

**THE CYBORGIZATION OF THE FISHERIES:
On Attempts to Make Fisheries Management Possible**

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Abstract Although natural resource exploitation has a long tradition, modern resource management is a more recent phenomenon. The huge variety in natural resource exploitation has made it difficult to place the industrial harvesting of marine living resources under political and managerial control. For most of history fish and fishing people have for all practical purposes been unmanageable. From the late 1960s, when it became apparent that important fisheries resources were about to be overexploited by industrial technologies, the process to transform fish, fishing people and fishing technologies to make them manageable has intensified. The management process contributes to an organizational change in the fisheries in which cybernetic forms of organization create complex and heterogeneous networks linking together nature, society, technology, science, markets, and policy in new ways. With Actor-Network Theory (ANT) and the history of industrial commercial fisheries in Norway, Canada and worldwide as points of departure, this article outlines a theoretical framework for the study of how natural and social entities are transformed and linked together to become modern fisheries resource management.

Introduction: Managing the Unmanageable

While North Atlantic coastal fisheries for cod were labour intensive, community-based and low tech fisheries well into the 1980s (Johnsen 2005), today they are radically different in terms of technology and how they are organized.¹ Several studies from Norway, Canada and other North Atlantic countries describe radical changes in technology, organization, fleet structure, knowledge, fisheries man-

agement, property rights, and relationships to communities across a number of fisheries (see for example: Apostle *et al.* 2002; Eythorsson 2000; Hersoug 2005; Pálsson 2000). In many of these studies, fisheries management plays a key role in the changes, even if it is not the only driver. Moreover, fisheries management is not a new phenomenon. To manage fish became important when fish became objects in economic exchange rather than a source of food for local subsistence. Marine life appears far less manageable when it is experienced in the wild. But such management has focussed on the economic and societal aspects, not on resource utilization and biological sustainability, as key concerns in modern fisheries resource management (Apostle *et al.* 2002; Holm 2001). For centuries, under the *Mare Liberum* regime and with the pre-industrial fishing industry, fishing could take place in a free-for-all and nobody had knowledge, competence, or means to control fish and fishers (Pontecorvo 1988; Bavington this issue). Today, however, in most of the western-industrialized world, management of the fisheries and the resource system is not only an abstract possibility, but an actual material force in the world. While the extent to which management succeeds has been debated, there is no doubt that resource management is a practical reality. With the adoption of the UN Law of the Sea Convention in 1983 and the international acceptance of the 200 mile Exclusive Economic Zones for Coastal States, more than ninety-five percent of fisheries resources were brought under national jurisdiction. *Mare Liberum* was replaced by *Mare Governabilicus* with management authority invested in the coastal state (Apostle *et al.* 2002; Caddy and Cochrane 2001; Holm 1994).

This process came to a symbolic peak in 1983. During the two decades since then, the slow pace of *Mare Liberum* has been replaced by swift and dramatic reform activities in a number of key areas (Caddy and Cochrane 2001). During the 1980s and 1990s the process of bringing ‘the unmanageables’ under control speeded up, with subsequent debates and disputes about the models, means, organizations, and institutions of fisheries management. During this period the management discourse centred around three different approaches. First, there were those who followed Hardin (1968) and his *tragedy-of-the-commons model*, arguing for a strong state – a Leviathan to enforce scientific management regulations. Second, there were those who followed Hardin’s advice to enclose the commons and argued for privatization and the use of market forces in fisheries management. Third, there were the contextualists who argued that common-property resource exploitation had to be understood and regulated within holistic frameworks that included cultural, social and institutional factors (Hannesson 2006; McCay and Acheson 1987; Pálson 1991).

The processes we describe in this special issue are scientifically complex. Fisheries management requires the application of science to translate fish, fisher folks and communities into abstract objects that can be handled by the management system. Fish stocks are counted and assessed for management purposes on a regular basis in all the world’s oceans, as Bavington describes in his article (this issue). However, even if science is a powerful transformative force, it does not remain unchanged in the confrontations with real fish, fishing people, and fishing communities to name a few of the many fleshy actors involved. Science is also not able to transform and translate everyone and everything (Latour 1999;

Mansfield 2003). One indication of the massive failure of scientific translation in action is the present state in many fisheries. Actually, many crises involving fishery collapse have occurred while the fisheries have been under scientific fisheries management. This has been interpreted by fishery scholars as knowledge crises (see Jentoft 1991; Neis *et al.* 1999; Pálsson 2000; Neis and Felt 2000). It requires a lot of work to address knowledge crises and this tends to meet heavy resistance by a number of entrenched actors with threatened interests. This is Bavington's point of departure in his article exploring the history of cod fisheries management in Newfoundland and Labrador, Canada. Indeed, transforming unmanageable objects into manageable ones is not an easy task, as Sinclair and his companions describe in their piece (this issue) exploring the knowledge network associated with federal cod fisheries management in Newfoundland and Labrador, Canada. Both articles highlight the problems that occur when one or a limited number of persons or groups have the power to define rational action and what constitutes legitimate knowledge. While debate continues on the appropriate framework for understanding fisheries management there is no doubt that both the fish and fishers have been transformed. The fish have been transformed into measurable and controllable single species populations (Bavington this issue). Fishers have been transformed from commoners and hunters into businessmen and property owners (Apostle *et al.* 2002) and ultimately into fishing actors constituted through increasingly cybernetic relationships as Johnsen, Murray and Neis describe in their article in this issue. Our articles highlight changes in the fisheries that have taken place parallel to the development of fisheries management from a modest attempt at crisis management, through the ambition of rationalization by means of state governance into a framework within which the fisheries can unfold in an ordered, profitable and rational pattern, with a number of strong actors and interest groups (Holm 2001; Johnsen 2004).

The main question we address in this special issue of *MAST* is how shall we conceptualise and understand the changes that have taken place in North Atlantic fisheries since the Second World War. In the remainder of this article we present the theoretical approach that has guided our collective studies of changes in the fisheries sector. To answer the question above we created new concepts to understand what has been going on in some of the North Atlantic fisheries since the 1970s.

The impressive quality and quantity of diverse disciplinary and interdisciplinary studies during the last two decades on North Atlantic Fisheries have produced important insights into changes in the fisheries. There have been several studies that have examined the introduction and effect of centralized and/or market management as opposed to more decentralised, user-based, or participatory-based management systems. In these studies there have been a number of helpful new concepts and knowledge generated and it seems fair to ask, 'Don't we have enough concepts and knowledge in this field?'. Our collective answer is 'No!'. With calls to base fisheries management on best practices and good governance approaches, we believe it is becoming evident that in the fisheries management community there is an urgent need to learn how to cope with uncertain natural resource fluctuations and make difficult choices between a variety of practices,

organizations and institutions. In order to understand these difficult choices and what is at stake in fisheries management insight into how relations that constitute fishery actors and actions change in character and substance will become necessary. 'The fisher' in a household-based seasonal fishery is relationally different from 'the fisher' we find onboard today's highly sophisticated vessels, and we need language and concepts that make it possible to distinguish between them and understand the consequences of the change. Thus, our ambition is to contribute to the development of concepts that clarify and pinpoint the relational changes and that help display how management is practised and has become institutionalised in North Atlantic fisheries today.

Following theorists like McCay and Acheson (1987), Jentoft *et al.* (1998) and Pálsson (1991) we have a relational understanding of the world of fisheries. Following these relationalists and based on the relational inspired methodology developed within the sociology and history of science, in particular Actor-Network theory and environmental history (Callon 1986; Latour 1993; 1999; Law 2004; Latour 2005), we describe the complex processes of change occurring in contemporary North Atlantic fisheries as *cyborgization*. Cyborgization changes fisheries from being constituted by close, affective and to a great extent informal relations to a sector more dominated by formalised cybernetic relations. *Affective relations* are the type of relations that we find in civil society, in the family and in the informal practices of everyday life (Kooiman, Bavinck *et al.* 2005; Murray *et al.* 2006; Johnsen *et al.* this issue). Through cyborgization fishery actors become reconstituted with new abilities and properties. Neither fish, fishers, managers nor technologies remain untouched by the process (Johnsen *et al.* this issue). Even though this article focuses on phenomena and consequences that will easily be perceived as negative, it must be added that technological, cybernetic and managerial developments have also contributed to make fishing into a safer and easier livelihood over the short term. Our approach is not to argue that it is better 'to fish with three men and six aching arms, than with one man and three jiggging machines' as a Norwegian fisheries minister has accused academics of supporting.² The point is to describe how the fishing actor has changed and the consequences of this change when the relations between three fishermen are replaced by mechanical relations among machines. Without such knowledge it will be difficult to develop appropriate and enduring fishing tools and practices that can be judged suitable for particular places, people and times.

The empirical foundation for this article is based on our research in the fisheries³ in combination with studies of fishery-related scientific texts and documents. In addition, the article builds on independent empirical material from Norway and Canada but examples could easily be selected from any highly or over-developed western fishery. All the articles in this issue adopt an exploratory approach and describe changes in fisheries as part of or parallel to changes in management. The stories told in the articles are about the struggle to manage and modernize North Atlantic fisheries. First, in this introductory article we describe the attempts to build a strong centralised management and governance system in the fisheries as a part of the modernization process. Second, we present a central mechanism in modern resource management, and in the last part of the article we concentrate on the outcome of the cyborgization processes and recent developments.

Crisis Management, the Leviathan and the Fishing Cyborgs

As described above, solving resource crises was the trigger for modern fisheries resource management. In accordance with the prominent ideas developed by biologists and economists in the 1950s and 1960s, governments were to play the most important role (Jentoft *et al.* 1998). “The Fisheries Leviathan” symbolises a strong presence of government in fisheries resource management’ (Jentoft *et al.* 1998:425) and the idea represents a struggle towards a panoptic fisheries sector where the managers through science and rationality could survey and control the fisheries, (see Foucault 1977 and Latour 2005). Dean Bavington’s article in this issue illustrates how this idea of resource management was a key element in the struggle to construct ‘the Fisheries Leviathan’. Both Bavington and Sinclair, Johnsen and Ripley (this issue) address how scientific knowledge and instrumental rationality are produced and deployed through political, technological and scientific development. Their stories about the struggle to manage the Northern cod in Newfoundland and Labrador (NL) are also stories about how the Fisheries Leviathan and panoptic fisheries management in NL never became a reality in the ideal form. However, the idea of resource management survived the collapse of the Northern cod and the Leviathan, and the idea of a strong role for government in fisheries management became embedded in processes of *cyborgization of the fisheries*. These processes towards more cybernetic organised fisheries are the subject for Johnsen, Murray and Neis’ article in this issue. In this article, the authors describe the organizational changes in fishing practices that followed the struggle for and failure of a panoptic fisheries management and how these changes led to redefinition, reorganization and reinstitutionalization of fisheries management. The outcome of the processes they describe is *cybernetic fisheries organizations* – fishing cyborgs through which people, fish and management are related in new ways.

By addressing these changes, the articles in this issue of MAST explore one side of modernity, namely the technologies for controlling and constituting the relationships between humans, nature, and society. Our research project, ‘The coming of the Cyborg Fish – on how objects become manageable’, from which the collection of articles in this issue of MAST is the outcome, has produced insight into the practices by which modernisation changes the world and how modern institutions gain control over nature, humans, and society. Different from what we expected at the beginning of the project, this control is not total or panoptic. Instead of the strong Leviathan, which we believed could be found in the fisheries, there are now several smaller, but highly effective devices for control and feedback that delegate control responsibility to the actors themselves⁴ and to their interest-based organisations organizations (Apostle *et al.* 2002).⁵ As Johnsen *et al.* describe, the result is that the actors change radically and that their relational configuration becomes rearranged.

The processes we describe are not necessarily negative. Our attempt is to explore and describe them to make sure that the institutional set up and the relational configurations can be known and become subject to societal and democratic control. Democratic control is particularly important because the right to fish is a privilege for the few, and because there is a potential for conflict between the privileged fishers and those who take part in what Nordstrand and Holm (this

issue) call the *refurbishing of the coast*. This refurbishing is undertaken both by former fishers and new actors who involve themselves in the development of new livelihood and businesses based on fishery resources. Through these activities, they claim to be accepted as legitimate stakeholders in fisheries management. By doing this they also challenge the 'last commons' in Norwegian fisheries, namely recreational and food fisheries.

The Rise and the Fall of the Fisheries Leviathan

Before the 1930s the North Atlantic fisheries mainly consisted of close and affective relations between humans and fish. Community and commons functioned through complex, informal social relations without centralised scientific systems for representation, governance, and intervention. The transformations of the North Atlantic fisheries during the 1930s, when our history has its origin, changed this situation both in Norway and Canada (Holm 1995; Wright 2001).

For example, in 1937, ten years after the Norwegian fishermen, with support from the state, had started to gain control over first hand fish sales and after the introduction of the first temporary *Trawler Act* in 1936 regulating trawling activity in Norwegian waters, the *Fisheries Profitability Committee* (FPC) (Lønnsomhetsutvalget 1937) proposed a program for technological and institutional modernization of the Norwegian fisheries. The program defined governance, institutional change, and technological development as the three pillars for modernization. Consequently, the outcome of this program was a fisheries governance system where the state took considerable responsibility for economic development in the fisheries. This governance system was built upon laws and the establishment of mandated institutions that had executive responsibility, inside a corporative system where the Norwegian fishermen's association (NFA), in accordance with the proposal from the majority in FPC, played an important role (Hersoug 2005; Holm 1995). This was not unique for Norway; also in NL, involvement from the state and the state planners' vision of development as a product of capitalism, technological development and rational state planning contributed to changing the NL fisheries in the same direction. The point was to 'modernize' the fisheries (Wright 2001).

However, the growth of the governance system and institutional reorganization were only two pillars of the modernization program. The third pillar was technological development. From at least the 1960s, industrial fishing technology became so effective that fish and fishing people became endangered around the world. Thus, parallel to the growth of an increasingly strong fisheries Leviathan for management and governance of the fisheries, the fish capture capacity continued to expand, inducing needs for new and improved management instruments and the organization of different scales of management into a comprehensive governance system working at many levels and through many different relations. With this increasing complexity the Leviathan became entangled in a web of different instruments, stakeholder groups, policies and sciences that made panoptic control and management impossible. Furthermore, rationality, truth and decision making in the system became objects for negotiation between scientists, users, politi-

cians and bureaucrats, and consequently the rational foundation of management became challenged (Finlayson 1994; Sinclair *et al.* this issue). The modernization program had started a never ending process of intensifying management operation. To be able to act and to keep rationality as a foundation, management had to be organised in a way that delegated responsibilities and divided politics and science. One of these mechanisms, *the TAC-machine*, played a prominent role.

Transforming Fish – The TAC-machine

Modern fisheries science, which originated during the industrial revolution, developed as a technology for industrial development and expansion, not for the preservation of wild fish or the way of life associated with hunting them for a living. The 1870s was a decade of large expeditions and explorations of the seas, followed by a period of close to 100 years in which fisheries biology and economics functioned as hand maidens for finding pockets of unexploited fishery resources. In this period, fisheries research was essentially an expensive apparatus for the expansion of profitable harvesting operations in the world's fisheries (Rozwadowski 2002; IMR 2004; Holm and Nielsen 2007).

Although fish finding was important, it was not enough to found and institutionalise modern fisheries science by itself. Through oceanographic expeditions, experimental fishing, and the orderly collection of catch information from fishers and other sources, marine researchers from many countries have amassed a tremendous amount of empirical data about the seas, materials that can be used for calculating, measuring and modelling economically profitable marine life. Almost a century after the first scientific experiments into the realm of fisheries, there was finally a breakthrough with the invention of a simple, but effective, stock assessment technology. The period from 1965 to 1975 represents the breakthrough of Virtual Population Analysis (VPA) assessment methodology in fisheries science and the emergence of Total Allowable Catch (TAC) as an important management instrument. Now, finally, a division of labour between scientists and managers could be established (Holm and Nielsen 2007; Nielsen and Holm 2008).

As an ideal type, modern resource management represented by the TAC-machine can be described as a sub-set of control strategies within the more generic category of *governance* by which objects, processes, people or practices are handled indirectly through a system of representation (Holm 1996; Nielsen and Holm 2008). Management is thus based on the development and deployment of a symbolic and formal system of power and knowledge (the management system) that corresponds to and controls, but also greatly simplifies a system of practices (the system to be managed). A fundamental precondition for management to succeed is that the system of representation, through some technology of intervention, is linked to a system of practices so that it becomes possible to translate, communicate, and intervene across these two realms (Holm 2001; Nielsen and Holm 2008). On this hinges not only how closely the symbolic system will correspond to the system of practices, but also the effectiveness with which decisions within the former can be transported to the latter.

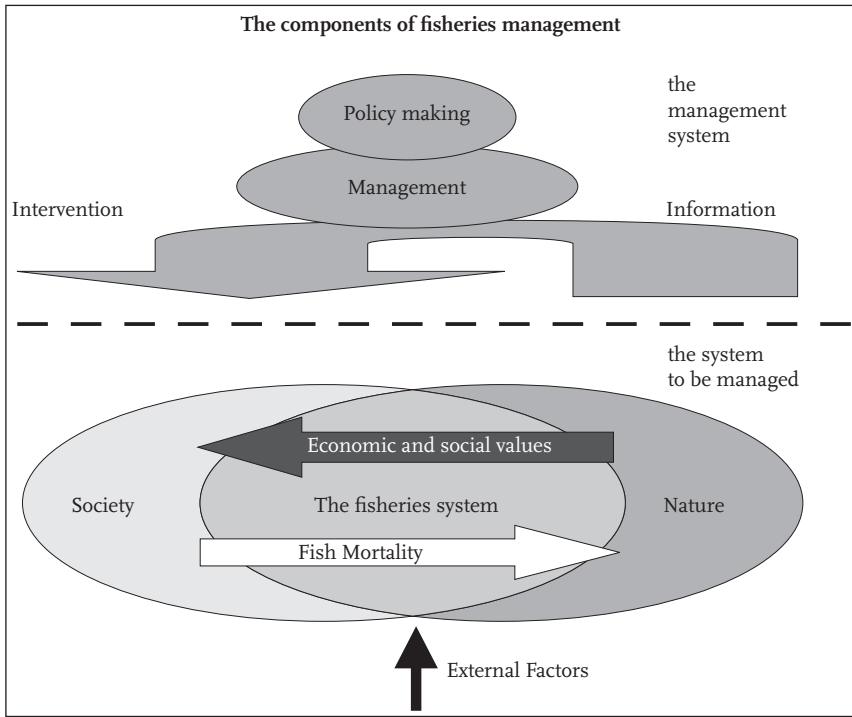


Figure 1. Fisheries resource management understood as a historical cybernetic control mechanism based on a system of scientific representation and a system of instrumental intervention. Based on Nielsen, K.N. and P. Holm. 2007. "A brief catalogue of failures: Framing evaluation and learning in fisheries resource management." *Marine Policy* 31:669-680.

The establishment of the 'TAC machine' (Holm and Nielsen 2007; Nielsen and Holm 2008), together with the new oceans regime that was negotiated through the 1970s, represents two major preconditions for cyborgization of the fisheries through the development of cybernetic subsystems that require a wide range of novel scientific representations, definitions, and measurements of fish, fishing and the fisherman (Holm 2003; Johnsen 2004; 2005; Nielsen and Holm 2008). Thus, today, fisheries science – a blend of fisheries biology, oceanography and computer modelling tools – is a main ingredient in the (attempted) production of sustainable fisheries resource management. In addition to finding fish, describing and modelling the seas have become important tasks for fisheries scientists. Through this process fisheries science was institutionalised within a centre of calculation, closely linked both to political institutions and to fisheries as a profit-seeking trade, but with its own bounded responsibility, namely to set TACs. The TAC-machine and the management system turn both fish and fishers into entities that can be calculated by using different methods, metered out in a variety of units, applied for the regulation of a wide range of processes at different stages with the systems elements and relations. Through the TAC-machine, the wild un-

manageable fleshy fish of nature can be translated into a domesticated manageable object (see Bavington this issue). In this process the fish, as well as the fishers, are continuously redefined and are attributed new properties. Neither the fish and the fishers, nor the management system is created once and for all. It becomes obvious that the TAC-machine does not become the final solution and that it has to be supported by other mechanisms. In Norway, the TAC-machine is supported by long-term keys for allocation of the annual quotas, to avoid the annual struggle about quotas. The allocation keys are negotiated between the fishers in the Norwegian Fishermen's Association and approved by the ministry. The TAC-machine makes fish counting possible and an allocation machine takes care of the distribution. Both the TAC-machine itself and the mechanisms and systems around it are the fountain of a wide range of controversies and disputes that occur in fisheries science, management and fishing practices. Because of the involvement from users the boundary between management system and the system-to-be-managed is blurred. All the mechanisms contribute to increased complexity through continuous transformations of the relational set up in the fisheries to which we will now turn (also see Bavington, Johnsen *et al.* and Sinclair *et al.* in this issue).

Catching Fish – From Affective Human Relations to Cybernetic Capture Systems

Once upon a time there were fish, vessels, and men like those we see in Figure 2. In the 1920s, when this photo was taken, human shoulders and arms were still a main source of energy in Norwegian and NL fisheries (see Illich, 1973). Although there were a few larger steam ships in the herring fisheries, small fishing vessels



Figure 2. Fishers, vessel, and fish in the 1920s

built and owned by fishers dominated. The fishers in the photo are representative in this respect. Like many other fishing vessels, this vessel was owned by a family partnership, which was also the dominant form of organization in NL (Wright 2001; Johnsen *et al.* this issue). The crew members who were not partners, like the author's grandfather (number three from the left in Figure 2) were neighbours and more distant relatives, all living in the same community.

The organization and social arrangements in the fisheries are well documented in historical and ethnographical literature from Norway and NL (Anderson and Wadel 1972; Sinclair 1988; Jentoft 1991; Neis 1999; Sinclair, Squires *et al.* 1999; Wright 2001; Sinclair 2002; Christensen and Hallenstvedt 2005). The picture represents fisheries dominated by affective relations. Together, they hunted and killed fish from a commons. While the social relationships in the commons might have been complex, the relations to the fish were simple and direct. The fishers, as members of hungry households and cash strapped communities, were after fish that could be both eaten by their families and exchanged for money. The vessel was a transportation device and a floating platform for gear handling. The basic relationship between fish and fisherman was mediated by the baited hook and line. If the baited hook slipped out of the cod's mouth or the line broke, the kids would go hungry to bed. Men fished and fathers taught their sons out on the water with baited hook and line hand gear. The hook and line produced the fisher as a hunter and killer of fish, but also as an active head of the household and community member.

During the 1930s, the relationship between fish and fishers started to become more complex, both in technological and institutional terms. With the introduction of trawlers, a continuous all-year industrial capitalist off-shore fishery was



Figure 3. Low tech Norwegian fishing vessels from the 1980s (Photo: J.P. Johnsen)

added to traditional seasonal fisher-owned coastal fisheries. From a troubled start – the trawlers were intensely loathed by the small-scale fishers – an off-shore fleet became powerful over the next sixty years (Holm 1995; Wright 2001). Nevertheless, within the open commons, for example in Norway, the conventional fisher-owned fleet was not dramatically influenced by this addition. Both in Norway and NL, even as late as the 1980s, the coastal fisheries, while considerably smaller than those of the 1920s in number of persons and vessels, had maintained some of the geographical distribution, employment system and ownership structure. Even if the vessels had become much more technologically sophisticated than their predecessors, with more powerful engines, hydraulic equipment, echo sounders, radars, autopilots, and so on, they continued to be striking similar to fisheries in the past. Most coastal vessels were still made of wood (Figure 3) and continued to exploit the coastal commons. The employment system was basically the same with most of the crew members recruited locally, through family or personal relations. The relations were still mainly affective. To handle 150 to 200 gill nets one still needed the energy of an able bodied four five man crew (See Johnsen *et al.* this issue).⁶

By 2000, this had all changed. By the new millennium, a typical coastal fishing vessel in Norway was between thirty and forty-five feet long and often made out of fibreglass or steel with the wheelhouse in the front. The vessels have become very technologically sophisticated. Usually, no more than three people are working aboard, aided by hydraulic haulers and mechanical helpers that rely



Figure 4. Onboard a modern Norwegian small-scale fish capture machine with fish, people gear and all its devices. The skipper is steering with his right hand, and is controlling the hydraulic hauler with his left hand, while the net clearing device is hanging at the stern. (Photo: J.P. Johnsen)

on petrochemical energy to operate. For navigation radar, GPS, digital chart machines, and an autopilot are used. The electronic equipment is integrated with the physical boat and by a click on the mouse in the wheelhouse the vessel can be steered to a geo-spatial position that the skipper has saved on his computer mapping software. All equipment on the boat (except sometimes the radar) can be switched on from one main switch in the wheelhouse. It is only the danger of collision with other cybernetic vessels that makes it necessary to be on physical watch. With quick training almost everybody is now able to navigate like a professional. While some experience is still useful for finding fish, contemporary echo sounders have made even this part of the process easier and deskilled. However, the deck machinery is more specialised than on the early 1980 boats and the fishing gear has changed dramatically. Both hauling and clearing are now mechanised, and the gear is adapted to allow mechanised handling. Different types of hydraulic gillnet haulers have replaced men's hands and arms for baiting and hauling and clearing gear (figure 4).

Like other forms of industrial production, fishing operations have become networked and are now deeply embedded in the service programme and knowledge infrastructure provided by gear manufacturers, shipyards, and other professional and commodified systems. Many of the skills that were required in the 1980s have been replaced by other types of activities and knowledge. While a great deal of the activities that used to constitute the work of the fishers has now been integrated into bureaucratic programs and technological systems, the focus of the fishing operators' responsibilities has shifted toward that of running a business, controlling finances and investments, and understanding fishing legislation. Henry, a fish harvester, in his early thirties, commented on the changes in his work situation like this: 'You have to be a lawyer when you are at home'.⁷

The successful fisheries enterprises consist not only of the owners, the crew, the vessels, the fish and the quotas available to them. The fisheries enterprises are also woven into the network of regulations that define their relations to the fish, with other fishing states, the production, interpretation and application of science, and the development of gear and vessel technologies. In the current context, commercial fishing enterprises must be able to enter into transactions related to buying and selling fishing rights and quotas, undertake planning, obtain finance and credit, and evaluate, mitigate and when necessary cope and adapt to fishery-related risks.

Fewer people from traditional fishing communities have direct or indirect access to wild fish for both personal consumption and sale (Hersoug 2005; Johnsen 2005; Holm and Nielsen 2007). In 1960 there were about 60,000 full-time fishers in Norway, most of them working on smaller coastal vessels. In 2004, of about 12,000 full time fish harvesters, about 9,200 worked year round operating vessels that produced between eighty and one hundred percent of the catch and total value of Norwegian fisheries. Fifty-eight percent of these fishers worked on approximately 250 vessels over twenty-eight meters long, while the remaining forty-six percent worked on 1,800 vessels under twenty-eight meters that operated full-time.⁸ The increasing complexity in Norwegian fisheries management has led to increasing delegation of management from the management system to

the system-to-be-managed. Also rights and responsibilities for management and governance have been transferred from the public to the private sector, although public 'ownership' of the fish is still stated to be the main principle (White Paper (St.meld.) number 19 (2004-2005)). Fishing crews no longer have any legal rights to fish in the sea; fishing families and communities now depend more on representatives of the commercial harvesting fleet to access fish to eat and exchange in the global seafood market.

Nature, represented by the fish, is now partially woven into the fishing enterprises. Based on vessel length and other criteria, the resource management model gives legitimate professionalized fish harvesters a certain biomass of fish or other marine resources to make decisions about and 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 not only a fish killing machine, but also represents an option on a certain amount of fish, which to a great extent must be killed and taken from the ocean, as quickly as possible, to remain profitable and out on the water fishing. It is as Johnsen *et al.* (this issue) describe, a *cybernetic organization*, a fishing *cyborg*. If allocated fish are not found, killed and harvested, both managerial intervention mechanisms and the right to fish can be lost. 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 Norwegian fishing industry have, at least temporarily, come closer to reality. However, as pointed out by Standal and Aarset (2002), the policy has also favoured lengthening fishing vessels, making it a promoter of technological modernisation and a driver of expanded capture capacity, despite the political goal to reduce such capacity. This process is reflected in the economic surveys done by Budsjettnemda and the Norwegian Fisheries Directorate 1989-2007⁹, which show that the long-term liabilities of the full-time operating fleet have increased since 1995. This reflects the increased technical standards and capital investments on the vessels (Johnsen 2005). In addition several companies have also bought quotas and fishing rights. Even if fewer people and fewer boats are directly involved in fishing, they have to achieve a higher catch value than in 1995 in order to pay for the increased costs of investment following the cyborgization.

This change is reflected in the fact that many commercial fishing vessels today, even small ones, are organised as corporations and no longer as partnerships in Norway, Canada and around the world (Anon 2002; Johnsen 2005; Johnsen and Vik 2008). Thus, the forms of organisation, institutional frameworks, rules for taxes and yield, and the financial situation of the global fishing fleet are much closer to the patterns we find in land-based corporate agri-businesses. When rights and quotas become elements in economic transactions, they can also be regarded as equity in the fisheries. Through this process institutions financing vessels gain more control over fishing activities and become intimate parts of the cybernetic fishing systems. Capital seeks investment opportunities, but with a smaller number of vessels and individuals with access to fisheries resources, positions from which to invest are becoming scarcer in global fisheries. When fewer fish, quotas, and people are involved, and larger amounts of capital are required to access marine resources, the result is sky-rocketing price increases for enter-

ing into relationships. If the scarcity of fish and quotas increases the price of fish, quotas, and the related costs of fishing, and if more intensive resource exploitation becomes necessary to meet the increased costs and rents due on invested capital, then the ecological benefits of removing fishing people while attempting to manage fishing gear quickly disappear.

Fisheries policies and the cybernetic organisation of the fisheries give priority to economic exchange over eating fish caught in adjacent waters and thus contribute to directing the action of the fishing cyborgs. 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 for profitable exchange in global markets. Fish to eat and other informal payoffs are reduced as a result because the professionalized fishing system formalises as many practices and relationships as possible, subduing them to the interest of exchange. The fishing cyborgs must therefore act as economically rational actors, with huge consequences for the fisheries and the management.

It is obvious that the fishing enterprise today is not only a boat, the crew members and the affective relations between the crew, but a mix of many professional systems that all aim to contribute to optimal efficiency in all subsystems of the operations for which they are responsible. One result of these changes is the reduced need for manpower. A steering position at the starboard reeling, behind the hauling equipment, is now a standard feature on all vessels under 50 foot, so that the skipper can control both the vessel and the fish hauling machinery from one position (figure 6). Mechanisation has made it possible for three men to tend the same number of gillnets on a forty-two foot fishing vessel as six men once strained



Figure 5. Fish capture machines from Newfoundland (Photo: Peter R. Sinclair)

to handle in the same period of time on a former sixty-four footer.¹⁰ Many skippers prefer to use as few crew members as possible, not only to have fewer hands to share in any profit, but because they want to lessen their responsibilities for other peoples' lives and income. It is not unusual for two vessels to 'buddy up' and operate together. Sometimes two skippers also team up and work as crewmembers for each other. Through this 'skipper fishery' labour costs are reduced and specialised moves toward more efficient labour utilization are possible (Johnsen 2005).

This replacement of people by mechanical and institutional systems has changed all relations in Norwegian and other industrialized fisheries. Industrial mechanisation has led to a reduction in affective relations in the world's fisheries. We can see similar, but not necessarily equal changes in fisheries in other parts of the world, for example in NL. Industrial for-profit fisheries are now nested within larger national and transnational fish harvesting systems based on the same ideologies as the production and manufacturing of other industrial products and their supporting scientific rationalities. Through involvement in the capitalist treadmill of assembly line production and the ideology of industrialisation, the designers and producers of vessels' and their equipment become more prominent in the relations that constitute fishing organizations. Contemporary fishing vessels are not mainly used for transport or accommodation; they exist now as one systemic node in a globally integrated technological and symbolic fish harvesting and production system. Before, one vessel could easily be replaced by another and gear could be interchanged among vessels. Today, however, gear and vessels are constructed together. Even the highly efficient fish factory trawlers operating in the North Atlantic in the 1970s were not as tightly integrated and organised as today's trawlers. Nor were they integrated into an overall fish killing system, as is evident in fishing vessels we see today (Warner 1983; Standal 2005).

The development of traditional inshore and coastal fishing practices into a situation where fishers undertake more and more standardised operations and systems with machines makes it reasonable to talk today about the gear, vessel and the crew as an integrated cybernetic system. As a matter of fact, fishing vessels have been transformed into highly effective *capture machines*, that have redefined the relationship between humans creating a new kind of fishing actor that is, part human, part systemic machine (Johnsen *et al.* 2005; See also Johnsen *et al.* in this issue).

The Cyborgization of the Fisherman

The existing Norwegian regulations give the seaman's doctor the right to evaluate if a sailor with a Body Mass Index (BMI) between thirty and thirty-five is for reasons of health unable to sail (Norwegian Minister of Health, Ansgar Gabrielsen 19.06.2002).

As one would expect with any professionalized technologically advanced operation, not every person can participate in commercial fishing. Physical and mental compatibility with techno-scientific fishing systems is now required to legitimately en-

ter a modern managed fishery. Consequently, health, age, and physical disability can now be used to keep men and women off the water and to deny access to fish. Since contemporary fishers are not above, or outside, techno-scientific systems, as masters or possessors of fishing tools, they must be seen as an integrated part of the fishing machinery. To be an individual fishing operator today one must adapt to the machinery and systems that constitute contemporary commercial fishing networks (Johnsen 2004; Johnsen 2005). The dimensions of gear, the work speed expected, and the precision required in operations are of such a character that human energy, labour power, knowledge and ability alone are insufficient for the necessary and desired performance of fish production, distribution and consumption systems. Expected performance is regulated and prescribed in documents and informal procedures, through regulations, laws, norms, values, expectations, and interest rates. In today's commercial fisheries, fishermen and women cannot replace machinery and systems, but machinery and systems can replace people, because machinery and systems are adapted more easily than people to the demanding requirements of natural and regional regulations and universal codes of conduct for responsible fishing (Johnsen 2004; 2005). As described by Johnsen *et al.* in this issue, people's performances in fishing are shaped, regulated, programmed, and governed by the demands and needs of the commercial production system, which often means the harvest machinery and a dense network of social and institutional relationships. As the quotation from the Minister of Health above states, fishermen and women's bodies must now meet certain requirements that make them capable to interface effectively with the fishery systems they are now imagined to be embedded within. 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.

John¹¹, a fish master, started his career in the herring fishery with only his hands, a line and a lead for sounding depth. He fished from an open skiff and had to rely upon his practical experience and senses to catch fish. Interviewed in 1997 when he was sixty years old and still active, he stated that during his last years he simply touched a few buttons on the sonar system in the comfortable bridge of his modern purse seining vessel. He described his current fish practice as being dominated by abstract technology rather than the personal feelings associated with his experienced sense of the touch, sound, taste and smells of fishing.¹² Technology now helps to shape fishing performance, placing requirements on the operators, the technological and institutional networks that produce them as operators, and the huge variety of ideas, values, goals, and interests that are materially expressed through contemporary techno-scientific fishing systems.

Standardisation has reduced the need and opportunity for variation in practical fishing work as the fishing machines require standardized operational procedures that are in many cases much easier to teach and learn than the old embedded fishing practices. Subsequently, the former practices and the knowledge linked to them vanish. Whereas in the past we could talk about human fishers with individual fishing knowledge, more and more of the knowledge is now embedded in machinery, organizations, and systems rather than in the individual fisher. Fisheries knowledge has been transformed into institutionally useful in-

formation and fishing relations have changed from primarily affective to cybernetic systemic interactions and feedbacks where managerial forms of knowledge and intervention rule over other ways of living.

Through this process, fishing people increasingly interact with automats, robots, institutions, and governance systems as Johnsen *et al.* describe in this issue. The fisher, who once was a hunter free to bait hooks, throw them into a common ocean and haul in a fish to eat or exchange for money, has been transformed into an element in a cybernetic fishing system. The professionalized fish harvester is almost like a '*robo fisher*'. Harry, a fifty-six year old Norwegian skipper describes his transformation into a robo fisher by observing that now, 'I've got a computer head'. Even if Harry's head does not quite look like the head of the real *Robo Cop* on the beat in Detroit, Michigan, he nonetheless succinctly expresses the fact that contemporary commercial fish harvesters no longer rely on the embodied energy contained in their bodies or the fleshy nature of codfish hungry enough to go for bait. Fishers' identities and practices are now thoroughly shaped and implemented through a variety of increasingly senseless and abstract biophysical systems and techno scientific techno-scientific networks. Within these systems and networks fishermen and women are reduced to elements in socio-ecological systems amenable to training and husbandry to maintain a profitable win-win balance between ecology and the industrial economy that brutally makes extinct and slaughters over twenty-five species a day in 'a death wish beyond measure' (Arney 2007). Throughout this process human and natural resources are represented as available for capital to put to use and exploit in ever more efficient ways through the tools of fisheries (capture and culture) science, technology and management.

But the robo fisher is also linked to a similar type of process at the macro level, which moves the fisheries as a system toward a state of representation, regulation, and intervention at all levels as Figure 1 depicts, but also where the distinction between the management system and the-system-to-be-managed disappears. Instead management is reorganised and a new division of labour develops. The practical execution becomes integrated in the practices, while the management system is more concerned with system design, control and monitoring in a close interaction with the users. The fisheries organizations become cyborgs as Johnsen *et al.* describe. While the term *cyborg*, in technical cybernetics means *cybernetic organism* and signifies an extreme interface between human and machine, we use the term cyborg for *cybernetic organisation*, which also allows us to include less extreme interfaces and to focus on the symbolic programming and the evolution of techno-scientific systems that takes place in today's fisheries (see Haraway 1997; Mirowski 2002). Even if this process of cyborgization at the micro level is more radical in Norwegian coastal fisheries than, for example, in Canada, it is also possible to identify a movement towards cybernetic organisation in NL and other commercial coastal fisheries worldwide (Murray, *et al.* 2006; See also Johnsen *et al.* in this issue).

Although increasing amounts of 'fishing knowledge' are built into and integrated with techno-scientific systems, this does not mean that anybody can occupy the human operator positions in the cybernetic fishing system and network. As mentioned previously, only certified people can operate and become success-

fully integrated as robo fishers. Even if the selection process for harvesters is not as extreme as when fighter pilots are selected, the move from rejection by the fishing community or self-selection into the fishing commons to today's discrimination is based on some shared striking similarities. Cybernetic fish harvesting requires specialists to take care of and operate the different bits, bytes, pieces, elements and relations that constitute contemporary fishing systems rather than the general all round set of knowledge and skills traditionally associated with the fishers. Furthermore, neither the development of advanced fish killing machines, nor the further evolution and integration of the robo fisher restricts opportunities for further development of contemporary commercial fisheries. Even if technology contributes to a restricted sense of what fishing practice can become, the restructuring of technological development has also opened up expansive new opportunities for a few. The question on everyone's lips today, however, is: 'With industrial fish capture machines and robo fishers ruling the world's oceans, can wild fish remain unchanged?'. The answer is obvious and it is 'No!'.

The Variable Ontology of the Actors in the Fisheries

As long as the ideology of the Norwegian government, the industry and the 'official' scientific framework for analysis give a prominent position to 'economic rationality' and financial 'mechanisms,' there will be a constant drive towards greater capitalisation in the fisheries (Standal and Aarset 2002; Standal 2003; Johnsen 2005; Standal 2005). The combination of profitability, management, and governance requirements has caused the vacuum created by those people and vessels that have left, and this vacuum has been rapidly filled by cyborgs and enhanced technological capture capacity. The reason why this is so is actually simple to understand. The ontological starting point for ideology formulation and the building up of fisheries management and governance institutions has been the individual, human rational actor and fish understood as members of a single species population. By regarding fishing people as individuated harvesters in need of social control and fishing as the removal of surplus production or biomass from single species fish populations, the agency of fish and fishing people as social, relational living beings is completely overlooked. With fisheries policy focussed on individual action and technocratic solutions, the contribution of policy, science, economics, and technology to the creation of cybernetic fish killing systems has remained invisible.

As in other North Atlantic states, pressures to modernise and increase profitability, technological and economic efficiency have become increasingly important in Norwegian fisheries policy. The difference between the effective technologies of the fifties, for example the factory freezer trawlers, and today is that in the 1950s these fish killers were beyond regulation and control (Johnsen 2005; Murray, Neis *et al.* 2006). (See Johnsen *et al.* and Sinclair *et al.* in this issue.) Today they represent important mechanisms in the cybernetic organisation of the fisheries Leviathan and as such their power has been increased, not diminished as originally planned.

The cyborgization processes define not only the relations between the fish and the individual fisherman, but also the appropriate actions that are required to be defined as a legitimate fisherman (see Bavington; Nordstrand and Holm; Johnsen *et al.* and Sinclair *et al.* in this issue). Even if the owners and skippers are still able to make choices and decisions, the integrated cyborg systems of which they are a part constrain the menu of choices, opportunities for decision making, and legitimized ontologies limit options available to fishing people. Seen from this perspective, the killing machine, the robo fisher, and the cyborg fish are all products of policy, science, technological development, markets, human relations, personal interests, skills and abilities that operate systematically in concert.

The current state of the world's oceans and fishing communities is partly the result of more than fifty years of fisheries management policies in the North Atlantic – policies created with the ambition to manage fisheries resources in a rational and profitable way. Through mechanisms and technology for fish counting, technological modernizing, concentration, and capital investment on behalf of employment and decentralisation, the actors in the fisheries have been transformed from unmanageable subjects into domesticated elements in a cybernetic fisheries management regime with economic rationality used as the main criterion to judge success. The result is that fish mortality is higher now than ever recorded and capture capacity is greater than the available fish in the sea. Furthermore, the long term liabilities of fish harvesters have continued to increase – which implies that fish mortality must also continue to grow and produce expected revenues to service capital investments in the fishing industry. Paradoxically, contemporary fish capture machines, robo fishers, and the system of which they are part are now so complex that the evaluation criteria do not do justice to the system.

The Future of the Fishing Cyborgs

Despite successes in turning resource management into the central policy issue within global commercial fisheries, and despite the incredible effectiveness of modernising global fisheries into a much more profitable, safe and secure business, the fisheries cyborgs are not stable entities. Fisheries management is, if not in crisis, at least continuously disputed. One of the reasons for this is that the central goal of fisheries management – to reduce harvesting capacity and rebuild fish stocks up to MSY levels – has not been fulfilled in many places. In fact, management and governance systems seem to have contributed what they were ostensibly designed to prevent – stock collapses and increased harvesting capacity (Standal and Aarset 2002; Standal 2003; Johnsen 2005; Standal 2005; Bavington this issue; Johnsen *et al.* this issue). This is an awfully strange and destructive paradox. The cybernetic harvesting systems seem impossible to effectively control or manage. The efficiency, power, and demand for fish in the managerial cyborg fishing system are so huge that industrial capture machines have not only laid waste to fish and fishers, but are now 'killing' each other through processes of consolidation, restructuring, and reshaping the relations and elements that constitute the systems' integrity. A pivotal question is whether the remains of the fishing Leviathan

itself, the pieces of centralized government, will survive these attacks or if we will end up with fully privatised fisheries where capture machines, perhaps even more automated and robotised than today, perform desperate acts of cannibalism to put the many cyborgs it conjured into existence under effective control. Or maybe there is still hope?

We do not know how this managerial cyborg story will end, but as described we see a movement towards delegation of management practices and toward self-control. The management system becomes more closely integrated into the capture system. Perhaps the contextualists' ideas about co-management and participation are closer to reality than the Leviathan? But this co-management may take place through cybernetic relationships in professional systems or networks more than through affective relations in fishing communities. Thus, the model in Figure 1 is probably illustrating the past. The two subsystems seem to have closer and closer interaction, and processes that before took place outside the capture system are today integrated into it. As mentioned above, neither management nor the cyborgs remains unchanged when controversies erupt between different groups of scientists, stakeholders and public interest groups out in the ocean and along the coast. A consequence of the many challenges and disputes in fisheries is the struggle to establish continuously new relations in desperate attempts to cope with rapidly rising challenges. Today, there are movements towards the inclusion of local fishers' knowledge, more open and participatory scientific methods, increased user participation in decision making, expansion of market over state-based management, claims for traditional rights and rights for new groups. The results are still uncertain. Profitability, precautionarity, ecosystem approaches, the emergence of industrial carnivorous aquaculture and many other issues are relevant to how fisheries resource management will develop in the future and if it will be able to continue to exist as a politically and morally viable option for humankind. All attempts to stabilize the cyborgs and the fisheries management system make cybernetic fisheries management systems even more heterogeneous and make the actors' ontology more uncertain and variable. With all these dynamics in mind, opening up the black boxes of the cybernetic fisheries management to make visible some of the relations, actors, practices, symbols, rhetoric, changes, and the translations that hold this heterogeneous network together will be the necessary first steps to begin to understand how fisheries management actually functions and what it brings to the marine world.

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Notes

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- 1 Participant observation by Jahn Petter Johnsen on a fishing boat taking part in the Lofoten arctic cod fishery in March 2007.
- 2 Speech given by former Norwegian Minister of Fisheries, Svein Ludvigsen, in 2005. *Ressurs, regulering og forvaltning*. Foredrag på årsmøte i Troms Fiskarfylking, Tromsø, 17. juni 2005
- 3 The project 'The Coming of the Cyborg Fish' funded by the Norwegian Research Council.
- 4 Observations and interviews on board a fishing vessel in the Lofoten cod fishery in 2007, for instance, gave the impression that the skipper and the crew actively controlled themselves, an impression that is confirmed by the Chief Public Prosecutor for fisheries crime in Norway (Fause 2007). Their internal control was related to fishing areas, quota, quality, and behaviour in relation to the other vessels on the grounds. The fishers not only passively comply with a set of rules, but perform them actively, by for example organizing the fishing and arranging the vessel in a way that makes control easier. One example is to reduce or increase the amount of gear when the sounder records large amounts of fish, to be able to get more stable catches from day to day and to secure quality. Moreover the fishers are obliged to record their catch in a log book. To get as accurate an estimate as possible, they can both measure the amount of fish that the bleeding bin takes and arrange the hold with boxes so the amount of fish can be easily and accurately estimated.
- 5 In Norway for example, the institutional setup gives considerable power to the Norwegian Fishermen's Organization (NFA), which has taken the responsibility to negotiate long-term quota allocation agreements between vessel groups. NFA's recommendations are followed more or less automatically by the Ministry of Fisheries. With a decreasing number of fishers and vessels fishing with permits and licences on limited quotas, requirements of feedback of scientifically coded information to the management system becomes more structured, and in some sense, easier. NFA also has influence over the technical regulation of the fisheries. By delegating and distributing this responsibility to a stakeholder organization, compliance becomes a smaller problem, and a link is created between individual interest and decision making on board the individual vessel and decision making at a central level. Since NFA started to take this responsibility in the early 1990s, the organization has become a part of the management system, and not in opposition to it. In this way the fishers' interests are built directly into the management system, and the interaction between the individual vessel and the management system become closer.
- 6 In the description here we draw on, amongst others, Johnsen's (2004; 2005) studies of change in Norwegian fisheries. The data sources are qualitative interviews, observations, material from fishery technology producers, technical journals, and documentaries.
- 7 The practices onboard a modern Norwegian gill net vessel are documented on the video 'Fishing Cod' by Jahn Petter Johnsen (2007). The video consists of clips shot under fieldwork onboard a cod fishing vessel in Lofoten in March 2007.
- 8 Figures from the Directorate of Fisheries in Norway (2004) and Norway Statistics (1961)
- 9 Budsjettnemda, the Budget Committee was until 2004 evaluating the economic situation in the Norwegian fishing fleet. Reports from 1989-2004 are used. After 2004 the Fisheries Directorate have made reports about the economic conditions in the Norwegian fishing fleet. See: http://www.fiskeridir.no/fiskeridir/fiske_og_fangst/statistikk/loennsomhetsundersoekelse_for_fiskeflaaten
- 10 The changes in the cod fisheries are described in Johnsen (2005). The description is updated with information based on observations, video recordings, and interviews from a cod fishing vessel in March 2007.
- 11 The three fishers John, Harry, and Henry were interviewed in the late 1990s: See Johnsen 2004. Their stories are not unique, material collected through observation and interviews by Johnsen 2001, see also Standal (2003, 2004) that indicate that the process of cyborgization is still going on.
- 12 The situation is probably even more radical today. In episode 2 of The Norwegian Television program 'Der fartøy flyte kan' <http://www.nrk.no/nett-tv/klipp/246653/> we can follow the skipper and the crew onboard Norway's most advanced purse seiner in

their hunt for mackerel. We can also see one of Norway's few female fishers fishing cod onboard her small, but technologically sophisticated coastal vessel, and follow the crew on Norway's oldest fishing vessel during the still labour intensive sprat fishery in a Norwegian fiord. See also Discovery Channel's famous reality show: 'The Deadliest Catch' from the Alaska Crab fishery. These television programs illustrate that modern fishing is technology intensive and dependent. We also get an impression of how the skippers and the crew adapt to management. Onboard on the Norwegian purse seiner, the skipper waits with the deployment of the gear until the sonar picture has such a character that he feels confident that the school of mackerel is big enough to fill the rest of the quota.

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