06/25
ARBEIDSNOTAT
WORKING PAPER

The Management of Multispecies Fisheries in Denmark – A Case Study of Fish Pools

Trond Bjørndal
Mogens Schou

SNF
Samfunns- og næringslivsforskning AS
Centre for Applied Research at NHH

SNF
SAMFUNNS- OG NÆRINGSLIVSFORSKNING AS

- er et selskap i NHH-miljøet med oppgave å initiere, organisere og utføre eksternfinansiert forskning. Norges Handelshøyskole og Stiftelsen SNF er aksjonærer. Virksomheten drives med basis i egen stab og fagmiljøene ved NHH.

SNF er ett av Norges ledende forskningsmiljø innen anvendt økonomisk-administrativ forskning, og har gode samarbeidsrelasjoner til andre forskningsmiljøer i Norge og utlandet. SNF utfører forskning og forskningsbaserte utredninger for sentrale beslutningstakere i privat og offentlig sektor. Forskningen organiseres i programmer og prosjekter av langsiktig og mer kortsiktig karakter. Alle publikasjoner er offentlig tilgjengelig.

SNF
CENTRE FOR APPLIED RESEARCH AT NHH

- is a company within the NHH group. Its objective is to initiate, organize and conduct externally financed research. The company shareholders are the Norwegian School of Economics (NHH) and the SNF Foundation. Research is carried out by SNF's own staff as well as faculty members at NHH.

SNF is one of Norway's leading research environment within applied economic administrative research. It has excellent working relations with other research environments in Norway as well as abroad. SNF conducts research and prepares research-based reports for major decision-makers both in the private and the public sector. Research is organized in programmes and projects on a long-term as well as a short-term basis. All our publications are publicly available.

SNF Working Paper No. 06/25

The Management of Multispecies Fisheries in Denmark - A Case Study of Fish Pools

Trond Bjørndal
Mogens Schou

SNF Project No. 10101:
Developing flexible instruments for mixed fisheries

The project is financed by the Research Council of Norway
(Project No.: 336200)

CENTRE FOR APPLIED RESEARCH AT NHH
BERGEN, DECEMBER 2025
ISSN 2704-0380 (Online)

Abstract

Management of mixed fisheries is challenging. This is particularly the case because current harvesting tools are largely based on single species management with overall and individual quotas set stock by stock. As harvest quantities may not be aligned with quotas, this may give rise to choke species, high-grading, discarding and IUU fishing. Challenges are typically compounded by heterogeneous fishing fleets. In this article we analyse this issue in the context of Danish demersal fisheries. A particular feature of the management of mixed fisheries in Denmark is fishermen's cooperatives, known as fish pools. These are essentially fishermen's cooperatives and play a crucial role in establishing a flexible transferability mechanism.

Acknowledgement
The authors are most grateful to Gordon R. Munro and Bruce Turris for very helpful comments about the British Columbia fisheries.

1. INTRODUCTION

As fisheries resources continue to be exploited at unprecedented rates, efficient management is essential to improve sustainability and economic efficiency (FAO, 2024; World Bank, 2017). In this respect, management of mixed fisheries is particularly challenging. As harvest quantities may not be aligned with quotas, this may give rise to choke species and discarding. We will in this article analyse this issue in the context of the management of Danish demersal fisheries.

EU countries including Denmark have heterogeneous fishing fleets with several different métiers[1] involved in mixed fisheries. For these reasons, management is challenging, also because current management tools are largely based on single species management with total allowable catch quotas (TACs) and, usually individual quotas set stock by stock. However, in the traditional single-stock management regime there is a general understanding that mixed fisheries are of concern, since catches of different species are interlinked due to technical interactions between different fleets and gears as well as species interactions[2] (Ulrich *et al*., 2012). Stocks that are managed individually, with quotas that do not align with actual catch compositions, may lead to high-grading, discarding and misreporting, including Illegal, Unreported and Unregulated (IUU) fishing, and it may lead to inefficient fishing practices including technological adjustments to circumvent regulations (Kristofersson & Rickertsen, 2009, Pramod *et al*., 2014). Where fisheries are managed by input regulations in the form of prescriptive rules on how to fish, discarding of non-quota catches may be mandated, as was the case in the Common Fisheries Policy. To the extent that central management is unable to establish the desired catch composition for all fleets, the effect is unaccounted discarding of non-quota catches.

Implementing output regulations, such as the reformed Common Fisheries Policy (CFP) TAC/quota system from 2013 and legally implemented in 2019, is challenging for the individual fisherman since he must balance his catches with his portfolio of quotas (Sanchirico, 2006; Bjørndal & Munro, 2012). If he is out of quota for just one species in a mixed fishery, he must stop the entire fishery; thus, this species becomes a "choke" species. Adequate management decisions depend on the monitoring of fishing mortality for all the stocks harvested. This requires registration and accounting of all fish harvested, which implies reporting the total catch including discards rather than just the landed portion as before the reform of the policy.

[1] A fisheries métier is a fishing activity defined by a particular combination of gear, target species, fishing area, and season. The concept is used in inter alia ICES advisory work where fleet behaviour matters for catch composition.

[2] The concept of choke species was not relevant, when discarding of non-quota catches was obligatory.

Preventing misreporting is an essential management consideration, and the reformed EU policy establishes the principle of full catch accountability and detailed and accurate documentation of all catches, for example by using CCTV (EU Regulation 1380/2013, art. 15). The policy also established a landing obligation for the harvested fish.

In the North Sea, discard rates for EU countries were in the past among the highest in the world (Diamond & Beukers-Steward, 2011). While discarding was prohibited in Norway, in the EU discarding was not prohibited for stocks in the TAC and quota system before the 2019 reform[3].

Abbott *et al*. (2015) argue that poor incentives for selective fishing may obscure significant flexibility in multispecies production technologies. The key to improvement is to give the skipper the choice of method in conducting his fishery according to the variability of the circumstances at sea. His incentive to optimise his catch portfolio and minimise unwanted catches will be driven by the principle of full catch accountability, including full documentation by Remote Electronic Monitoring (REM)[4], as required in the CFP. However, this is not fully enforced or complied with in the EU, largely due to political reluctance to highlight the 'choke species' problem that an efficient ban on discarding might cause."

REM is the key to making full catch accountability work. Furthermore, when all catches and the associated fishing mortality are accounted for, the need for prescriptive rules on the construction and use of fishing gear are superfluous and the requirement to land all catches becomes an unnecessary toll on the fishing resource. As long as all catches are counted against quotas, undersized, low value market fish should be released so at least a fraction may grow to size instead of being disposed of when landed. In April 2025 the New Zealand Government initiated a hearing with a view to revise the fisheries act to among others “enable commercial fishers to return Quota Management System (QMS) species to sea when monitored by on-board cameras or observers”.

The principle of free choice of gear has been tested in scientific trials, including “Reducing discards without reducing profit: Free gear choice in a Danish result-based management trial” (Mortensen *et al.*, 2017) and “Untangling the net: Redefining fisheries management with fully documented fisheries” (Bertelsen, Feekings & Storr-Paulsen, 2025).

[3] See https://ec.europa.eu/oceans-and-fisheries/fisheries/rules/discarding-fisheries_en.
[4] In New Zealand there is currently (2025) a hearing about allowing the possibility of discarding conditional on a full count of fish harvested. See https://www.mpi.govt.nz/dmsdocument/67947-Proposed-Changes-to-the-Fisheries-Act-1996-Consultation-Cabinet-paper (consulted November, 2025).

Removing prescriptive rules on fishing methods is one way to let best practices, new technologies and innovations flourish within the fishing industry. It is equally important to have a system of quota allocation that enables the fisherman to match his daily catches with a quota entitlement. In this article we present a case study of the management of quota allocation in multi-species demersal fisheries in Denmark. In so doing, we point to two deciding factors when implementing a fisheries management system based on the principle of full catch accountability (output regulation). The first is to give the fishing industry the incentive and the opportunity to improve fishing methods to have a more selective and targeted fishery. The second is the need for transferability for fishermen to cover their unexpected catches with a quota entitlement. Both factors are very important in the Danish management system.

A particular feature of the management of mixed fisheries in Denmark is fishermen's cooperatives, known as fish pools, which play a crucial role in establishing a flexible transferability mechanism. The system has two purposes: i) To optimise the economic yield from fisheries. ii) At the national level, to align quotas with catches at vessel level. We will analyse how successful this system has been in terms of overall objectives. Moreover, we will study lessons learned in the Danish system that may be of value for the management of fisheries in other jurisdictions.

This article is organised as follows. In the next section, we explain the reasons underlying the introduction of fish pools, how they operate and what outcomes have been observed. We will also look at comparable management systems in British Columbia, Canada and Iceland. In section three, we will analyse the outcomes of this management system.

2. BACKGROUND

2.1 EU and Danish fisheries policy

Denmark is the third largest fishing nation in the EU after Spain and France, with landings of 464,000 tonnes in 2024 at a landed value DKK 3.1 billion. The five most important species harvested in 2024 were blue whiting (quantity (Q) = 101.521 tonnes, value (V) = DKR 234.7 million), sprat (Q = 97.017 tonnes, V = DKR 304.6 million), herring (Q = 96.350 tonnes, V =DKR 610 million), sandeel (Q = 70.081 tonnes, V = DKR 147 million) and mackerel (Q = 27.848 tonnes, V = DKR 368.4 million). Mackerel and herring are used for human consumption and fetch far higher prices than blue whiting, sprat and sandeel which are used for reduction into fish meal and fishoil. High value species harvested in smaller quantities include Norwegian lobster (Q = 4.689 tonnes, V = DKR 306.3 million) and shrimp (Q = 5.549 tonnes,

V = DKR 211.6 million). The fleet consisted of 1,687 vessels of which 456 were above 10 m. Total tonnage reached 60,000 GT[5].

Vast overcapacity, poor economic performance and discarding of fish led to a reform of the Danish system for allocation of fish in 2007[6]. While the EU is responsible for the resource policy, including the setting of TACs, technical rules and fleet capacity, it is a Member State prerogative to allocate the fish nationally.

The original Danish allocation scheme was essentially based on a common pool, open access system where vessels each month would be allowed to fish a certain amount of each stock – called a ration - depending on the length of the vessel. However, the authorities would not know how many vessels would participate in the fishery. For this reason, the ration was adjusted each month depending on the number of vessels participating in the fishery. Vessels would race for fisheries with high prices and fisheries where national quotas were at risk of being exhausted. Typically, the vessel rations had to be reduced month after month, and often the fishery was closed well before the end of the year as national quotas were exhausted.

Rations for different species did not reflect actual catch compositions in mixed fisheries, and quota mismatches and early closures resulted in non-quota discarding, which at the time was in fact an obligation according to EU policies. The system left no chance for fishermen to plan their operations, and they had no way to demonstrate a secure holding of quotas to financial institutions, making it very challenging to obtain loans for renewing their vessels and other purposes. This changed dramatically after the national reform. In effect the need for a state-owned Fisheries Bank running deficits ceased, as private banks could now offer better terms based on defined and secure assets. The government Fisheries Bank has later been closed.

In 2008 a Danish proposal to base a new EU fisheries quota management on total catches rather than registered landings was presented. This principle, which was instituted in the EU reform in 2013, calls for a high degree of quota transferability. In fact, Danish officials explored the possibility of a common EU pool that could enhance flexibility even more through in-year leasing and swapping directly between fishermen. This, however, was seen as going too far in terms of “quota trading”, with the risk of undermining the EU quota allocation mechanism; Relative Stability.

The EU reform is very ambitious, requiring from 2019 that all catches are accounted for and, with some exemptions, landed. However, discarding is still a major problem. In March

[5] Source: Fiskeriets regulering - LFST
[6] See https://stm.dk/statsministeriet/publikationer/nye-maal/ p. 46 (consulted November 2025).

2025 an independent study[7] concluded that, "Discard rates have remained relatively unchanged." The European Commission noted that the study highlights a number of limiting factors on the implementation of policy, including

- insufficient incentives for fishers to comply,
- ineffective monitoring and enforcement tools,
- conflicts with maintaining the economic viability of fisheries due to the loss of commercially valuable catches when increasing selectivity, and
- challenges in improving species and gear selectivity.

Moreover, the EU will require CCTV monitoring of certain vessels above 18 m from 2028, and in general rules are being tightened[8].

In mixed fisheries, a major challenge for fishermen is to overcome the choke-species problem. This involves moving from a situation where they used to optimise the result of their catch portfolio by being obliged to discard non-quota catches to a situation where they must optimise catches through selective fishing practices and flexible quota systems. Schou (2019) gives an account of the problems and possible solutions. He suggests that quota transferability is an indispensable tool in a management system where full catch accountability goes hand in hand with an optimal use of the available TACs/quotas.

2.2 The Danish system and its fish pools

Following a political agreement in the Danish Parliament in November 2005, the transition from a ration-based fishery to what is known as individual transferable fishing concessions was completed in 14 months, most of the time used to allow for fishermen to contest the resulting allocations. The transferable fishing concessions, hereafter referred to as Individual Transferable Quotas (ITQs), were introduced 1st January 2007. The initial allocation of shares was based on historic fishing with 50% weight to catch figures for 2005, 30% for 2004 and 20% for 2003.

In addition, a system to take account of non-typical situations, such as being ship-wrecked, changes in ownership etc. was included. A share of the Danish quota allocation[9] was reserved for a quota up-lift for small-scale active fishermen, a share for the Fishing Fund's (FishFund) development and generation pool, and a share for the group of less active fishing

[7] Source: Independent study highlights some challenges in implementing the landing obligation across EU fisheries - European Commission

[8] Control regulation - European Commission

[9] Almost all Danish fisheries are shared with other countries. In the EU, quotas are shared between relevant countries based on the principle of relative stability (Bjørndal & Munro, 2022).

vessels who would continue fishing on rations. The FishFund allocates fish for young fishers' first vessel, development of fisheries, and it may in effect serve as a "resource rent buffer", e.g. in case the government should decide to auction off fishing rights in order to retrieve the resource rent to cover public costs associated with fisheries management.

A very important instrument, especially in relation to the desired development towards full catch accountability in the Common Fisheries Policy, was included in the new management, namely fish pools.

In March 2011, then European Commissioner Maria Damanaki in a ministerial high-level meeting suggested that an effort management system could be the way to ensure full catch accountability and end discarding[10]. The alternative she said, "is full catch accountability combined with a landing obligation. In such a system it would also be necessary that Member States allocate quotas in line with the real catches of their vessels." The conclusion of the meeting was that the TAC/quota system should continue, now based on "catch quotas" instead of "landing quotas". Later in 2011, Damanaki pointed to the Danish model as a tool to tackle the choke species problem: "Fishing concessions give operators enough flexibility to implement the discard ban and adapt to quotas. If vessel owners are allowed to trade concessions they can obtain a tailored combination of quotas according to their actual fishing patterns. They can fine-tune that allowance in real time, during fishing operations, or even retrospectively within the quota year by leasing somebody else's concession so as to land all catches without breaking the law."[11]

Initially, there were about 10 fish pools; today (2026) there is one main fish pool with 450 vessels in operation[12]. In addition, 34 vessels are members of a pool for mussel vessels. Almost all vessels with individual demersal or pelagic quotas are members of a pool. The pools are voluntary organisations, essentially fishermen's cooperatives operating under government framework legislation. Members appoint a board and management to represent them, also vis-à-vis the government. The pool is especially relevant for mixed demersal fisheries, where quota transfers are used to adapt quota portfolios and align catches with quota entitlements.

In 2024, the most important demersal species were haddock (Q = 6.445 tonnes, V = DKR 64.9 million), plaice (Q = 6.687 tonnes, V = DKR 138.2 million), shrimps (Q = 5.549 tonnes, V = DKR 211.6 million), cod (Q = 4.789 tonnes, V = DKR 191.8 million), Norway

[10] High Level Meeting on banning discards.
[11] European fisheries reform speech by commissioner Maria Damanaki | Fishing | The Guardian.
[12] Source: Danish Fisheries Agency (private communication), and Ny fælles pulje: Dansk Puljefiskeri og Puljefiskeren bliver til Puljefisk.dk

lobster (Q = 4.690 tonnes, V = DKR 306.3 million), hake (Q = 2.206 tonnes, V = DKR 91.5 million) and saithe (Q = 2.108 tonnes, V = DKR 32.5 million). The most valuable on a per unit basis are Norway lobster, cod and shrimps.

Each vessel has ITQs which are expressed as fixed quota shares calculated as a per mille of the Danish national quota after deduction of a varying share for the FishFund. Following the yearly TAC/quota agreement in the EU, new vessel quotas are allocated in January every year. These may be sold on a permanent basis or partly leased out during the quota year. The fish pool operates an electronic trading platform for leasing[13], in essence a home-banking system for quota exchanges and transfers. According to Bonzon *et al*. (2013), nearly all leasing is done through fish pools. The fish pool system and private brokerages have combined to promote a well-functioning quota market. There is no statistical account of the activities in the pool, but it is estimated that around 8,000 quota transactions take place every year.[14]

A vessel may lease out a maximum of 25% of its quotas per year. As a rule, at least 60% of fishermen's income must come from active fishing. This to ensure that the quota owner is an active fisherman and avoid the so called "slipper skipper" problem. There is full transparency about leasing and quota trades.

The EU quota year runs from January to December. However, membership of a fish pool must be for at least 13 months, i.e., the quota year plus one month. This is to allow fishermen time to compensate for possible quota overshooting by January the following year.

The flexibility of the system means that a fisherman can land and sell fish at market price even without a quota, e.g. in a situation with unexpected bycatch. The only requirement is that he leases in quota from others within the quota year.

No discarding of a species is permitted if quotas are available in the pool. This has led to a reduction in discarding, as illegal discarding is still a major problem in the EU despite the landing obligation.

Quota control is with the total catches of the pool, not with the individual fisherman. For the daily quota control, The Fisheries Agency view all vessels in the pool as one vessel. If the pool stays within the total quota ceiling, individual fishermen may overshoot their quotas within the quota year. When new quotas are allocated in January, overharvesting by a fisherman from the previous year, if any, will be deducted from the current year's quotas. If a pool exceeds the available quotas, the quotas for the following year may be reduced by the same amount or

[13] See www.puljefisk.dk

[14] Source: Arnth Bærentzen, developer and manager of the electronic trading platform for the pool (private communication 2025).

in certain cases by a bigger amount. Underharvesting can be transferred to the following year within the quota flexibility established in the EU's yearly TAC/quota regulations for selected stocks.

Permanent transfers between registered fishermen are permitted. Such transfers, for example if a fisherman wants to scrap his vessel and retire from fishing, are allowed provided rules of concentration and fishing activity are respected. Permanent transfers are handled by the government. Fishermen register and obtain approval for the transfer from the Fisheries Agency (Bonzon *et al*., 2013).

Less active fishing vessels, defined as vessels with a yearly turnover of less than € 30,000, were kept out of the ITQ system. This group gets a joint share of the national quotas, typically around 2-4%, based on their historic fishing. These vessels continue fishing on rations.

In principle, all quota allocations may legally be withdrawn by the Ministry of Fisheries with 16 years' notice. However, in practical political terms this merely constitutes a tool that allows the government to make adaptations and redistributions. Clearly a complete withdrawal of quotes is not a likely option. In case of a formal withdrawal, it is to be expected that negotiations on a new arrangement would take place, and, given mutual interest, might enter into force well before the end of the 16 years.

2.3 Outcomes

Permanent transfers have resulted in an alignment between fishing opportunities and fleet capacity. In 2007, the year ITQs were introduced, the Danish fleet consisted of 3,210 vessels with an aggregate gross tonnage of (GT) 88,984 and kW of 316.555. By 2024, the number of vessels had been reduced to 1,687 vessels with an aggregate GT of 60,000 GT and an aggregate kW of 194,759 kW[15]. This represents a reduction in vessel numbers of 45%, with a smaller reduction in gross tonnage and kW. Consequently, average GT per vessel increased from 27.7 in 2007 to 35.7 in 2014, a 29% increase.

Following the introduction of transferable quotas all parts of the Danish fishing sector had, by 2012, experienced a substantial reduction in fleet capacity and a marked improvement in profitability, once the initial structural adjustment had been completed. The reduction was similar across both larger and smaller vessel groups. Operating profits kept increasing until

[15] Source: Fartøjsrapport - Registrede fartøjer i løbet af året - SAS® Visual Analytics.

2016, after which they declined again up to 2023. However, smaller vessels (under 18 m) showed low profitability throughout the whole period[16].

In short, there are now (2026) fewer, but larger vessels in operation than in 2007. This has greatly improved the economic efficiency of the fleet.

2.4 Other Countries

There are different management systems around the world that have similarities with the Danish system. We will review systems for multi-species fisheries in British Columbia, Canada and Iceland to compare with Denmark.

The British Columbia, Canada groundfish fishery is composed of six components: a Pacific halibut longline fishery, a longline and trap sablefish fishery, a rockfish longline fishery, a dogfish longline fishery, a lingcod longline fishery and a groundfish trawl fishery. The groundfish trawl fishery is larger than the other five fisheries combined, in terms of volume and catch, and is explicitly a multispecies fishery. The other five were initially managed as single species fisheries but did have extensive bycatches.

The groundfish trawl fishery (GTF) has caught up to 100,000 tonnes of fish per year (Bjørndal & Munro, 2012). However, in 2023, the fishery caught just over 71,000 tonnes[17]. Important species include rockfish, hake, pollock, Pacific cod, and different kinds of flatfish. There has been an active commercial groundfish trawl fishery in British Columbia since the 1940s.

ITQs were introduced in the sablefish fishery in 1990 and in the Pacific halibut fishery in 1991. The more complex groundfish trawl fishery adopted ITQs in 1997, initially as a trial system. This was largely a response by the Canadian Department of Fisheries and Oceans (DFO) to address resource sustainability issues such as overharvesting and misreporting, as well as the poor economic state of the fisheries. Eighty percent of the species' TACs were allocated to licence holders (limited entry) and 20% to a newly created non-profit society called the Groundfish Development Authority whose responsibility is to promote regional development, market and employment objectives, sustainable fishing practices and fair and safe treatment of fishing crews.

[16] Sources: Dansk kystfiskeri: Struktur og økonomi 2013 IFRO_Udredning_2013_1.pdf and Regnskabsstatistik for fiskeri 2023.

[17] https://www.dfo-mpo.gc.ca/stats/commercial/land-debarq/sea-maritimes/s2023pq-eng.htm (consulted 14th October 2025).

The TACs were first divided between trawl and hook and line. The allocation of individual ITQs for trawlers was then made based on catch history and vessel length (Grafton, Nelson & Turris, 2007). Trawlers received proportionate shares across all species and stock combinations. There is now (2026) a total of 64 different stock-area ITQ allocations[18], all expressed as percentages of the respective stock TACs. Some TACs are area specific. As an example, while there is one coastwide TAC for widow rockfish, there are four area specific TACs for Pacific Ocean perch.

To participate in the groundfish trawl fishery, vessels must have what is called a Category T (Groundfish Trawl) license issued annually by the DFO. This is a vessel-based license and must be associated with a vessel. The T license also has vessel length restrictions which vary by vessel and there can be only one T license on a vessel at any one time. Moreover, a vessel can only fish one T license in a fishing year. The T license has an associated total holding quota, which limits the total amount of groundfish trawl quota a vessel can hold. These holding caps vary by vessel based on the original allocation of individual quotas in 1997.

Vessels are allowed to fish up to 30% over their quota of a species within an area for specific allocations (for some species such as halibut and hake the overage allowance is 15% and for salmon it is 10%). If they exceed their quota, they are not allowed to continue fishing unless additional ITQs are acquired to put them within their overage allowance limits. (For most species, transferability is permitted only among trawlers. However, since 2006, for some species transferability is permitted also between trawl and hook and line sector vessels.)

The six fisheries were initially segmented for management purposes. Therefore, if a halibut fisherman caught e.g. Pacific cod (deemed a groundfish trawl species for management purposes), the Pacific cod would have to be discarded. Similarly, a groundfish trawl fisherman catching halibut or sablefish would discard them. Obviously, this made no sense, neither from a biological nor an economic point of view.

The multispecies groundfish trawl ITQ scheme proved to be a great success, producing great efficiencies and improved catch data and stock management. This success, in turn, led to an integration of the six B.C. ITQ schemes, with the integration being completed in 2006 (Bjørndal & Munro, 2012).

Consider again the halibut fisherman catching Pacific cod. Rather than being called upon to discard the cod, the fisherman would, after 2006, be able to retain the cod, and to then obtain cod quota through the market. Similarly, the groundfish trawl fisherman catching halibut

[18] Source: Fisheries and Oceans Canada. Sector Catch Summary Effective Date: 24-Jan-2026 07:30:00 AM.

would be called upon to retain the halibut, and to then go to the market to obtain halibut quota (Bjørndal & Munro, *ibid*.). Thus, the six fisheries, integrated for management purposes, became de facto a large multispecies fishery.

Individual vessels may retain fish caught in excess of their quota not only by buying additional quota, but they may also apply it to the next year's ITQ. ITQ underages (up to 30% for most species) may also be transferred forward to the following year, however, this underage expires at the end of the following year and thus cannot be accumulated. Maximum overages and underages per vessel are regulated. Vessels also have individual halibut bycatch quotas, although they are not permitted to retain halibut (Grønbæk *et al*., 2022).

The successful introduction of the ITQ scheme in the multispecies groundfish trawl fishery led not only to massive increases in efficiency in that fishery, but also to greatly improved efficiencies in the hook and line fisheries.

Fleet size has been reduced from 135 groundfish trawl licenses in the mid-1990s to about 70 boats in the mid 2000 (Grafton, Nelson & Turris, 2007) to about 50 in 2021 (Grønbæk *et al.*, 2022), and according to industry sources, currently (2026) to about 30.

There is an active market in quota transfers. In the mid-2000s, there were over 2,700 transfers among 70 boats annually (Grafton, Nelson & Turris, 2007). Currently (2026), the number of transfers is about 1,300-1,400 annually, a reduction due to reduction in fleet size. These transfers, which take place mainly through private brokers, are temporary in-season transfers to address a vessel's quota needs consistent with their fishing operations (based on area, species, product type, time of year, bycatch, changing species abundance, and markets). Transferability rules are such that they aim to prevent concentration of quota as well as a desire for quotas to stay with "active" vessels. Furthermore, as mentioned above, there are limits on how much quota can be accumulated by individual boats.

The most significant change with the advent of ITQs has been in terms of fisher behaviour. The previous system was essentially what Munro & Scott (1985) classify as a Class II Common Property System with licensed vessels competing for maximum shares of the TACs. Under this system there was an incentive to fish all species in all areas. However, fishermen now specialise both in species and areas. After the introduction, nearly all of the very small and some midsize and larger boats have exited the fishery. The ones that stayed have been able to specialise in area, species and time of year, while earlier they would fish all areas throughout the year to make sure they would get some catch before the limits were reached (Grafton, Nelson & Turris, 2007). There has also been the development of "shopping lists", where vessels make shorter trips to satisfy market demand for particular species and qualities (Grønbæk *et al.,*

2021). Multispecies management has largely been arranged by vessel specialisation (Bjørndal & Munro, 2012).

Greater specialisation and quota consolidation has led to improved economic outcomes for vessels. These benefits are manifested in different ways, including increased prices (Grønbæk *et al.*, 2022). It should also be pointed out that the policy of counting discards against quota allocation has given fishers the impetus to be much more selective in their fishing practices.

Finally, let us point to another matter pertaining to the groundfish trawl fishery that is of general interest. The waters off British Columbia are home to 60 - 80 species of cold-water coral and over 300 species of sponge[19] (Wallace *et al*., 2015). Groundfish bottom trawling had a detrimental impact on sponges and corals, both in terms of damage to their habitat and in terms of incidental harvest. The sponge and coral catches of the trawlers were of no value to the vessel owners. Moreover, there were no regulations pertaining to the vessels' impact on these species. For these reasons the trawlers had no incentive to avoid sponges and corals.

With time, the seriousness of this externality increased. In 2003, the DFO implemented extensive area closures to reduce the damage by trawlers on sponge and corals. This went some way towards mitigating the problem, but it was not eliminated.

At some point, environmental non-governmental organisations (ENGOs) got involved and mounted a campaign, issuing reports on the habitat destruction caused by the bottom trawlers. This came to the attention of the Monterey Bay Seafood Watch programme, which declared the B.C. groundfish fishery unsustainable. This threatened the industry's access to the key California market. This meant that the B.C. groundfish trawl industry now had a powerful economic incentive to worry about its bycatches of sponges and corals.

In this situation, the industry, represented by the Canadian Groundfish Research and Conservation Society, approached a consortium of ENGOs with the hope of entering into discussions leading to a resolution of the problem (Wallace *et al*., 2015). The objective of the negotiations was to achieve a system that would result in a "yellow" habitat score or better from the Monterey Bay Seafood Watch and thereby secure market access.

The negotiations led to an agreement reached in 2012 with three components which was approved by the DFO and incorporated in its Integrated Fisheries Management Plan (Wallace *et al*., 2015). One component, the Habitat Conservation Bycatch Limit, means the fleet had to be subject to an annual maximum catch of sponges and corals. This annual catch represents a

[19] See Wallace *et al*. (2015) and Grønbæk *et al.* (2022) for more detail.

TAC that is allocated to the fleet as vessel quotas which are transferable. In fact, this is one of the 64 TACs referred to above.

The results of the Agreement were successful, and this has been the case ever since (Wallace *et al*., 2015). As a consequence, the B.C. groundfish fishery is now classified as sustainable by the Monterey Aquarium Seafood Watch Programme. Moreover, the fisheries were given Marine Stewardship Council classification in 2025[20]. If anything, this classification is likely to lead to more demand for seafood from this industry.

With a total catch of 995,000 in 2023, down from 1,377 tonnes in 2022[21], Iceland is one of the most important fishing nations in the North Atlantic. The reduction from 2022 to 2023 was due to the failure of the capelin fishery. While pelagic species are most important when it comes to quantities, in terms of value, cod is by far the most species. It is also important to note that Iceland was one of the first countries to introduce ITQs in their fisheries (see e.g. Arnason, 2005).

In addition to ITQs, that allow transfer of quotas among vessels, Iceland also has in place a system for catch-quota transferability for individual vessels.

Various catch-quota balancing mechanisms have been tried out in the Icelandic demersal fishery (Woods *et al*., 2015). What is particular about the Icelandic system is that for individual vessels ITQs can be "transformed" from one species to any other species. The rates of conversion are according to "cod equivalents" which are based on values in the previous year. For the 2025-26 fishing season, the cod equivalent index is by definition one for cod; for some other important species it is 0.71 for haddock, 0.61 for saithe and 0.54 for redfish. This means that e.g. 1 kg cod quota can be transformed into 1.48 kg of haddock while 1 kg of haddock can be transformed into 1.31 kg of redfish. However, there is an important exception to this: while cod quota can be transformed into quotas for other species, the reverse is not possible; thus, the only way to increase the cod quota is by leasing or buying quota from other vessels.

The quota transformations apply to the quota holdings of a vessel according to its quotas in a given fishing year. The quota shares (%) of a vessel will result in a realised quota in tonnes. Transformation thus relates to the realised quota in tonnes, not to the quota shares. As catches of say species A are realised and registered, they are taken from the pool of unused quota still available to the vessel. This pool is all the quotas summed across species still available but converted to cod equivalent units instead of kg. As a result, the quota generated for species A is removed from the pool of all species with available quota. In a sense this means that the

[20] Our proven path and dedication to certified sustainability - BC Groundfish.
[21] Source: Statistics Iceland. Catch and value of catch in 2024 - Statistics Iceland.

"source" species is not really chosen by the vessel. An implication of this system is that the TACs of some species may be overharvested.

This system of species transferability gives flexibility to the vessels. As noted, they can also lease in or buy quotas from other vessels.

3. ANALYSIS

The Danish fish pool system has worked out very satisfactorily. Overfishing by individual members within the pool is a collective responsibility and is controlled and sanctioned within the pools. There is no data showing the amount of discards, however the internal non-discarding code in the pool and the fact that more than 8,000 quota transactions take place every year is an indication that catches taken are largely covered by quota and landed. In any event the system is tailored to the reformed CFP requiring all catches to be counted, and eventually being "accurately documented", as stated in the EU Council Regulation. Current political opposition against accurate documentation of catches is partly due to inefficient quota allocation schemes in EU Member States. However, about 50% of Danish catches equivalent to approximately 35% of the landed value is now done on a voluntary basis under a REM system.

As mentioned above, one intention with the ITQ system is that it should lead to economic optimisation of the fisheries. The ITQ system has allowed the most efficient vessels to purchase quotas from the less efficient ones. As a consequence, efficiency has improved, with a great reduction in vessel numbers combined with a substantial increase in average vessel size. The same outcomes have been observed for British Columbia, as illustrated above, as well as for Iceland (Arnason, 2005).

Fish pools are interesting from two perspectives: First in terms of resource optimisation. With the fish pool system, all fish harvested count towards the quota. Several instruments can be used to optimise harvesting. Most importantly, i) fishing methods to harvest selectively, and ii) to match harvest with quotas. With fish pools one can retroactively lease-in quotas for previous non-quota harvests. Thus, pools serve as a tool to optimise the outcome of fisheries within the given fleet capacity, actually on a daily basis.

It was believed that while ITQs would function well in single species fisheries, this was not the case for multi-species fisheries (Squires *et al*., 1998). The experiences from British Columbia and Denmark prove this to be wrong. Denmark, British Columbia and Iceland all have very flexible and well-functioning ITQ systems for multispecies fisheries.

Evidence suggests that discarding has been reduced in Denmark due to the fish pool system. The same appears to be the case in British Columbia and Iceland.

The British Columbia management system shows many of the same features as the Danish in terms of vessel quota flexibility. While there are many similarities, there are also differences. In Denmark the day-to-day management operations are undertaken by fishermen themselves through cooperatives or fish pools.

Multispecies fisheries with ITQs, as well as having all the efficiencies outlined, have a great efficiency arising from the fact that such schemes increase the malleability of the produced and human capital in the fishery. Vessels and crews are not constrained to the harvesting of a single species – they may adjust their operations and adapt technology and skills if opportunities in other fisheries turn out to be better. This has been observed in British Columbia where over time many vessels have specialized in terms of species, area and season.

In a multispecies fishery, if a particular fishery resource is seen to be in difficulty, requiring a significant reduction in the TAC, the fishermen can shift to other resources provided bycatch does not become a binding constraint. It also suggests that management becomes a cooperative game where fishermen also play an active role in stock management (Bjørndal & Munro, 2012).

Transferability is essential to allow fishermen to match catches taken with a quota entitlement once the fish has been caught. However, the main challenge is to develop "precision harvesting" so that the desired catch composition is achieved in the first place. By giving the fisherman the choice of method in conducting his fishery according to the variability at sea this is an incentive for innovation and best practices. This free enterprise approach was considered in a science study[22] requested by the European Parliament. The study concluded "This approach (described by Schou, 2018) suggests relaxing REM vessels from most technical rules against the full documentation and monitoring of their catches. The main point is that catches are recorded and accounted for. This combined approach is thought to be potentially the most adequate and cost-effective way to implement the objectives of full catch accountability, moving the focus away from stringent technical rules into a more flexible management system focusing on impact and controllability".

[22] Research for PECH Committee - Landing Obligation and Choke Species in Mixed Fisheries

References

Abbott, J.K., Haynie, A.C. & Reimer, M.N. (2015). Hidden Flexibility: Institutions, Incentives and the Margins of Selectivity in Fishing. *Land Economics* 91: 169-195.

Arnason, R. (2005). Property Rights in Fisheries. Iceland's Experience with ITQs. *Reviews in Fish Biology and Fisheries* 15: 243-264.

Bertelsen, S.K., Feekings, J.P. & Storr-Paulsen, M. (2025). Untangling the net: Redefining fisheries management with fully documented fisheries. *Marine Policy* 177, 106684. https://doi.org/10.1016/j.marpol.2025.106684.

Bjørndal, T., Gordon, D.V., Arnason, R. & Sumaila, R. (2007). *Advances in the Economics of the Fishery. Festschrift in Honour of Professor G. R. Munro*. Blackwell.

Bjørndal, T. & Munro, G.R. (2012). *The Economics and Management of World Fisheries*. Oxford University Press.

Bonzon, K., McIlwain, K., Strauss, C.K. & Van Leuvan, T. (2013). Catch Share Design Manual, Volume 1: A Guide for Managers and Fishermen (2nd ed.). Environmental Defence fund.

Diamond, B. & Beukers-Steward, B.D. (2011). Fisheries Discards in the North Sea: Waste of Resources or a Necessary Evil? *Reviews in Fisheries Science* 19(3): 231-245. https://doi.org/10.1080/10641262.2011.585432

FAO (2024). *The State of World Fisheries and Aquaculture 2024 – Blue Transformation in action*. Rome.

Grafton, R.Q., Nelson, H.W. & Turris, B. (2007). How to Resolve the Class II Common Property Problem? The Case of British Columbia's Groundfish Trawl Fishery. In Bjørndal, T., Gordon, D.V., Arnason, R. & Sumaila, R.: *Advances in the Economics of the Fishery. Festschrift in Honour of Professor G. R. Munro*. Blackwell.

Grønbæk, L., Lindroos, M., Munro, G.R., Pintassilgo, P. & Turris, B. (2022). The Avoidance of Unwanted Catch and Cooperation: the Case of the British Columbia Groundfish Trawl Fishery. *ICES Journal of Marine Science* (0): 1-9. https://doi.org/10.1093/icesjms/fsac005.

Kristofersson, D. & Rickertsen, K. (2009). Highgrading in Quota-Regulated Fisheries: Evidence from the Icelandic Cod Fishery. *American Journal of Agriculture Economics* 91(2), 335-346.

Mortensen, L.O., Ulrich, C., Eliasen, S. & Olesen, H.J. (2017). Reducing discards without reducing profit: free gear choice in a Danish result-based management trial. *ICES Journal of Marine Science* 74 (5): 1469–1479. https://doi.org/10.1093/icesjms/fsw209

Munro, G.R. & Scott, A.D. (1985). The Economics of Fisheries Management. In Kneese, A.V. & Sweeney, J.L. (eds.) *Handbook of Natural Resources and Energy Economics* vol. II. Amsterdam: North Holland.

Policy Department. Directorate General for Internal Policies of the Union. Research for PECH Committee -Landing Obligation and Choke Species in Multispecies and Mixed Fisheries -The North SeaPramod et al., 2014.

Sanchirico, J.N., Holland, D., Quigley, K. & Fina, M. (2006). Catch-Quota Balancing in Multispecies Individual Fishing Quotas. *Marine Policy*, 30(6), 767-785.

Schou, M. (2019). Barriers and Solutions to Full Catch Accountability in the Common Fisheries Policy. Available on cfp_barriers_and_opportunities_rev1.pdf

Squires, D. et al. (1998). Individual Transferable Quotas in Multispecies Fisheries, *Marine Policy* 22(2).

Wallace, S., Turris, B., Driscoll, J., Bodtker, K., Mose, S. & Munro, G.R. (2015). Canada's Pacific groundfish trawl habitat agreement: A global first in an ecosystem approach to bottom trawl impacts. *Marine Policy* (60): 240-248.

Woods, P.J., Holland, D. S., Marteinsdo´ttir, G. & Punt, A.E. (2015). How a catch–quota balancing system can go wrong: an evaluation of the species quota transformation provisions in the Icelandic multispecies demersal fishery. *ICES Journal of Marine Science* 72: 1257–1277.

World Bank (2017). The sunken billions revisited: progress and challenges in global marine fisheries (English). Environment and Sustainable Development series. Washington, D.C.: World Bank Group. http://documents.worldbank.org/curated/en/347431487184280381.

Management of mixed fisheries is challenging. This is particularly the case because current harvesting tools are largely based on single species management with overall and individual quotas set stock by stock. As harvest quantities may not be aligned with quotas, this may give rise to choke species, high-grading, discarding and IUU fishing. Challenges are typically compounded by heterogeneous fishing fleets. In this article we analyse this issue in the context of Danish demersal fisheries. A particular feature of the management of mixed fisheries in Denmark is fishermen's cooperatives, known as fish pools. These are essentially fishermen's cooperatives and play a crucial role in establishing a flexible transferability mechanism.

SNF

Samfunns- og næringslivsforskning AS
Centre for Applied Research at NHH

Helleveien 30
NO-5045 Bergen
Norway

P +47 55 95 95 00
E snf@snf.no
W snf.no

Trykk: MAKE!Graphics - avd. Bergen