Stock Annex: Ling (*Molva molva*) in Division 5.b (Faroes grounds)

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Ling
Working Group:	Working Group on Biology and Assessment of Deep-sea Fisheries Resources (WGDEEP)
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Authors:	
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A. General

A.1. Stock definition

WGDEEP 2006 indicated: 'There is currently no evidence of genetically distinct populations within the ICES area. However, ling at widely separated fishing grounds may still be sufficiently isolated to be considered management units, i.e. stocks, between which exchange of individuals is limited and has little effect on the structure and dynamics of each unit. It was suggested that Iceland (Division 5.a), the Norwegian Coast (Subarea 2), and the Faroes and Faroe Bank (Division 5.b) have separate stocks, but that the existence of distinguishable stocks along the continental shelf west and north of the British Isles and the northern North Sea (Subareas 4, 6, 7 and 8) is less probable. Ling is one of the species included in a recently initiated Norwegian population structure study using molecular genetics, and new data may thus be expected in the future'.

WGDEEP 2007 examined available evidence on stock discrimination and concluded that available information is not sufficient to suggest changes to current ICES interpretation of stock structure.

A.2. Fishery

During the first half of the 1900 century ling (and tusk) were only caught as bycatch in the British trawl fishery. In the 1950s the longline fishery for ling (and tusk) expanded considerably and was conducted by British, Norwegian and Faroese vessels. The British fishery declined steadily from the beginning of the 1960s and in the late 1970s the Faroese deep-water fisheries started following the expansion of the national EEZs to 200 nm and a wish to reallocate fishing effort from traditional shelf fisheries. The fishery for ling in Division 5.b has not changed substantially in recent years. The demersal fisheries in Division 5.b are detailed described in Chapter 2, Demersal Stocks in the Faroe Area in ICES NWWG Report, 2011.

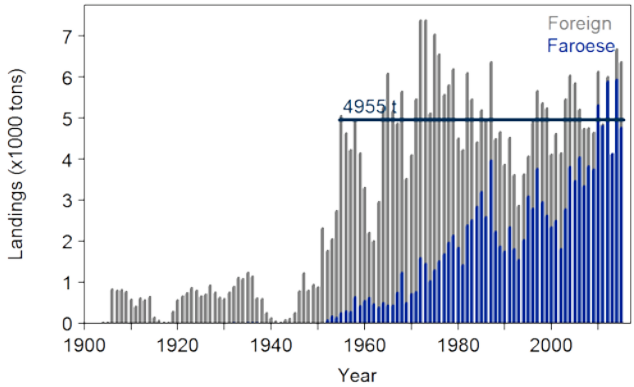

Figure 1. Nominal landings of ling in Division 5.b from 1903 to 2015.

The traditional longline fleet fishing ling, tusk and blue ling consist of 24 longliners larger than 110 GRT; they are mainly targeting cod and haddock and in years where the availability of these species is high and market conditions satisfactory, they spend very little effort in deep water. The main deep-water fleet consist of about 13 otter board trawlers with engines larger than 1000 HP. However, due to poor economic conditions especially the very high fuel prices, the number of vessels has declined in the most recent years and the effort towards deep-water species has declined further due to a switch to pair-trawling targeting mainly saithe. The single trawlers greater than 400 HP were in 2011 included into the fishing days system and were allocated a number of fishing days. The pair trawler fleet consist of xx pair trawlers larger than 1000 HP are mainly targeting saithe, but there are some bycatch of ling in this fishery.

Around 50–70% of the ling in Division 5.b was caught by longliners and the rest mainly by trawlers (30–40%). Only a minor part of the landings were by other gear. Most of the ling caught in 5.b by Faroese longliners and trawlers is caught at depths less than 500 meters. The main fishing grounds for ling in 5.b as observed from logbooks are on the slope of the Faroe Plateau and a minor part on Faroe bank.

A.3. Ecosystem aspects

It seems like the primary production on the Faroe shelf (<130 m) and the subpolar gyre index (for deeper areas) has importance for species like cod, haddock and saithe in Faroese waters (Section 2.1.3 in ICES NWWG report, 2011) - and this could also have impact on the ling.

A.4. Management

The Ministry of Fisheries is responsible for management of the Faroese fisheries and implementation of the legislation. The Ministry issues regulations for commercial fishing for each fishing year. The fishing year started on 1st September and ended 31st August the following year.

During the 1980s and 1990s the Faroe authorities have regulated the fishery and the investment in fishing vessels. In 1987 a system of fishing licences was introduced. The demersal fishery at the Faroes has been regulated by technical measures (minimum mesh sizes and closed areas). A reduction of effort has been attempted through banning of new licences and buy-back of old licences.

A quota system, based on individual quotas, was introduced in 1994 for cod, haddock, saithe and redfish. A new system entered into force on 1st June 1996 that is based on

individual transferable quotas in days within fleet categories. Nearer description of the day quota system is in Section 2.1.2 in the ICES NWWG report, 2011.

A system of instant area closure is in place for many species. The aim of the system is to minimize fishing on juveniles. An area is closed temporarily (for two weeks) for fishing if on-board inspections (not 100% coverage) reveal that more than a certain percentage of the catch is composed of fish less than the defined minimum length. To prevent fishing of small fish various measures such as mesh size regulation and closure of fishing areas are in place. Discard is banned in the Faroese demersal fishery.

All fishing boats operating in Faroese waters have to maintain a logbook record of catches in each haul/set. The records are available to the stock assessors at the Faroe Marine Research Institute.

B. Data

B.1. Commercial catch

The text Table below shows which data from landings is supplied from ICES Division 5.b.

ICES Division 5.b			Kind of data		
Country	Caton (Catch in weight)	Canum (catch-at-age in numbers)	Weca (weight-at-age in the catch)	Matprop (proportion mature-by-age)	Length composition in catch
Denmark (Greenland)	x				
Faroes	x	x	x		x
France	x				
Norway	x				
Scotland	x				

Faroese ling catch in tonnes by month, area and gear are obtained from Statistical Faroe Islands (www.hagstovan.fo) and Faroese Coast Guard (www.vorn.fo). The distribution of catches is obtained from logbook statistic where location of each haul/sets, effort (hours/1000 hooks), depth of trawling/longlining and total catch of ling is given. Good logbook information of selected commercial trawlers/longliners are available since 1995. From 2010 to present are almost all logbooks available. Landings from foreign nations fishing in Division 5.b are given by the Faroese Coast Guard and reported to the Directorate of Fisheries.

B.2. Biological

Biological data from the commercial longline and trawl fleet catches are collected from landings by technicians of the Faroe Marine Research Institute (FAMRI). The biological data collected are length (cm), gutted weight, and otoliths for age reading. Most of the fish that otoliths were collected from were also weighted (to the nearest gram). Each sample consists of 200 length measurements and from 1995 were also 60 weights and otoliths taken in some of the samples. From 2007 very few otoliths have been taken of ling, but there are good sampling of lengths and gutted weights.

The biological data from the fishery are stored in a database at FAMRI. The data are used for description of the catches from the fishery and abundance indices.

Data from the groundfish surveys in 2013–2015 of 1299 ling (lengths from 25–150 cm) indicated a L_{50} = at 70.7 cm (females = 73.9 cm, males = 68.1 cm), and ages from 1242 ling (22–16 years old) indicated an A_{50} at around 6.2 years (females = 6.48 years and males = 5.84 years). This fit well with the statement that ling become mature at ages 5–7 (60–75 cm lengths) in most areas, with males maturing at a slightly lower age than females (Magnusson *et al*., 1997). W_{50} = 2070 g (N = 1308) and gutted weight GW_{50} = 1435 g (N = 295).

No annual measurements of maturity-at-age were available and knife-edge maturity for age 7 and older has been assumed for previous assessments.

No information is available on natural mortality of ling in 5.b, but a natural mortality of 0.15 is assumed for all ages in previous assessments.

Population biology of ling in 5.b from Magnússon *et al*., 1997: Ling eggs were observed scattered over wide areas of the Northeast Atlantic and no spawning aggregations of ling have been observed so far. In Faroes waters spawning occur in April to June, in depths of 60 to about 500 m. Ling eggs are planktonic, without oil globule and of 1 mm diameter in size. In Faroese waters pelagic stages of ling have been observed mainly on 0-group surveys which were carried out since 1972 in June/July. 35–40 cm ling are taken on hooks near land. Young ling (<40 cm) are about 2–4 years old. Length–weight relationship from the annual Faroese spring survey in March (1983–1994) was $W=0.0027\ L^{3.1574}$, $R^2=0.97$. For most areas, 50% of the ling seems to become mature at-ages 5–7, corresponding to lengths 60–75 cm. Ling is mainly feeding on species as Norway pout, blue whiting, Argentines, herring and cod depending on their availability. Other foods are squids, crustaceans and echinoderms.

B.3. Surveys

The spring groundfish surveys in Faroese waters were initiated in 1983 with the research vessel Magnus Heinason. Up to 1991 three cruises per year were conducted between February and the end of March, with 50 stations per cruise selected each year based on random stratified sampling (by depth) and on general knowledge of the distribution of fish in the area. In 1992 the first cruise was not conducted and one third of the stations used up to 1991 were fixed. Since 1993 all the 100 stations on the Faroe Plateau are fixed.

The summer (August–September) groundfish survey was initiated in 1996 and covers the Faroe Plateau with 200 fixed stations distributed within the 65 to 520 m contour. Half of the stations were the same as in the spring survey. Effort for both surveys is recorded in terms of minutes towed (~60 minutes).

Survey data of ling are available to the WG from both the spring (since 1994) and summer (since 1996) surveys. There are lengths (cm) and round weights of ling from these two groundfish surveys and a recruitment index was calculated as the stratified number and biomass of ling less than 40 cm. The abundance indices from the groundfish surveys are standardized according to number of stations in each stratum and weighted with strata area for all the different strata.

The summer survey is considered descriptive of biomass trends.

B.4. Commercial cpue

Data used to estimate cpue for ling in Division 5.b are obtained from logbooks of the Faroese longline and trawl fleet. The effort obtained from the logbooks is estimated as number of fishing (trawling) hours from the trawlers, as 1000 hooks from the longliners and the catch as kg stated in the logbooks.

For the longliner cpue series sets where there were catch of ling and the catch of ling and tusk combined represented more than 60% of the total catch and depth was >150 m were selected. In 2016, a new series from longliners were adopted where the data selected were only from sets where ling was more than 30% of the total catch. Then the new Faroese series were comparable with the Norwegian longliner series.

The bycatch series for ling from the Faroese pair trawlers > 1000 HP is limited to hauls where they catch ling and the catch of saithe is more than 60% of the total catch in the haul.

A general linear model (GLM) was used to standardize all the cpue series (kg/h or kg/1000 hooks) for the commercial fleet where the independent variables were the following: vessel (actually the pair ID for the pair trawlers, otter board trawlers or longliners), month (January–April, May–August, September–December) and year. The dependent variable was the log-transformed kg per hour or kg/1000 hooks measure for each trawl haul or longline setting, which was back-transformed prior to use. The reason for this selection of hauls/settings was to try to get a series that represents changes in stock abundance.

B.5. Other relevant data

C. Historical stock development

Assessment: data and method

Ling in Division 5.b is a category 3 stock according to the ICES DLS approach proposed by the ADG in 2012.

In the advice in 2015 a 3.2 rule was used based on the cpue index from the Faroe Plateau groundfish summer survey.

There are possibilities to increase ling in 5.b to a category 1 stock with the excising data.

Exploratory analysis

An exploratory assessment of ling in Division 5.b was done by using an age-based extended survivor analysis model (XSA) (Ofstad, WD WGDEEP 2016). The summer survey series was used as tuning series. The summer surveys on the Faroe Plateau cover most of the spatial distribution area and the fishery areas. In addition, the summer survey also had the same trend as the longline series.

D. Short-term projection

E. Medium-term projections

F. Long-term projections

G. Biological reference points

No biological reference points are defined for ling in 5.b.

A modified yield per recruit analysis was used to calculate F_{MAX} and $F_{0.1}$ (Ofstad WD WGDEEP 2016). The selection patterns, as well as the weights, were calculated as the average for the whole assessment period (1996 to present). The F_{MAX} was well-defined (F-factor of 0.8 giving an absolute F of 0.31). Fishing of F_{MAX} gave a catch of around 4700 tons and a biomass of 28 000 tons. The estimate of $F_{0.1}$ (F-factor of 0.40 giving an absolute F of 0.15) gave a catch of around 4300 tons and biomass of around 39 000 tons. The estimate of $F_{0.1}$ could be used as a conservative F_{MSY} proxy.

At the 2012 WGDEEP meeting was F_{max} and $F_{0.1}$ calculated from a yield per recruit model (Figure 4.2.17). This analysis indicated F_{MAX} to be around 0.33, when the age of first catch, AFC = five years and F_{MAX} = 0.27 with AFC = four years. Other input values was L_∞ = 227 cm, K = 0.052, t_0 = -0.93, M = 0.15, L_{50} = seven years. The results are shown in the table below.

AFC=	4	5	AFC=	4	5
F_{MAX} =	0.27	0.33	F=	0.1	0.1
Y/R =	1.38	1.55	Y/R =	1.07	1.09
SPR =	3.42	3.51	SPR =	8.67	9.58

At the 2012 WGDEEP was also WKLIFE Gislason spreadsheet applied using an L_{MAX} of 180 cm and AFC = 5. The parameters estimated by the model (k = 0.11,) were unrealistic based on what is known about this stock and the F_{MAX} value (F_{MAX} = 0.22) was substantially lower than that estimated by YPR.

H. Other issues

I. References

ICES. 2011. Report of the North Western Working Group (NWWG)m 26 April–3 May 2011, ICES Headquarters, Copenhagen, Denmark. ICES CM 2011/ACOM:7. 975 pp.

Magnússon, J., Bergstad, O.A., Hareide, N.R., Magnússon, J. Reinert, J. 1997. Ling, Blue Ling and Tusk of the Northeast Atlantic. TemaNord 1997:535.

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