

Paper X

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Cod in Faroese Waters.

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S. H. í Jákupsstovu, J. Reinert and P. Steingrund: Cod in Faroese waters

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Introduction

There are two self-contained cod stocks within Faroese waters (Figure 1). One is on the Faroe Plateau and the other on the Faroe Bank; both are fished in a multi-fleet and multi-species fishery. The fisheries regulation in force in Faroese waters, which is a combination of access limitation, technical measures, closed areas and effort limitations, is primarily aimed at regulating the demersal fisheries in Faroese waters, especially the fisheries for cod, haddock and saithe.

This paper offers descriptions of the life history of the Faroe Plateau cod stock, the fisheries for cod and the regulatory regime.

Cod stock characteristics

The two stocks of cod in Faroese waters are regarded as two separate management units. This concept is supported by numerous tagging studies, (Jákupsstovu and Reinert, 1994; Steingrund, unpublished material), which have shown that only about 1 in 1000 cod tagged and released are recaptured outside the area of tagging, *i.e.* the two stocks are stationary. Morphometric, biometric and biochemical studies also support the existence of two separate stocks (Jákupsstovu and Reinert, 1994). Joensen *et al.* (2000) were also able to demonstrate significant differences in the fatty acid compositions of the two stocks. Recent tagging experiments also suggest that the majority of cod on the western parts of the Faroe-Icelandic ridge within Faroese waters (which is considered as Vb1 – Faroe Plateau) are of Icelandic origin (Steingrund, unpublished data).

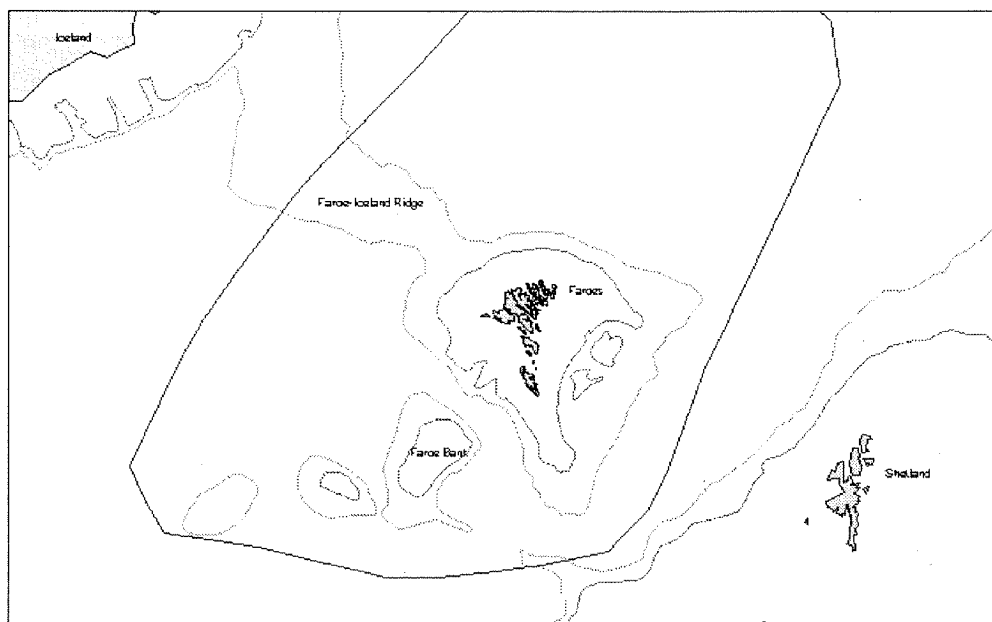


Figure 1. Map showing the Faroese waters.

The Faroe Plateau cod, however, constitute by far the majority of the cod landed from the Faroe area, and as this is the only cod stock where an age-disaggregated stock assessment is available, we will deal only with this stock in this paper.

There are two main spawning grounds on the Faroe Plateau: one north of the Faroe Islands and one to the west (Figure 2.). There are also other smaller spawning areas. The depths of these spawning areas range from 80 to 140 m. Extensive tagging experiments in recent years (Steingrund, unpublished data) suggest the existence of sub-populations, as cod from the eastern and northern area spawn on the northern spawning site, whereas cod from western and southern areas mainly spawn on the western spawning site. Spawning begins in late February and ends in April, the peak being in late March. After spawning, cod migrate back to their original feeding sites. Cod mature in three to four years, at a length of 52-60 cm (Fig. 3). Cod smaller than 70 cm are mainly found in shallow waters (< 200 m) whereas larger fish are found in deeper areas as well. Their main prey in shallow water are sandeels (*Ammodytes spp.*) and benthic crustaceans such *Hyas coarctatus*, *Galathea spp.*, *Pagurus spp.*, shrimp (Pandalidae), and swimming crabs (Portunidae). In deeper waters, fish like Norway pout (*Trisopterus esmarkii*) and blue whiting (*Micromesistius poutassou*) dominate as food sources. Benthic crustaceans like *Munida spp.* are also important (Faroese Fisheries Laboratory, unpublished data). Calculations of production suggest that cod larger than 30 cm normally are in the third trophic level (Steingrund and Gaard, *submitted*).

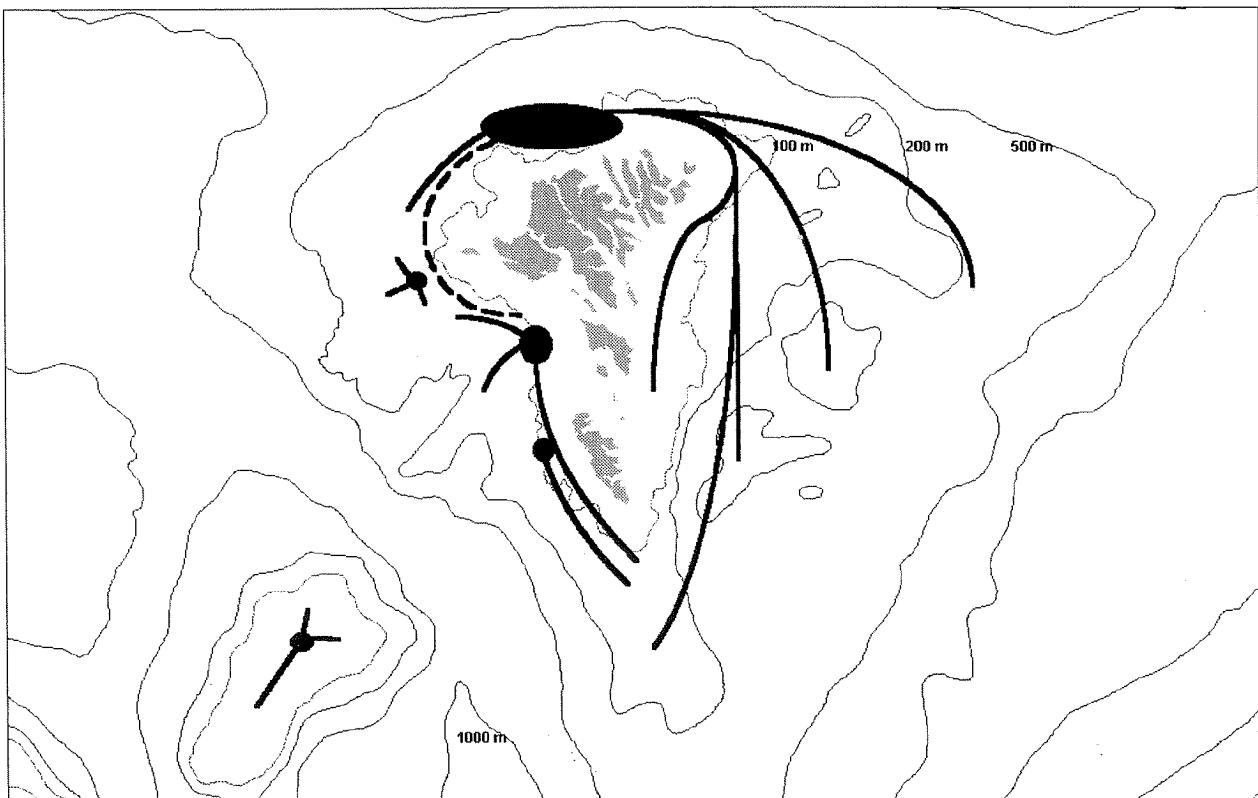


Figure 2. The main spawning areas of cod on the Faroe Plateau. Migration routes to and from the spawning areas are shown. Dashes indicate minor routes.

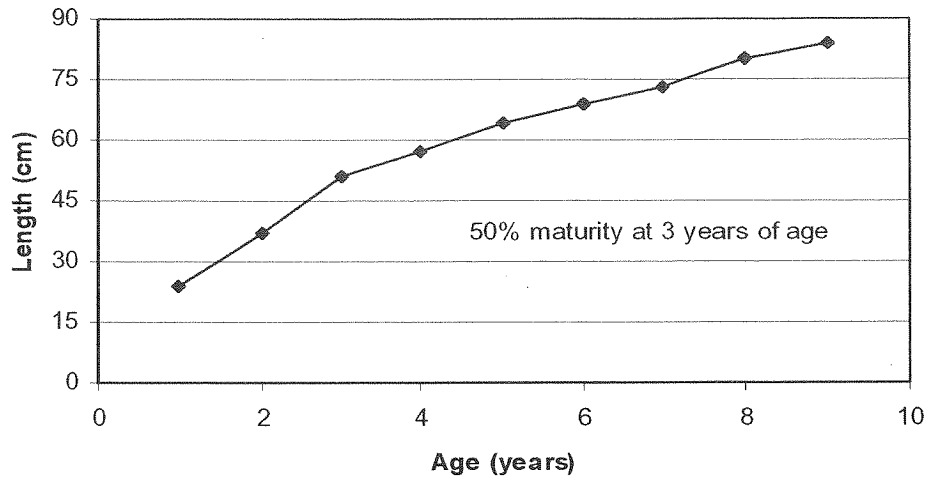


Figure 3. Mean length at age for Faroe Plateau cod; 50 % maturity at three years of age is indicated.

History of the fishery

Landing statistics are available back to 1903 (Figure 4). English and Scottish vessels (trawlers) took the majority of the catch up to the 1960s. In 1977, the 200 nm EEZ was introduced, and since then Faroese vessels have dominated the cod landings, which (ICES statistical areas Vb1+Vb2) have fluctuated between 6 000 and 45 000 tonnes a year (excluding 1903-1905), the average being around 25 000 tonnes. There was a slight drop in the landings during the First World War 1914-1918, but landings fell to 12 000 tonnes in 1921. In 1923-1937 landings were high (more than 25 000 tonnes) but during the Second World War (1939-1945), landings dropped below 10 000 tonnes. After a long period of regular fluctuations between 20 and 40 000 tonnes, landings fell below 10 000 tonnes during 1991-1994. These low catches added significantly to the severe financial crisis, which occurred in the same period in the Faroe Islands. Landings have since reverted to the traditional pattern.

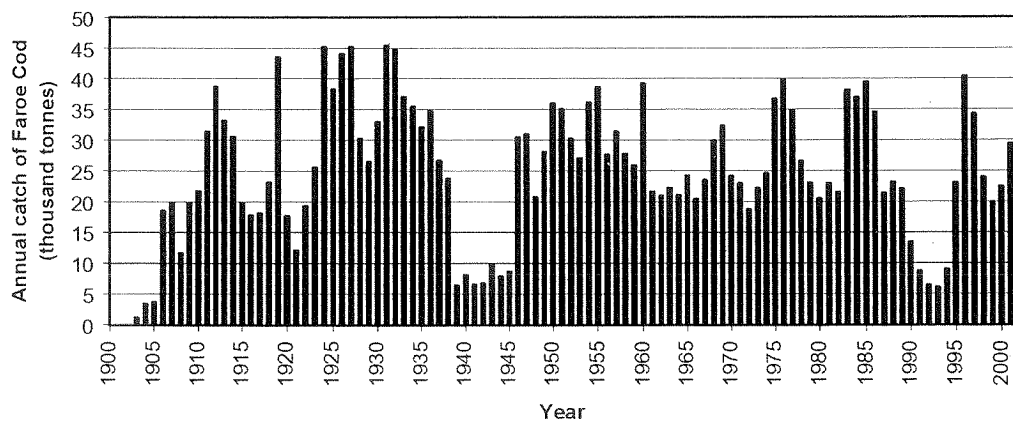


Figure 4. Landings of cod from the Faroe area 1903-2002. For the period 1903 –1960, Faroe Bank and Faroe Plateau statistics are combined; for 1961-2002 the statistics are from the Faroe Plateau only.

The stock size decreased during the 1920s and 1930s as indicated by catch per unit effort (CPUE) series (Jákupsstovu and Reinert, 1994). After the Second World War, CPUE indices were very high, but they fell rapidly during the 1950s to their lowest level around 1960 (Jákupsstovu and Reinert, 1994). Results of the analytical assessments (available from 1961)

(Figure 5) indicate that stock sizes increased until the mid-70s, but decreased after the introduction of the EEZ. After a rise at the beginning of the 80s, the stock size decreased steadily to 1992 when the spawning stock biomass reached its lowest level ever assessed at around 20 thousand tonnes. The stock size increased spectacularly from 1992 to 1995 due to good recruitment and growth, which is also the current situation.

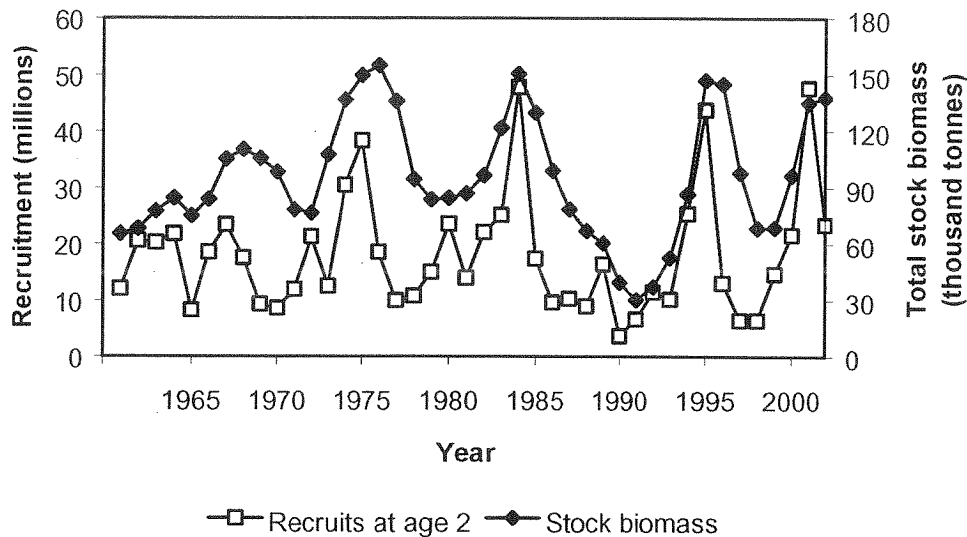


Figure 5. Total stock biomass and recruitment of Faroe Plateau cod (ICES, 2003).

Since 1990, primary and secondary production on the Faroe Plateau has been monitored annually (Gaard, *et al.*, 1998). From these studies, it is apparent that the fluctuations in the cod stock are linked to productivity in the Faroe Plateau area (Gaard, *et al.*, 2002; Steingrund and Gaard, *submitted*). When the production of phytoplankton is high, there is high production of cod in the following 12 months, which is demonstrated by good recruitment of two-year-old cod, as well as rapid growth of older cod. Thus, recruitment and growth appear to be positively related to phytoplankton production.

History of the management system

Before 1977 (introduction of the 200 nm EEZ), there was no formal regulation of the demersal fisheries in the waters around the Faroe Islands. However, 12 nm limits for trawl fishery and for non-Faroese vessels had been introduced. The fleets, Faroese and foreign, moved freely to other areas when catches in Faroese areas were low. Most other Faroese fisheries also took place outside Faroese waters, *i.e.* off Iceland, in the Barents Sea, near Greenland, in the Western Atlantic from the Gulf of Maine to Labrador and in the North Sea.

With the general extensions of national fishery limits, a large part of the Faroese fishing fleet reverted to fishing within the Faroese 200 nm limit.

It quite soon became apparent that the area was unable to support this increased effort, and during the 1980s the Faroese authorities attempted to regulate the fishery and investment in fishing vessels. In 1987, a system of fishing licenses was introduced, and, in addition, regulation of capacity was attempted by technical measures such as minimum legal mesh sizes, permanent and temporarily closed areas for trawling, an import ban on fishing vessels and buy-back of fishing licenses.

Following the deep crisis in the fisheries in the late 1980s and early 1990s, the need for stricter measures was realised, and in 1994 a system with TACs was introduced for the

main demersal stocks, viz. cod, haddock, saithe and redfish. There was deep scepticism on the part of fishermen and many politicians regarding the practicality of a quota system in a multi-fleet and multi-species fishery. The bycatch problem was also difficult to manage via regulation. Furthermore, an unexpectedly good recruitment of cod from the 1992 and 1993 year classes, combined with higher availability and catchability of older cod than foreseen in the assessments, made the bycatch problem so large that the system had to be abandoned in 1996.

A new system, a transferable (within fleets) effort quota system, was introduced on 1 June 1996. The system was planned in co-operation with various groups of fishermen, long-liners, trawler operators, coastal fishermen, etc., the Fisheries Laboratory and the Fisheries Ministry. Finally, with some amendments and the introduction of wider area closures in the political process, the new system came into force and is still working. The following paragraphs attempt to describe the whole range of regulations of the demersal fisheries in Faroese waters.

All vessels fishing in Faroese waters need a license to fish, and they are grouped into several fleet categories. The main fish stocks, which the regulation process attempts to protect, are cod, haddock and saithe. In addition, there are special regulations for the gillnet fishery for Greenland halibut, anglerfish, and the trawl fishery for lemon sole and plaice and greater silver smelt. There are also special mesh size allowances for directed fishery for black scabbard fish and blue ling.

The demersal fishing fleet

The fishing fleet is comprised of several groups of vessels that use trawls, on the one hand, and passive gear, such as hand-line/jigging, long line and gill nets, on the other.

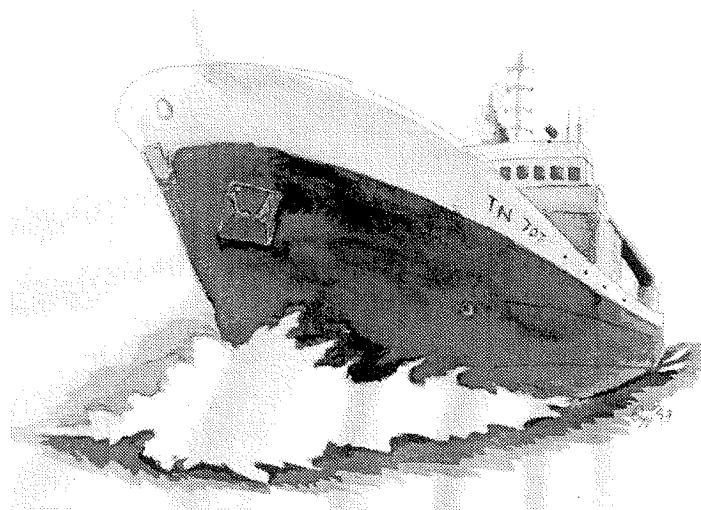


Figure 6. *Brestir* is one of the larger demersal single trawlers.

The larger stern trawlers (in total 13) operate as single trawlers (Figure 6). They are usually powered by engines of more than 1000 HP and fish mainly in deeper waters. The vessels are not regulated by the effort quota system, but are allowed an annual quota of 100 tonnes of cod and 100 tonnes of haddock on the Faroe Plateau. Their main targets are redfish, saithe, cod on the Faroe-Iceland Ridge, which is not under the regulation; blue ling, black scabbard fish, grenadiers and other deep-water fish species.

The pair trawlers (31 licenses) are all powered by engines of more than 400 hp (Figure 7). These vessels are regulated by the effort quota system and operate on the Shelf proper with saithe as their main target species. However, depending on availability, they also have significant bycatches of cod and haddock.

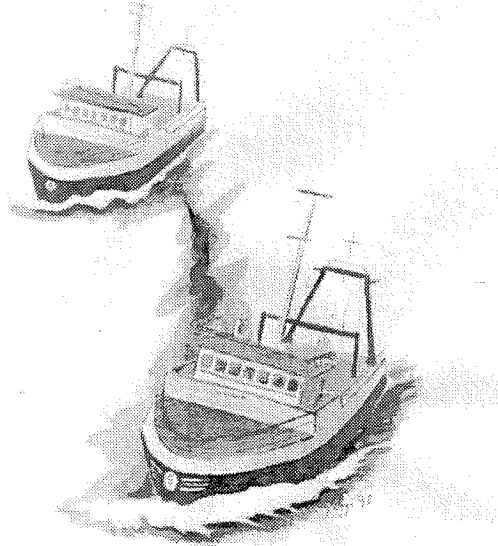


Figure 7. The "Cuba" trawlers operate as pair-trawlers

The long-liners (19 licences) are larger than 110 GRT (Figure 8). These vessels are regulated by the effort quota system, and operate all over the Shelf and on the Faroe Bank, targeting cod and haddock and, off the Shelf, tusk and ling.

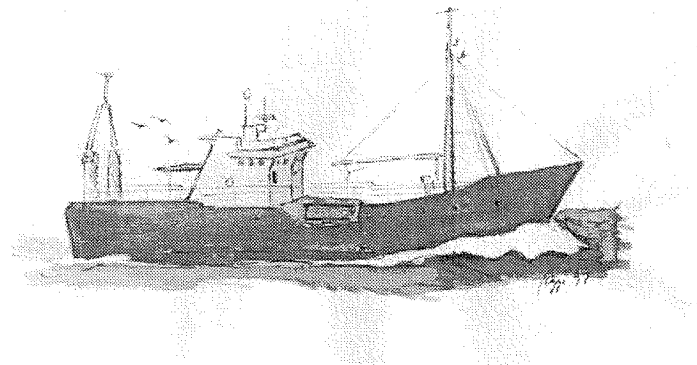


Figure 8. *Mascot* is a typical Faroese long-liner.

The coastal long-liners and jiggers between 15 and 110 GRT (Figure 9) are 72 in total. They operate mainly on the Shelf and on the Faroe Bank, targeting cod and haddock and are regulated by the effort quota system.

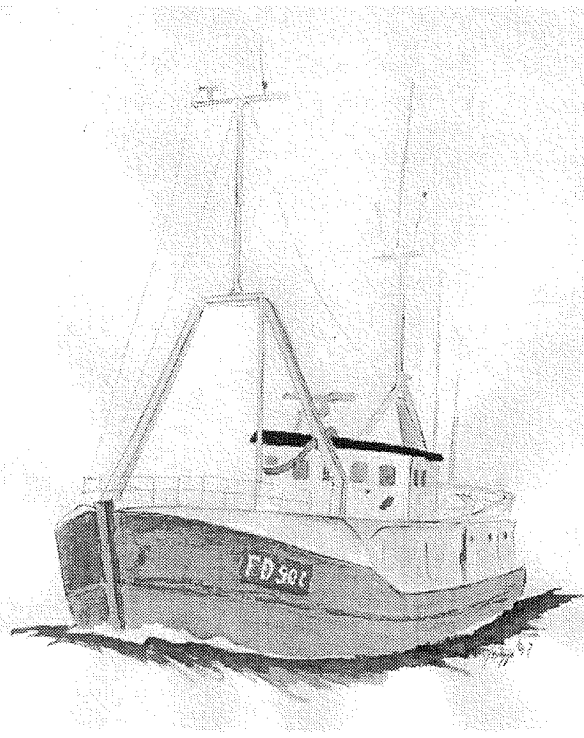


Figure 9. *Hovnin* is a traditional coastal long-liner. Some of this group of vessels also operate as single trawlers

Single trawlers powered with engines of less than 400 HP total 14. These vessels operate on the Plateau only. Their main targets are cod and haddock; however, they also fish for anglerfish and other demersal species. They are regulated by the effort quota system. During the summer, 11 of these vessels are specially licensed to fish lemon sole and plaice within specified areas inside the 12 nm limit. However, this has to be done within their effort quota. Coastal long-liners and jiggers of less than 15 GRT are divided into two groups. There are 179 full-time fishing vessels and they are allocated individual effort quotas. Part-time fishing vessels (in total 1,040) have a combined effort quota. This fleet, which fishes mainly for cod and haddock on the Shelf, comprises a variety of different types of boats - from the traditional Faroese open boats (Figure 10) to sophisticated high-powered fibreglass boats equipped with automatic baiting devices.

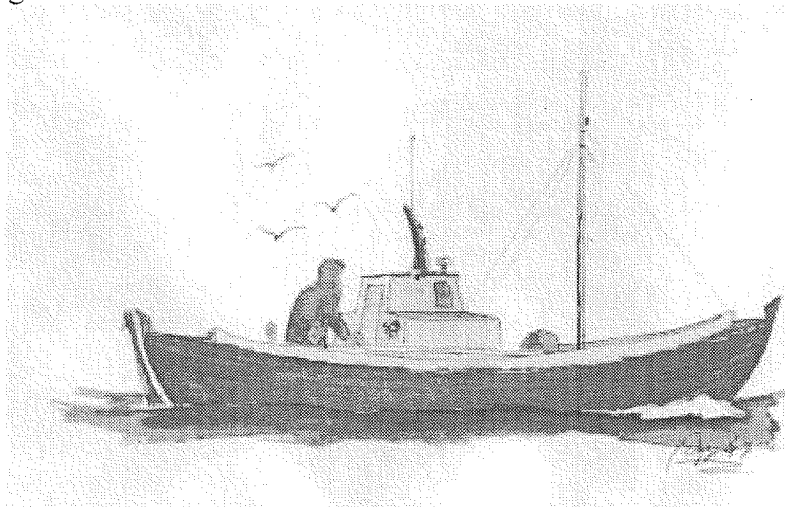


Figure 10. A traditional Faroese open boat used for hand-line, jigging and shorter long-lines.

Gill-netters A few vessels have special licenses for gillnetting Greenland halibut and anglerfish. In these fisheries, there are stipulations on the number of nets operated, and on bycatch of non-target species.

The effort quota system

As mentioned earlier, the catch quota management system introduced in the Faroese fisheries in 1994 was not very successful and resulted in substantial misreporting of catches. As a result, the Faroese Parliament adopted, in close co-operation with the fishing industry, a new system based on individual transferable (within fleet categories) effort quotas measured in days. The new system entered into force on 1 June 1996.

The within-fleet category individual transferable effort quotas apply to:

- *Pair trawlers*
- *Long-liners larger than 110 GRT*
- *Long-liners of less than 110 GRT*
- *Jiggers and single trawlers of less than 400 HP*
- *Long-liners and jiggers of less than 15 GRT*

The single trawlers larger than 400 HP are not subject to effort limits, but are not allowed to fish within the 12 nm limit and in the areas closed for trawling outside this limit. Their fishery for cod and haddock is limited by maximum bycatch allowances of 4% and 1.75%, respectively. In addition, in the present fishing year, they are allowed individual catch quotas of 100 tonnes each of cod and haddock on the Plateau. The single trawlers < 400 HP are given special licenses to fish inside 12 nm, targeting lemon sole and plaice with bycatch allowances of 30% cod and 10% haddock (Table 1).

Group no	Fleet category	1996/1997	1997/1998	1998/1999	1999/2000	2000/2001	2001/2002	2002/2003	No of licenses
1	Single trawlers > 400 HP	Regulated by area and bycatch limitations only							13
2	Pair trawlers > 400 HP	8225	7199	6839	6839	6839	6839	6771	31
3	Longliners > 110 GRT	3040	2660	2527	2527	2527	2527	2502	19
4	Longliners and jiggers 15-110 GRT. Single trawlers < 400 HP	9320	9328	8861	8861	8861	8861	8772	86
5	Longliners and jiggers < 15 GRT	22000	2365	22444	22444	22444	22444	22220	1219
	Gillnetters Greenland halibut	Regulated by area, no. of nets and bycatch limitations only							
	Gillnetters Angler fish	Regulated by area, no. of nets and bycatch limitations							

An integral part of the regulations is the system of closed areas. Some of these are closed for trawling either throughout the year or for parts of the year and some are spawning areas closed for all fisheries during the spawning season. An overview of the closed areas is shown in Figure 11, and the timings in Table 2. However, no areas are protected from all fishing during the whole year.

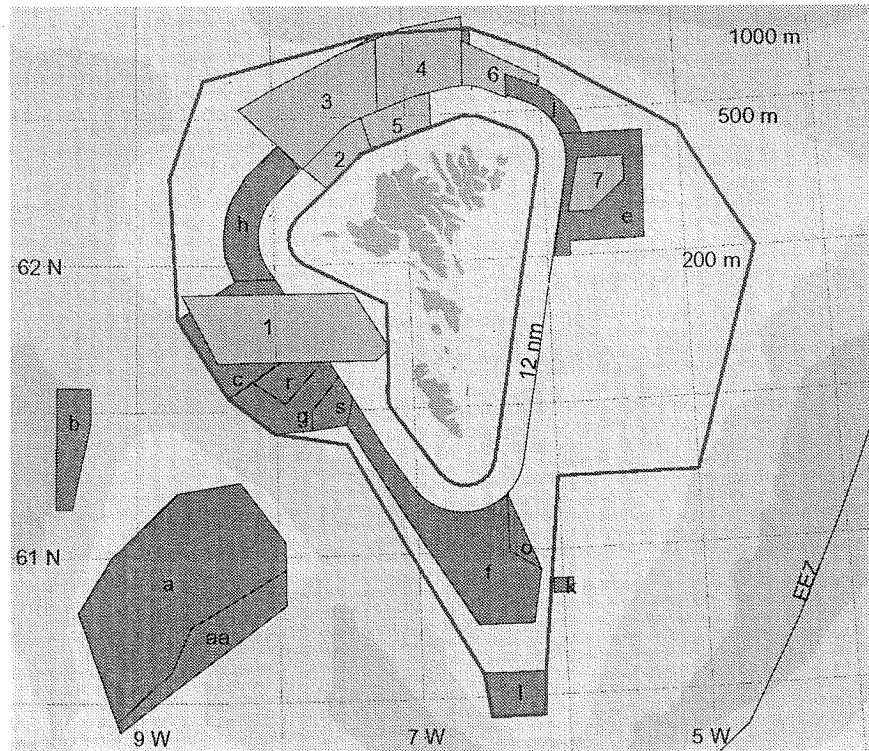


Figure 11. The closed areas in Faroese waters.

Table 2. Timings of the area closures.

Closed areas to trawlings

Areas inside the 12 nm zone closed year round

Area	Period
a	1 jan- 31 des
aa	1 jun - 31 aug
b	20 jan- 1 mar
c	1 jan- 31 des
d	1 jan- 31 des
e	1 apr- 31 jan
f	1 jan- 31 des
g	1 jan- 31 des
h	1 jan- 31 des
i	1 jan- 31 des
j	1 jan- 31 des
k	1 jan- 31 des
l	1 jan- 31 des
m	1 feb- 1 jun
n	31 jan- 1 apr
o	1 jan- 31 des
p	1 jan- 31 des
r	1 jan- 31 des
s	1 jan- 31 des

Spawning area closures

Area	Period
1	15 feb-31 mar
2	15 feb- 15 apr
3	1 feb- 1 apr
4	15 jan- 15 mai
5	15 feb- 15 apr
6	15 feb- 15 apr
7	15 jan- 1 apr

Holders of individual transferable effort quotas who fish outside the thick line encircling the shallower parts of the Faroe Plateau, an area where cod and haddock are normally found, can fish for three days for each day allocated within the area. One fishing day by long-liners smaller than 110 GRT is considered to be equivalent to two fishing days for jiggers in the same gear category. Therefore, long-liners of less than 110 GRT (and single trawlers < 400 HP) may double their allocations by converting to jigging. The effort quotas are transferable within gear categories.

In addition to the number of days allocated, the law also states what percentage of the total catches of cod, haddock, saithe and redfish each fleet category on average is allowed to fish (Table 3).

Table 3. The percentage catch by species and fleet group aimed at in the regulation.

Fleet category	Cod	Haddock	Saithe	Redfish
Long-liners < 110 GRT, jiggers, single trawl < 400 HP	51	58	17.5	1
Long-liners > 110 GRT	23	28	0	0
Pair-trawlers	21	10.25	69	8.5
Single trawlers > 400 HP	4	1.75	13	90.5
Others	1	2	0.5	0.5

The calculations of fishing days was based on:

- 1) a reappraisal of the North Western Working Group (NWWG) assessment of the demersal fish stocks in Faroese waters (ICES, 1995, Maguire, *et al.*, 1995); and
- 2) the goal that the allocation of the number of fishing days by fleet categories, together with other regulations of the fishery aimed at ensuring an average fishing mortality on each of the three stocks of 0.45, should result in catches corresponding to average annual catches of 33% of exploitable stocks.

Built into the system is an assumption that the day system is self-regulatory, on the expectation that the fishery will move between stocks according to the relative availability of each of them, thus preventing any stock from being overexploited.

Mesh size regulations. A general minimum legal mesh size of 145 mm stretched mesh is in force. However, for directed fisheries for fish species other than cod and haddock exceptions are allowed under bycatch stipulations and in some cases also area restrictions.

Juvenile protection in addition to mesh size regulations is attempted by means of short-term closures of areas with high concentrations of juvenile fish.

The performance of the effort quota system

In this discussion, the main emphasis will be on the performance of the system with respect to the cod stock.

An inherent feature of any effort regulation scheme is the incentive to overinvest in vessels and gear in order to maximise the catch by a given effort. There is no system at present in place for monitoring the efficiency of individual vessels, and it is therefore impossible to quantify any changes in the fleet's current overall efficiency relative to 1996. There has been some modernisation of older vessels and replacement by new vessels, and there may also be a better utilisation of the available number of fishing days. At present, it is impossible to quantify the effects of this on overall capacity.

The fishing mortality estimates by the North Western Working Group for cod on the Faroe Plateau for the period 1983-2002 are shown in Figure 12 as F_{3-7} and F_{3-6} .

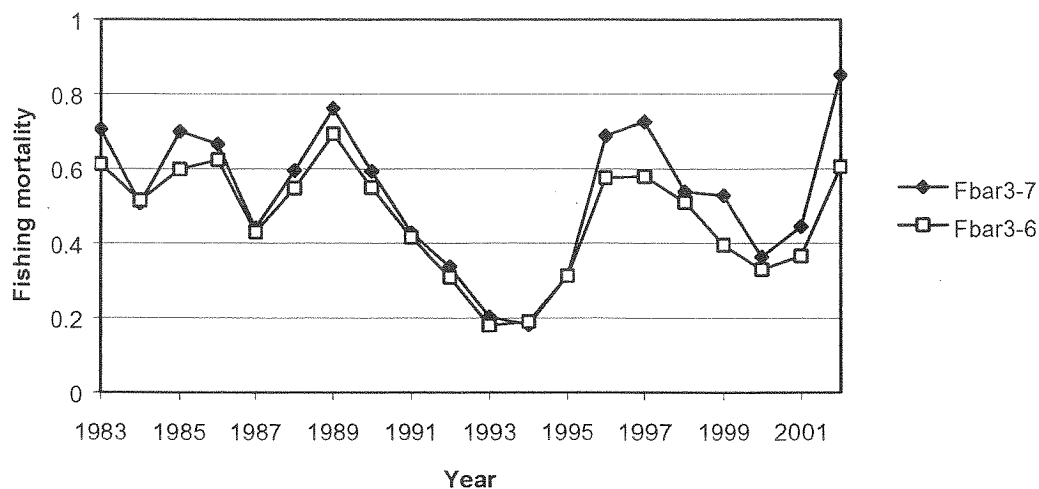


Figure 12. Average fishing mortality on Faroe Plateau cod 1983-2002.

The low recruitment in the late 1980s and the simultaneous high effort significantly reduced the fishable stock, with the result that the profitability of the fishery and the effort declined. At the peak of the crisis in 1992 and 1993 the F of cod was only 0.2. Following the recovery, the F increased again, but apparently with wide fluctuations and at a lower level than before (Table 4).

Table 4. Average fishing mortality (F_{3-6} and F_{3-7}) for Faroe Plateau cod for 1983-1990 and 1995-2002.

	1983-1990	1995-2002
F_{3-7}	0.62	0.56
F_{3-6}	0.57	0.46

The catch control rule of $F=0.45$ refers to the age group of three- to seven-year-olds. Due to the relatively few seven-year-old cod found in the catches, however, the fishing mortality on this age group is poorly defined, and the $F_{bar\ 3-6}$ is therefore presented as well.

From Figure 12 and Table 4, it can be seen that the average fishing mortality of cod has been higher than that intended by the Faroese Government. In recent years, the NWWG overestimated the F 's on the three- to seven-year-olds, and in the most recent years, the average F (in Table 3) might be an overestimate. It is unlikely, however, that any corrected value would be as low as 0.45.

Biological reference points were established by ICES in 1998, on the basis of the report of the Study Group on the precautionary approach (ICES 1997). These reference points are presented in Table 5. According to these values, the present F of cod is significantly above F_{pa} and also above the stipulated target.

Table 5. Biological reference points set by ACFM (ICES, 2003)

B_{lim} is 21,000 t, the lowest observed biomass	B_{pa} be set at 40,000 t
F_{lim} is 0.68	F_{pa} be set at 0.35

The NWWG (ICES, 2003) stated that "over the period covered by the assessment, fishing mortality has been equal to or less than the proposed F_{pa} in only 6 of 40 years of available data. This suggests that $F_{pa} = 0.35$ may be overly conservative". However, the Working Group agrees with the SG on Precautionary Reference Points for Advice on Fishery Management (SGPRP – February 2003) that there is no basis to change the existing B_{lim} for Faroe cod.

The main closed areas forbid trawling within the areas. However, fishery with hook and line is permitted. In addition, there are spawning season closures that forbid all fisheries during defined periods. The area closure system was significantly increased with the introduction of the new regulatory system. The impact of the closed areas on the stocks and fisheries has been modelled by Zeller and Reinert (2003) and is currently being studied in more detail. Violations of the closed area system have been claimed. However, satellite monitoring of all large fishing vessels introduced in 2003 aims to reduce this problem

Pope (2000) examined changes in stock sizes and price and could not find relationships that would support the hypothesis that the economics of the fishery would prevent overfishing of the stocks by shifting the fishing effort to the most abundant species. The number of days fished by gear category since 1985 is presented in Table 6.

	Long-liners 0-110 GRT, jiggers, trawlers < 400hp	Long-liners <110 GRT	Pair-trawlers > 400 HP
Average 85-95	22333	3023	10778
1998	23971	2519	6209
1999	21040	2428	7135
2000	24820	2414	7167
2001	29560	2512	6771
2002	30333	2680	6749
Average 98-01	25945	2511	6806

As this table gives the number of days used on an annual basis rather than on the basis of fishing year, it is not possible to compare the number of days used with the number of days allocated. While the number of days used has decreased in the period 1998-2001 in comparison with 1995-1998, the number of days used by the smaller vessels has increased.

Comparing the fishing mortality on cod, haddock and saithe during the period 1993-2002 (Figure 13) the F of cod increased from a low level in the early 1990s to values above 0.5 in the period 1996-1998. This was followed by lower F values in the following three years, but a significant increase in 2002. However, as mentioned above, this might be an overestimate. The F values for haddock similarly increased from a low level of less than 0.2 in the early 1990s to peak values in 1998-1999 of above 0.5, but have decreased somewhat since. The fishing mortality of saithe decreased from 0.4-0.5 in the early 1990s to about 0.3 in the period 1997-1998, but has since increased to 0.4-0.5.

These variations reflect, to a certain extent, the variations in the state of the stocks. Stocks of cod and haddock were at low levels in the early 1990s, and the fishery by the larger vessels and pair trawlers was targeted at saithe. Very good recruitment of cod and haddock increased stocks to high levels in the latter half of the 1990s, when the saithe stock at the same time was at a low level. The effort on the stocks switched accordingly. In later years, recruitment to all three stocks has been good. The fishing mortality of cod varies more than that of haddock and saithe. This is most probably due to increased effort on cod on the part of the coastal fishing vessels, which increase their effort significantly when large year-classes of cod recruit to the fishery. This was particularly the case in 1996, 1997 and 2002. The catchability factor of long line for cod also appears to have varied significantly with the availability of food for cod (Steingrund, *unpublished data*).

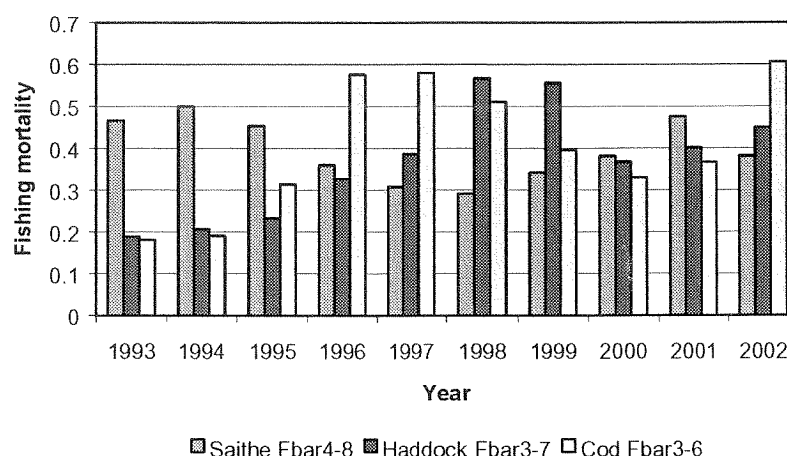


Figure 13. The fishing mortality on cod, haddock and saithe for the period 1993-2002

Concluding remarks

The benefits of the effort quota system in Faroese waters are:

- A. The system has a high degree of legitimacy, as it was designed in co-operation with the industry.
- B. All fish caught, apart from undersized fish, are legal and can be landed. There is little temptation to legally or illegally discard fish, as in a TAC system. All discarding of fish is forbidden by law.
- C. Reliable catch statistics.

The drawbacks of the system are:

- A. The system encourages over-investment in vessels and vessel capacity in order to increase the catch obtained by any given effort.
- B. The system invites fishermen to focus on the size of the catch rather than on its value.
- C. The fishing industry and the politicians are very reluctant to decrease the number of fishing ays. This may lead to a gradual build up of a large surplus capacity, which would then have to be reduced in larger steps.

In addition to traditional fish stock assessment there is a need for better monitoring of the fishing capacity.

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See PowerPoint presentation on enclosed CD.

