Stock Annex: Tusk (*Brosme brosme*) in subareas 1 and 2 (Northeast Arctic)

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Tusk
Working Group:	Working Group on Biology and Assessment of Deep-sea Fisheries Resources (WGDEEP)
Created:	March 2011
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Last updated:	April 2021
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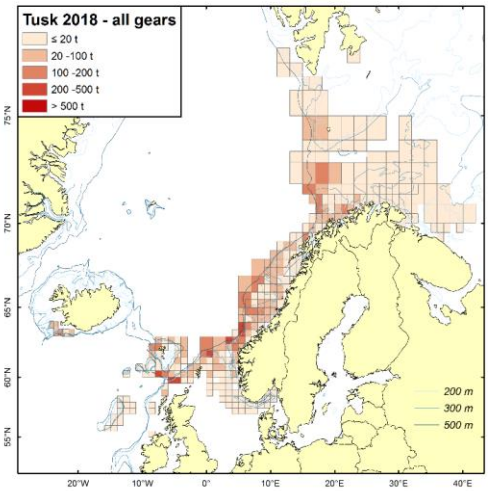
A. General

A.1. Stock definition

In 2007, WGDEEP examined the available evidence of stock discrimination in this species. Based on the genetic investigation, the Group suggested that Tusk in 1 and 2 should be treated as one unit.

A.2. Fishery

Tusk has been caught primarily as a bycatch in the ling and cod fisheries for centuries, and the historical development is described by Bergstad and Hareide, 1996, which also includes the post-World War II increase caused by a series of technical advances. Currently the major fisheries in Subareas 1 and 2 are the Norwegian longline and gillnet fisheries, but there are also bycatches by other gears, i.e. trawls and handlines. The Norwegian landings, around 85% of the total, are taken by longlines, 10% by gillnets and the remainder by a variety of other gears. Other nations catch tusk as a bycatch in the trawl and longline fisheries. The following map shows the spatial distribution of total catch in the Norwegian fishery for 2018 (ICES 2019a)



A.3. Ecosystem aspects

Tusk prefers hard, or sandy seabeds with large rocks. It inhabits depths that range from 50 to 1000 m, but is mainly found between 200 and 500 m (Pethon, 2005). It is believed that they occur alone or in small schools (Gordon et al., 1995). The maximum weight and length of tusk is about 15 kg and 1.1 m, respectively. Tusk matures between six and eight years and may live for 40 years. The main spawning areas are between Scotland and Iceland, but tusk also spawns along the Norwegian coast and in the fjords from April to August at depths between 200 and 400 m (Pethon, 2005). Eggs and larvae are pelagic and hatch after about 9 days. Tusk feeds mainly on shrimps, crabs. and small fish (Magnusson et al., 1997, Pethon, 2005).

B. Data

Full landings data are available from 1988 to present but it is thought that fisheries in some of these areas pre-date the time series. Incomplete landings data are available from Norwegian longline fisheries from 1889 onwards. Additional landings data from other areas may be available from 1950 onwards.

B.2. Biological

Length data for the Norwegian reference fleet in Subarea 2.a have been routinely collected since 2002.

Tusk is a demersal species and is most common at depths between 200-500m. They are usually found over hard or rocky bottoms where they feed on small fish and crustaceans. Tusk lives alone or in small schools. The growth is slow (k=0,15) and they can be up to 40 years old. Natural mortality is usually set to 0.2. Tusk is mature at 6-8 years old. Spawning takes place in April-August and a large female can spawn between 2-3 million eggs (Fishbase, Pethon 2005).

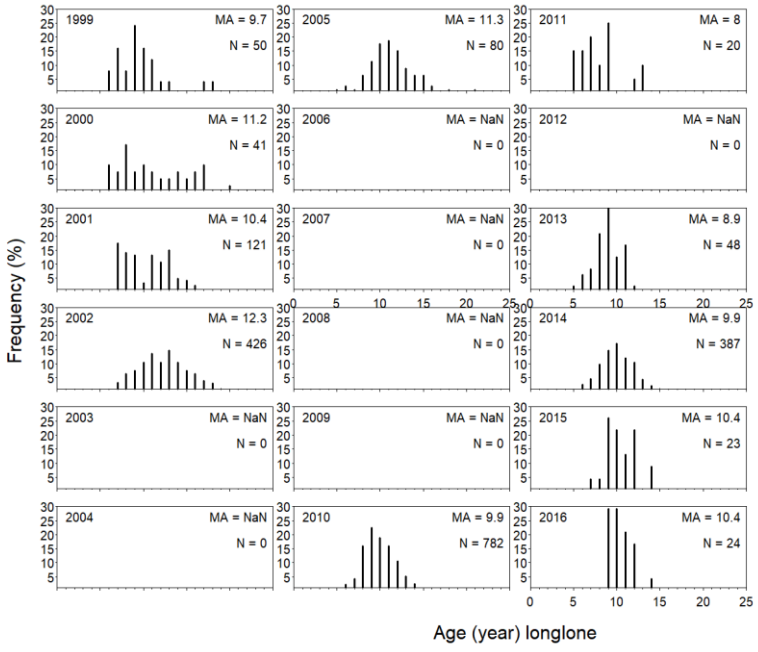
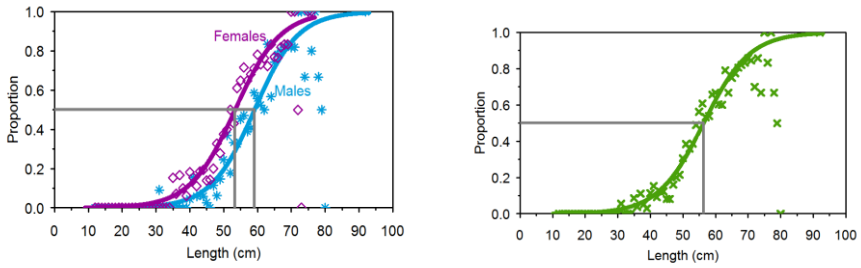


Figure 5.5.8. Catch-at- age composition from the longline fishery in areas 1 and 2.

Maturity ogives for tusk are in the figyre and in the table below. There were insufficient age data to determine A_{50}.

Maturity parameters:

Stock	L_{50}	N	A_{50}	N	Source
Usk-arct	56.3	2616			Norwegian long liners (Reference fleet) and survey data



Tusk Area 1 and 2, Maturity ogive on length for males and females, and all data combined.

Age compositions

The average length and weight-at-age for males and females based on the combined data for the years 2000–2002, 2004, 2005, 2010, 2011, 2013-2016 are shown in Figure 5.5.7 and the catch-at- age compositions from the longline fishery in areas 1 and 2 are shown in Figure 5.5.8.

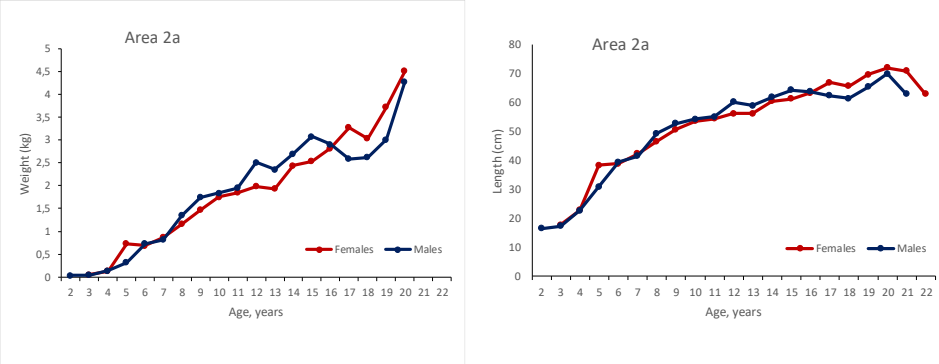


Figure 5.5.7. Average length and weight-at-age for all available data for the years 2000–2002, 2004, 2005, 2010, 2011, 2013–2016.

B.3. Surveys

Scientific surveys do not sufficiently cover the deep-water habitats occupied by tusk, and the amount of tusk caught in the surveys are insufficient for use in traditional assessments.

B.4. Commercial CPUE

Norway began in 2003 to collect and enter data from official logbooks into an electronic database, and these data are now available for the period 2000–2019. Vessels were selected that had a total landed catch of ling, tusk and blue ling exceeding 8 t each year. The logbooks contain records of the daily catch, date, position, and number of hooks used per day.

The method for estimating cpue for tusk is given in Helle *et al.*, 2015. An analysis based on these data is in the WD Helle and Pennington, 2020. Two cpue series, one based on all data and one when tusk was targeted were presented (Figure 5.5.9). No research vessel data are available.

B.5. Other relevant data

C. Assessment: data and method

No assessment model is used in the advice for tusk.

Two cpue series based on data from the Norwegian reference fleet for tusk, one using all data available and the other using only data when tusk were targeted (>30% of the total catch). A generalized linear model was found appropriate

$$y_{i,j,k,l} = c + \mu_i + \alpha_j + \beta_k + e_{i,j,k,l} \quad (1)$$

where; $y_{i,j,k,l}$ is the catch (kg) per hook in year i, month *j* for set *l* by vessel *k*; *c* is a constant; μ_i , *i* = 2000-2015, is the year effect; α_j is the month effect; β_k is the vessel effect, and $e_{i,j,k,l}$ is the error term model (for more details see Helle *et al*., 2015).

Since the data often contains a large proportion of zeros, the GLM model (1) was combined using the delta method (Pennington, 1983; Stefánsson, 1996; Maunder and Punt, 2004). That is the estimator of the year effect, μ_i based on all the data is given by:

$$\hat{\mu}_i = \frac{m}{n}\hat{\mu}'_i, \quad (2)$$

where *m* is the number of catches of tusk greater than zero, *n* is the total number of sets and $\hat{\mu}'_i$ is the year effect based on model (1). If the number of zeros is statistically independent of $\hat{\mu}'_i$ and the distribution of zeros is assumed to be binomial, then the variance estimator of $\hat{\mu}_i$ is given by (Pennington, 1983; 1996)

$$\mathrm{var}(\hat{\mu}_i) = \frac{m(m-1)}{n(n-1)}\mathrm{var}(\hat{\mu}'_i) + \frac{m(n-m)}{n^2(n-1)}(\hat{\mu}'_i)^2. \quad (3)$$

Other data limited models have been explored and this study is still in progress.

D. Short-Term Projection

No short-term projections are performed.

E. Medium-Term Projections

No medium-term projections are performed.

F. Long-Term Projections

No long-term projections are performed.

G. Biological Reference Points

No reference points are defined for this stock in terms of absolute values. The SPiCT-estimated values of the ratios F/FMSY and B/BMSY are used to estimate stock status relative to the proxy MSY reference points.

Framework	Reference point	Value	Technical basis	Source
MSY approach*	MSY $B_{trigger_{proxy}}$	$\frac{B}{B_{MSY}} = 0.5$	Relative value from SPiCT model. B_{MSY} is estimated directly from the SPiCT assessment model and changes when the assessment is updated.	ICES (2019)
	$F_{MSY_{proxy}}$	$\frac{F}{F_{MSY}} = 1$	Relative value from SPiCT model. F_{MSY} is estimated directly from the SPiCT assessment model and changes when the assessment is updated.	ICES (2019)
Precautionary approach	B_{lim}			
	B_{pa}			
	F_{lim}			
	F_{pa}			
Management plan	SSB_{mgt}			
	F_{mgt}			

H. Other Issues

H.1. Management process

Management of tusk in Subareas 1 and 2 is based on the precautionary approach. The ICES advise is that catches should be no more than 11 077 t in 2020 and in 2021. Total catches are assumed to be landed.

There is no quota for the Norwegian tusk fishery, but vessels participating in the directed fishery for ling or tusk in Subareas 1 and 2 are required to have a licence. There is no minimum landing length in the Norwegian EEZ.

The EU TAC (for community vessels fishing in community waters and waters not under the sovereignty or jurisdiction of third countries in 1, 2 and 14) was set to 21 t in 2019.

H.2. Historical management

In 2003- 2006, the advice was to reduce the effort by 30%. For 2007-2013 the advice was based on the average catch in the previous three years. From 2014, tusk has been managed as an ICES stock data category 3.3.2 and advice based on cpue trends. There were no tusk quotas for Norwegian vessels in Subareas 1 and 2.

The Norwegian longline fleet (vessels larger than 21 m) increased from 36 in 1977 to a peak of 72 in 2000, and afterwards the number stabilized at 26. The number of vessels declined mainly because of changes in the law concerning the quotas for cod.

I. References

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