

**The evolution of the “harvest machinery”: Why capture capacity
has continued to expand in Norwegian fisheries**

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By

Jahn Petter Johnsen

Abstract

Controlling the expansion of capture capacity has been a major challenge for the fisheries management systems around the North Atlantic. Despite focused attempts to reduce this capacity in recent years in different jurisdictions, it has continued to expand. This chapter uses a case study of changes in Norwegian fisheries to help explain why this has happened. The article supports the replacement of the rational actor approach that is currently hegemonic within fisheries management by a relational approach to the analysis of capture capacity expansion. A relational approach offers new insights into the ways political, economic, and technological forces continue to fuel capacity expansion within fishing. By use of this approach the article describes how the harvest machinery comes into existence.

Key words: Fishery Policy; Capture capacity expansion; Management models, Cod fisheries; Harvest machinery

1. Fishery policy, management, and technological change

It is widely acknowledged that high fishing effort sustained over several decades was one of the causes behind the collapse in cod stocks in the north-east and north-west Atlantic in the 1980s and 1990s. In Norway, for example, the collapse in the cod stock came in 1988/89 after a period of reduced profitability, huge subsidies to the sector, and technological modernisation that allowed the capture capacity in the fishing fleet to expand [1 and 2]. When the cod stock collapsed Norway, like other states in the north Atlantic, followed the dominant school of thought within resource management and abandoned open access fisheries regimes [3, 4, and 5]. Over the last decade all the fisheries directed at the important commercial fish stocks in Norwegian waters have been closed in an attempt to control capture capacity. Despite these closures and despite related reductions in the number of fishing vessels and people involved in fishing (Figure 1; Tables 1 and 2), capture capacity in both the coastal and offshore sectors has increased during the last 10 years [13, 14 and 15].

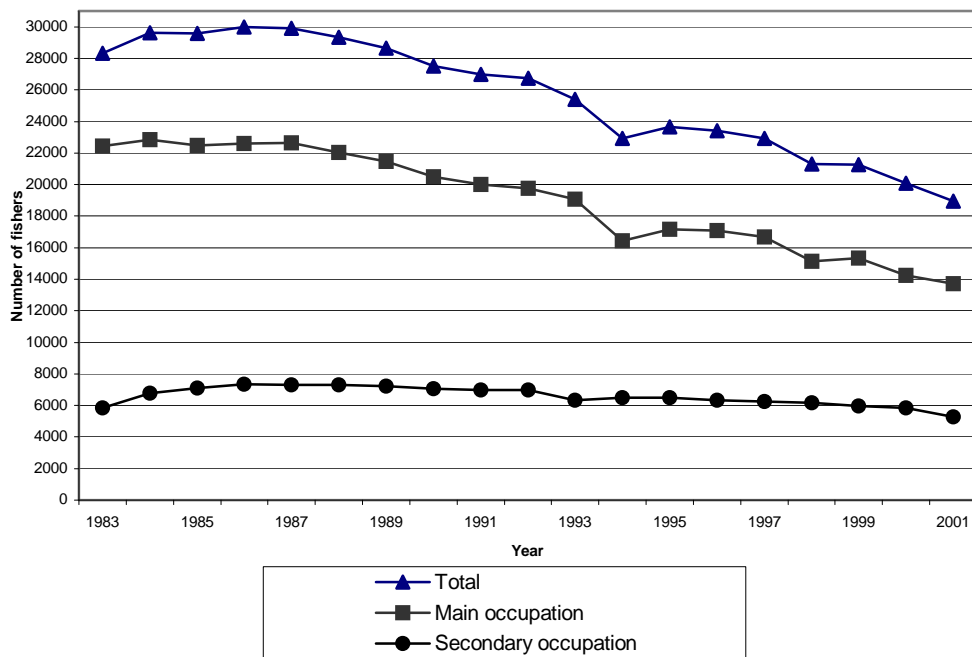


Figure 1. Fishers in Norway 1983-2001. Source: [6]

Table 1 shows the change in number of year-round operating fishing vessels in Norway¹ between 1995 and 2000. These vessels account for more than 80% of catch

¹ Hereafter named as year-round fishing vessels.

and value in the whitefish sector and 100 % of catch and value in the pelagic sector. While the number of smaller, year- round vessels decreased, the number of year- round vessels over 41 m increased in the period 1995-2000. Figures from the Fisheries Directorate show that the total gross tonnage in the fleet (both year-round and other vessels) has been maintained, while the total horsepower of the fishing fleet increased during the 1990s [12 and 13]. Other sources have documented how the oldest and least effective vessels in the Norwegian fishing fleet have been replaced by fewer, more powerful, and technologically more sophisticated fishing vessels [1 and 2]. This expansion in capture capacity is seen as the main obstacle to sustainable resource management, increased profitability in the fisheries, and to the legitimacy of the fisheries management system in Norway.

Table 1. Change in numbers of whole year operating vessels 1995 and 2000. Source: [7-12] [15]

Length groups	Year and number of vessels		Change in number of vessels
	1995	2000	1995-2000
8–12,9 m	1317	1179	-138
13–20,9 m	753	577	-176
21–30,9 m	180	190	10
31–40,9 m	128	116	-12
41 m og over	169	189	20
Total	2547	2251	-296

Table 2. Average man-labour years per vessel in different groups of whole year operating vessels in 1995 and 2000. Source: [7 –12] [15]

Length groups	Average man-labour years per vessel		Relative change 1995–2000
	1995	2000	
8–12,9 m	1,2	1,2	0
13–20,9 m	3,4	3,1	-9 %
21–30,9 m	6,1	6,0	-1,6 %
31–40,9 m	9,7	8,8	-9,3 %
41 m og over	14,4	12,8	-11 %
Average change in for all groups 13 m and over			-7,5 %

Why then, has capture capacity continued to expand, despite a huge effort to reduce it? This article tries to answer this question. The article is based on data and results from a doctoral project at Norwegian College of Fishery Science, University of Tromsø, undertaken in the period 1996-2002² [15]. The data sources are political and official documents, official statistics, research reports, articles, and qualitative interviews with fishers. Section 2 describes the ideas and models on which Norwegian fisheries policy is based. Section 3 charts the course towards an alternative framework for understanding the fisheries and designing policy. Section 4 lays out the theoretical framework used in the analysis and introduces the empirical description of the changing practices and relations in fishing in section 5 and 6. Section 7 returns to the larger questions related to the relationships between fishing practice, policy and science and how these relationships contribute to capacity expansion and section 8 summarises the lessons learned.

2. The ideas and models behind the recent fisheries policy and management

Recent fisheries policy in Norway is heavily influenced by the ideas linked to the theory of the Tragedy of the Commons. Related to this, management is based on combination of biology and economics, bio economics.³ In the theory of the Tragedy of the Commons the individual and economic rational behaviour of people in open access regimes is regarded as the main cause of over-exploitation of resources and low profitability [3, 4 and 5]. Related recent fisheries policy and management build on the assumption that actors exploiting a common resource in a regime with open access and no regulations will always try to maximise their profit by expanding exploitation capacity. In the case of fisheries, this takes the form of capture capacity. The actors are defined as humans acting like pure micro-economic actors, or *economic men*. The cumulative product of their individually rational actions is a collective disaster, the Tragedy of the Commons, where resources are over-exploited [3 and 4]. In this view, the actors in the fisheries are people and the expanding capture capacity is viewed as a result of their individual and economic rational

² Royal Norwegian Ministry of Fisheries through the Norwegian Research Council, the Norwegian College of Fishery Science, and the Centre for Rural Research, Trondheim, Norway financed the doctoral work. A grant from the program “Marked og Samfunn” (Market and Society) in the Norwegian Research Council made it possible to write this article on the basis of the material.

behaviour. This understanding has formed the basis for fisheries management in Norway and other countries in the North Atlantic [5, 15, and 16].⁴

The continuing growth of capture capacity in Norway and elsewhere, despite concerted steps to close off access to fisheries resources suggests that the ideas and models on which management and policies are based, fail to accurately describe how actors in the fisheries are constituted and how action takes place [1, 2 and 15] Some researchers have suggested that the failure to control the expansion of capacity in the Norwegian fisheries through a reduction in the number of vessels and people, as prescribed by the authorities [5], indicates that the authorities' understanding of the process of capacity expansion is poor. In other words, there is reason to ask whether the simplistic economic man approach that forms the basis of the current fisheries policy's understanding of what "fishers" are and how they act, might be one of the reasons behind the expansion of capture capacity. Several fisheries researchers, who identify themselves with the co-management school of fisheries management, claim that this is the case. Representatives of the co-management school argue that the actors in fishing are not pure economic actors, but people embedded in social relations, norms and values [16 and 17]. This leads them to view individual action as a result of the relations, negotiations and co-operative actions between human beings in a society. The co-management school has made little progress in its attempt to establish an alternative to the dominant school in fisheries management [18].

The approach taken here does not support one or the other of these two schools. Instead, it is more in line with Standal [2], who argues that more integrated perspectives taking into account the dynamics of technology development, knowledge, policy, and economy are needed to understand the continued expansion of capture capacity. This third approach requires a relational approach to actors and actions in the fisheries.

3. Towards a relational approach to actors and action in the fisheries

Paradoxically, the ideas and models that have fuelled the enclosure of the Norwegian fisheries commons still make impact on interpretations of developments within those fisheries even after open access fisheries have ceased to exist. Thus, for example, a

³ The combination of biological and economic models is the basis for the economic sub discipline, resource/bio economics, concerned with the management of renewable natural resources.

recent White Paper [5] describes Norwegian fishers as pure, economically rational actors. Its analysis and related policy solutions start with the assumption that these rational actors are fully responsible for the capture capacity expansion. Attributing excess capacity to the substantial properties of the individual fishers leads the authors of the White Paper to conclude that the solution to expanding excess capacity is to reduce, even further, the number of people involved in the fisheries [5 and 15]. In this substantialistic approach, where Economic Man is cause, explanation and outcome, responsibility and attention are removed from the management system and from policy makers, scientists and technology.

Official, political, and scientific analyses of capture capacity expansion in Norway take different variants of this powerful, substantialistic understanding of the actors and the results of their actions for granted. Even analyses of the current situation that are critical of this hegemonic perspective tend to be attracted to the ideas and the rhetoric of the theory of the Tragedy of the Commons. Thus Standal and Aarseth [1], for example, attribute the continued increase in harvesting capacity to what they call the Tragedy of “Soft Choices”. By this they mean the small adjustments and adaptations the individual actors make every day [1]. Despite being critical of attempts to use the Tragedy of the Commons as the basis for fisheries management, their own understanding of the actors ends up being very similar to that of Hardin and his followers.

Studies of the dynamic relationship between political, economic, and technological factors as crucial elements in the expansion of capture capacity [2] require relational approaches to actors and to the processes in the fisheries. These approaches imply that neither expanding capture capacity nor other outcomes of processes are driven forward by substantial properties of individual actors. Instead capacity expansion and other outcomes are treated as consequences of processes of changing relations and networks. Relational perspectives are prominent in works of often-cited theorists like Bourdieu [19] and Latour [20], but the potential of relational approaches has not been fully utilised in studies of the fisheries and fishery policy. While the co-management school regards actors as social constituted and is thus influenced by this perspective, co-management theorists also tend to believe that

⁴ For instance in Canada; the fisheries management system is based on the same ideology as in Norway [16].

human beings have certain substantial properties and also believe in of the existence of certain kinds of social systems, like local communities [16 and 17].

A more radical relational approach that rejects substantialism, as does Latour [20], has not been much used in fisheries research. This article draws on the few exceptions [15, 18, and 21] that exist. These works abandon the substantialistic understanding of human fishers as the core actors in the fisheries. Instead they regard fishers as heterogeneous networks of relations.

4. The fisher as a heterogeneous network of relations

From a relational point of view, the world consists of relations and networks [19 and 20]. Consequently, neither the actors in the fisheries, e.g. the fishers, nor the fishing sector, nor the resources themselves can be understood as fixed entities in themselves; instead, their properties or substances are products of the relations between them [15 and 18]. All the elements in relations can be viewed as the outcome of relations between heterogeneous actors [20]. To say that the actors are heterogeneous means that they consist of relations that are not purely social and that the world of relations never ends. This is the starting point for Actor-Network Theory (ANT), which forms the theoretical basis for this article. ANT, like other system theories, moves the focus away from the properties of individuals; placing emphasis instead on the relational aspects of the many different practices we perform [20 and 22]. ANT studies never start with a fixed understanding of an actor's properties, but study instead how actors are constituted in networks of relations [22]. In ANT the fisher as an actor must be seen as something that is continuously produced through certain processes and relationships. From this perspective, the fisher's essence, rationality, actions, abilities and possibilities will change under changing circumstances. Thus, what we regard as the fisher depends on the whole network of relations that participate in creating the fisher including rhetoric, science, politics, technology, fish, weather, shore, bottom, currents, gear, and fishing performance. Hence, a distinction can be made between the individuals in the fisheries and the fishers as actors. In ANT, individuals can be performers, but the actors, actions, and the products forming action are regarded as outcomes of a whole complex of players, processes and events, rather than representing the individual properties of the performers [22 and 23]. Thus, an individual fishing with a handline is related to the fisheries in a different way from an individual on board a purse

seiner, although these individuals can have the same properties as human beings. Neither the actors nor the actions are the same in these two settings.

ANT is also opposed to the assumption that actors are determined by structural elements. Actors come into existence by making relations, by using different tools and strategies, but they do not come into existence by people entering an open space in an existing structure [20]. Instead, they come into existence through the continuous production of relations; a production process that human individuals also participate in. Thus, ANT does not assume that the individuals alone can be defined as the actors, because they are not able to define their space and possibilities for action only by themselves, without relations. Nor does ANT regard the actors as defined by or embedded in a structure, because the relations that create the actors do not exist *a priori*, but come into existence through the action that takes place. Indeed, the shape and the boundaries of the actors can be vague. ANT-based studies aim therefore not at complete descriptions of actors, but towards descriptions of action. ANT provides a methodology for identifying the processes that create and form the actors, the space and action. The individuals are seen as participants in processes where they are defining other elements' identities, action, and space, but where they also are defined, forced to act, acted upon and put in position by the rest of the network [22 and 23]. In ANT it is not an airplane or a person that flies, it is an airline or an institution like the Air Force that flies. And this institution is not only an organisation or structure, but also a collective of humans, material things, and natural laws represented by science, regulations, signs and symbols related to each other [20 and 22].

From the perspective of ANT, the fishery is not conducted by individuals, but by fishing enterprises of different sizes, shapes, and characters. The fishing actors are the enterprises, with all their relations, persons, technologies, regulations, etc. Thus to understand how change occurs in the fisheries, we have to study how the relations that make up these enterprises are changing, and how they link together. The individuals can be allowed to speak on behalf of the enterprise, and on behalf of those who are given the legal right and the political status as "fishers," but these representatives must not be confused with the real actors, which consist both of the human individuals and of all the relations that allow them to hold this prominent position.

ANT describes how the many bits, pieces, and relations that actors and enterprises consist of are woven together in strong networks so that an actor or a group of actors become the central point through which all rhetorical, material and practical processes must pass [24].

This, then, is the core of the actor-network approach: a concern with how actors and organizations mobilize, juxtapose, and hold together the bits and pieces out of which they are composed; how they are sometimes able to prevent those bits and pieces from following their own inclinations and making off; and how they manage, as a result, to conceal for a time the process of translation itself and so turn a network from a heterogeneous set of bits and pieces each with its own inclinations, into something that passes as a punctualized actor.

The “fisher” as an actor consists of many bit and pieces [25] and must be considered as such a heterogeneous network of human action, politics, laws and regulations, technology, science, social relations, and economic responsibilities, folded out in time and space, but also punctualized in the human beings who represent and speak for the rest of the complex [15]. And as my empirical description from the cod fisheries in the next two sections shows, new relations are continuously introduced, enrolled in the network and mobilised to participate in the constitution and change of the actors and the practices in the fisheries. From the point of view of ANT, it is through the description of how these processes go on, that we see the relationship between actors, actions, and capture capacity expansion.

5. Cod gill netting in the 1980s – a loose but localised network

In the 1980s there were wide variations in the Norwegian coastal fishing fleet. The fleet consisted of vessels of many different types and ages (figure 2). The gill net fishery for cod was important for many vessels and a typical coastal gillnet vessel could be between 50 and 65 feet long, built of wood, with the superstructure almost at the stern. The deck machinery was simple and flexible, with a hydraulic gurdy and often, also, a winch on the foredeck, where most of the work was carried out. Both the winch and the gurdy could be used for many purposes. To switch between different fisheries usually meant a change of gear, and did not require much change in the deck machinery. The vessels had an echo sounder, radar and Decca or Loran C

for navigation, autopilot, and several radio transmitters. The wheelhouse equipment was not interfaced or linked electronically; a skilled skipper was needed to operate them. The skipper switched on every individual item when the need became evident.



Figure 2: Norwegian low tech fishing vessels in the 1980ies. (Photo: J.P. Johnsen 1986).

Traditionally, boats of this type had from 2-5 owners, who often also worked on board; in Norway this is called partner ownership. As recently as the early 1980s, many of the crews were relatives or neighbours. The crews consisted of 4 to 6 persons who handled 150 to 200 nets. Around 1980 most of the gill nets in the cod fishery were still made of nylon twines; a great improvement on the former cotton twine nets. During the 1970s the twine became thinner and thinner, and more difficult to mend. The nets were usually rigged with plastic rings as floats and iron rings as sinkers. Floats and sinkers were attached to the headline and footline with a short band. The nets were linked together in fleets of about 30 nets. In the early 1980s the fishers could choose between 4 or 5 types of cod gillnets with different mesh sizes, twine and depths.

Nets that were damaged during fishing were taken out of the string and either repaired on board by the fishers or repaired after the season. Before every season the

nets were thoroughly mended and repaired, and usually a net lasted for several seasons. The nets made of the thinnest twine (steel nylon) were usually damaged beyond repair and the netting had to be totally replaced. The repair was traditionally undertaken by the fishers themselves, family members, and by hired, retired fishers from the community [15].⁵ The amount of work after a season could be formidable. The family based crew that partly owned the gear, the need for local labour for maintenance, and the partnership that was necessary to raise the capital for investment, linked the vessel to the communities where the owners, the crew and the hired labour lived. Through family and community relationships, the fishery and the fishery enterprises were an integrated part of life in many families and communities. In the early 1980s a seasonal labour force was still available [26, 27, and 28].

All variable costs, like oil, ice, food and sounder paper, were deducted from the value of the catch and the remaining or net catch value was divided into three parts, one part to the boat, one to the gear and one to the crew, the skipper included. Usually the crew got 60% of the net catch value, and the share was paid out after the season.⁶ Often some of the crewmembers owned nets, which gave them part of a share in the gear. The gear was a part of the real capital in fishing, and in this way the capital was shared between several persons, likewise the income and the risks.

When setting out the gear the skipper was in the wheelhouse, steering, using the navigation and fish finding equipment, but also looking for landmarks if possible. Positions, landmarks, and the profile of the sea bottom at the fishing grounds were recorded in the skipper's head, and in written records. Before navigation instruments became available, navigation was a challenge, especially in the winter with snow and little daylight. Equipment like Decca and Loran C made it much easier to navigate in the early 1980s than earlier, but still everything had to be done manually, and the skipper was tied to the wheelhouse. After the skipper had ordered: "let go" under setting and the first grapnel was thrown, everything on the deck depended on the deck hands. Two men watched the gill nets running over the stern and the rest of the deck hands threw out grapnels, stakes, buoys, and warps.

⁵ This account is based on personal experience as a gill net fisher in the 1980s, a documentary film, "Kystfeskar" from 1984, telephone interview with a fishing vessel producer, material collected at the Norfishing exhibition, relevant literature, and interviews with the fishers Jacob, Roy and Peter. In addition I have also obtained technical information from a gillnet producer.

⁶ The share system is regulated through agreements between crew and vessel owners within the Norwegian Fishermen's Association.

The skipper remained in the wheelhouse during hauling. Most of the work on deck was manual. One man was hauling the nets over the roller on the foredeck with the gurdy. From the gurdy two men manually hauled the nets on a gutter to the setting position at the stern. One to three men worked along the gutter taking the fish out of the nets, before they were hauled back. The two men at the stern, one on each side of the boat, cleared and untangled the nets, and split the headline with the floats from the footline with the sinkers, by pulling the footline to one side of the stern and the headline to the other. The floats and the sinkers on each fleet of nets were neatly piled side by side on each side of the stern, with new fleets being placed on top of each other until all fleets were on board. A float or a sinker in the wrong position meant the string would tangle when the gear was being set. The same could happen if trash was left in the net. The soft thin nylon threads tangled easily if the fishers did not clean the threads. However, the clearing was the fastest operation and the two men responsible for this work helped the crew on the foredeck if necessary. The work was organised in a cycle, and the crew shifted positions from fleet to fleet, in order to vary the work. With enough crew, one man usually also worked gutting the fish. With moderate amounts of fish, that allowed the hauling and clearing to go on without stopping, 5-6 men took about one hour to haul a fleet of 30 nets.

Most of the boats were manned for a good fishery. The manpower “slack” that could occur if the fishery was poor could be used to increase the value of the catch by splitting and salting fish on board. If the crew was too small, the efficiency dropped, even with a moderate catch, because fewer nets could be handled. Fishing also became more difficult, risky and weather dependent with a small crew.

There were informal procedures for how the work should be done, with room for individual adaptations. Individual preferences for work positions, different abilities, speeds and rhythms for the work, and differing personalities working together had practical relevance. To be a recruit could be both difficult and confusing due to conflicting instructions from the other crewmembers.

The gill net fishery in the early 1980s was a manual, labour intensive fishery, dominated by local relations through crewmembers, ownership, capital and hired labour. All the human, technical, scientific, and political bits and pieces which made up the enterprises and actors in this fishery, were neither woven tightly together, nor particularly standardised or specialised [15]. To be a skipper and a vessel owner required an ability not only to find fish and to lead the work at sea, but also to

coordinate several processes of employment, maintenance, training, and management. In this informal universe, the space for variation was huge and many of the processes relied on local input of manpower and knowledge, more than on standardised procedures and systems.

To be successful, skippers in the coastal fishing fleet in the 1980s required a presence in or close connection to fishing communities, which were the only arenas for all these processes. In these arenas the fishing enterprises produced fish, money, labour, activity, sociality, status, and power. The outcomes were multiple and many; many informal pay -offs existed. During the 1990s this changed radically.

6. From loosely coupled bits and pieces to integrated harvest machinery

Twenty years later, around 2000, a typical gill net vessel is between 30-45 feet, with the wheelhouse in front - in Norwegian called “Sjark” (figure 3).



Figure 3: A modern Norwegian capture machine, 43 feet long, with about 150 monofilament nets and hydraulic equipment for net handling. Operated by two to three men. (Photo: J.P. Johnsen 2003.).

During the 1990s the “sjarks” have become more standardised and specialised both in size and in terms of their equipment [15]⁷. Rarely more than three men operate these boats, which are usually drifting with between 50 and 300 nets. For navigation they use radar, GPS, digital chart machines, and autopilot. These last three elements are interfaced and by a click on the mouse in the wheelhouse the vessel steers to the position that the skipper has saved in the computer. All the equipment, except sometimes the radar, is switched on from one main switch in the wheelhouse. As “Jacob” said: it was only the danger of collision with other vessels that made it necessary to be on watch, and the navigation is much faster than when they had to use charts in combination with Decca or Loran C. The new colour echo sounders also make it easier to find the fish. With a short introduction almost everybody is now able to navigate, even if some experience is still needed to find the fish.

The deck machinery is more specialised than on the old gill-netters and the gear has also changed. Both the hauling and the clearing are mechanised, and the gear is adapted to mechanised handling. Different types of hydraulic gillnet haulers have replaced the man who held the nets in the gurdy. The nets still run through a gutter to the stern and skipper and the other crew cooperate in taking out the fish and gutting it.

The nets are made of monofilament with floating line for headline and lead line as ground line. Monofilament nets are more invisible in the water than multifilament nets and fish better in daylight and in shallow water than the multifilament nets. The mesh size and depth have not necessarily changed, but a wide variety of nets is available; today more than 20 types of cod nets are available. The floats and the sinkers are an integrated part of the gill net and do not have to be piled neatly on each side. Since the monofilament thread does not entangle like the soft nylon threads, clearing is an easy operation. The nets are hauled to the setting position very fast. There is no need to separate the headline and the leadline and spread the nets out over the whole stern. Without separate floats and sinkers, less space is needed and the nets are hauled into bins at the stern by a hydraulic device (garngreier) (figure 3). According to Roy and Jacob, mechanisation has reduced the physical workload and standardised and increased the speed of operations.

⁷ In the 1980s various producers and types of boats dominated. Today, fewer producers and boat types are dominating the market.

The nets are not repaired in the “old way”. When the season is over, the damaged nets are cut loose from the main lines. The lines are brought to the net manufacturer where new nets are mounted. Some manufacturers can also store the nets for the boat between the seasons. The mechanisation, as well as these new practices, link the gear and the boat closer together and also reduce the interest of crewmembers in owning their own nets. The gear is no longer an investment that will last or something that can be repaired by the owner alone and a minimum of organisation is required. Gill nets can be regarded more as a production factor than a part of the real capital, although the tariffs and agreements about sharing the catch still treat them as a part of the real capital. Hence the knowledge of making and repairing nets has vanished among the people involved in fishing as more and more of the manual skills that were required in the 1980s are replaced by other types of knowledge that are more relevant for today’s fishing enterprises. These include the ability to run a complex business, control finances and investments and understand the fishing regulations [15].

The knowledge about nets is still important for fishing, but has been translated into the manufacturing system. Since fishing operations have become more dependent on the knowledge and service provided by manufacturers, the fishery and industrial manufacturing system have become more closely linked, not least through the formal economic transactions that take place. Actually, the gear manufacturer has become a part of the relations that constitute the fishing enterprise. The relationship between them represents a sharing of the work in the enterprise. A professional system for gear making and maintenance takes care of the land-based activities. The sharing of work allows those operating on the sea to devote themselves to the capture activities. Since the equipment can handle a wide variety of nets, they can change to fishing other species like tusk, ling and Greenland halibut when the quota-regulated fisheries are over. But instead of changing gear, for instance to longline as many did before, it is now possible to continue and specialise in gill net fishing, like the fishing enterprises that Jacob and Roy are involved in have done. Professional systems now take care of more and more of the activities that the skipper and the crew undertook during or between fishing seasons.

The fishing boat is the point at which all these systems meet, and even if the owner and the skipper become their representative, it is obvious that the enterprise is not only a boat and the crew members, but a mix of many professional systems that

all aim to contribute to maximal or optimal efficiency in the parts of the operations they are responsible for. One result of these changes is the reduced need for manpower. Two to three men operate these vessels, but Roy and Jacob can, if necessary, operate without other crewmembers. A steering position at starboard reeling, behind the hauling equipment, is standard on all vessels, so the skipper can control both the vessel and the hauling from one position. As Roy said, mechanisation has made it possible for three men to tend the same number of gillnets on a 42 footer as 6 men could handle in the same period of time on his former 64 footer. Jacob usually fishes with one and sometimes two crewmembers in the winter and without crew during the summer. He prefers to have less responsibility for other peoples' lives and income. It is not unusual for two boats to "buddy up" and operate together, sometimes with the same crew and with the same nets, but sharing the work, the costs and the catch between the vessels until both the vessels have caught the quota. Sometimes two skippers also buddy up and work as crewmembers for each other. Through this "skipper fishery" they reduce labour costs, specialise, and move towards more labour efficient practice.

People's work on board has also changed. The gear is handled through technical devices that require standardised operation. All these devices are part of the enterprise and link it to the different networks from which the devices originate. Through these networks also flow a continuous flood of new ideas, technologies, practices, and possibilities for action. The human relations directly involved on board are reduced, and local links are replaced by the more global links which the technology represents, weakening the coupling of the enterprises and actors in fishing to the local environment. Simultaneously, they become more tightly integrated into a strong fisheries network, which runs through fishing enterprises linking them at the local, regional and global levels. In this respect the fisheries are becoming more and more integrated into modern society.

This replacement of people by machines and institutions has changed all relations in the Norwegian fishery. Fishing practices have been turned into an assembly line type of production, and have become part of a larger national and international fisheries harvesting system based on the same ideologies as the production and manufacturing of other industrial products, and on science and rationality. Through involvement in this assembly line of production and the ideology of industrialisation, the designers and the producers of the vessels'

equipment become more prominent in the relations in fishing. One outcome is that a larger amount of gear can be handled more effectively, with fewer people. A second outcome is that the relationship between fishing enterprises and their communities has changed.

Now, what does all of this have to do with the persistent problem of excess capture capacity in Norway's fishery? Budsjettnemda⁸ has documented the reduction in manpower that has taken place in recent years in Norway's fishery (table 2). Between 1995 - when the Budsjettnemda [7 –12] made the first estimates of the work effort in man-labour years and 2000, all groups of fishing vessels in the Norwegian year-round fishing fleet, except the smallest, have experienced a reduction in average man-labour years per vessel.⁹ For all groups of vessels over 13 m the average reduction in man-labour years per vessel has been 7.5%. The actual amount of work, in respect of hours behind each man-labour year and the number of working hours per man, varies between the different types of fisheries and from year to year due to factors like quotas, regulations, market situation, weather, resource availability, technological innovations and renewals in the fleet. However, the decline in man-labour years and in the number of fishers in the period 1995-2000 has neither resulted in reduced capture capacity, nor harder work for the remaining fishers. In fact, fewer vessels and registered fishers landed a higher catch and value in 2001 than in 1995, with fewer days at sea, and with a lower number of working hours and man-labour years [7-12]. In part, this development is the result of fish availability, quotas, and fish prices, but it is also a direct result of a higher level of mechanisation and more efficient operations.

The difference between the 1980s and today is that all the relations have changed. There are fewer people involved, fewer local links, and, as we shall see below, an increased amount of external capital has been invested in Norway's fisheries. Our description of the *sjark*, for example, where men undertake more and more standardised operations with machines makes it reasonable to talk about the gear, vessel and the crew as a more coherent and integrated system today than earlier [15]. Several sources document that this is the case in all Norwegian fisheries [1 and 2].

⁸ *Budsjettnemda* is a committee with members from both the authorities and business, and evaluates the economic situation in the Norwegian fishing fleet every year.

⁹ Man\year expresses the average use of manpower on board a fishing vessel.

Today's fishing technology can be characterised as *integrated harvest machinery* within which people are not placed outside the machinery as users and masters, but must instead be seen as an integrated part of the machinery. Like workers on an assembly line, people's performances in fishing are shaped by the production system, which in this case is the harvest machinery, and a dense network of social and institutional relationships. As performers, people have become more closely linked to and more dependent on the machines and the technological, scientific, and economic networks of which they are a part. The role of technology within fishing is not neutral. Just as much as the people involved in fishing, technology helps shape fishing performance, represents the technological networks that produce it, and conveys ideas, values, goals and interests. However, the people's experiences are also important. The exchange of experiences and the individual success or fiascos of those who have the formal status of "fisher" are continuously fed back into the technological network, where they play a role in the continuous development and adaptation of technology. The flow and exchange of ideas, experience, knowledge, and possibilities create a dynamic and changing fisheries sector. In short, the new, strong relationships and the exchange of experience and knowledge have made the technology more efficient and contributed to the expansion of capture capacity within Norway's fisheries.

Standardisation has reduced the need and opportunity for variation in practical work and when the machinery requires certain operational procedures, which in many cases are much easier to learn than the old practices, the former practices and the knowledge linked to them vanish [15]. As a result, fishing cannot happen without the machinery on which fishing has become more dependent. Whereas earlier we could talk about human fishers with individual fishing knowledge, more and more of the knowledge is now embedded in machinery and the institutions, rather than in the individual. Fishing knowledge has been transformed from personal to institutional knowledge, making it possible to systematise it and strengthen some elements while weakening others. Personal beliefs, values, and ethics can, for instance, be filtered out, and the knowledge can be purified and directed towards specific goals, like more efficient fishing or more responsible fishing.

Although personal knowledge and experience are still important for a successful skipper, today, most of the services and inputs can be purchased from

professional services, which are no longer necessarily locally available. The skipper no longer has to be localised in, or have relationships with a local community, in order to gain access to essential processes and inputs for the enterprise. It is still necessary, however, to coordinate and hold the bits and pieces together, but in another way, by other means, and involving different allies and arenas than before. This brings us to policy, science, and economy and the way that they participate in the creation of actors, action and capacity expansion.

7. How policy, science, and economy participate in creating actors and actions

From the mid 1930s to the beginning of the 1990s a cooperative model, where cooperative institutions controlled by the fishers held considerable power and influence, played a central role in the institutional framework of Norwegian fisheries. In particular a close formal cooperation between the Norwegian Fishermen's Association (NFA) and the authorities existed [29, 30, and 31]. This legal and institutional framework gave the fishers, as an organised professional group, formidable power, with exclusive legal rights to set prices for fish and to control sales of their fish through mandated sales organisations (MSOs) [29 and 32]. From 1964, NFA had the exclusive right to negotiate subsidies to the fisheries through the Main Agreement between NFA and the Ministry of Fisheries [33, 34, 35, and 36]. The cooperative framework and the power it gave to NFA and the MSOs were, throughout the 1970s and the 1980s, regarded by fisheries economists as contributing to the profitability problems in the sector starting in the late 1950s [34, 37, and 38]. Legal protection and the view that these cooperative institutions were protectors of fishing communities made it difficult to change strong institutions like NFA and the MSOs. A totally new situation in the cod fisheries was needed before the strong legal, political, and social network of the cooperative model could be weakened enough for changes to be made.

The collapse of the Norwegian Northern cod stock and the sudden halt that occurred in the fishery in 1988/89 was partly unexpected. The new situation required *force majeure*, and the fisheries authorities had to act quickly. In 1989, open access was abandoned. With this move an important part of the foundation for the cooperative model was taken away, because the cooperative's members were now given different statuses in law based on those with and without rights to the

resources. This inequality caused a lot of turbulence in the cooperative institutions in the following decade.

Fisheries economists argued in the 1980s that the cooperative model contributed to an excessively high fishing effort and to a situation in Norwegian fisheries similar to the Tragedy of the Commons [37, 38, and 39]. With the collapse of the cod stock, the cooperative model and all its institutions were put under pressure [40]. NFA was weakened both through the internal tensions in the organisation that followed because of the reduced importance of the Main Agreement, and because of the turbulence caused by the closure of the fisheries. With a weaker NFA, the power in the Norwegian fisheries management system could be centralised as prescribed in the theory of the Tragedy of the Commons [15, 18, and 31]. The authorities were able, during the first half of the 1990s, to take full control of the situation and a new model for the fisheries replaced the cooperative model in Norwegian fisheries.

The ideas and solutions that underlay this new resource management model had developed after the collapse of the herring fishery in the 1960s, through what Holm [32] calls a silent revolution. This resource management model's scientific basis combines Beverton and Holt's population dynamic model from biology with the micro economic models for economic behaviour [4]. Hence, the resource management model is strongly related to the same understanding of the actor as the theory of Tragedy of the Commons [4 and 15]. The contribution of bio economics is that both nature and society can be treated inside the same models [18 and 41] and economic solutions to the problems caused by open access can be launched.

In bio economics, limited access to and sole ownership of resources are seen as the most efficient ways to achieve sustainable use of a resource, secure profitability, and to cope with excess capacity. Private owners are regarded as more protective of their property than users in an open access fishery [4 and 16]. The resource management model reflects these underlying assumptions; its universal solution to problems in the fisheries is to introduce quotas. Licences and quotas had already been introduced in the trawler fleet and in the pelagic sector in Norway [42], and since their introduction, these Norwegian fisheries have become much more concentrated, closed, professionalized, and industrialised than the more open access, coastal water fisheries [43, 44 and 45]. When this resource management model was established as the basis for fishery policy in Norway, the authorities argued that a

system based on individual transferable quotas (ITQs) was the preferred long term goal. That idea was turned down by NFA and the Parliament at the start of the 1990s in favour of a system based on individual, non-transferable vessel quotas [40]. However, in practice, indirect sale of quotas occurs [42] and, as in other countries with resource management based on quota systems, the move from open access to closed fisheries has led to a concentration of rights and quotas [16].

The introduction of quotas has had other effects as well. Quotas are not a neutral tool, they link together in new ways, the resources, the vessels, the owners, the politicians, the bureaucrats, the scientists, and many other agents including the banks that finance the buying and selling of quotas, and the producers of fishing technologies. Thus we see that a fishing enterprise does not consist of a vessel manned by individuals with the same interests and inherent approach to fishing. Instead, it consists of a complex web of relations extending beyond the boundaries of the vessels and the fishers to local, regional, national and international organizations, as well as into the sea to fluctuating and changing marine ecosystems. We also see that changes in the resource base, in technologies, ideas and policy change have changed that web of relations with consequences for current and future fisheries trends.

A successful fisheries enterprise consists not only of the owner, the crew, the vessel, the fish and the quotas available, but is also woven into the network of regulations that define its relations to the fish, negotiations with other states, the production, interpretation and application of science, and the development of gear and vessel technology. In the current context, the enterprise must be able to enter into transactions related to buying and selling rights and quotas, undertake planning, obtain finance and credit, and evaluate risks. The change from open access to a closed system has promoted a process that turns fishing enterprises into more professionalized, businesslike relationships. Fishing is becoming a professionalized business and trade like other professions, businesses and trades in modern society.

The process of enclosure and professionalization is changing the relationship of the crews, coastal communities and general public to marine resources. Thus, fewer people from the communities have direct or indirect access to the fish [7, 15 and 42]. Rights and responsibilities are being transferred from the public to the private sector. The ordinary crew, who no longer has any legal rights to the fish resources, their families, and their communities, now depend more on representatives

of the capture network for their access to the fish resources and the wealth they generate. These changes are not only a result of fisheries related changes but also of other changes in Norwegian society and coastal communities [15].

The resource management model described above has contributed to the shift from labour intensive, locally based and loosely coupled fishing operations to operations based on integrated harvest machinery. The fish that, before, were no one's property in law, have now become the quasi-private property of some actors. Nature, represented by the fish, is now partially woven into the fishing enterprise. Based on vessel length and other criteria, the resource model gives fishers a certain volume of fish or other marine resource to act upon. In so doing it has made exclusive rights and quotas to fish the basis for profitability and sustainability within the industry. A boat is no longer only a boat, but now represents an option on a certain amount of fish. Although the exact quota and price vary from year to year, likely income levels can be estimated. The possibility of a good year is replaced by the guarantee of a more secure, but limited income.

By virtue of this process of rolling Nature into the fishing enterprise, the longer term political goals of increased stability and reduced income variation within the industry have, at least temporarily, come closer to reality. However, as pointed out by Standal and Aarseth [1], the policy has also favoured lengthening fishing vessels, making it a promoter of technological modernisation and a driver of expanding capture capacity, despite the political goal to reduce such capacity. This process is reflected in the change in patterns of investment during the rather short period between 1995 and 2001. Table 3 shows that more than 7 billion Norwegian kroner have been invested in the fishing fleet over 13 m since 1995. The long-term liabilities of this fleet have increased by 168% during the period 1995-2001, which is many times higher than the rate of inflation and reflects an increase in technical standards on the vessels. Related to these changes, capital costs have increased while the wage paying ability of enterprises has declined (table 3), according to the figures from Budsjettnemda [7- 12]. Even if fewer people and fewer boats are directly involved in fishing, the remaining boats and people have had to achieve a higher catch value in 2001 than in 1995 in order to pay for the increased costs of investment.¹⁰

¹⁰ The declining interest level will improve this situation in short term.

Traditionally, not even the biggest vessel owners expected yield from the invested equity in the Norwegian fishing fleet [46 and 47]. Ownership in the fishing fleet was characterised by patience in respect of yield from invested capital, not least because much of the capital was local and because of the many different social benefits derived from the fishing enterprises. Professional capital owners, like banks and other financial institutions, government investment bodies, and private investors, behave quite differently from traditional owners in the fishing fleet in this respect [15, 46, 47, 48, 49, and 50]. Both fishing vessel owners and people selling accountancy services to fishing vessels report a change in this area. Fishing is now regarded as a purely commercial activity, and the professional capital owners require higher profit in the short term than owners in the fishing sector traditionally have expected. [15]. As a consequence, even those who have traditionally been patient have to adapt to the more impatient market economics [49, 50, and 51].

Many fishing vessels today, even small ones, are organised as corporations and no longer as partnerships [47]. The ideology, the forms of organisation, the institutional framework, the rules for taxes, yield, etc. and the financial situation in the fishing fleet are therefore much closer to the patterns we find in land based businesses. When, for example, rights and quotas become elements in transactions, they can also be regarded as a part of the equity in the fisheries [47]. In this way the institutions financing vessels gain more control over fishing activities and strengthen their links with the fishery resources [48, 49, and 50]. Capital seeks investment opportunities, but with a smaller number of vessels and individuals with access rights, the positions to invest in are becoming scarcer in the fisheries. Fewer fish, quotas, and people can increase the price for entering into relationships. If the scarcity of fish and quotas increase the price of fish and quotas, and the related costs of fishing, and more intensive resource exploitation becomes necessary to meet the increased costs – then the ecological benefits of limiting access to the fisheries may disappear.

The fisheries policy and management system give priority to economic values [51, 52, 53, 54, and 55]. As a result, fishing enterprises are no longer regarded as producers of many products, like fish, labour and social benefits, but mainly as producers of added economic value. The informal pay offs are reduced as a result, because the professionalized network formalizes as many practices and relationships as possible. These enterprises must therefore act as economically rational actors. As

a result, there are strong pressures to increase efficiency and this tends to be accomplished through increased capture capacity.

8. Capture capacity is increased by policy and management, not reduced

Norway's fisheries are enhancing capacity instead of reducing it despite huge investments in attempts to control separate elements, like the number of people, vessels, hold capacity and engine size. As long as the government and industry ideology and the official framework for analysis [5 and 51] give such a prominent position to financial "mechanisms", there will be a constant drive towards greater capitalisation in the fisheries [1, 2, 15, and 16]. When the focus is on profitability and so long as it is possible to replace people with more effective machines, better gear, boats and equipment that allow the processes to go faster and faster thereby increasing the economic value of the catch, the vacuum created by those people that leave will be filled by enhanced technological capture capacity.

With the policy focus on technical measures, the contribution of policy to the creation of the tightly interwoven enterprises has remained invisible. The increasing speed in fishing processes has also been missed. Many strong interests and forces are pulling in the same direction, towards creating more and more capture capacity.

As in other North Atlantic states, pressures to modernize and increase technical and economic efficiency have become increasingly important in Norwegian fisheries policy [15, 16, 30, 31, 40, 51, and 57]. Within contemporary resource management in Norway, the fish has become a limited right, an option, an opportunity, and a requirement that does not give the actors the choice, whether they want it or not, to remain "fishers". The fish must be fished. If not, the fisher loses both his position in the network and the status of an actor in the fishing regime. The fish must also be fished in increasingly efficient ways, with as little human effort as possible and with as much added value as possible if the enterprise is to survive. The management model defines not only the relation between the fish and the individual, but also the appropriate actions that are required to be defined as also the actors; i.e. the fishers [15, 18, 31, and 41]. Even if the owners and skippers are still able to make choices and decisions, the network they are a part of structures the opportunities for choice and decision-making constraining their options.

Seen from this perspective, changes in the harvest machinery and capture capacity expansion are not the result of people's "soft choices", but products instead

of rather hard forces and strong and complex processes where policy, science, technological development, market economy, human relations, personal interests, skills and abilities act together. The machinery's existence is partly a result of more than 50 years of fisheries policy in the Northern Atlantic where the accepted path to economic efficiency has been concentration, technical modernisation, and capital investment on behalf of employment and decentralisation [15, 16, 56 and 57]. The realisation of these goals can be found in the integrated harvest machinery of today, humans, politics, economy and technology are tightly linked together, and capture capacity is continuously expanded [15].

By studying the actions through which the integrated machinery has come into existence we can see the many relations and actions that have contributed to this increase in capture capacity. From this perspective, it becomes clear that a reduction in the number of people and number of vessels involved in fishing will not necessarily reduce the problem of overcapacity in fisheries or ensure the development of sustainable fisheries. One reason for this is that we are not talking about single entities like engines, nets and boats but rather about a whole complex of relations. As long as fisheries policy and management overlook the fact that expanding capture capacity is an effect of a network of relations rather than a product of the individual actions of rational economic actors, capacity will continue to increase. The first step towards changing this is to acknowledge this relational effect. How to control it, however, is quite another matter.

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Illustrations and tables:

Table 3. Wage payment ability, results of financial items, and long-term liabilities in the year-round Norwegian fishing fleet 1995–2001. Source: [7-12] [15]

Year	1995	1996	1997	1998	1999	2000	2001
Wage payment ability (1000 NOK)	2144	2522	2898	3450	2860	2365	2232
Results of financial items (net financial costs in 1000 NOK)	195	249	261	315	484	555	596
Long-term liabilities (1000 NOK)	4173	4601	5003	6020	7158	9646	11175