Some biological parameters of the Faroe Plateau Cod

by: Jón Kristjánsson
Reykjavík Iceland

Draft, V. 1.5 - April 2017

Introduction

Catch statistics for cod in the Faroe area is available since 1904.

The catch figures are characterised by oscillations which are exceptionally regular (fig.1). This is interesting and some attempts have been done to explain this.

There are mainly two separate cod stocks inside the Faroe EEZ zone, the (small) Faroe bank stock and the (large) Faroe plateau stock. Vital biological parameters have been recorded since 1961 and in recent years landings from the two stocks have been separated. **As the fishery in Faroes is controlled by effort the catch is supposed to reflect stock size.** The stock size and has been calculated with conventional methods, using fixed natural mortality M of 0.2 and VPA - analysis and survey data to estimate the total mortality Z in order to estimate the fishing mortality F.

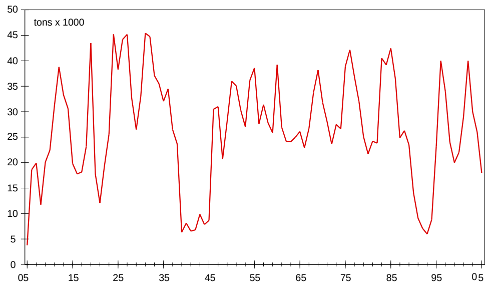

Fig. 1. Reported catches of cod from the Faroe area 1904-2005.

It is the opinion of the author that M is highly variable and survey/ VPA- data very inaccurate, leading to inaccurate and unreliable estimates of the calculated stock parameters.

However, this is the best available information, and the only one that can be used to expose relative fluctuations, inaccurate as it is.

Fishery and management

The fishery has bee managed by effort control since 1996. 1994-1996 there was a quota system.

Before that fishery was managed by technical measures. Before the 200 mile EZZ limit was set the grounds were heavily fished by British trawlers, mainly Scottish. Up to 1995, they fished up to 3 miles from the shore. That year new ground points were set that closed fjords and bays, and in 1956 a 6 mile limit was set. In 1964 the limit was increased to 12 miles and in 1974 some trawl free zones were set outside the 12 mile limit. 200 miles came in 1978 and some areas protected from fishing were introduced. Mesh size in trawl was 80 mm until 1967 when it increased to 100 mm. 110 mm were allowed in 1970, 135 mm 1978, 155 1990 but put down to 145 mm again the same year.

Materials and Methods.

Data from the ICES working reports on the Faroe plateau cod have been prepared in order to expose some biological characters in the stock (reveal short term fluctuations in the stock).

In some instances, running three years average was used to smooth short time fluctuations. Nine or thirteen year running average were used to show long time oscillations. If long term average is subtracted from the short time average, oscillations around the mean are exposed.

The long time average can also be drawn by hand, before the days of computers, this was usual method.

Data on weight at age are not based on true measured weights, they have been computed from length, therefore, changes in condition factor is nor reflected. Annual growth rate G of year class i in year n was calculated from the formula: (Gin= ln (weight i n+1 /weight i n)

Stock size

Stock size is calculated from the landings according to estimated parameters (F and M). Figures are available for the period 1961-2005.

Fig. 2 shows landings, fishable stock and spawning stock.

Fig. 3, below, shows the fraction that the fishery removes from the stock (calculated).

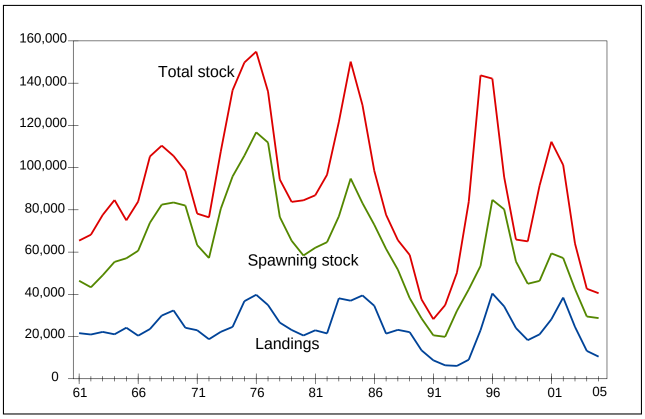

Fig. 2. Relationship between total biomass, spawning biomass and landings 1961-2005.

Management policy

It is a political decision in Faroes that the fishing pressure should be of such magnitude that it would remove approximately one third of the fishable stock each year.

Fig. 3 shows the annual removal (catch rate) from the fishable stock according to VPA-analysis.

Most of the time the catch rate is below the political goal, - which is 0.33.

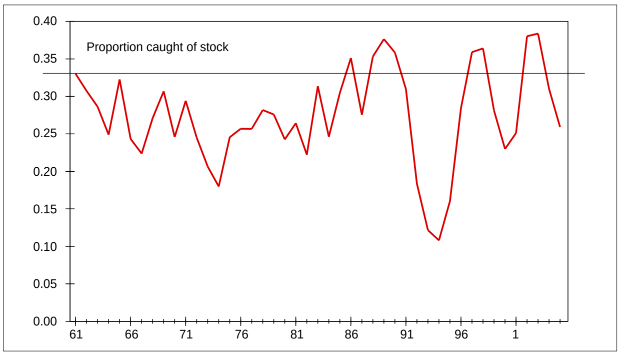

Fig. 3. The fraction that the fishery removed from the total stock 1961-2005.

Growth

Weight at age

Mean weight at age of 2-6 year old cod 1961-2005 is shown in fig 4.

The average weight 3+ and older has been falling through the period which indicates gradual deteriorating feeding condition trough out the period. This may be related to more restrictions put on the fishery, i.e. extended fishery fishery limits to drive the foreign fleet from the fishing grounds.

However, the weight of 2+ has increased in the period. That indicates selective fishing. Measures have been taken to reduce fishing pressure (protect small fish) on small fish by increasing mesh size in the cod end of trawls, thereby the biggest fish in the year class will be over represented - leading to an increase in the mean weight.

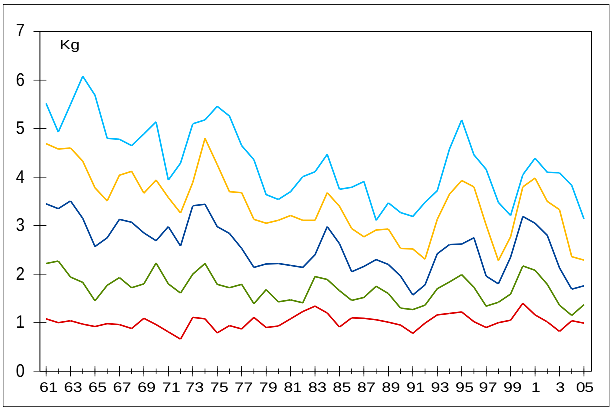

Fig. 4. Weight at age 1961-2005 (calculated from length).

Growth rate

To remove the accumulated growth of the various year classes, the annual growth rate G can be calculated.

The results for 3 and 4 year old fish is shown in fig. 5.

It can be seen that growth is fluctuating regularly.

There is a good correlation between the growth of both age classes, they are in phase, showing how growth reflects good and bad environmental conditions.

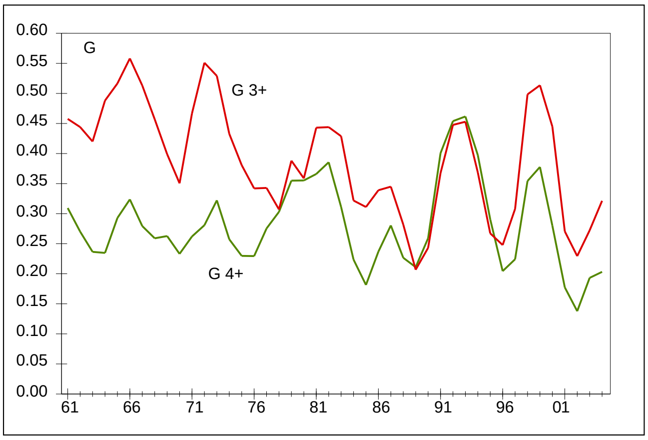

Fig. 5. Annual growth rate for 3+ and 4+ cod 1961-2005.

Recruitment

Smoothed curve on recruitment is shown in fig. 6, revealing regular fluctuations of 7-9 years.

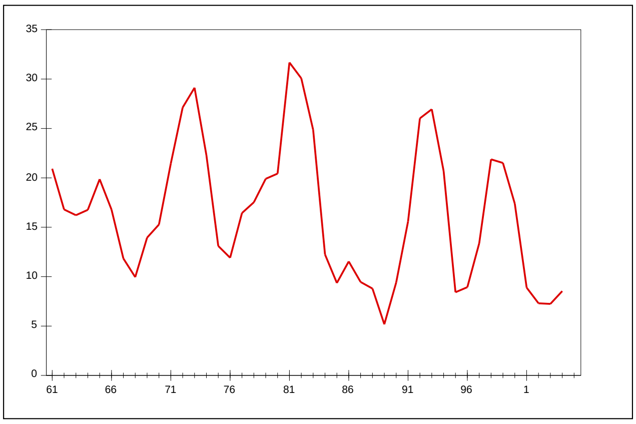

Fig. 6. Recruitment of cod 1961-2005, smoothed (3 ave).

Growth and recruitment

Fig. 7 shows growth and recruitment (smoothed) 1961-2005, and they oscillate in phase throughout the whole period. Growth reflects the general feeding conditions, thus the sensible conclusion is that good feeding condition lead to good recruitment and vice versa.

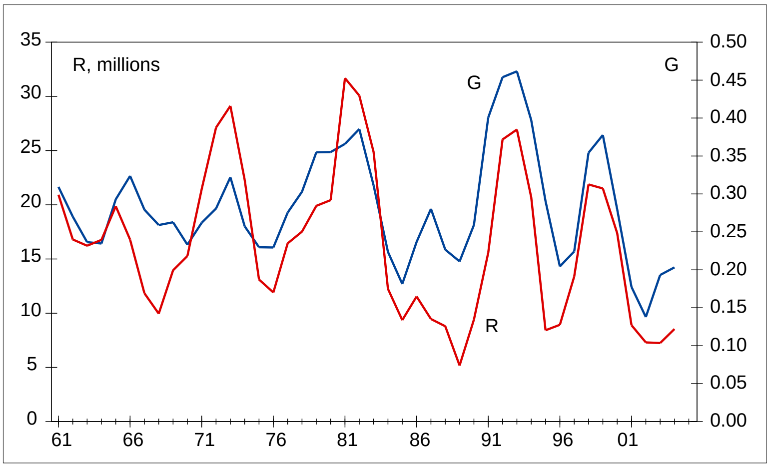

Fig. 7. Growth and recruitment 1961-2005.

Stock recruitment relationship

(Spawner recruitment relationship)
Fig 8 shows the spawners recruitment relationship for Faroe plateau cod 1961-2004. **The curves are in opposite phase**. When the spawning stock increases (from a good recruitment earlier) the recruitment decreases and vice versa.
There is an inverse relationship between the size of the spawning stock and the recruitment.

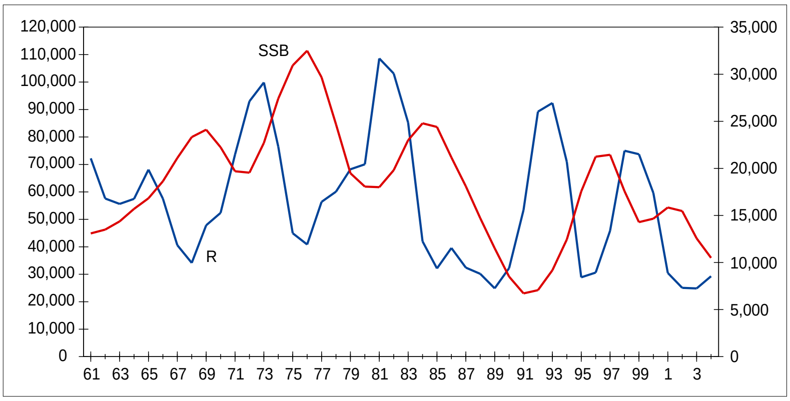

Fig. 8. Spawning stock, SSB (smoothed) , red line, and recruitment, R (smoothed), blue line, 1961-2005).

Total biomass and recruitment

Fig. 9 shows the relationship between total biomass (calculated) and recruitment). Much the same pattern. that is when the stock is big there is a low recruitment.
When the stock is big, there is no "room" for new recruits,

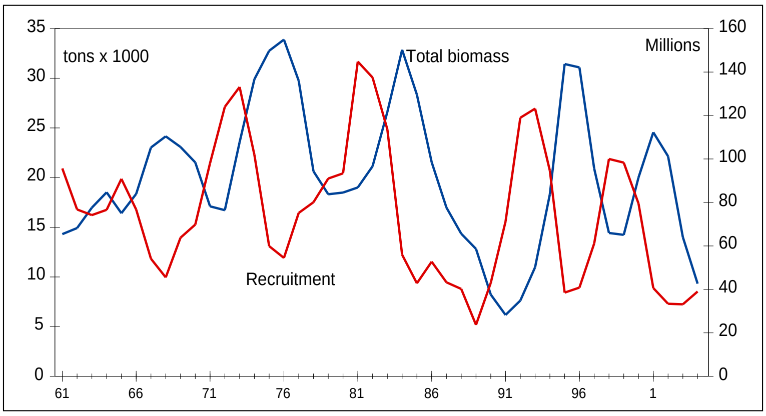

Fig. 9. Stock biomass (blue line) versus recruitment (red line) 1961-2005.

Stock biomass and growth

Fig. 10 shows the relationship between total biomass and growth rate. Growth seems to be inversely related to stock size, i.e. density dependant.

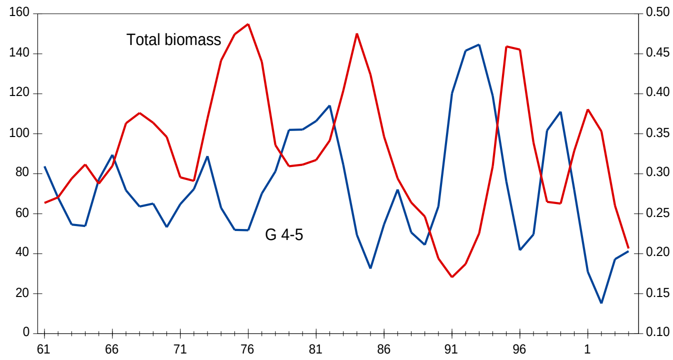

Fig. 10. Stock biomass (red line) and growth (blue line) 1961-2005.

Fishing mortality and growth

Fig. 11 is the relationship between the calculated average fishing mortality F and growth, G.
They are in the opposite phase and the question arises weather "fishing mortality" is in reality natural mortality?
This is examined further in fig. 13.

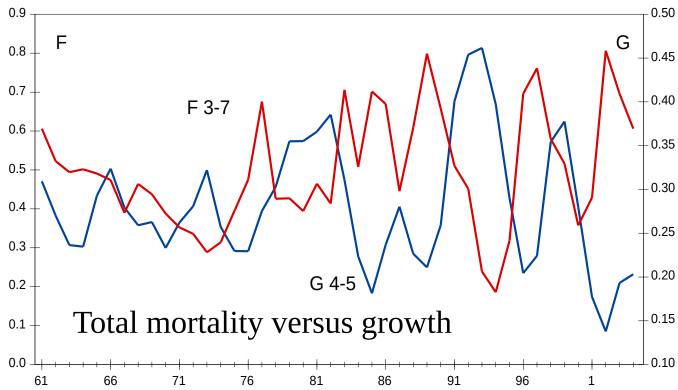

Fig. 11. Relationship between fishing mortality and growth 1961-2005.

Total mortality, Z - Fishing mortality, F

Average Z

This figure shows the total mortality of the year classes 3-7 in the period 1961-2004.
Mortality is calculated as the **arithmetic mean of the calculated values** for the age classes, without taking into consideration that the year classes differ in size.
Mortality is lowest within the 3 year old fish and it is most often highest in the oldest age groups.
(Mortality increases as the age increases and is always lowest in the youngest fish.)
The period after 1987 is interesting and is shown separately in fig. 13, below:

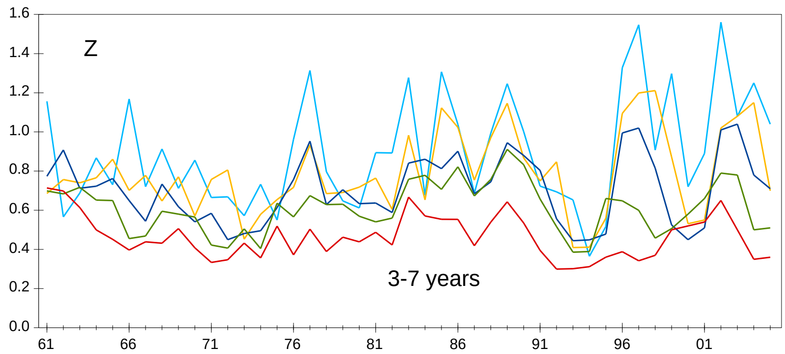

Fig. 12. Total mortality, Z, of the 3-7 year old cod 1961-2005.

Total mortality Z related to growth conditions

This is a plot of the total mortality of the 3-6 year classes 1987 - 2005. Growth rate 4-5 years (smoothed) is superimposed.
As natural mortality is set M=0.2, for all year classes it is easy to calculate the total mortality Z from the equation Z=F+M

Periods of high mortality are when the growth is slow and vice versa, in periods of good growth the mortality is low. This suggests that the main part of the mortality is from natural causes, **i.e. hunger.**

In good growing conditions, mortality is low for all year classes; because M is low and F is is similar for all ages of fish after age 3-4.
The older fish need more food as they are bigger, therefore they have higher mortality when food is scarce.
This is most interesting: **Natural mortality is not constant for all ages, on the contrary.**

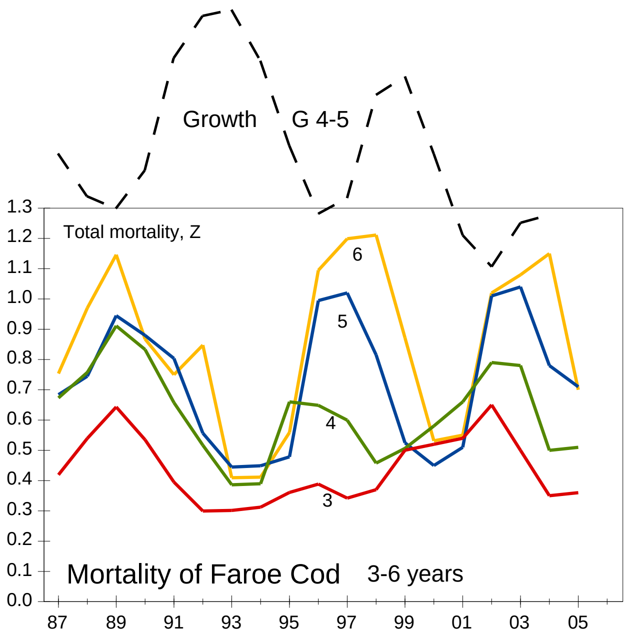

Fig. 13. Total mortality, Z, in the 3-6 years old cod 1987-2005. Growth from age 4-5 is superimposed.

It is also interesting to note that in 1993-1994 and 2000-2001, the total mortality is only 0.4-0.5.
In 1997 and 2003 it is much higher. However, the fishing pressure is similar in all the period, but from 1996 the fisheries have been managed by effort control.

This puts discussions on overfishing in a new light.