VOLUME 4

1 The Faroe Plateau Ecosystem

1.1 Ecosystem overview

1.1.1 Ecosystem components

Topography, water masses, and circulation patterns

The Faroes are situated on a submarine ridge, which extends from Greenland, over Iceland, to Scotland (Figure 1.1.1.1, left panels). This ridge separates the Atlantic Ocean southwest of the ridge from the Norwegian Sea to the northeast. The sill of the ridge reaches different depths in different areas. Most of it is shallower than 500 m, but a small part is deeper with the Faroe Bank Channel being the deepest passage across the ridge.

The upper layers of the waters surrounding the Faroes are dominated by 'Modified North Atlantic Water' which derives from the North Atlantic Current flowing towards the east and north-east (Hansen and Østerhus, 2000) (Figure 1.1.1.1, upper left panel). This water is typically around 8°C and salinities around 35.25.

Deeper than 500–600 m (Figure 1.1.1.1, lower left panel) the water in most areas is dominated by cold (T<0°C) with salinities close to 34.9.

In shallow regions, there are strong tidal currents which mix the shelf water very efficiently. This results in homogeneous water masses in the shallow shelf areas. The well-mixed shelf water is separated relatively well from the offshore water by a persistent tidal front, which surrounds the shelf at about the 100- to 130-m bottom depth. In addition, residual currents have a persistent clockwise circulation around the islands.

The Shelf-front provides a fair, although variable, degree of isolation between the on-shelf and the off-shelf areas. This allows the on-shelf areas to support a relatively uniform shelf ecosystem, which in many ways is distinct from off-shelf waters. The ecosystem has distinct planktonic communities, benthic fauna, and several fish stocks. Furthermore, about 1.7 million pairs of seabirds breed on the Faroe Islands and take most of their food from the shelf water.

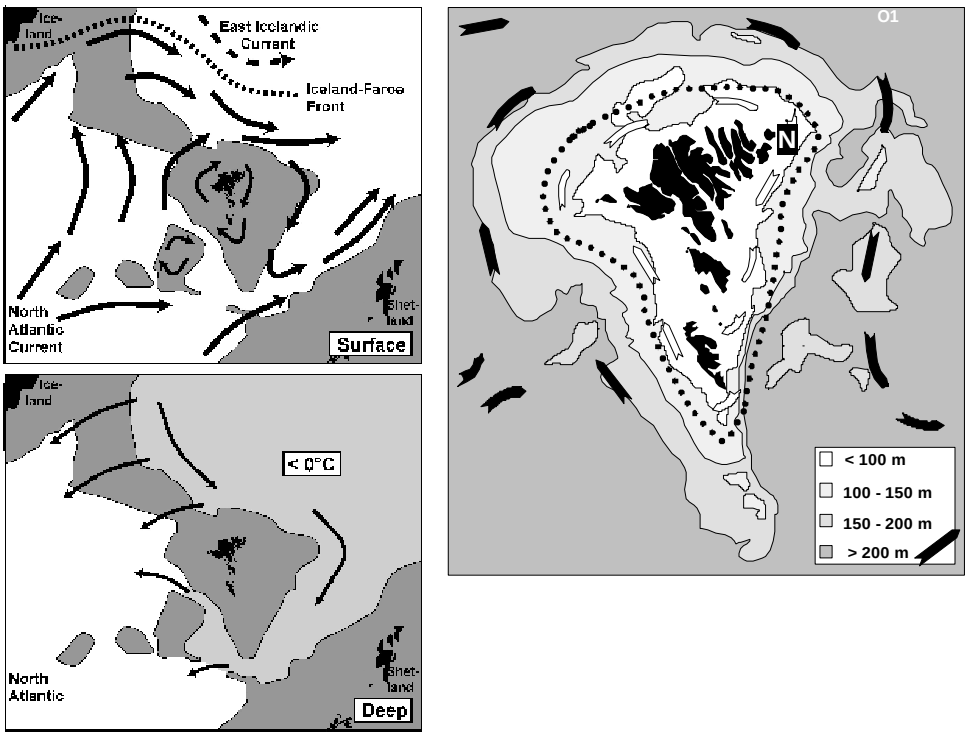

Figure 1.1.1.1 Bottom topography, circulation and water masses at the surface (top left panel), at depths greater than about 500 m (bottom left panel) in the area around the Faroes and on the Faroe shelf (right panel). Dashed lines indicate fronts.

Phytoplankton

These three regimes (well-mixed, frontal, and stratified) give different conditions for primary production. While the shallow well-mixed part is relatively well studied, little is known about production cycles in Faroese waters, and their dependence on the variable weather conditions in the two other regimes in the region.

One distinguishing feature is a typical earlier establishment of the spring bloom on the shelf than off-shelf, but observations (Gaard, 2003; Hansen *et al.*, 2005) have shown that the timing and intensity of this bloom can vary very much from one year to another.

In most years the phytoplankton community on the shelf is dominated by diatoms. However, in summers with low nutrient concentrations, smaller flagellates may take over (Gaard *et al.*, 1998).

Most of the new primary production on the shelf is between May and July. There has been observed high interannual variability in potential new primary production (Gaard, 2003). From 1990 to 2004 this new primary production (from spring to mid-summer) has fluctuated by a factor ~5 (Figure 1.1.1.2).

A characteristic feature of this variability is a high correlation between the onset and intensity of new primary production. In years with an early spring bloom, the total new primary production from April to late June may be several times greater than in years with a late spring bloom development (Gaard, 2003; Hansen *et al.*, 2005). It has furthermore been observed that this high variability is transmitted quickly upwards through the food chain (See later sections in this document).

The mechanisms controlling the primary production on the shelf are not well understood. However, recent modelling studies indicate that the variable exchange rate between on-shelf and off-shelf waters may be a main controlling factor for the timing and intensity of the spring bloom (Hansen *et al.*, 2005).

The index for 2004 is close to the 1990–2004 average (Figure1.1.1.2).

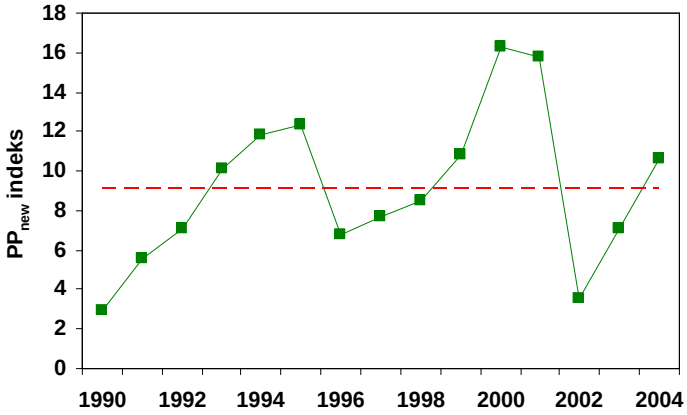

Figure 1.1.1.2 Index of new primary production from spring to mid-summer on the Faroe shelf since 1990. The horizontal line represents the average primary production index during the 1990–2004 period.

Zooplankton

While the zooplankton community outside the shelf front is largely dominated by the copepod *Calanus finmarchicus*, the shelf zooplankton community is basically neritic (shelf related species). During spring and summer the zooplankton in the shelf water is largely dominated by the copepods *Acartia longiremis* and *Temora longicornis*. *C. finmarchicus* is advected from off-shelf and occurs in interannually, highly variable abundance in the shelf water. Usually the abundance of *C. finmarchicus* is highest in spring and early summer. Meroplanktonic larvae, mainly barnacle larvae, may also be abundant, and decapod larvae and fish larvae and juveniles are common on the shelf during spring and summer (Gaard, 1999).

Reproduction rates of copepods depends largely on their feeding conditions and co-occurring fluctuations have been observed between phytoplankton abundance and copepod egg production rates, abundance, and composition.

Fish community

A total of 170 fish species are found in Faroese waters. Many of these species occur, however, in low abundance and are not exploited. Of the demersal species, saithe, cod, and haddock are the most abundant. Other common species are monkfish, Norway pout, ling, tusk, redfish, Greenland halibut, blue ling, and other. Most of these species spawn locally; however, some species (e.g. redfish and Greenland halibut) have their spawning grounds outside the Faroese area and apparently are common stocks over large parts of the Northeast Atlantic. An overview of typical depth distribution of the main species in offshore and shelf areas (deeper than 65-m bottom depth) is shown in Figure 1.1.1.3.

Of pelagic fish blue whiting is the most abundant. After spawning to the west of the British Isles in early spring, they start their feeding migration further north into the Norwegian Sea. They usually enter the ecoregion in May. They feed mainly on krill and other large zooplankton at depths between 300 and 500 meters, and partly also on the smaller *Calanus finmarchicus* closer to the surface. In late summer and autumn mature individuals migrate southwards again towards the spawning area while juveniles stay in Faroese water and the Norwegian Sea. Mackerel make a similar migration, although is has a more eastern and shallower distribution. Their main food items are *C. finmarchicus* and krill.

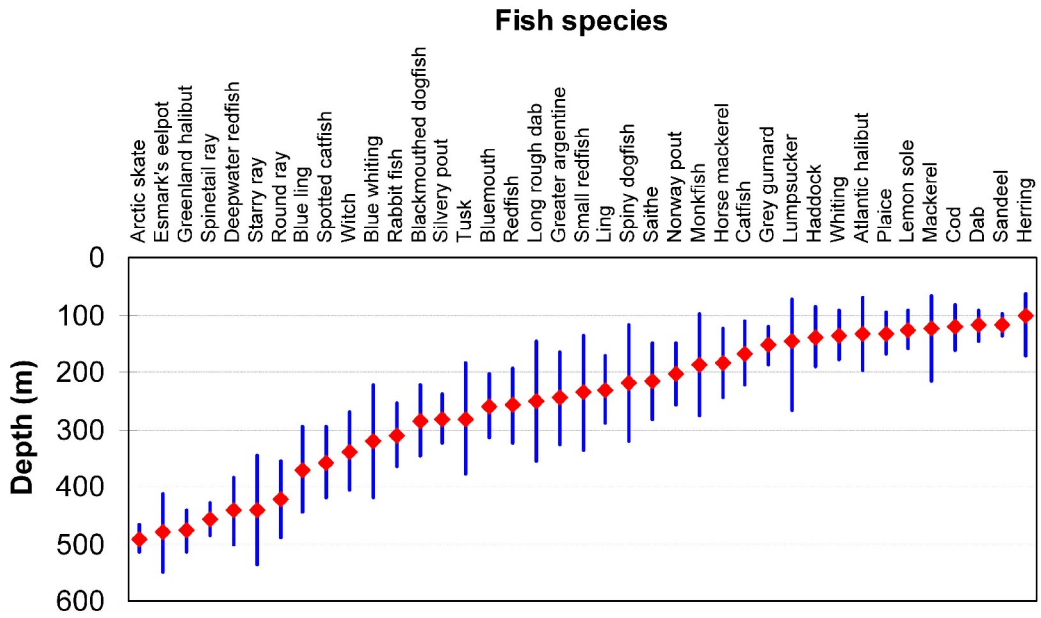

Figure 1.1.1.3 Typical depth distribution of fish in areas deeper than ~65 m on the Faroe shelf and in the ocean around the Faroes.

Cod and haddock and saithe are the most commercially important demersal stocks in Faroese waters.

Their spawning takes place on the shelf in spring. The spawning grounds of the haddock are more disperse than those of cod and saithe. Their offspring is dispersed by the strong currents throughout the shelf area. As they grow they predate on progressively larger zooplankton prey items on the shelf (Gaard and Steingrund, 2001; Gaard and Reinert, 2002). In July, at lengths of about 4 cm, the cod juveniles migrate into the littoral zone of the fjords and sounds, while the haddock make the transition to a predominant demersal habit on the plateau and the banks at depths of 90–200 m. The offspring is found close to the shores already in May. At an age of about 3 years they migrate into deep habitats, mainly on the upper slope.

Detailed knowledge about variability in food consumption of cod and haddock in Faroese waters is not conclusive. Both cod and haddock show diversity in prey items, and predate on benthic fauna as well as fish, with fish being a somewhat more prevalent prey item for cod than for. Of the fish prey, sandeel seems to be a key species in the shallow areas and is a main link between zooplankton and higher trophic levels. When sandeels are abundant they are a preferred food item for cod on the shelf and hence affecting the feeding conditions for demersal cod on the shelf already during the first year after recruitment of the sandeel. At bottom depths less than 200 m sandeels and benthic crustaceans may also be important cod diet, but when sandeels are abundant, they form the principal food item for cod. Years with high cod production seem to be associated with a high abundance of sandeels.

In deeper areas other species (mainly Norway pout) have been observed to be more important as prey items for cod and haddock. On the slope other species, e.g. blue whiting may be important.

Despite a marked increase in fishing effort on cod and haddock, the landings have not increased correspondingly. The long-term landings of the cod usually have fluctuated between 20 000 and 40 000 tonnes during the 20th century and of haddock between 15 000 and 25 000 tonnes since the 1950s. The catches of these two main fish stocks have therefore for a long time reached the limit for long-term production within the ecosystem. Consequently, it is likely that the catches reflect interannual variability in production of these fish stocks.

There has been observed a very clear relationship, from primary production to the higher trophic levels (including fish and seabirds), in the Faroe Shelf ecosystem, and all trophic levels seem to respond quickly to variability in primary production in the ecosystem (Figure 1.1.1.4). The temperature on the shelf has increased about 1°C during the last ten years. However, interannual temperature variability does not correlate with variability in primary production or cod and haddock growth or recruitment.

In 2002 the primary production was on a very low level, and this affected cod and haddock recruitment and weight-at-age shortly after. In 2004 the production again reached average levels.

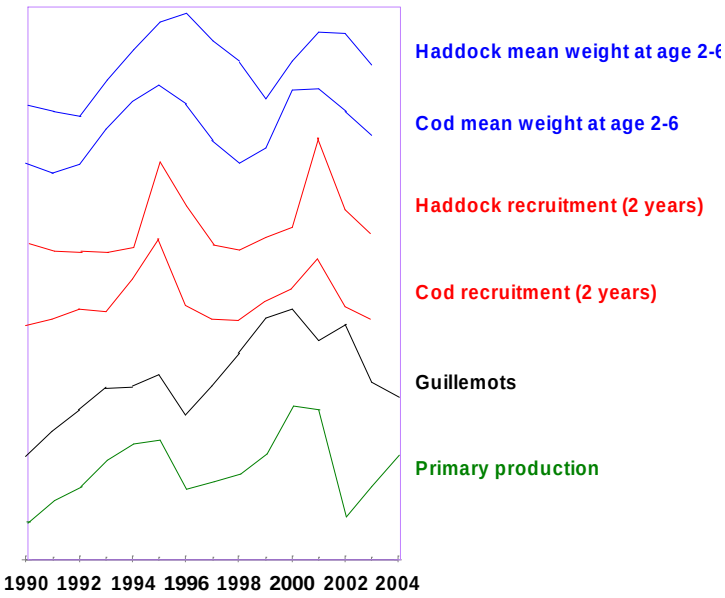

Figure 1.1.1.4 Relative variability in calculated new primary production, number of attending guillemots, recruitment of 2-year-old cod and haddock, and mean weight of 2- to 6-year-old cod and haddock since 1990 (Updated from Gaard *et al.*, 2002).

Benthos

Due to strong tidal currents on the shelf, the seabed consists mainly of sand on stones. In deeper areas is mort silt and organic material. The benthic fauna on the shelf is diverse with e.g. decapods and echinoderms and bivalves as important groups. On the slope coral and sponge areas occur. The coral areas have been reduced due to trawling and therefore the authorities recently have closed three areas for trawling. On the shelf there is local fishery (dredging) for scallops and in inshore areas there is lobster (*Nephrops*) fishery for pots.

1.1.2 Environmental impacts on the ecosystem dynamics

Cod and haddock recruitment

There is no clear relationship between fluctuations in cod and haddock spawning stock biomasses and recruitment on the Faroe plateau, but long-term relations between cod and haddock recruitment and weight-at-age have demonstrated that periods with high weight-at-age occur simultaneously with good recruitment of 2-year-old fish (Gaard *et al.*, 2002; 2005). Since 1990, when monitoring of environmental parameters in the Faroe shelf ecosystem started, clear co-occurring fluctuations can be observed in primary production and recruitment of cod and haddock (Figure 1.1.1.4).

The cod and haddock stocks have proven several times that when environmental conditions are favourable, they are, even with very small SSB, able to recover quickly. But it is when the environmental conditions are poor that the importance of spawning stock size and age composition most likely is significant. Therefore, the lack of direct relationship between SSB and recruitment is no argument for decreasing the significance of SSB.

The year-class strength of cod seems to be determined rather late in life, i.e. during the second winter, which coincides with the migration towards deeper waters (Steingrund and Gaard, 2005). The bottleneck seems to be food availability in the area, which is determined by phytoplankton production (about 6 months before) and competition from older cod (Figure 1.1.2.1).

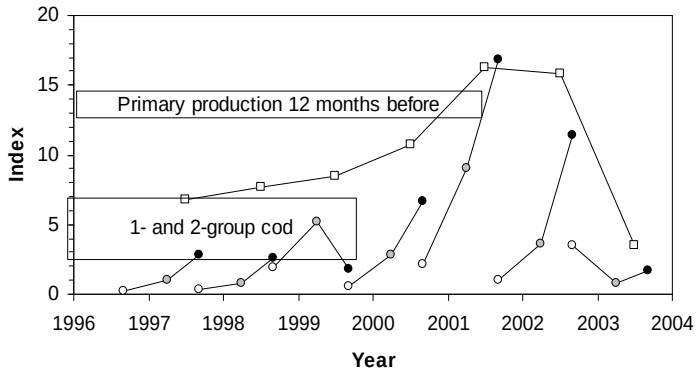

Figure 1.1.2.1 Relationship between primary production (12 months before) and catch per unit effort (number per trawl hour) of 1-group cod in August and 2-group cod of the same year class in March and August the following year (Steingrund and Gaard, 2005).

Cod and haddock growth

Growth rates on cod and haddock on the Faroe plateau are highly variable. Since 1990 the mean growth rates of 2- to 7-year-old cod have fluctuated between 0.24 and 1.36 kg individual^{-1} year^{-1} and the mean growth rates of 2- to 7-year-old haddock between 0.13 and 0.46 kg individual^{-1} year^{-1}. There is no correlation between the growth rates and the *in situ* temperature, but good relationship is found between primary production and growth variability of both species (Figure 1.1.2.2). The growth rates are mainly affected by the highly variable food production. The causal mechanism seems to be a positive relationship between phytoplankton production, zooplankton production, and the production of food organisms for cod (e.g. benthic crustaceans and especially sandeels).

Since primary production is rapidly transferred to cod and haddock, they obviously eat young prey items. Detailed analysis of interannual variability in food items for cod and haddock are not available at the present, but the available information indicates that sandeel is the main food item during productive years. In low-productive years they seem to predate more on benthic fauna. Fish furthermore seems to be a somewhat more prevalent prey item for cod than for haddock. This may be the reason why haddock growth variability is often lagging one year behind cod growth variability, especially during low productive periods (Figure 1.1.2.2). Possibly, the benthic fauna have higher ages than the fish prey (which mostly are 0-group sandeels in the shallow areas). Detailed analysis of this is needed before final conclusions can be drawn.

The increased primary production during the last two years, just above average level, indicates that a minor increase of growth rates (mainly of cod) can be expected (Figure 1.1.2.1).

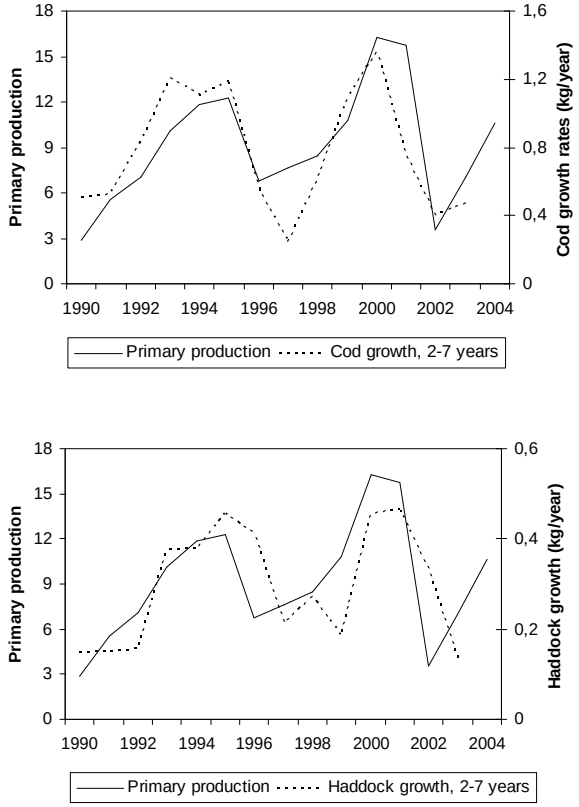

Figure 1.1.2.2 Primary production and cod growth rates (upper panel) and haddock growth rates (lower panel) during the 1990–2004 period.

Fish production

Fish production in the ecosystem is clearly food limited. Mainly cod production (numbers x individual growth summed up for all age groups) fluctuates well with primary production (Figure 1.1.2.3). When comparing primary production with production of cod haddock and saithe combined, the correlation is even better.

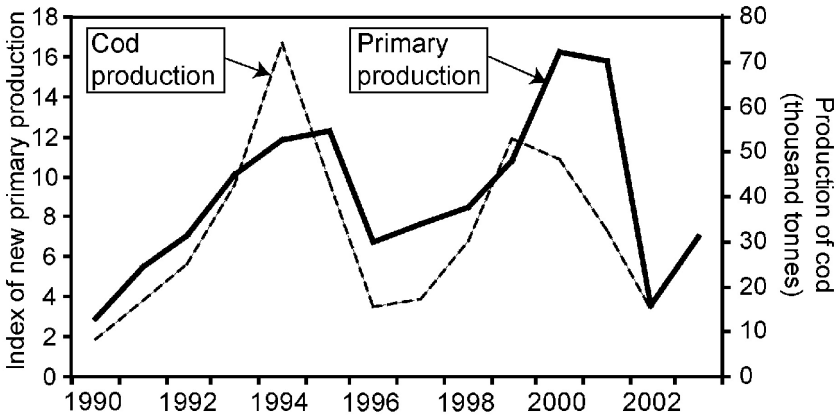

Figure 1.1.2.3 Index of new primary production on the Faroe shelf and corresponding production of Faroe Plateau cod older than 1.5 years. Updated from Steingrund *et al.*, 2003.

Since young age classes are the most numerous (mainly in the productive years) the observed variability in cod production in Figure 1.1.2.3 largely is due to variable abundances of recruits (Figure 1.1.2.4). The figure furthermore illustrates that in the 1960s and 1970s the proportion of production of older age classes was clearly higher than in recent times. The reason most likely is higher fishing mortalities in the later years.

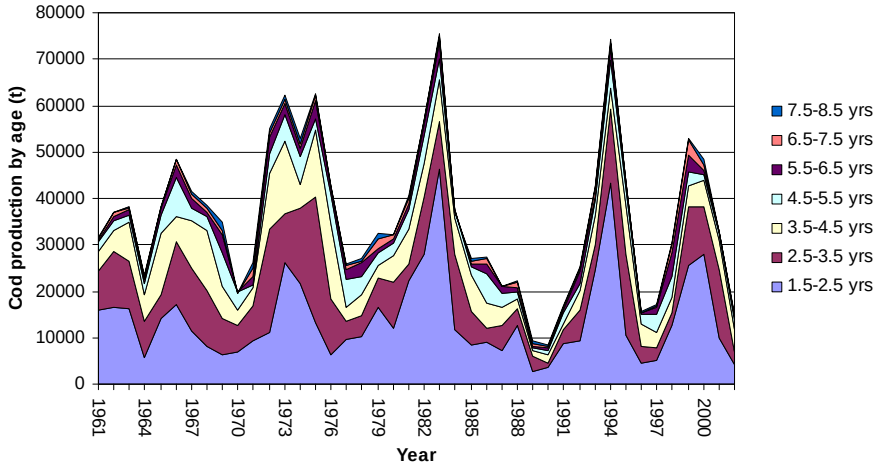

Figure 1.1.2.4 Production of Faroe Plateau cod split into age groups.

As cod grow older, they tend to move into deeper areas, feeding on the slope outside the shelf front (Steingrund and Gaard, 2005). Since fish production in the system is food limited (even year by year), a higher proportion of individuals feeding in deeper areas seems to be the only possibility for increased fish production. It is likely that a reduced fishing mortality, allowing a higher fraction of older individuals in the stock, would allow a higher total cod production, and would possible also have a smoothing affect on the stock production variability. There is, however, not sufficient available information at the moment to quantify this potential effect.

1.1.3 Fisheries effect on the ecosystem

Trawling activity has caused a significant reduced the distribution areas of corals (*Lophelia pertusa*) on the shelf and bank slopes. Therefore the Faroese authorities have recently closed three coral areas for trawling.

Since fishery on the Faroe Plateau is effort regulated, discard of commercially fish most likely is small. Bycatch of non-commercial species and of non-commercial size in unknown and may be higher, especially during periods of high recruitment.

1.1.4 Concluding remarks

Since studies on environmental conditions on the Faroe shelf started in 1990, a clear relationship has been observed between primary production and cod and haddock, recruitment, and growth rates. Food production seems to be transferred quickly into higher trophic levels in the ecosystem.

The food production (based on primary production, as shown in Figure 1.1.1.2) reached average values in 2004, after having being well below average in recent years. An increase in growth rates of cod toward average value can therefore be expected. Haddock growth rates may be somewhat smaller, since their fluctuations often lag somewhat behind the cod growth rates, especially during recovering periods. Feeding conditions for the coming year will, however, largely depend on food production in spring-summer 2005. These data will be available in July 2005.

There is no clear relationship between fluctuations in cod and haddock spawning stock biomasses and recruitment on the Faroe plateau, but their recruitment success correlates well with variability in primary production, while the correlation to SSB is weak.

The cod and haddock stocks have proven several times that when environmental conditions are favourable, they are, even with a very small SSB, able to recover quickly. But it is when the environmental conditions are poor that the importance of spawning stock size and age composition is most likely significant. Therefore, the lack of direct relationship between SSB and recruitment is no argument for decreasing the significance of SSB.

Fish production in the ecosystem clearly is food-limited. Since cod tend to migrate into deeper feeding habitats as they grow older, this may be a way to increase the total cod production. There is, however, not sufficient available information at the moment to quantify this potential effect.

Catchability analysis

In an effort management regime with a limited numbers of fishing days, it is expected that vessels will try to increase their efficiency (catchability) as much as possible in order to optimise the catch and its value within the number of days allocated. "Technological creeping" should therefore be monitored closely in such a system. However, catchability of the fleets can change for other reasons, e.g. availability of the fish to the gears. If such effects are known or believed to exist, catchability changes may need to be incorporated in the advice on fisheries.

The primary production of the Faroe Shelf ecosystem may vary by as much as a factor of five and given the link between primary production and recruitment and growth (production) of cod as demonstrated by Steingrund & Gaard (2005), this could have pronounced effects on catchability and stock assessment as a whole. Below are the results from an analysis regarding Faroe Plateau cod, Faroe haddock, and Faroe saithe.

For cod there seems to be a link between the primary production and growth of cod (Figure 1.1.4.2). The growth of cod seems to be negatively correlated with the catchability of longlines (Figure 1.1.4.3), suggesting that cod prefer longline baits when natural food abundance is low. Since longliners usually take a large proportion of the cod catch, the total fishing mortality fluctuates in the same way as the longline catchability and there is thus a negative relationship between cod growth and fishing mortality (Figure 1.1.4.4).

For haddock there seems to be a similar mechanism as for cod. Although the catchability for longliners (which take the majority of the catch) as estimated from the longliner logbooks does not follow the expected pattern for the first part of the series (1986–1995), it may be a result of very small catches in this period when stock biomass was low. The fact that we observe a negative relationship between growth and fishing mortality (Figure 1.1.4.5) suggests that the same mechanism is valid for haddock as for cod.

It is, however, important to note that the relationship between the productivity of the ecosystem and the catchability of long lines depends on the age of the fish. The relationship is most clear for fish age 5; for cod age 3 and 4 the relationship is less clear, and for young haddock there apparently is no such relationship between productivity and catchability.

For saithe no clear relationship was observed between the catchability for the Cuba pair trawlers (pair trawlers take the majority of the catch) and other variables such as primary production, growth, and stock size.

The analysis reported above suggests that natural factors may have a larger influence than technological ones, at least for Faroe Plateau cod and haddock on changes of catchability. In addition, the available data indicate that there has not been sufficient time since the implementation of the effort management system in 1996 to detect convincing changes in catchability. However, from a management perspective, if the hypothesis that catchability is related to productivity is true, and if productivity in 2004 and 2005 is low, there is the potential for very high fishing mortality to be exerted on cod. It could therefore be prudent to consider substantial reductions in fishing effort for the next fishing season.

1.1.5 References

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1.2 The human use of the ecosystem

1.2.1 Overall impacts

1.2.2 Fisheries

The total demersal catches decreased from 120 000 t in 1985 to 65 000 t in 1993, but have since increased again to above 120 000 t in 2002; the demersal catches in 2004 were about 105 000 t. The decrease up to 1993 was mainly due to lower catches of cod, haddock, and saithe, and the most recent decrease due to lower catches of cod.

Part of the catches of mackerel, Norwegian spring-spawning herring and blue whiting are taken around the Faroe Islands. The catches of these species are reported together with the catches from other areas in the section on widely migrating stocks, see Volume 9.

The main fisheries in Faroese waters are mixed-species, demersal fisheries, and single-species, pelagic fisheries. The demersal fisheries are mainly conducted by Faroese fishers, whereas the major part of the pelagic fisheries is conducted by foreign fishers licensed through bilateral and multilateral fisheries agreements.

The longliners fish mainly cod and haddock; in addition, some longliners fish in deep water for ling and tusk. Most of the trawlers fish cod, haddock, and saithe, while some large trawlers fish in deeper waters for redfish, blue ling, Greenland halibut, and occasionally grenadier and black scabbardfish. The jiggers fish mainly saithe and cod. Recently, gillnet fisheries for Greenland halibut and anglerfish and a directed pair trawler fishery for argentines have been introduced.

Pelagic fisheries. Three main species of pelagic fish are fished in Faroese waters: blue whiting, Norwegian spring-spawning herring, and mackerel; several nations participate. The assessment and status of these stocks are discussed as "widely migrating stocks", see Volume 9, as these fish occur in major parts of the Northeast Atlantic. The Faroese pelagic fisheries are almost exclusively conducted by purse seiners and larger purse seiners also equipped for pelagic trawling. The pelagic fishery by Russian vessels is conducted by large factory trawlers. Other countries fishing for these fish in the Faroese ecosystem use purse seiners and factory trawlers. These fleets fish the pelagic stocks in other areas as well.

Demersal fisheries. Although they are conducted by a variety of different vessels, the demersal fisheries can be grouped into fleets of vessels operating in a similar manner. Some vessels change between longlining, jigging, and trawling, and they can therefore appear in different fleets.

The small boats fishing in these waters are Faroese. The fleets of other countries are longliners > 110 GRT and otter board trawlers with more than 1000 HP.

Open boats. These vessels are below 5 GRT. They use longline and to some extent automatic, jigging engines and operate mainly on a day-to-day basis, targeting cod, haddock, and to a lesser degree saithe. The large number of open boats participating in the fisheries (above 1400 licenses) are often operated by non-professional fishermen.

Smaller vessels using hook and line. This category includes all the smaller vessels, between 5 and 110 GRT operating mainly on a day-to-day basis, although the larger vessels behave almost like the larger longliners above 110 GRT with automatic baiting systems and longer trips. The area fished is mainly nearshore, using longline and to some extent automatic, jigging engines. The target species are cod and haddock. The number of licenses is about 90.

Longliners > 110 GRT. This group refers to vessels with automatic baiting systems. The main species fished are cod, haddock, ling, and tusk. The target species at any one time is dependent on season, availability, and market price. In general, they fish mainly for cod and haddock from autumn to spring and for ling and tusk during the summer. During summer they also make a few trips to Icelandic waters. There are 19 Faroese vessels in this fleet. Vessels of the same type as the Faroese longliners larger than 110 GRT from other countries (mainly Norway) also fish in these waters. They target mainly ling and tusk with bycatches of cod, haddock and blue ling. Norway has in the bilateral fishery agreement with the Faroe Islands obtained a total quota of these species; numbers of vessels can vary from year to year.

Otter board trawlers < 500 HP. This refers to smaller fishing vessels with engine powers up to 500 Hp. The main areas fished are on the banks outside the areas closed for trawling. They mainly target cod and haddock. Some of the vessels are licensed during the summer to fish within the twelve nautical mile territorial fishing limit, targeting lemon sole and plaice.

Otter board trawlers 500-1000 HP. These vessels fish mainly for cod and haddock. They fish primarily in the deeper parts of the Faroe Plateau and the banks to the southwest of the islands.

Otter board trawlers >1000 HP. These vessels, also called the deepwater trawlers, consist of 13 vessels. They target several deepwater fish species, especially redfish, blue ling, Greenland halibut, grenadier, and black scabbard fish. Saithe is also a target species and in recent years they have been allocated individual quotas for cod and haddock on the Faroe Plateau. Vessels flying the flags of France, Germany, Greenland, United Kingdom, mainly otter board trawlers of the same type as the Faroese otter board trawlers also fish around the Faroe Islands. The smaller of these vessels, mainly from the United Kingdom and Greenland, target cod, haddock, and saithe, whereas the larger vessels, mainly French and German trawlers, target saithe and deep-sea species like redfish, blue ling, grenadier, and black scabbardfish. As for the longliners, these vessels fish under a bilateral fishery agreement with the Faroes, obtaining a total quota of these species; the numbers of vessels can vary from year to year.

Pair trawlers <1000 HP. These vessels fish mainly for saithe, however, they also have a significant bycatch of cod and haddock. The main areas fished are the deeper parts of the Faroe Plateau and the banks to the southwest of the islands.

Pair trawlers >1000 HP. This category targets mainly saithe, but their bycatch of cod and haddock is important to their profit margin. In addition, some of these vessels during the summers have special licenses to fish in deep water for greater silver smelt. The areas fished by these vessels are the deeper parts of the Faroe Plateau and the banks to the southwest of the islands. The number of vessels in the two pair trawlers fleets is 31.

Gillnetting vessels. This category refers to vessels fishing mainly Greenland halibut and monkfish. They operate in deep waters off the Faroe Plateau, Faroe Bank, Bill Bailey's Bank, Lousy Bank, and the Faroe-Iceland Ridge. This fishery is regulated by the number of licensed vessels (8) and technical measures like depth and gear specifications.

Jiggers. Consist of a mixed group of smaller and larger vessels using automatic jigging equipment. The target species are saithe and cod. Depending on availability, weather, and season, these vessels operate throughout the entire Faroese region. Most of them can change to longlines and in recent years jigging effort has decreased as compared to longlines.

Poor recruitment in the late 1980s combined with high fishing effort reduced the SSBs of Faroe Plateau cod and Faroe haddock to low levels, and in the period 1993–1995 ICES considered these stocks to be well below minimum biologically acceptable levels and consequently advised no fishing. Both stocks have since increased due to improved recruitment and growth. The most recent SSB estimate of Faroe Plateau cod is below the precautionary SSB level ($\mathbf{B}_{pa}$) whereas SSB of haddock is far above $\mathbf{B}_{pa}$. The fishing mortality on both Faroe Plateau cod and Faroe haddock was reduced during the crisis in first half of the 1990s and has since then increased and is now above the precautionary level ($\mathbf{F}_{pa}$). The Faroe Bank cod stock seems to be at or slightly above average. The SSB of Faroe saithe has been increasing from the record low in 1992 to above the $\mathbf{B}_{pa}$ in 1998–2003; in 2004, however, it has been estimated below $\mathbf{B}_{pa}$. The fishing mortality is above the precautionary level ($\mathbf{F}_{pa}$).

1.3 Assessments and advice

Fisheries advice

Mixed fisheries and fisheries interactions

The pelagic fisheries exploit stocks that occur widely in the Northeast Atlantic. Since these fisheries are single-species fisheries, management of these stocks should be done based on single-species upper boundary considerations and should consider exploitation in all areas where these stocks are fished, see Volume 9.

Most demersal fisheries are mixed species fisheries; exceptions are gillnet fisheries for Greenland halibut and gillnet fisheries for anglerfish where bycatches are small.

Some of the demersal stocks are local, whereas others like Greenland halibut, anglerfish, redfish, and most deep-sea stocks occur over a wider area than the Faroese waters and management of them should consider exploitation in all areas where these stocks are fished.

At present, only a few stocks are assessed among those currently exploited in Faroese waters. Proper mixed fisheries considerations should include several other species that are not currently assessed. If proper fishery-based advice taking

mixed fisheries issues into account should be given for the fishery in Vb, ICES would need to evaluate the status of these stocks.

In the present management regime, the stocks of cod, haddock, and saithe are regulated by gear and fleet specifications, area closures, and number of fishing days. Consequently, the status of each of the stocks must be taken into account in the regulation. Several of the fisheries could be described as mixed cod-haddock fisheries (i.e. the longline fisheries), whereas others (i.e. pairtrawlers and occasionally single trawlers) are saithe fisheries with bycatches of cod and haddock.

Single-stock exploitation boundaries and critical stocks

The state of stocks and single stock exploitation boundaries are summarised in the table below.

Species	State of the stock				ICES considerations in relation to single-stock exploitation boundaries			Upper limit corresponding to single-stock exploitation boundary for agreed management plan or in relation to precautionary limits. Tonnes or effort in 2006
	Spawning biomass in relation to precautionary limits	Fishing mortality in relation to precautionary limits	Fishing mortality in relation to highest yield	Fishing mortality in relation to agreed target	In relation to agreed management plan	In relation to precautionary limits	In relation to high long term yield	
Faroe Plateau Cod	Increased risk	Harvested unsustainably	Overexploited	Above agreed target	Reduce effort by more than 40%	Rebuilding plan Reduce effort by more than 50 %	N/A	Rebuilding plan that should at least reduce the fishing mortality to the $\mathbf{F_{pa}}$ level. This would amount to an effort reduction in the neighbourhood of about 50% compared to the recent level (≅ about 8600 tonnes).
Faroe Bank Cod								Effort not to exceed that of 1996-2002
Faroe Haddock	Full reproductive capacity	Increased risk	Overexploited	Below agreed target	The current F estimate is below the management target	Reduce effort by about 23%	The current F estimate is above $F_{0.1}$	Fishing effort be reduced to correspond to a fishing mortality below $\mathbf{F_{pa}}$=0.25, corresponding to an effort reduction of about 23% ≅ less than 18 000 t
Faroe Saithe	Increased risk	Harvested unsustainably	Overexploited	Below agreed target	The current F is estimated around that management target. The present effort can be maintained.	Reduce effort by at least 40%	The current F estimate is above $F_{0.1}$	Fishing effort in 2006 should be reduced to a level corresponding to a fishing mortality below $\mathbf{F_{pa}}$ = 0.28, corresponding to an effort reduction of about 40% (≅ 24 000 t. The present spawning closures should be maintained.

Advice for fisheries management

The Faroese effort management system links fishing mortality on the demersal stocks, i.e. that the effort level (number of fishing days) concurrently determines the fishing mortality on all three demersal stocks. The fishery for haddock and cod are closely linked. The fishery for saithe is a more directed fishery, albeit with bycatch of cod and haddock.

Fishing mortality for the Faroe Plateau cod in 2005 is more than twice the level that is recommended based on precautionary principles. For haddock and saithe the present fishing mortality is also above the precautionary level.

Therefore, ICES recommends a reduction of the fishing effort directed at the Faroe Plateau cod and haddock in the neighbourhood of 50%. For the saithe fisheries ICES recommends that effort be reduced by around 40%. This effort is predicated on the present low bycatch of cod and haddock in the saithe fisheries. If the bycatch of cod or haddock is observed to increase in the saithe fishery, then effort will have to be reduced proportional to the increase in bycatch rate. For Faroe Bank cod effort should be reduced to the 1996–2002 level.

Regulations in force and their effects

The catch quota management system introduced in the Faroese fisheries in 1994 was met with considerable criticism and resulted in discarding and in substantial misreporting of the catches. Reorganisation of enforcement and control did not solve the problems. As a result of the dissatisfaction with the catch quota management system, the Faroese Parliament discontinued the system as from 31 May 1996. In close cooperation with the fishing industry, the Faroese government has developed a new system based on individual transferable effort quotas in days within fleet categories. The new system entered into force on 1 June 1996. The fishing year from 1 September to 31 August, as introduced under the catch quota system, has been maintained.

The key elements in the Faroese fisheries management of the demersal stocks are:

1. A separation of the fishing vessels into fleet segments that are based on physical vessel attributes, mainly size (GRT and HP) and vessel types (trawlers, longliners etc.). The fleet segmentation is a central element in controlling capacity, effort and the fishing pattern.
2. A capacity policy aiming at maintaining the fleet capacity at the 1997 level. The capacity is in principle maintained within each fleet segment, but there are rules for allowing vessel transfers between groups (e.g. in conjunction with vessel replacement). The capacity policy is based on vessel licenses.
3. An effort system that allots a total number of fishing days for the coming fishing year to each of the fleet segments. The total fleet segment effort is subsequently divided between the individual vessels. Except for the small scale coastal fishery the general rule is that all vessels within the fleet segment gets an equal share. The small scale coastal fishery (fleet segment 5B) fishes on a common effort quota. The fishing days may be traded within fleet segments and with some restrictions between segments. The effort regulation is maintained through a fishing license system.
4. A complex system of area closures that regulates access to the fishing grounds for the various fleet segments. The main restrictions are: The trawlers are generally not allowed to fish within the 12 nautical mile limit and within other areas closed to trawlers, implying that large areas shallower than 200 m are closed to trawling. There are exceptions for small trawlers that are allowed a summer fishery for flatfish on the plateau. The near-shore area (inside the 6 nm line) is closed to the larger longliners. Gillnetters are only allowed to fish at depths deeper than 350 m.
5. A number of supplementary technical regulations such as: Spawning area closures, minimum mesh sizes, sorting grids, real-time closures to protect small fish, and minimum landing sizes. The Faroe Bank shallower than 200 m is closed to trawling.

The fleet segmentation used to regulate the demersal fisheries in the Faroe Islands and the regulations applied are summarised in Table 1.3.1.

The single trawlers that target deepwater resources (redfish, saithe, blue ling, Greenland halibut, and others) are not covered by the effort regulation, and catches of cod and haddock are limited by maximum bycatch allocation. Similarly, the gillnetters that target monkfish and Greenland halibut are not included in the effort system – their catch of cod, haddock, and saithe is almost nil due to the depth of fishing and the large mesh sizes. One fishing day by longliners is considered equivalent to two fishing days for jiggers in the same size category. Longliners could therefore double their allocation by converting to jigging. Holders of individual transferable effort quotas who fish outside this line can fish for 3 days outside for each day allocated inside the line. The effort history and allocation of effort is summarised in Tables 1.3.2 and 1.3.3.

The allocations of number of fishing days by fleet categories was made such that together with other regulations of the fishery they should result in average fishing mortalities on each of the 3 stocks of 0.45, corresponding to average annual

catches of 33% of the exploitable stocks in numbers. Built into the system is also an assumption that the day system is self-regulatory, because the fishery will move between stocks according to the relative availability of each of them and no stock will be overexploited.

The management system with individual transferable days introduced in 1996 had as an objective to maintain the fishing mortality at an average of 0.45 for both plateau cod, haddock, and saithe. The current assessment shows that saithe and haddock have on average been harvested within this objective, whereas for cod the fishing mortality has exceeded the objective and in the most recent years has been around double of the target.

The fishing law also prescribes the percentage of total catches of cod, haddock, saithe, and redfish, which each fleet category on average is allowed to fish. However, these percentages are of little practical importance since they have not been used directly in the regulations since the abolishment of the quota system after the fishing year 1995–96. These percentages are as follows:

Fleet category	Cod	Haddock	Saithe	Redfish
Longliners < 110GRT, jiggers,				
single trawl. < 400HP	51%	58%	17.5%	1%
Longliners > 110GRT	23%	28%		
Pairtrawlers	21%	10.25%	69%	8.5%
Single trawlers > 400 HP	4%	1.75%	13%	90.5%
Others	1%	2%	0.5%	0.5%

An overview of the average catchability of the principal fleets for the three major stocks in Division Vb does not indicate any long-term positive or negative trends in catchability for the period 1985 to 2003. Natural factors may have a larger influence than technological, at least for Faroe cod and haddock, where the longline fishing constitutes a large part of the catch. Hence the short-term trends in the catchability of both cod and the haddock may be a result of variability in the productivity in the ecosystem as explained above.

Under effort management there are incentives for vessels to optimise their catch and its value per effort unit through an increase of efficiency (catchability). This introduces “Technological creeping” which has been demonstrated for many fishing fleets. Such “creeping” needs therefore to be monitored closely and accounted for in the regulations.

The relative prices for the three commercial fish species (cod, haddock, and saithe) are important. In 2003 and 2004, the price for cod has been substantially higher than for haddock and saithe which may have contributed to an increased targeting and high fishing mortality for this species in these years. The relative prices will shift fishing focus from one stock to the other.

Quality of assessments and uncertainties

The resources in the area have in general been managed on the basis of long time-series of commercial catch-at-age information. There are two annual ground fish surveys available from the mid-1990s. Several commercial CPUE series are available. The commercial CPUE series include larger vessels (fleet segments 1-3) only and are based on logbooks from a few selected vessels that are considered representative for the fleets. Detailed CPUE statistics that cover the majority of all fishing operations exist but are not at present available for assessment. This impedes a comprehensive analysis of the development in catchabilities that is necessary to evaluate the implementation of the effort system used in the Faroes.

Except for some selected fisheries, no estimates of discards are available. However, since almost no quotas are used in the management of the demersal fisheries, the incentives to discard in order to highgrade the catches should be low. Moreover, according to Faroese legislation, all discarding is banned. The landings statistics are therefore regarded as being adequate for assessment purposes.

Table 1.3.1 Main regulatory measures by fleet in the Faroese fisheries.

Fleet segment		Sub groups		Main regulation tools
1	Single trawlers > 400 HP	*none*		Bycatch quotas, area closures
2	Pair trawlers	*none*		Fishing days, area closures
3	Long-liners > 110 GRT	*none*		Fishing days, area closures
4	Coastal vessels>15 GRT	4B	Trawlers > 40 tonnes	Fishing days
		4B	Longliners>40 tonnes	Fishing days
		4A	Trawlers< 40 tonnes	Fishing days
		4A	Longliners<40 tonnes	Fishing days
5	Coastal vessels <15 GRT	5A	Full-time fishers	Fishing days
		5B	Part-time fishers	Fishing days
6	Others		Gillnetters	Bycatch limitations, fishing depth, no. of nets
			Others	Bycatch limitations

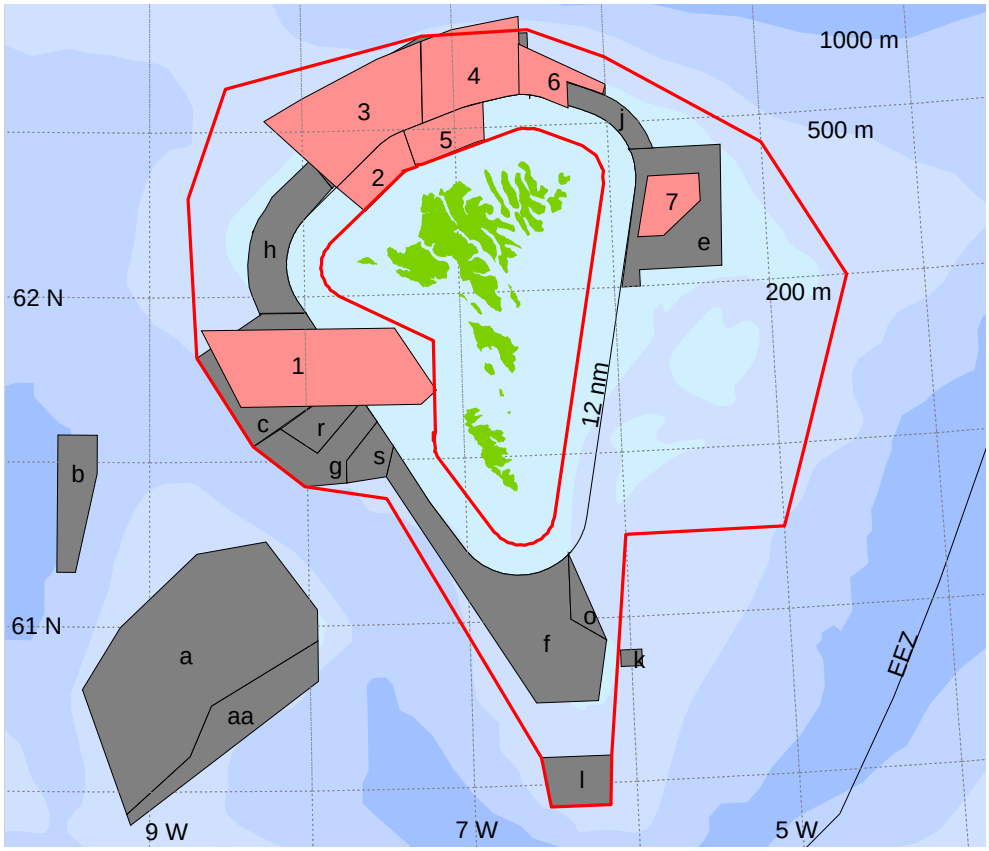
Table 1.3.2 Number of fishing days used by various fleet groups in Vb1 1985–1995 and 1998–2004. For other fleets there are no effort limitations. Catches of cod, haddock, saithe, and redfish are also regulated by bycatch percentages given in the text. In addition there are special fisheries regulated by licenses. (This is the real number of days fishing not affected by doubling or tripling of days by changing areas/gears).

Year	Longliner 0-110 GRT, jiggers, trawlers < 400 HP	Longliners > 110 GRT	Pairtrawlers > 400 HP
1985	13449	2973	8582
1986	11399	2176	11006
1987	11554	2915	11860
1988	20736	3203	12060
1989	28750	3369	10302
1990	28373	3521	12935
1991	29420	3573	13703
1992	23762	2892	11228
1993	19170	2046	9186
1994	25291	2925	8347
1995	33760	3659	9346
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
2003*	27642	2196	6624
2004*	22211	2728	7059
Average(98-01)	25945	2497	6816

* Preliminary, not all days included

Table 1.3.3 Number of allocated days inside the outer thick line in Figure 1.1.4.1 for each fleet group since the new management scheme was adopted, and the number of licenses per fleet.

	Fleets	1996/1997	1997/1998	1998/1999	1999/2000	2000/2001	2001/2002	2002/2003	2003/2004	2004/2005	No. of licenses
Group 1	Single trawlers > 400 HP				Regulated by area and by-catch limitations						13
Group 2	Pair trawlers > 400 HP	8225	7199	6839	6839	6839	6839	6771	6636	6536	28
Group 3	Longliners > 110 GRT	3040	2660	2527	2527	2527	2527	2502	2452	2415	19
Group 4	Longliners and jiggers 15-110 GRT, single trawlers < 400 HP	9320	9328	8861	8861	8861	8861	8772	8597	8468	106
Group 5	Longliners and jiggers < 15 GRT	22000	23625	22444	22444	22444	22444	22220	21776	21449	696



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

Figure 1.1.4.1 Fishing area regulations in Division Vb. Allocation of fishing days applies to the area inside the outer thick line on the Faroe Plateau. Holders of effort quotas who fish outside this line can triple their numbers of days. Longliners larger than 110 GRT are not allowed to fish inside the inner thick line on the Faroe Plateau. If longliners change from longline to jigging, they can double their number of days. The Faroe Bank shallower than 200-m depth (a, aa) is regulated separate from the Faroe Plateau. It is closed to trawling and the longline fishery is regulated by individual day quotas.

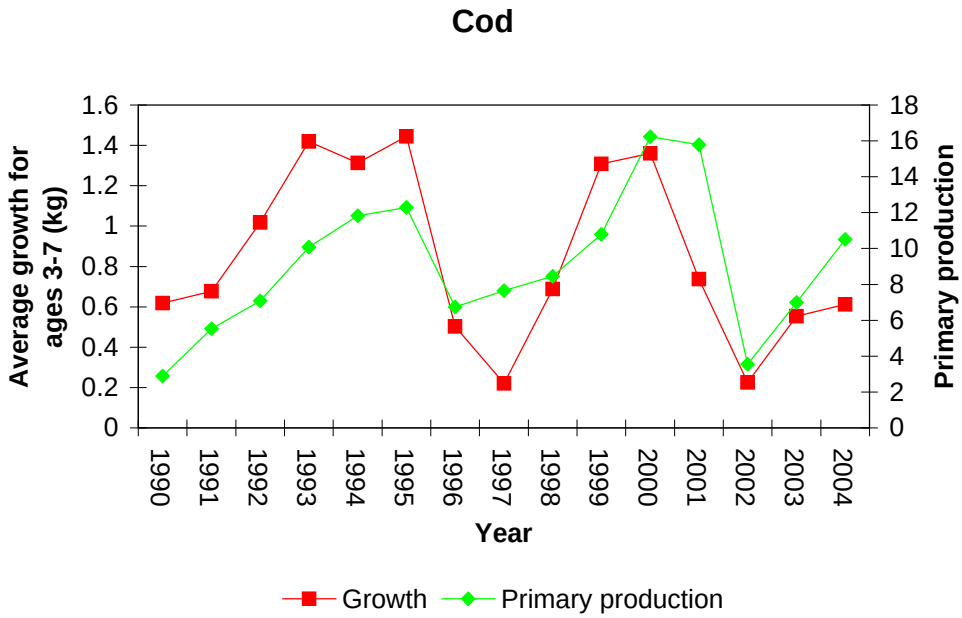


Figure 1.1.4.2 Faroe Plateau Cod. Relationship between primary production and growth of cod during the last 12 months.

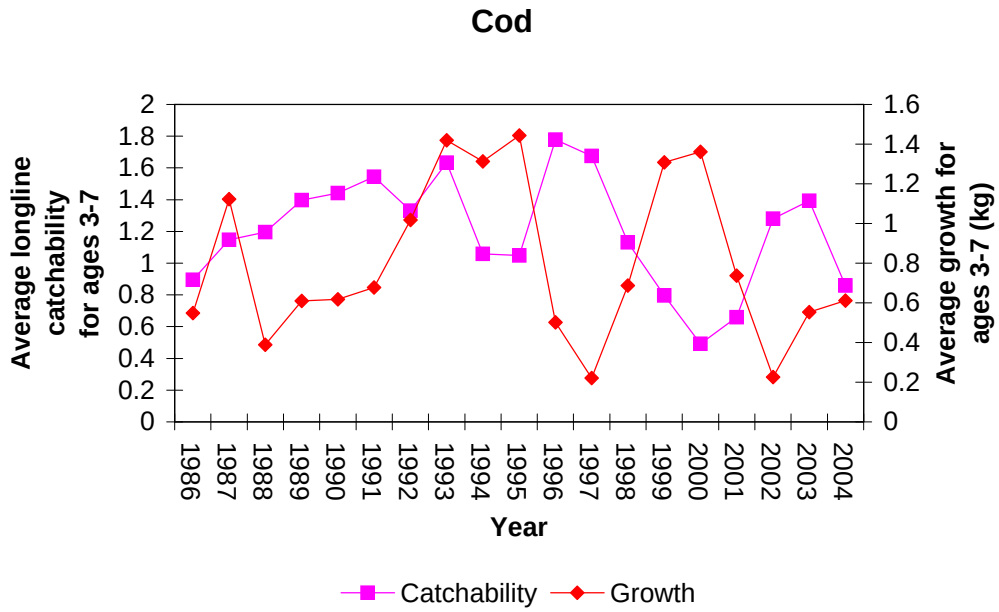


Figure 1.1.4.3 Faroe Plateau Cod. Relationship between long line catchability and growth of cod during the last 12 months.

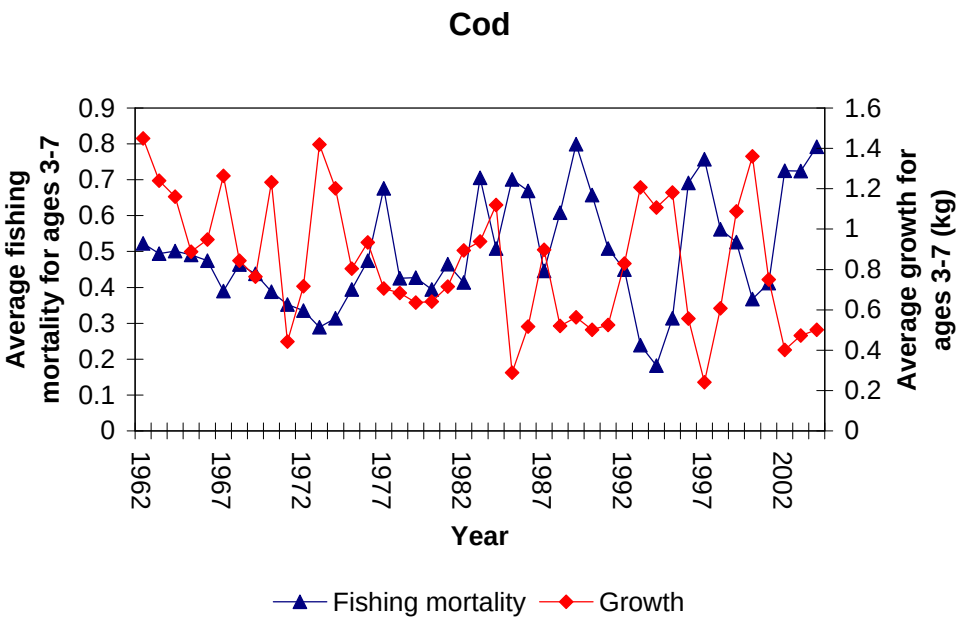


Figure 1.1.4.4 Faroe Plateau Cod. Relationship between fishing mortality and growth of cod during the last 12 months.

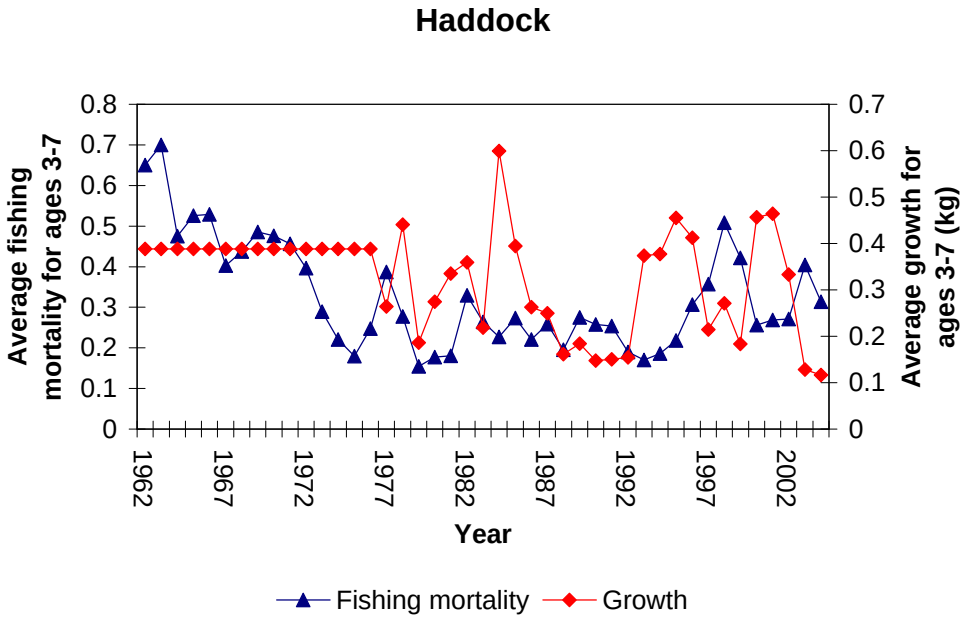


Figure 1.1.4.5 Faroe Haddock. Relationship between fishing mortality and growth of haddock during the last 12 months.