



Illegal fishing: A challenge to fisheries management in Norway

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ABSTRACT

The management of the Norwegian Northeast Atlantic cod fishery has in many ways been a success story; quotas have been high (but now declining), profitability has been higher than most other industries and there is great interest among young recruits to enter the fishery. However, over the last decade illegal fishing of allocated quotas and black-market transactions throughout the value chain have become a significant of the political debate in the fishery, especially in northern Norway. Fisheries crime has been described as a priority area for law enforcement. To combat illegal overfishing the introduction of new automatic catch monitoring technologies onboard fishing vessels is considered a key strategy by the Norwegian Directorate of Fisheries. However, the new quota control measures are met with considerable resistance by the fishermen. This paper outlines the key elements of modern fisheries management to address sustainability goals, how the institutional subsystems connect with each other, and how illegal overfishing may threaten the stability of the entire management system. The gravity of illegal overfishing supports the authorities' new strategies to increase catch- and quota control. Nevertheless, the implementation of new control technologies may not be straightforward. Especially small-scale fishermen have presented a number of valid arguments against the proposed control measures. Thus, this study outlines how the implementation process may gain increased support from the fishermen.

1. Introduction

In March 2023, all authorities involved in fisheries regulation enforcement performed a spectacular raid on a fish processing facility in Northern Norway. The raid involved the Directorate of Fisheries (DoF), the police, custom authorities, and tax authorities as well as the Coast Guard. Illegal fishing was again in the headlines. Last year, the director of the National Authority for Investigation and Prosecution of Economic and Environmental Crime (*Økokrim*) proclaimed that:

“Fishing crime is highlighted as one of the major threats to the welfare state, in that large values are channeled away from the community. *Økokrim* believes this happens through, among other things, systematic under- and misreporting of catches, social dumping and black sales” [1].

Rumors of illegal fishing have been quite common since the introduction of the 200-miles Exclusive Economic Zones (EEZs) in 1977. Since then, resource management in the form of annual TACs has become the most important management tool to secure sustainable fishery [2,3]. This was followed by a detailed allocation system and the

introduction of individual vessel quotas (IVQs) to secure a permanent adaptation of the fleet to the resources. Together, the three sub systems should provide for social, economic and biological sustainability [4,5].

Despite the construction of a comprehensive and solid management regime institutions, fisheries regulations are not self-enforcing (Nøstbakken, [6]. As many fisheries are subject to a significant rationalization of the fleet and the creation of resource rents, illegal over-harvesting of quotas may contribute to large profits [7]. According to Hilborn [7] and Diekert et al. [8], enforcing a management regime is thus, paradoxically, most important when the design of a new quota regime leads to large profits. This also applies to Norway, as the introduction of IVQs from 2004 to 2005 onwards have led to a substantial reduction in the numbers of vessels and a strong increase in the economic efficiency of the fleet [9,10]. In 2021, the operating margin of the coastal fleet was calculated to be 14%, while in the ocean-going fleet, the figure was 22%, as compared to an annual average operating margin of 5.2% in the Norwegian industry. This has implied that both owners and fishermen have generous salaries, way above the Norwegian average industries, while the processing industry is struggling with extremely low profitability [11]. This is because the legal framework

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regulating ex-vessel sales of fish favors fishermen at the expense of the land side of the industry.

The fishermen's support of the governance system is generally considered fundamental for sustainable fisheries. Nevertheless, to what extent the institutional design of the management functions well or poorly, may influence the fishermen's moral inclinations to follow the rules and support of the management system [12]. Fisheries management must be considered fair and legitimate among the fishermen, and needs to demonstrate its ability to monitor and enforce rules to secure equal treatment of all fishermen [4,13]. If not, compliance among actors, who normally perceive regulations as protective of their own fisheries, may suffer [14,15].

In Norway, illegal fishing has become a significant feature during the last decade, especially during the annual winter season fisheries of Northeast Arctic (NEA) cod (*Gadus morhua*) [16]. In 2013, almost 40% of fishermen participating in a questionnaire survey confirmed that "cheating" is accepted, while more than 60% of the respondents knew about other fishermen misreporting catch quotas [17]. In 2015, another survey showed that more than 40% of fishermen argue that high-grading and under-/misreporting of their actual catches could be justified "occasionally" [18]. This trend is also confirmed in a questionnaire survey conducted by SINTEF Ocean in 2021 [19]. Here, 28% of the fishermen from the northernmost regions participating in the coastal NEA cod fishery, confirmed *de facto* knowledge about other fishermen overfishing their allocated fish quotas.

Even though no specific amounts of fish over the allocated quotas captured are not revealed by the above-mentioned surveys, the strong persistence of the subject triggered the establishment of an expert panel appointed by the Norwegian Ministry of Trade, Industry and Fisheries in 2018. The mandate was to evaluate the current resource control, identify system weaknesses and suggest future solutions to combat illegal overfishing and strengthen resource control [16]. The report identified an outdated quota control regime and significant weaknesses in keeping track of ex-vessel transactions within a fragmented fleet structure and decentralized landing facilities, especially within the coastal NEA cod fisheries. The Norwegian fleet consists of 235 deep-sea vessels (larger than 28 m) and more than 4800 coastal vessels [20]. Most of the coastal vessels conduct day fisheries and approximately 240,000 ex-vessel transactions are carried out each year. As less than 1% of the transactions are physically controlled each year, the authorities' ability to carry out an effective quota control is very limited [16].

The report also described illegal overharvesting of fish quotas and black-market transactions as highly profitable, and with low risk of being caught. Combined with relatively low penalty levels, illegal fishing may be a tempting activity [16]. This is confirmed by the Norwegian Police Security Services (PST) annual report; the National Threat Assessment for 2022 [21]. Here, PST highlights overfishing and black-market transactions as a major societal problem, which undermines sustainable resource management and brings loss of tax income to the public purse. In addition, illegal overfishing creates an unjust competition among fishermen, which threatens the fishermen's collective support of the total management system [21].

The Directorate of Fisheries [22] have thus suggested a totally new strategy to combat illegal overfishing and black-market transactions. This strategy refers to the implementation of new sensor technologies based on machine vision onboard each fishing vessels for automatic catch and quota control. Each single fish caught shall be registered according to species and size, and hence contribute to a detailed catch and quota control regime where data is available to all relevant authorities involved.

As fish resources are held in public trust [23], the new control measures are defined as a "collective good" by the Directorate of Fisheries, necessary to achieve better law enforcement and resource management. However, among fishermen, the new strategy is regarded as a top-down decision by the authorities and is met by considerable resistance [24]. In this context fishermen perceive the new strategy as an

Orwellian "surveillance technologies", to control their daily work, and they also question the functionality of the new control technologies [25].

Intuitively, illegal overfishing may only threaten the actual resource management. However, as modern fisheries management are deeply rooted as nested systems to secure biological, social, and economic sustainability, we aim to demonstrate how illegal overharvesting fish quotas may also negatively impact the sustainability of the entire management system. While Sutinen and Kuperan [26] and Diekert et al. [8] focus on *why* fishermen cheat, we explain *how* illegal fishing is organised, including the fish processing industry. Furthermore, we describe the basic elements of the new control regime, and explain why fishermen resist to the introduction of a more efficient catch control system. Finally, we discuss why the introduction of new technical surveillance measures has been so different in Norway compared to other cases, using the Danish (pelagic) fisheries as example.

The next section briefly describes an institutional approach to fisheries management focusing on management systems as *nested systems*. Section 3 describes *how* illegal fishing is organised. Sections 4, 5 and 6 describe how illegal fishing affects the three nested sub-systems in the management system. Section 7 outlines the new control strategies recommended by the fisheries authorities. Section 8 deals with the reactions among the coastal fishermen, with reference to the important NEA cod fishery in the high north, while Section 9 outlines some recommendations to improve the legitimacy of the new control measures. Finally, Section 10 offers the conclusions.

The material presented in this article is based on both authors' work on the institutional aspects of Norwegian fisheries and their management, and in particular on Standal and Hersoug [5,27,28]. The material is based on interviews, fieldwork, official publications and not least on work performed by colleagues over the last 25 years. It analyzes the reactions to the new, proposed control regime through opinions presented in the fisheries newspaper *Fiskeribladet* over the last three years. In addition, we have carried out a survey that includes the answers from 300 fishermen participating in the most important fisheries in all of Norway's coastal regions. The survey specifically addresses their views on illegal fishing and opinions regarding the new control regime suggested by the authorities. [16,22].

2. An institutional approach to fisheries management

From a social science perspective, the management of natural resources takes place through institutions [29]. Changes in a management regime to cope with new sustainability attributes, e.g. increased quota control, take place through the establishment of new institutions or by adding new goals and tasks to existing institutions [30]. As new governance challenges are put on the agenda, institutions become the key arenas for operationalizing policy goals and organising the field of action. However, even though institutions shall stabilize the management system towards specific goals, they are not static units [31]. Institutions change over time and represent historical events in relation to future challenges [32,33]. The legitimacy of the fishery management system rests therefore on the ability to provide equal treatment to legitimate actors, catch up with real-time policy problems, demonstrate required institutional changes and the ability to meet relevant sustainability attributes. To understand the concept of "institution", Peters [34] includes the following features:

- Institutions must be a structural feature of society,
- institutions must exist over time,
- institutions must affect individual behavior,
- there are shared values and meanings among the members of an institution.

In our setting there are a variety of institutions involved in fisheries management, from the formal, such as the Directorate of Fisheries, to the

informal networks of cooperation between fishermen at sea. Institutions in fisheries management also include scientific organizations providing inputs for resource management (such as the International Council for the Exploration of the Seas (ICES) and the Institute of Marine Research (IMR)) and the fish sales organizations dealing with the ex-vessel (first-hand) sales of catch.

Traditionally, fisheries management institutions are defined as regulative management bodies, which impose rules, restrictions, and incentives to achieve policy goals. Institutions are also interpreted as rule-enforcing mechanisms [13]. Applied to fisheries management and the goal to strengthen the resource control, institutions set rules intended to move actors towards defined aims. Furthermore, rules act to organise actors with respect to a functioning institutional body. The relationships between rights and rules, and organizations as operational agencies, are highly recognized in fisheries management [35,36]. Thus, institutions also reflect rules for determining who and what are included in a decision-making process, which action is taken within the framework of the regime, and how individual actions will be transformed into collective decisions.

In an alternative perspective to the traditional regulative approach, management institutions are embedded in larger social structures. As a reference to this approach, Scott [37] points out that institutions function at different levels of jurisdiction in society. This definition is congruent with Ostrom's [2] idea of institutions as "nested systems", a perspective where institutions are linked to each other and form networks. Scott [37] argues that institutions should be regarded as open systems, in the sense that institutions affect and depend on each other. Hence, institutions do not exist or survive in a social vacuum. This perspective applies to fisheries, as the management system is constituted by several institutional subsystems, which are interlinked to address biological, social and economic sustainability [12,29].

Fishermen may also experience institutions as slow adapters to urgent problems, creating high transaction costs.¹ Holm [39] finds that fisheries institutions are slow changers, often with a built-in inertia maintaining outdated norms and values. Old institutions do not easily change, and necessary reforms may not be implemented. In this perspective, many institutions may be wary of radical changes, and will search for alternatives that only marginally deviate from their current modes of operation. Hence, if institutions do not cope with new sustainability challenges, management bodies may be perceived as outdated or as lagging behind the problems they are supposed to address.

The core elements of the general sustainability concept correspond to biological, social and economic sustainability [40]. Applied to the main principles of modern fisheries management, the concept refers to the annual production of science-based total allowable catch figures (TACs) to secure sustainable resource management, fixed resource allocation keys to address social sustainability, and the design of the quota system and structural policies that are essential for economic sustainability of fisheries.

After the introduction of TACs in Norway, the relative stability in the resource allocation first laid the basis for the introduction of the individual vessel quota system (IVQ) and later structural regulatory measures (ITQ's) to reduce the numbers of vessels, thereby strengthening the quota base for the remaining vessels. The importance of the allocation policy can be highlighted by its position between the TAC-regulations and the structural measures introduced to avoid capacity creep. Fig. 1 describes the position of the TAC-regulations, the resource allocation keys and the structural measurements, how they are connected and constitute a central part of the Norwegian fisheries management system:

While the three subsystems are different in functionality and dynamics, each part is closely connected to the others. Hence, disturbances in of one subsystem can therefore influence and cause imbalances in the

total system [5]. Since the early 1990 s, the annual TAC-regulation for commercial fish stocks and the system for sharing fish resources between different gear and vessel groups, have become stabilized by routine-based procedures within the management system [3,41].

However, despite the functionality of the total system, the management system is vulnerable to institutional stressors or external factors which may undermine its institutional stability. In this setting, illegal fishing may negatively impact each element of the three subsystems. In the next section we explain more precisely how overfishing (cheating) is organised needs to be explained more precisely.

3. How is illegal fishing organised?

In principle, there are four types of illegal fishing [42]. The first is high-grading. This means that small fish is either thrown overboard or into the grinder. Thus, fishermen delivered only the larger fish, which is better paid. The small fish discarded does not appear in the resource accounts or in the delivery reports. As pointed out above, the risk of being caught by an inspection at sea is small, although in seasonal fisheries like the Lofoten fishery, the number of boats in an area is so large that peer pressure normally will prevent high-grading on a large scale. For the offshore fleet the situation is different, large scale high grading can only be discovered by air inspection, by drones or satellite surveillance as vessels are operating in much larger geographical areas.

The second way of illegal fishing is referred to a "long hundred" (*størhundre*), which means that by landing of e.g. 12 tons of fish, only 10 tons are reported. The processor gets 2 tons extra while the fisher gets a higher price for the 10 tons delivered. Both parties earn an extra profit, and only the resource is negatively affected by the repercussions described above. Longhundred is an old trick, described already in the year 1600 [43]. In the old days, before the establishment of fish sales associations, this was a method practiced by *nessekonger* holding privileges to trade fish in local communities along the coast. However, also in the modern context, the practice occurs during the large seasonal fisheries where huge amounts of fish are landed in a short time and processors are overloaded by fish. One way for the buyer to limit the number of boats seeking to land their catch is then to demand extra fish, not accounted for by the landing reports. When quotas are low and the competition for raw material is strong, it may work the other way around: fishermen demanding a higher price in return for extra deliveries. If this requirement is not met, the fishermen will deliver to a competing processor.

The third method of illegal fishing is to land one species (for example NEA cod) but register the fish on the landing note as another, e.g., saithe, which is less in demand and where quota restrictions are more generous (*brunsei*). This implies that fisher and processor cooperate. In practice it means that the quota for the most valuable fish (normally NEA cod) then can be overfished, which in turn corrupts the resource accounting and the data that are the basis for quotas in the years to come.

The fourth method of illegal fishing is more complicated, dealing with conversion factors from gutted fish to whole round fish (which is the official currency). The standard conversion factor in the cod fisheries is 1.20 for gutted and 1.40 for gutted and headed (as per 2023). In a report from the Directorate of Fisheries [16] the actual conversion factors used during the 2015 season were "significantly higher" than the official ones (between 11.1% and 12.3%).² The conclusion is revealing:

"The weighted conversion factors for cod fished with coastal gear in the winter season, the resource extraction within this fleet segment

¹ For a review of the term transaction cost, see e.g., Williamson [38]

² The conversion factors for both products were highest in March with several measurements over 1.30 for the product gutted and over 1.70 for the product gutted and headed (round average). The high percentage of sloe in the cod, dominated by roe and milk, is probably the most important reason for that the conversion factors for the mentioned products are high in the winter season.

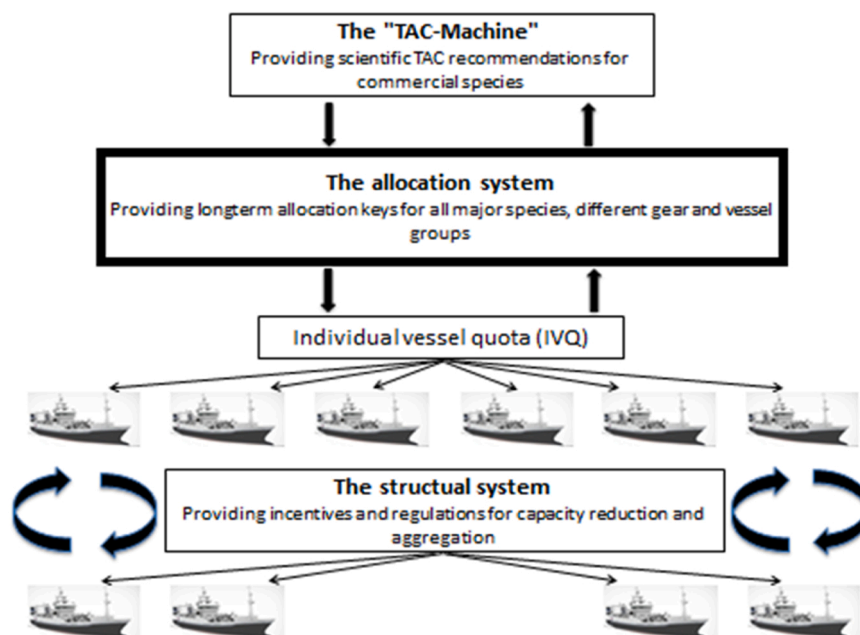


Fig. 1. The subsystems making up the fisheries management.

Source: Standal and Hersoug [5].

would have been in the order of 20,000 tons higher per year than what appears in the official the fisheries statistics for the years 2012–2014". [42]

Using the least generous conversion factor implies a larger catch than actually registered, which corrupts both the landing reports and the resource accounting system underpinning the scientific basis for the setting of TACs.

There is at present no scientific evidence on the relative importance of the four methods of illegal fishing described above. Frequent media reports over the last decade indicate that the use of "long hundred" is most frequent. According to a recent report in the fish press, the method is simple and the potential gains large:

"The catch when weighed during landing showed 2350 kilos. The landing note in Norway's Råfisklaget it says that 1800 kilos were delivered. Both fisher and fish buyer gain from this. The losers are the cod population and the authorities which keep track of not fishing more than is permitted. Other losers are fish buyers, who compete in the market with the same cod, which they bought more expensively, if they are not also involved in the cheating" [42].

The gains are not negligible; in this case calculated to be around 10,000 NOK in one single landing, divided equally between fisher and processor. If we use current prices for cod, the gains in 2023 would be around 20,000 NOK for just one single landing. With 25 landings - which are quite common in the Lofoten cod fisheries - the accumulated gains would be around 500,000 NOK (or 47,500 USD in 2023). By under-reporting, the quota can be fished once more and sold at good prices. At present there is no transparency for such landings, which according to the Norwegian Raw Fish Association (*Råfisklaget*) is due to competition concerns. According to the minister of fisheries, there is nothing new with this example, but he pins his hopes on the on-going reform of fisheries control and surveillance [42].

4. Illegal fishing undermines the annual TAC

The transition from open access and unregulated fisheries to the closing of the commons and the introduction of a strict quota regime represented a radical state intervention in fisheries [44]. By the

establishment of the 200-mile EEZ in 1977 and the nationalisation of fish resources, resource management was implemented as a single-species management aiming for Maximum Sustainable Yield (MSY), through the setting of annual TACs in accordance with the principles of the Gordon-Schaefer model [45,46]. This was a new, scientifically based method of stock management that linked together the biological- and economic effects of a given catch effort [47,48]. The TAC-regime has become the main management tool to secure a sustainable resource management. According to Nielsen and Holm [3], the profound importance of the TAC regime refers to four specific functions:

- A single stock TAC constitutes the main instrument for controlling fishing mortality (F).
- The production of a TAC supports Virtual Population Analysis (VPA) enabling catch forecasts.
- For shared stocks the allocation of quotas among nations and vessels is based on an annual TAC.
- Surveillance and control efforts refer to the enforcement of TAC.

The annual TAC-production is depicted in Fig. 2:

Fig. 2 illustrates a four-step model to produce an annual TAC. While the first step refers to scientific stock assessment, step two refers to the production of limits for the fishing mortality (F) for a sustainable quota advice (TAC). Precautionary Approach (PA) criteria are a vital part of this process and are elaborated to keep the total stock and the spawning biomass within safe biological limits (B_{lim} indicating the lowest acceptable stock level). In the third step the quota advice for e.g. the NEA cod is handled over to the joint Norwegian-Russian Fisheries Commission for the formal decision of next year's TAC. In addition to the scientifically based recommendations for a given quota from ICES, the Commission also includes socio-economic aspects before the final quota is fixed. In step four, the Norwegian part of the NEA cod TAC (50% of the total TAC) is managed by the Directorate of Fisheries. Here, sharing among groups and technical regulations for different gear- and vessel groups are outlined for next year's fisheries. Over the years, the scientific production of TACs has become a routine-based annual operation, producing sustainable quotas in a predictable- and consensus-based manner. In Norway, more than 20 commercial fish species are managed by TAC-regimes [11].

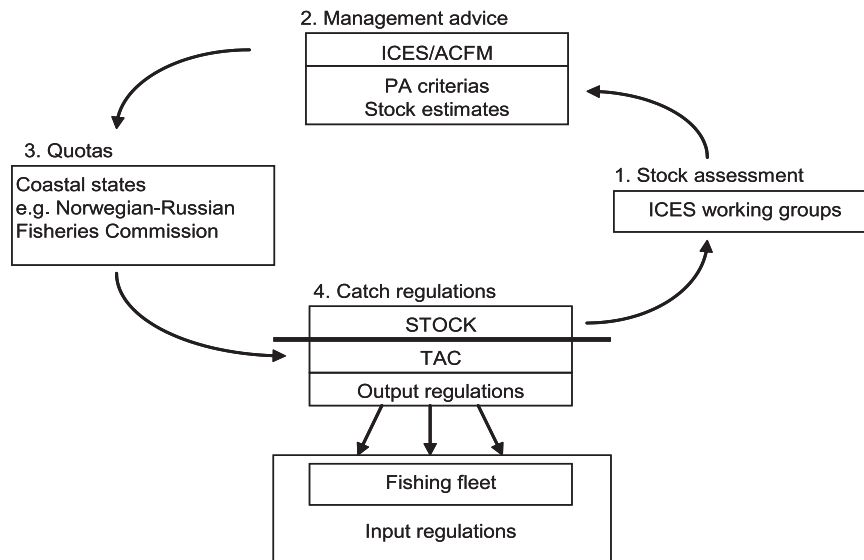


Fig. 2. Annual production of a total allowable catch (TAC). Source: Nielsen and Holm [3].

As the management system integrates several aspects of the sustainability concept, the need for stability is vital for the functionality of the management system. However, the TAC-production is vulnerable to external disturbances, which may negatively impact the resource management. First, overfishing quotas may contribute to overharvested fish stocks. A reduced quota-base also represent an economic loss for the fishermen and fisheries dependent regions. Overharvested- and mismanaged fish stocks may also trigger allocation conflicts among different gear- and vessel groups and regions, contributing to unprofitable over capacity in the total fleet segment. Hence, for the maintenance of long-term sustainable fish stocks and economic viable fisheries, a fundamental assumption is that fishermen comply to the TAC-regime and their allocated fish quotas.

If the actual or unregistered fishing mortality (F) significantly exceeds the F recommended by the ICES for the annual TAC due to illegal overfishing quotas, this may negatively impact stock assessment and reduce the stock in the long run. In such a situation the legitimacy of the annual TAC-production may also be challenged and put under pressure [3,49]. This may also weaken the trust to the scientific community's advisory role to politicians and decision makers [50]. To maintain a sustainable resource management, it is thus vital to avoid illegal overfishing of scientifically sanctioned fish quotas.

5. Resource allocation is vulnerable to illegal fishing

For the NEA cod, the TAC-regime was introduced in the 1970 s. As

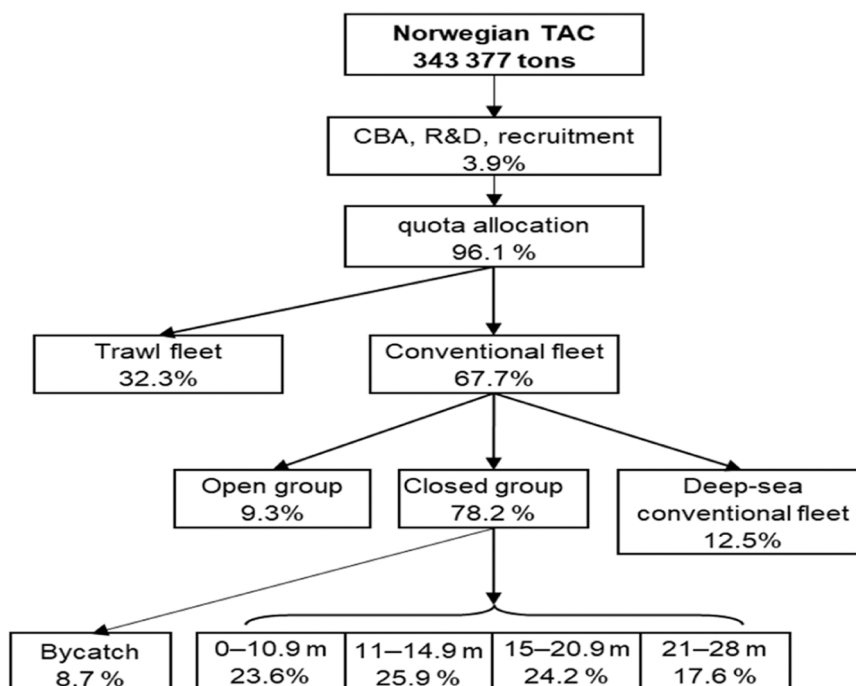


Fig. 3. Allocation of Norwegian TAC for Northeast Arctic cod to gear- and vessel groups, 2022. Source: Directorate of Fisheries/regulatory meeting [11].

the TAC represents a limited quota, a legitimate sharing of the TAC between different gear- and vessel groups became urgent [4]. In principle, a sole TAC may secure a sustainable resource management. However, due to the totally different catch efficiencies between coastal- and deep-sea vessels and socio-economic status between regions, unrestricted fishing within the TAC (c.f., an “Olympic fishery”) would not ensure a fair resource allocation and provide social sustainability among fishermen, especially in rural areas. Hence, after the rough sharing the TAC between the main vessel groups (trawlers and vessels fishing with conventional gears), a system of individual vessel quotas (IVQs) was introduced in 1991 also for the coastal fleet. In the Norwegian case, quota shares were allocated according to the size of the vessels, subject to certain modifications. Fig. 3 outlines the percentage sharing of the TAC between different gear- and vessel groups:

After minor amounts of the annual TAC are earmarked for research and recruitment purposes, the TAC is shared between the trawler fleet (32%) and vessels fishing with conventional gears (68%), e.g., line, gillnets and demersal seines. The group quota for the conventional fleet is further shared among several subgroups, such as the deep-sea conventional (long line) fleet (13%), the open group for part-time fishermen (9%) and the closed group for full-time professional coastal fishermen (78%). The latter receive is allocated the largest share of the NEA cod TAC. This group divided into four different length groups. According to Armstrong [51] the allocation of limited quotas among different gear- and vessel groups, were not based on scientific bio-economic advice.

The elaboration of fixed resource allocation keys among gear- and vessel groups are the most complex and conflicting process in contemporary Norwegian fisheries management [52]. Allocating quotas to different fleet groups, operating in different regions with different fishing gear and fleet structures, soon turned out to be a rather complicated affair. The task was not made easier by the will to maintain the rural settlement pattern and a diversified fleet as supplementary goals. Short time after the introduction of the IVQ- model, it was apparent that the system did not capture the huge diversity of the coastal fishermen’s adaptations to fishing. Smaller vessels were granted larger quotas than their traditional catch, and larger vessels were granted smaller quotas than their historical catch. Further, new and old vessels within the same length group carrying different debt burdens were granted equal quotas. Thus, the new management regime thus served to intensify existing allocation conflicts.

Between coastal fishermen from high north rural districts and the deep-sea fishermen from more urban areas, consensus about the sustainability concept, value adding and socio-economic contribution to the society have been difficult to reach. Instead, the process has led to continuous conflicts about interpretation, implementation and definition of key values, also after the allocation keys became operative in 1989 onwards. Since the early 1990 s, several replays between groups and regions have been made. This is also why the Norwegian Fishermen’s Association have conducted two comprehensive rounds of adjustments to the allocation regime [53,54]. During the last decade the allocation keys have been stable. However, despite the large effort of governance inventiveness and adjustments to maintain the allocation of fish resources as basis for legitimacy and compliance to maintain a sustainable management system, the allocation keys are continuously under pressure. Illegal fishing intensifies the allocation conflicts, with frequent claims from various fleet groups that others are cheating, thus undermining the entire allocation system. The logic seems to be: “If they are cheating or getting a larger share than deserved, why shouldn’t we fish more than our allocated share”.

6. Illegal fishing create unfair competition in terms of structure

While a legitimate and fair resource allocation policy serves as guarantee for the fishermen’s compliance with the TAC-regime, a fixed and predictable allocation among gear and vessel groups, also serves as a platform for structural measures to reduce unprofitable over-capacity

[5]. Since the state was no longer willing to take responsibility for capacity adaptations via financial subsidies, a market based structural policy, based on transactions among actors gradually gained increased importance. It started with the introduction of the Unit Quota system (UQ) in the trawler fleet, where companies were allowed to merge two vessel licenses to increase catch on one vessel on the condition that the other was scrapped. This system was further developed through the 1990 s and a system of *structural quotas* was introduced also for the coastal fleet in 2004 [55]. Here the fleet was divided in four groups (the “Finnmark model”) according to vessel size, where the vessels in the three largest size groups were allowed to merge quotas when decommissioning the vessels selling their quotas. Only the smallest vessel group (under 11 m), which is the most numerous group, was not allowed to merge vessel quotas, mainly fearing a large reduction in numbers of vessels and subsequent repercussions for small processing plants and the settlement of remote communities. Up to 2023, the system has been subject to a number of changes and modifications, such as a gradual increase in the number of quotas that may be merged. Overcapacity has been reduced and profitability in the closed group of fishing vessels with guaranteed quotas has been considerably improved [10].

By 2023 the uncertainty regarding how the structural quotas shall be administrated has increased. Structural quotas transferred through the mergers are granted for 25 years and the first quotas will be terminated by 2027. The original premise was that these quotas should revert to the vessel group from which it originated (now considerably reduced) and be part of the total quota share of the various vessel groups. However, in the meantime, the overall fleet structure has changed considerably, bringing to debate how these quotas should be redistributed, according to the original capacity of the vessels, according to their shares of the structural quotas, or a compromise in between [56].

In our perspective the lack of stability in this complex structuration scheme may spill over to the allocation keys and offer incentives to overfish the allocated quotas. But overfishing may threaten the structuration scheme, which is essential to address overcapacity. The logic is simple: the fishermen who overfish their quotas gain an advantage, which in turn enables them to buy more quota shares. This competition is considered unfair as it may encourage more overfishing, also among the fishermen who normally stick to the rules. The same logic applies to fish processors, where the ones who operate according to the rules, are losing out to those accepting extra deliveries over and above the allocated quotas.

7. The control system – between old practices and new technological opportunities

Since the closing of the commons and the introduction of the individual quotas for coastal vessels in 1991, quota control systems and reporting routines have been implemented by the Directorate of Fisheries and the fish sales organizations that are mandated to perform certain control functions [57]. Reports of each ex-vessel transaction recording inter alia amounts of fish and species from the fish buyer to the sales organization have been mandatory since 1991. Also, in 2009 a reporting system was introduced to keep track of the operation field of the vessels during active fishing. With reference to the Ocean Resources Act [23], the regulation for positioning reporting and electronic reporting for Norwegian fishing vessels [58] sets out a detailed and strict reporting system for fishing vessels. According to its §1, the overall purpose of the regulation is to:

“Secure effective regulations of commercial fishing, strengthen the resource control and lay the basis for a better catch statistics and research, by using electronic systems and digital communication to report commercial fishing”.

The ERS-system [58] covers the activities of each vessel from the time it leaves port, during active fishing, and until it returns to port to unload the catch. In practice, the vessels are obliged to send an

electronic message to the Fisheries Directorate's FMC-center (fisheries monitoring control) and inform when they are planning to leave port and the destination for specific fishing grounds. The vessels must then receive a go-message back from the FMC-center before they may leave port. When the vessel has reached the fishing ground, a new message must be sent, informing the FMC-center about the use and amounts of fishing gear used (e.g. numbers of gillnets, hooks in line systems, number of nets, etc.), the mesh size (in gillnets and trawl), the GPS-position and the duration of the fishing activity. A message about the position of gillnets and line systems must also be sent to BarentsWatch and thereby the Fish-info system, so that the positions can be openly shared with other vessels operating at the same fishing grounds. During fishing, the amounts of fish and species for each haul (trawl), must be logged and reported. Also, a message of the total catch per day must be reported to the FMC-center. When the fishing trip is finished, a message reporting the total catches and species must be sent before the vessel reaches the landing or unloading destination. For vessels below 15 m, the reporting system is somewhat simpler. However, FMC-messages prior to leaving the harbor, the fishing gear GPS-positions and catch reports are mandatory also for the smallest coastal vessels. Moreover, Automatic Identification System -systems (AIS) that provide the exact location of the vessel at all times have been mandatory for all vessels above 15 m since 2010. Electronic vessel tracking via the Vessel Monitoring System (VMS) for exact localization of the coastal fleet (below 15 m) will be introduced during 2023.

In addition to the autonomous AIS and VMS-systems, the Directorate of Fisheries has developed an app for log in and electronic reporting to the FMC-center and transactions of fish to sales organizations via smart electronic devices. However, despite the significant modernization of the total reporting systems, a major weakness is still that all information, including catch rates and species etc., must be manually fed into the system by the fishermen. Hence, the system does not rely on independent or objective data input, but depends on the fisher's subjective judgement. According to NOU [16], this is a *major system weakness* when the goal is to secure correct information from the fishing operations and transactions.

To get away from the manual inputs based on the fisher's subjective judgements regarding the amount of catch and species distribution, NOU [16] suggested a new strategy based on automatic detection technology onboard each vessel. This strategy, implemented by the Directorate of Fisheries, has become the main mechanism for increasing quota and resource control for each individual vessel [22]. The new technology will be based on machine vision for optical detection of each specific fish, according to species, live weight, and size, and thereby establish the basis for a detailed catch and quota accountability for each vessel, including bycatch. By exact logging, the total catch rates for each fish species and statistical data from commercial fishing shall be strengthened, providing support for a better stock assessments and the setting of annual TACs. Moreover, the automatic sensor technology is also intended to help the fisher's assessment of catch reporting and make daily work easier. Moreover, for control purposes, the system also makes it easier to benchmark catch rates and catch composition among vessels operating in the same fishing grounds. Despite both national and international initiatives it is worth mentioning that these technologies are still under development, and the current status of implementation corresponds to a relatively low technology readiness level (TRL) [59].

8. Reactions to new control devices: "Doing better, but feeling worse"?

The potential negative impact from illegal fishing supports the Fisheries Directorate's strategy to radically increase resource- and quota control and enforcement. However, according to numerous articles in the fishery press, the fishermen have strongly protested the implementation of new control technologies on board their vessels. Most fishermen claim that illegal fishing is not representative, while the

negative attitude and resistance towards new control technologies refers to increased surveillance and costs as well as mistrust of the functionality of the new control technology.

The negative attitude is also confirmed in a questionnaire survey conducted by SINTEF Ocean [19]. When fishermen were asked to what extent implementing automated catch monitoring systems onboard fishing vessels would reduce overfishing quotas, most expressed a negative attitude. Table 1.

From a total of 300 participants, 52% of the cod fishermen answered that the technology will not reduce overfishing, 31% believed the technology may reduce overfishing and 15% expressed uncertainty or did not know. When analysing the survey data from a regional perspective, we find that the cod fishermen from the two northernmost regions of Norway were the most negative to installing control technology on their vessels. Fishermen from the northwest region (Møre and Romsdal) were the most positive.

This is also confirmed by the Norwegian Fishermen's Associations hearing statements according to the public report entitled "The future fisheries control" [16,24]. This is also why most fishermen suggest that the new technologies should be installed at the land-based processing facilities, and not onboard their own vessels. However, for the Directorate of Fisheries the new control technologies are defined as a collective good, which contributes to a better resource management and a more predictable economic income for all fishermen. To the authorities, it is therefore a paradox that the Fishermen's Association does not support the new technologies to prove the legal conduct of most fishermen.

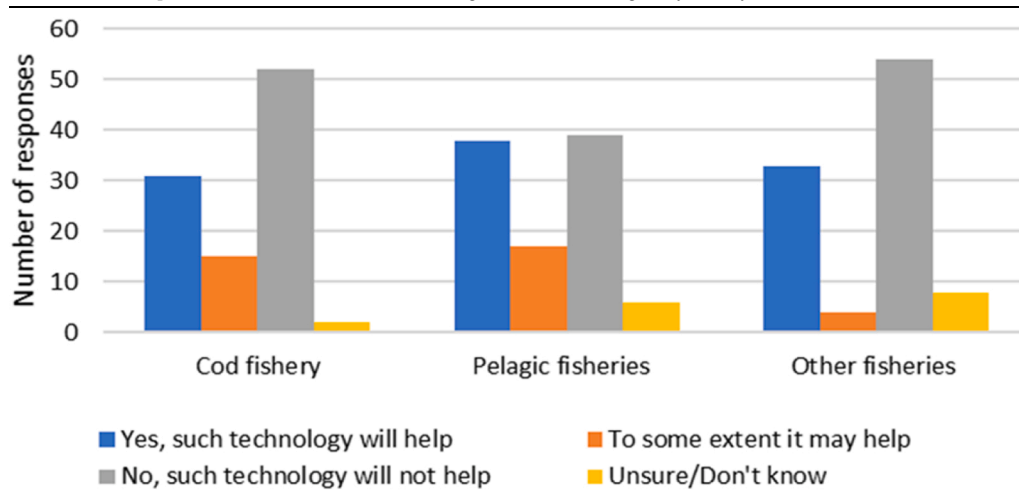
Contrary to the negative attitude among Norwegian fishermen, Danish fishermen are more receptive to new harvest control technologies. As the first fleet in Europe, the Danish pelagic fleet is now introducing fully documented fishing on all member-vessels of the Danish Pelagic Producer Organization [60]. The Danish initiative reflects new policy goals for the EU-fisheries policies. With the new Common Fisheries Policy (CPF) adopted in 2014, the EU pelagic fishery are faced with landing obligations since January 1st, 2015. At sea monitoring is one of the potential methods to confirm compliance with the new regulations [61]. During 2008 – 2015, full-scale surveillance technologies were tested on a voluntarily basis among Danish deep-sea pelagic fishermen. The testing included installation of video and associated sensor systems for online monitoring of the harvest operations. Contrary to the Norwegian approach, the project was initiated by the fishermen's organization, and carried out in close cooperation between public authorities, fishermen and scientific experts. From the first of January 2023, the system will be implemented for all member-vessels [60]. The main goal is full documentation of the catch processes to prove that the fleet complies with the management regime. In this context, the fishermen are also expected to receive potential future rewards in terms of increased quotas and simpler management rules [62].

9. The road to better compliance: bottom-up, participation, incentives and gradual implementation

Although the coastal Norwegian NEA cod fishermen and the Danish pelagic deep-sea fishermen's perceptions about control technologies may not be comparable, it is interesting to note the difference in attitude between the two actors. In this context, different approaches to the introduction of the new technologies may be vital to understand the different receptiveness to new technologies. While the Norwegian approach represents a sole bureaucratic "top-down" initiative and lack of involvement from fishing industry, the Danish initiative represents a "bottom-up approach" from the fishermen's own organization (DPPO). User involvement in close cooperation with implementing authorities, may thus contribute to a stronger ownership and acceptance of radical shifts in the resource control systems.

This is also confirmed in a research study about the introduction of Remote Electronic Monitoring (REM) technologies and landing

Table 1
Fishermen's viewpoints about new automatic catch registration technologies by fishery.



Source: SINTEF Ocean [19].

obligation for increased resource- and quota control in Denmark. Here, Michelin et al. [63] and Plet-Hansen et al. [64] state that for a successful introduction of new REM-technologies, it is vital to ensure stakeholder acceptance and means to verify compliance to the new regulation. Also, an assessment conducted by Battista et al. [65] and Fujita et al. [66], suggests that implementation of catch monitoring technologies require high levels of stakeholder participation to succeed. Furthermore, positive incentives and ownership to the new idea may be crucial for the total outcome of the new strategy demonstrating the overall benefits of monitoring for fishermen, e.g., in the form of reduction in administrative procedures, documentation of access to the best paying markets, increased quotas and improved sustainability. These potential benefits may strengthen the fishermen's willingness to support the new strategy.

As the new control technologies are still in a development phase, the Directorate of Fisheries should actively include fishermen in the implementation processes. A stronger involvement from legitimate stakeholders is also advocated by Kooiman et al. [35] as interactive governance and co-management in decision making processes. A stronger user participation among the fishermen may thus increase the acceptance and support of new control technologies as a *collective good*, which could benefit not only fishermen, but processors and managers as well.

10. Norwegian fisheries management – between old, established practices and new technological possibilities

In the 1990 s Norway was hailed as the worlds foremost nation regarding fisheries management. At that time the former director at the Directorate of Fisheries replied that “the competition had been rather weak” [66]. Since then, the Norwegian fisheries management system has evolved considerably and it is still considered a success, delivering relatively stable quotas for most key species and good incomes for fishermen [67]. However, the economic success of the IVQ-regime has also brought an increased incentive for cheating, or more precisely, of performing illegal fishing. This is a cause of great concern for the authorities, and the government has recently pointed out that illegal fishing is a major threat, not only to the resources but also regarding money laundering, illegal labour practices and tax evasion.

Our main concern in this article is to demonstrate that illegal fishing, and in particular overfishing of allocated quotas, represents a threat to the entire management system. As pointed out by Standal and Hersoug [5] there is a close relationship between the three subsystems of modern resource management; the “TAC machine” providing the annual total catch level, the allocation system dividing the TACs into individual

vessel quotas, and the structural measures to secure economic sustainability. All three elements can be seen as institutions established to achieve political goals, such as biological, economic, and social sustainability.

A sound resource base and stable resource allocation keys for gear and vessel groups are fundamental to avoid conflicts and maintain the relative predictability in the resource base for all fishermen. Such stability is also vital for compliance with the TAC-regime and the functionality of structural policies. Absence of a fair allocation regime may reduce compliance with regulations and bring overfishing to allocated quotas, a situation which may threaten sustainable resource management. Likewise, shifts in the resource allocation keys between groups may undermine the basis for structural measures addressing non-profitable overcapacity. Today, the latter is of particular importance, as the NEA cod stock has shown a downward trend for years and TACs are now half the level of what they were a decade ago. The TAC for NEA cod is now at its lowest level since 2009 [11], and is likely to continue its decline. In this setting, a surplus harvesting capacity represents increased pressure on the TAC-system and the fragile system of allocation keys distributing quotas among various fleet- and gear groups.

Fishermen who overfish their quotas are free riders who enrich themselves on behalf of the common resource pool. Free riders reap the benefit from overfishing, while the costs, due to overfished and declining fish stocks, are shared with all other fishermen. As fishermen who comply with the quota regime do not know if all fishermen behave the same way, the effect on their own legal conduct remains uncertain. Fishermen that comply with the law are thus not guaranteed a future reward, despite adhering to the rules. Hence, in a situation of legal fishermen who know that other fishermen conduct illegal fishing, this may contribute to a *system coercion* [68], which lowers the fishermen's morale and incentives to follow the rules and lead also legal fishermen towards overfishing. Illegal overfishing by “a few” free riders, can therefore contribute to increased illegal activities undermining the entire management system.

In this situation, it is a paradox that fishermen in the coastal fleet strongly oppose to new initiatives for improved catch control measures and strengthened enforcement. Several studies confirm a high frequency of overfishing, while it is hard to provide exact numbers. Nevertheless, fishermen are sceptical to onboard surveillance technology, and they have already obtained several exceptions and simplifications in the new ERS regime. When studying the reactions, especially from fishermen operating vessels smaller than 15 m, it is obvious that what they most strongly disapprove of is the actual process of implementing the new VMS and ERS systems. The initiative comes from the top, with the clear

message that there is no room for reconsideration, even in the face of boycott from fishermen [69]. Gradually, the new Minister of Fisheries has tried to defuse the issue and the most stringent demands have been eased, accepting a long introductory period before sanctions may be applied. However, the key issue remains unsolved: the Directorate of Fisheries is strongly committed to introduce *automated technology on-board* (cameras and automatic reporting), to which fishermen still strongly object. Whether a more cooperative style, trying out the system over a relatively long period and possibly introducing incentives to facilitate that the technology will work, remains to be seen. The strong link between legitimate fisheries regulations and compliance is well documented [70,71]. In the end, the fisheries authorities are dependent on legitimate rules and regulations. For the time being, the technology is not considered a legitimate control measure among most Norwegian coastal fishermen, even, it is accepted by e.g. Danish pelagic fishermen.

As per 2023 it is clear that stronger control on *land*, involving electronic weighting, direct electronic accounting, camera surveillance and a stronger presence of fisheries inspectors, is supported by most fishermen, as also signalled by the Norwegian Fishermen's Association and the Norwegian Coastal Fishermen's Association. Such measures will make it more difficult to land fish from illegal fishing applying any of the three "cheating strategies" described in Section 3. However, these measures will not cover high-grading at sea, which still will remain a major challenge for a correct resource accounting system and hence for the sustainability of the stocks involved.

In the end, this will be a battle over the whole perception of what the coastal fisheries shall be. A few years ago, coastal fishing was characterized as "Norway's best and freest profession" [72]. However, the freedom has been gradually circumscribed as to *where* to fish, *when* to fish, with *what type of fishing gear*, etc. Now it looks like coastal fishermen will also be observed 24/7, reporting their catches electronically. Perhaps we are close to the end of the iconic coastal small-scale fisherman as the freest and most independent occupation in the world? Or to phrase it on a more positive note: the privilege of harvesting a common resource (without paying any resource rent) comes with a cost; the guarantee that this resource is harvested sustainably.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

Data will be made available on request.

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