an EU-funded project to deal with the seal problem in one region and part of the project budget was directed at gear testing.

At first the funding was needed to get fishermen to become involved in the research institutes' tests, as without fishermen the tests could have not been conducted. An important point that was highlighted by one Finnish gear developer was that there had to be enough funds to pay fishermen to ensure that they were seriously committed to testing new gear. Testing constitutes a great risk for fishermen if the prototype being tested does not work. If it does not catch fish or does not prevent seal damage, the fisherman risks losing the whole season's catch, which most of them cannot afford. Without proper funding, a fisherman would not test the prototypes in good fishing spots. Instead he would try them in a place where the test would not influence the catches in his ordinary pound nets. Consequently, the test would provide little information about the prototype except the information that gear developers do not need: the gear does not catch fish in a place where there is very little fish.

After Swedish tests in the late 1990s had proved that the push-up traps were very successful in preventing seal damage to catches, or salmon in particular, promoting the gear became more important. A new phase also started in Finland where a fishing organisation in a region that traditionally had close contacts to Sweden launched an EU-funded project in 2001 to show the benefits of the new model (Varjopuro and Kettunen *forthcoming*). Later the organisation acquired funding from other sources to continue promotion. In an interview, the organisation's representative said about their strategy that "...now we were able to buy some of this new gear. We could let fishermen test these in different places and see for themselves how it works. Now we could spread the idea. Once they had tried it and seen how good it was, they would already be 'seduced' so that they would buy their own 'push-ups'". In 2003 and 2004 more projects with similar goals were started in other coastal regions in Finland. These focussed on adapting the new models to local conditions and spreading information. Not longer were they concerned with developing new solutions.

An interesting development in Finland was that the national research institute of the fisheries administration tenaciously tried to make their own models. Some fishermen in Finland and even some gear developers in Finland and Sweden saw this as stubbornness to have their own model instead of using the Swedish one, while gear developers in charge formulated their goal as to 'find effective, inexpensive and practical alternative designs' to the 'push-up' (Suuronen *et al.* 2004, 11). Tests showed that it was almost as effective as the push-up trap and much cheaper, but the crucial weakness of the Finnish prototype was its impracticability: it was heavy and even dangerous to use at sea.

Practical testing and promotion were not the only means to change fishermen's attitudes. They were targeted by a lot of information through the media. There were several articles in the professional journals of fishermen in Finland and Sweden and the projects promoting the new gear organised press conferences and demonstrations of the new technologies to the press to get more publicity. There were also several positive stories in newspapers about the new 'push-up trap' in Finland in early 2000s.

Subsidised Diffusion of an Innovation

To get fishermen to test was one part of the strategy, but ultimately, the crucial test was whether fishermen really invested in the gear or not. One should note that these new models are expensive. The price of the 'push-up trap' is therefore a decisive issue. Here again government funding played a central role. In Sweden a subsidy to 'seal-proof' fishing gear had already been introduced in the 1990s. In practice the subsidy was so attractive that the first investments were made quite rapidly. Diffusion of the new model was quick as the fishermen were pleased with the results of the tests and with a subsidy it was also a profitable investment. Today about 40% (>200) of all pound nets in use in Swedish coastal fishery are of the 'push-up' type. As the Swedish gear developers mentioned, the fishermen were encouraged to use the new models. Here the strategy has been very successful. Almost all of the pound nets used today are of the 'push-up' type.

In Finland a similar subsidy was introduced in 2004 and fishermen appeared to be quite enthusiastic about investing in the new gear, as about 90 fishermen applied for subsidies for 250 new pound nets. Of these, approximately two thirds were 'push-up traps'. However, while in Sweden the subsidy was paid from a national fund specialised in compensating for damage by wildlife, in Finland, where such funding is not applicable to fisheries sector, the funds came from the EU's structural funds, from the Financial Instrument for Fisheries Guidance (FIFG). With this move, things became even more complicated than before. FIFG funds were used, among other purposes, as an instrument to guide development of the European fishing fleet towards the general goals of ensuring sustainable fishing. As many of the commercial stocks were in an alarming state, the rules of FIFG funds did not generally allow the subsidising of new fishing gear. The situation changed, however, if new fishing gear could be used in a selective way to protect endangered fish stocks or to reduce by-catch. Such gear was eligible for subsidies from FIFG funds. This is a very relevant issue in the context of Finnish coastal fishing, since protection of wild salmon stocks in the Baltic Sea has high priority in fisheries' policies of the region. Subsidising the 'seal-proof' pound nets progressed smoothly because they could be built to allow selective fishing (see above). This became a decisive aspect of the new 'seal-proof' pound nets: they were presented to the European Commission as gear for protecting wild salmon.

Discussion: Finding Dynamic Stability in Complexity

In this paper we have described a long process that led to a promising, though partial, solution to the fishermen's seal problem. The process was not just interesting because it was successful, but also because concentrating on the role of fishing gear allowed us to explore the interconnectedness of human, biological and technical elements in solving a problem that has emerged between the conservation of the grey seal and coastal fishing. The interconnectedness or interaction of various elements is always inherent in fishing in general and, in fact, 'the seal' problem forced this interconnectedness to surface. It made it more visible. Why are such interrelationships inherent in fishing? Because fishing is essentially a technological activity, in which fishermen, in their pursuit of catch to be sold to markets (in the case of commercial fishing) use a range of technical devices to catch fish. Biology of fish and fishermen's (often socially) mediated knowledge, together with demands from markets and increasing technical regulations determined in fisheries policies, affect the technical solutions developed by fishermen. Interrelationships grow even more complex when the material, such as the "Dyneema®", used in the devices is taken into account.

We concentrated here on how a technical device was developed, not what followed. Ståle Knudsen (2003, 98) argues that many of the scientific and technological studies have only concentrated on making devices and objects, not on how they intertwine in socio-political fabrics of society after they have been created. In other words, too little emphasis is given to studying the use of technology and how technological devices may change societies or how they are addressed in social relations. We agree with Knudsen's observation. Indeed, much emphasis has been placed on the formulation of objects in our paper. However, social processes of object formulation and the role of technical devices after they become objects (see Latour 1987) in society can be analysed as separate processes and, therefore, respective research questions are also different. The main reason why we concentrated on the development of the 'seal-proof' pound net is that in Finland, the main focus of our paper, only very few such pound nets are in use. This is likely to change soon, as a subsidy for these pound nets was introduced in 2004 and the first investments were made in 2005. In a couple of years we will be able to study what followed from building a 'seal-proof' pound net. How has it been adapted to fishing practices and how has it changed social relations in fishing communities? These are the same important questions that Knudsen addresses in his paper about the sonar in Turkish fishery (Knudsen 2003). We can assume that adapting to the environment in which seals are abundant will produce drastic structural and technological changes. For instance, the most common fishing gear – the gill net – does not have, at least not yet, technical devices for protection against seals. This type of fishery will probably decline, while the availability of 'seal-proof' pound nets will replace gill net fishing in many regions.

The actor-network approach (ANT) to studying science and technology is one among other well established approaches. For instance, in sociology the so-called 'social construction of technology' (SCOT) approach is another common approach. Similarly in economics, the 'evolutionary economics' (EE) approach would provide useful tools to study our case, as would the SCOT. Both approaches do have advantages. The SCOT approach concentrates on studying the building of technological objects and highlights the importance of social relations and controversies in technological development. The EE approach, devotes a lot of attention to the diffusion of innovations and highlights the economic conditions for innovating. It also analyses innovations in their wider systems context, for instance, the national systems of innovations. (Bruun and Hukkinen 2003; Sharif 2004.) However, we still find the ANT approach more suitable for studying our case, in which social, economic, and political aspects as well as material and ecological ones are intertwined. The SCOT does help to analyse the social contexts and the influence of disputes in innovation processes, but it reduces the processes to the social aspects, missing material and ecological issues. The EE helps to see the economic dynamics which are very important in our case too, but its rather general view of the innovation process itself would not help us to study how the 'seal-proof' pound net was actually produced. The EE has a concept of national innovation system that could also have helped our analysis to a certain extent. As the different approaches in Sweden and Finland indicate, there are different 'national innovation systems' at play, but a closer look showed that borders were crossed in various ways. The 'push-up trap' was adopted in Finland from Sweden, but the actors at the sub-national level were the forerunners and actually became independent from the national gear developing activities and partly even from national state funding. State funding was important in the spread of the 'push-up trap' innovation to Finland too, but initially it was the subsidies in Sweden that convinced the Swedish fishermen and which later convinced the Finnish fisheries organisations with close connections to Sweden. In the latter phase, EU funds were used in Finland to support the spread of the innovation. We chose instead the ANT approach that helped us to study the process itself and allowed us to take into account the material and ecological aspects so crucial in the case.

We studied how various heterogeneous elements were brought together in a process in which agency was achieved by building connections between different parts of the gear and also to political processes and fishermen's daily practices at sea. We organised our analysis into separate trials of strengths. The first and very obvious one was the attempt to keep seals away from catch. Equally important was to ensure that the pound net caught fish, which was the second trial. The third trial was to make the gear seaworthy, which is always an important issue in large stationary fishing gear. Finally we concentrated on the fishermen as dissenters. This was a multi-faceted trial, involving ergonomics, state subsidies, selective fishing and relationships between scientists and local people. We divided our analysis into four parts to make this long and complex story palatable. However, it is important to recognise the connections between them. After all, a really functioning 'seal-proof' pound net must perform various tasks at the same time: it has to keep seals away, it has to catch fish, it cannot be destroyed by heavy weather, fishermen have to use it in their fishing activities and, furthermore, it must be compatible with more general goals of fisheries and nature conservation policies.

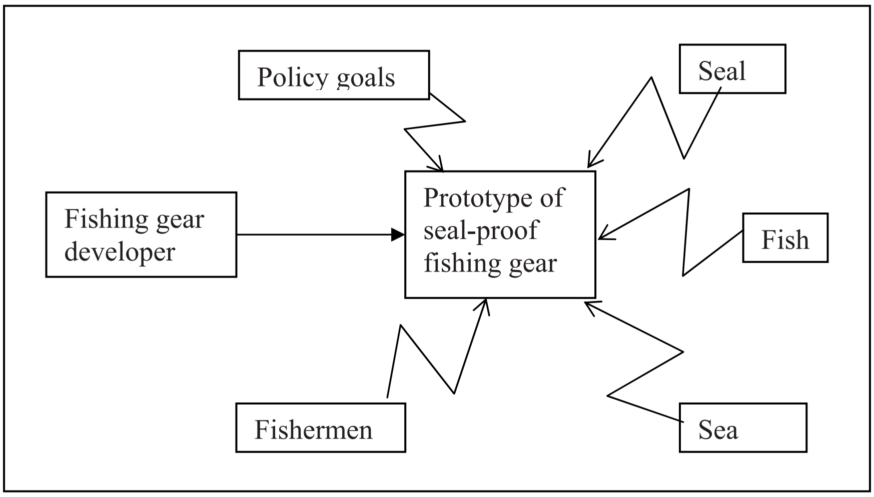

Figure 4. *Trials of strength in developing seal-proof fishing gear*

Fishing gear is the focus of development work aimed at overcoming concrete obstacles, as all the knowledge required to catch fish, keep seals away and make the gear capable of enduring weather are acquired through the gear. There are no other instruments which provide this knowledge – hence the source of knowledge is the same for fishermen and developers. This also applies to the video recording and remote sensing of seals and fish focuses on the gear. Therefore the seals, the fish and the sea co-construct the new gear with the developers by resisting and testing the developers' products. By behaving in a certain way, seals and fish 'reveal themselves' and give information to developers about the faults of their products. Fishermen are also dissenters in the same way, but they act in other fora than close vicinity to the gear. In fact, in some cases fishermen's resistance or support was directly aimed at gear developers.

The pound net is a complex device: it consists of different parts working fairly independently and many parts can therefore be applied in different constructions. This complexity is both a strength and a weakness at the same time. Its strength lies in the various possibilities of adapting it to different situations and the alternatives it provides. The fish bag, for example, could be modified, as could the wings if need be. Its weakness lies in its complexity: if a seal cannot get fish from a fish bag, it can direct its efforts to other parts of the big gear.

The old technical solutions were no longer functional. They were suited to an environment where seals were not numerous and it worked well for a long time. The new solution had to keep seals at bay, but it also had to perform the traditional tasks of fishing gear, namely to catch fish, endure the sea and be practical in use. Avoiding seal damage required major changes in construction and many issues had to be reconsidered so that the gear would perform all these tasks at the same time. In order to enhance its design, tasks needed to be defined. In this case they were: a) to keep seals away, b) to catch fish and c) to endure the sea, but also regarding the availability of subsidies in Finland the gear had to d) facilitate selective salmon fishing and, finally, satisfy nature conservation goals and the environmentalists' demand e) not to kill seals. An important aspect here is that a, b and c are directly related to fishing activities, whereas selective fishing has its origin outside the seal-fishery interaction and is of more remote interest to fishermen. It has a larger political framework coming from the need for sustainable use of resources, but in this particular case, mobilising selective fishing into the process opened up the possibility of subsidising the new pound nets. Similarly, avoiding seal bycatch mainly finds its reference in the nature conservation sector, but fishermen also prefer pound nets that do not kill seals – many for ethical reasons, some only to avoid the hard work of removing 200 kg male seal carcasses. Complexities come from the need to perform various tasks of both ecological and political nature at the same time (see e.g. Law 2002, 125-126). The pound net's complex and modular structure made this possible.

Even though we separated the analysis above according to different trials of strengths, we do not mean to imply that developing gear could really be separated into different segments or phases as a clear trajectory of events (see Latour 1987, 107-108). Ultimately, the gear must perform various tasks at the same time and this is achieved by building a complex network of heterogeneous elements. Naturally, the strategy of gear developers is to take one trial at a time, but this was seldom possible. And as we have seen, the developers themselves tried to convince dissenters through the ability of different parts to perform various tasks at the same time. More important than neatly distinguishing different paths for developing a 'seal-proof' gear into separate categories is the ability to recognise how they were interwoven on the way (Latour 1987, 222).

To succeed in managing the heterogeneity means that a state of 'dynamic stability' (Haila and Dyke 2006) has been achieved. However, as the term hints, it is a dynamic state and not stabilised in the sense that movement has halted. As we pointed out at the start of this paper, different policies and needs are linked to the interaction between seals and the fishery. From the fisheries' point of view, it comes down to the social sustainability and continuity of fishing as a livelihood, whereas for nature conservationists it is a question of securing the conservation of seals. Finding 'dynamic stability' is to create the different processes that ensure that various needs meet in time and space. Gear development became a moment that could make the different processes meet at the same time and space and, furthermore, if successful, maintain 'dynamic stability' over time. After all, the continuing interactions between seals and fisheries are largely located in the pound net, as are fishing operations in general, for that matter. Fishing gear is a medium by which the different cyclical and linear processes important for maintaining 'dynamic stability' in coastal fishing must meet.

A state of 'dynamic stability' is achieved when a functioning 'seal-proof' pound net is built and put in the sea to bring income to fishermen in a way that protects seals and meets larger fishery policy goals of protection of wild salmon. The processes that achieve and maintain this in everyday fishing operations, in other words, the actions and things that perform 'dynamic stability' could be seen as a seed for a concrete co-management arrangement. Firstly, it is oriented towards fishing activities with a clear sense of the social sustainability of coastal fishing. Secondly, it incorporates the environmental goals that are part of the present political environment of fishing. On the other hand, as an institutional arrangement it is not 'co-management'. Furthermore, the power relations and the lack of use of fishermen's knowledge in the Finnish gear development project referred to in this paper have not been in line with the ideals of collaborative management. Fishermen claim that their views, interests and knowledge have not been sufficiently appreciated in the development process. Einar Eythorson (1998) holds that besides being knowledge of a location and fish behaviour, fishermen's local knowledge is practical knowledge, such as how to use different fishing technologies under different local, ecological, topographic/geological and social conditions. Their knowledge is the result of their long term engagement with their social and material environment (Ingold 2000). However, fishermen's knowledge is mediated through their fishing gear. It is the nets and other equipment that provides fishermen with information, because in marine environment direct monitoring of fish is difficult. This is especially the case when fishermen are compared to Ingold's hunters, who have many opportunities and media to observe their game animals. In fisheries, engagement with the environment is strongly technology-mediated. An important point is that the scientists' knowledge is also mediated through their research equipment (Eythorson 1998) – in the case of 'seal-proof' pound net through the very same fishing equipment. There should be no apparent reason why fishermen's local observations could not be included in the knowledge base of scientific resource management.

However, there is no turning back to fishermen's independence in gear development. New interests and institutional structures have narrowed the space for fisheries' self-management and increased the number and weight of issues to be dealt with. International agreements and institutions have both contributed to the seal problem (nature protection) and provided funds for achieving the solutions. The national fisheries institutes have acted in between the international and local level, but recently Finnish commercial fishermen have started to organise co-operative regional development projects – often funded by EU or national funds – with minor connections to the state level organisations. These projects could be new examples of seeking the areas where 'dynamic stability' can be found and maintained.

Epilogue

The interviews with gear developers conducted for this study show strong optimism about the 'seal proof pound net' as a technical solution – albeit partial – to the fishermen's seal problem. One and half years after the interviews the optimisms has been shaken. In summer of 2006 they learned that seals cause damage to fish again in large areas along the coasts in Sweden and Finland. New observations of seals' behaviour were conducted and video footage showed clearly what the seals are doing. They wait for the salmon in front of the grated entrance "like a goalkeeper" as expressed by a Swedish gear developer. Seals had learned a new way of using the pound-net and to some extent have pushed 'the seal proof pound net' back to the world of artifacts.

This event highlights two aspects in our paper. First, stabilising technical objects in natural environment is a difficult task because so little is controllable and some of the control variables may change substantially in this environment compared to technological environments. In technological environments control variables of the systems are known and often even controllable. Second and related to the first aspect, finding a dynamic stability in a 'system' of coastal fishing is extremely difficult. The small operation margins of small-scale coastal fisheries makes coastal fisheries vulnerable to abrupt changes in the environment – especially to changes of natural or economic nature.

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