5 Tusk (*Brosme brosme*).

5.1 Stock description and management units

In 2007, WGDEEP examined the available evidence for separate tusk stocks in the ICES region. Based on genetic investigations, the group suggested the following stock units for tusk:

- Area 5.a and 14;
- Mid-Atlantic Ridge;
- Rockall (6.b);
- Areas 1, 2.

All other areas (4.a,5.b, 6.a, 7,…) should be assessed as one stock unit until further evidence of multiple stocks become available.

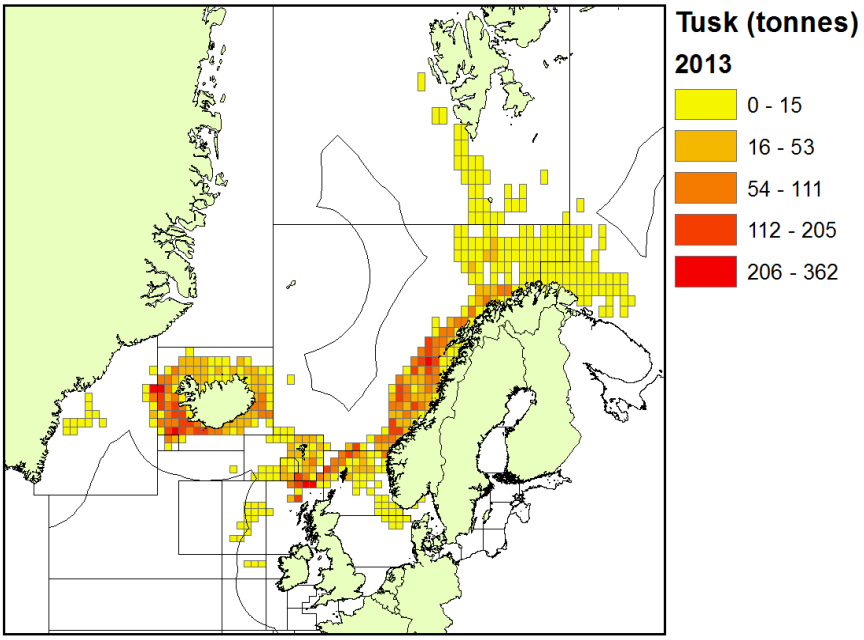

Figure 5.1. Reported landings of tusk in the ICES area by statistical rectangle in 2013. Data are from Norway, Faroes, Iceland, France, UK (England and Wales) and Spain. Landings shown in account for 99% of all reported landings in the ICES area.

5.1 Tusk in 5.a and 14 (*Brosme brosme*)

5.1.1 The fishery

Tusk in 5.a is caught in a mixed longline fishery, conducted in order of importance by Icelandic, Faroese and Norwegian boats. Between 150 and 240 Icelandic longliners report catches of tusk, but ~100 more vessels have small amounts of bycatch landings (Table 5.1.1). Far fewer gillnetters and trawlers participate in the fishery. The number of longliners reporting tusk catches have been continually decreasing in the past few years (Table 5.1.1). Most of tusk in 5.a, around 97% of catches in tonnes, is caught by longlines, and this proportion has been relatively stable since 1992 (Table 5.1.2).

Table 5.1.1. Tusk in 5.a. Number of Icelandic boats with tusk landings and their total landings

	Number of Boats			Catch (Tonnes)				
Year	Bottom trawl	Gill nets	Longlines	Bottom trawl	Gill nets	Longlines	Other	Total catch
2000	106	175	370	93	44	4564	37	4738
2001	83	224	350	73	63	3248	38	3422
2002	80	174	304	75	93	3722	30	3920
2003	78	148	305	56	41	3941	21	4059
2004	74	130	303	85	28	3007	15	3135
2005	77	101	324	108	19	3398	14	3539
2006	72	82	338	91	40	4912	16	5059
2007	64	65	308	95	38	5834	20	5987
2008	63	59	255	114	42	6762	19	6937
2009	66	65	239	107	72	6757	16	6952
2010	59	62	228	92	52	6761	14	6919
2011	51	54	221	69	24	5742	12	5847
2012	53	68	228	60	13	6255	16	6344
2013	53	43	233	74	15	4911	17	5017
2014	52	43	249	86	18	6045	14	6163
2015	47	32	228	69	7	4745	14	4835
2016	54	32	206	61	6	3420	8	3495
2017	50	31	180	48	5	2481	6	2540
2018	55	27	158	83	8	2841	8	2940
2019	48	22	155	102	7	3326	9	3444
2020	52	23	126	107	31	3270	12	3420

Most of the tusk caught in 5.a by Icelandic longliners is caught at depths less than 300 meters Figure 5.1.1). The main fishing grounds for tusk in 5.a as observed from logbooks are on the southeast, southwestern and western part of the Icelandic shelf (Figure 5.1.2 and Figure 5.1.3). The spatial distribution of catches in 5.a according to logbook entries shows a decreasing trend in the southeast until 2015, but this proportion has been increasing in the last 5 years (Figure 5.1.2 and Figure 5.1.3). The proportional catch in the northwest has also increased over the years. Around 50–60% of tusk is caught on the southern and western parts of the shelf (Figure 5.1.3).

Tusk in 14 is caught mainly as a bycatch by longliners and trawlers. The main area where tusk is caught in 14 is 63°–66°N and 32°–40°W, well away from the Icelandic EEZ.

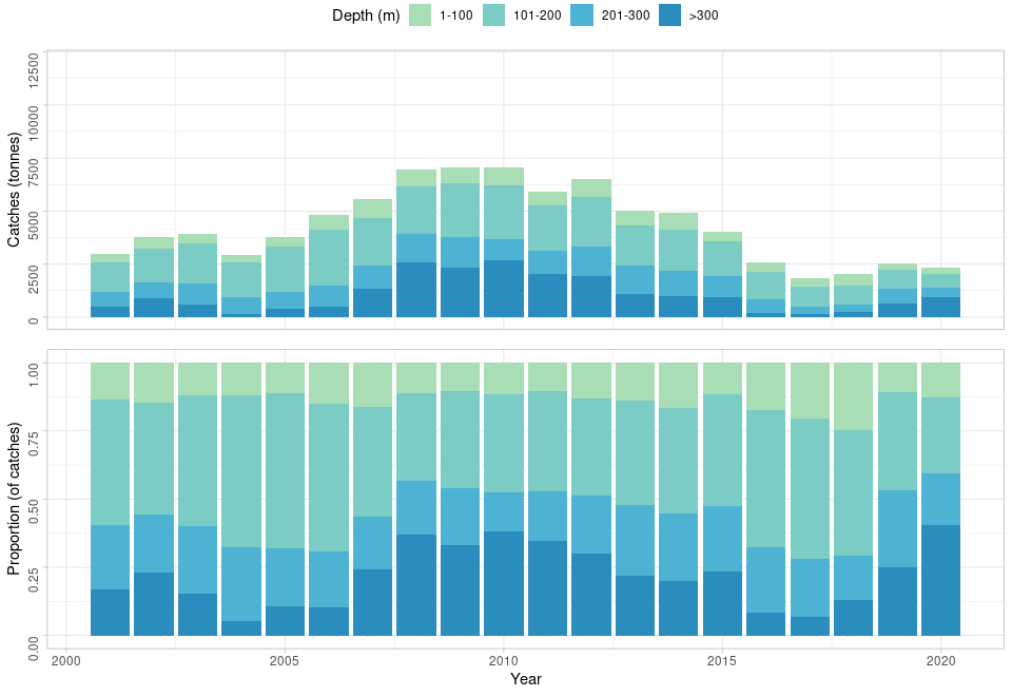

Figure 5.1.1: Tusk in 5.a and 14. Depth distribution of catches in 5.a according to logbooks. All gears combined.

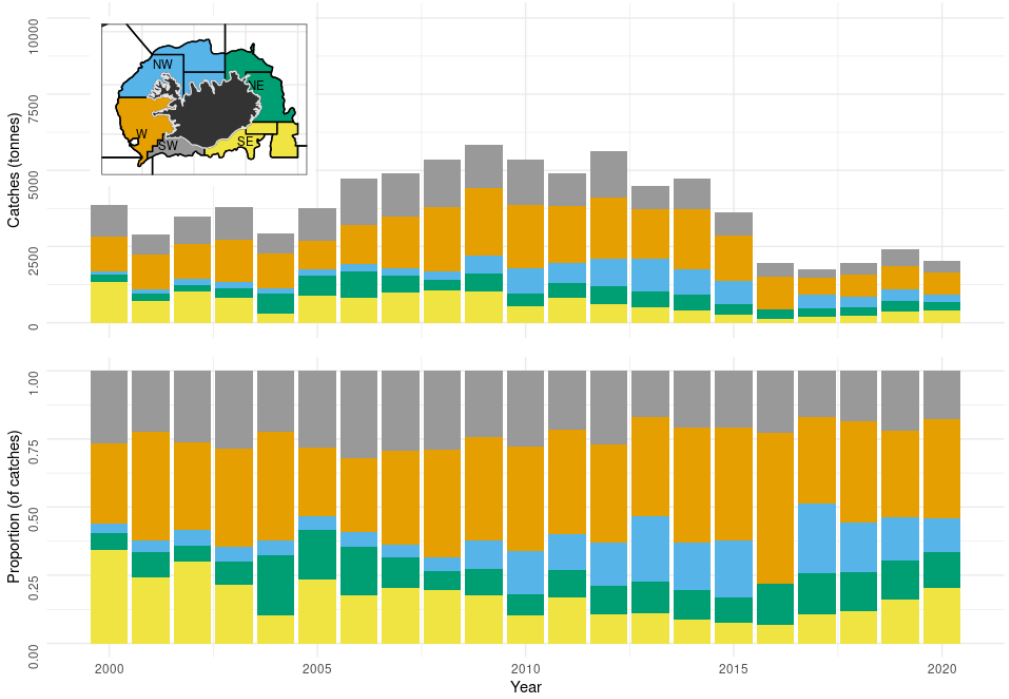

Figure 5.1.2: Tusk in 5.a and 14. Catch distribution and proportions by area according to logbooks. All gears combined.

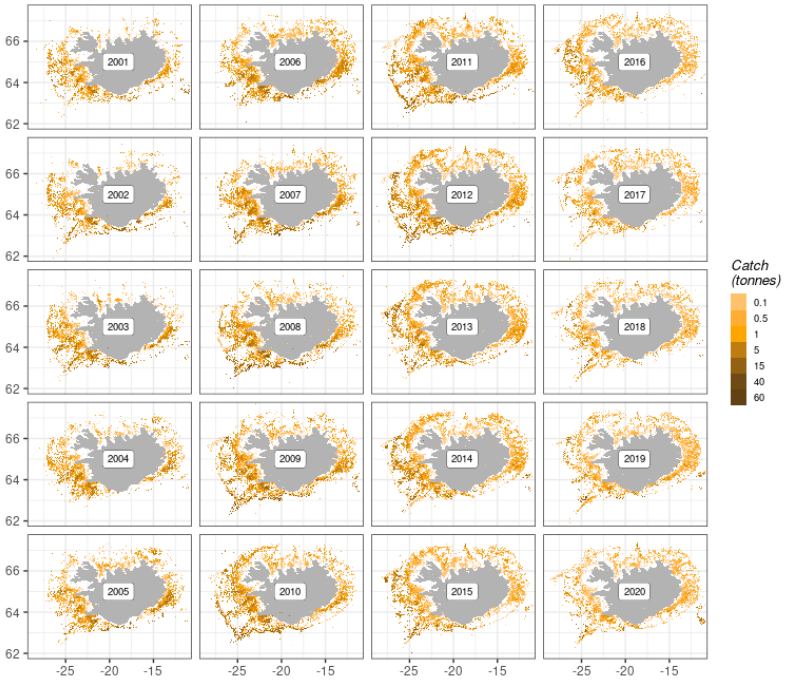

Figure 5.1.3: Tusk in 5.a and 14. Geographical distribution (tonnes) of the Icelandic longline fishery since 2000, as reported in logbooks by the Icelandic fleet.

5.1.2 Landing trends

The total annual landings from ICES Division 5.a were around 3420 tonnes in 2020 (Table 5.1.1), signifying a continuous decrease in landings from 2010. This is contrary to the trend in landings from 2000 in which the annual landings gradually increased in 5.a to around 9000 tonnes in 2010 (Figure 5.1.4).

The foreign catch (mostly from the Faroe Islands, but also from Norway) of tusk in Icelandic waters has always been considerable. Until 1990, between 40–70% of the total annual catch from ICES Division 5.a was caught by foreign vessels, mainly vessels from the Faroe Islands. This proportion reduced to 15–25% until the most recent years in which it increased to closer to 50% due to a reduction in Icelandic catches (Table 5.1.2).

Landings in 14.b have always been low compared to 5.a, rarely exceeding 100 t. However, around 900 tonnes were caught in 2015, after which catches have been consistently substantial. Catch data from section 14 reported by the Greenland Institute of Natural Resources (WD02, Annex to WGDEEP 2019) also reflect this trend. Around 566 tonnes in 2019 were caught in the 14.b mainly by Faroese and Greenlandic vessels (Table 5.1.3). This has however decreased in 2020 to about 233 tonnes constituting 7% of the annual catch.

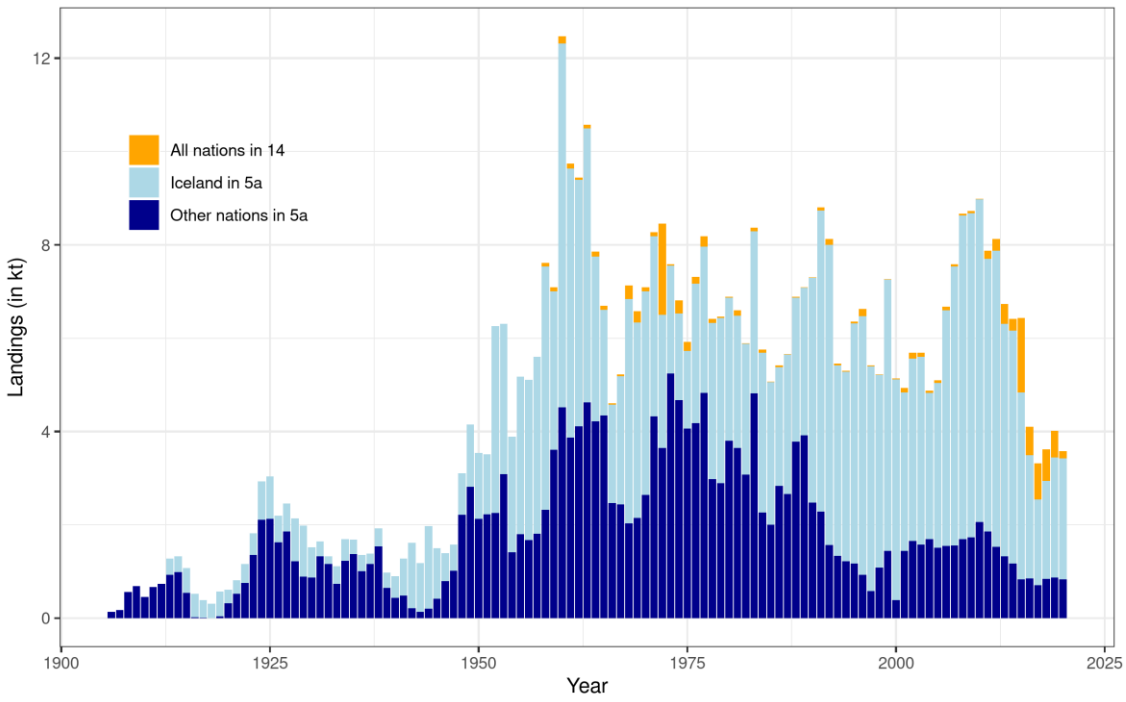

Figure 5.1.4: Tusk in 5.a and 14.Nominal landings within Icelandic waters by Icelandic vessels (light blue) or foreign vessels (dark blue), or within Greenlandic waters (orange). (source for 14: STATLANT).

Table 5.1.2. Tusk in 5.a and 14. Nominal landings by nations in 5.a.

YEAR	FAROE	DENMARK	GERMANY	ICELAND	NORWAY	UK	TOTAL
1980	2873	0	0	3089	928	0	6890
1981	2624	0	0	2827	1025	0	6476
1982	2410	0	0	2804	666	0	5880
1983	4046	0	0	3469	772	0	8287
1984	2008	0	0	3430	254	0	5692
1985	1885	0	0	3068	111	0	5064
1986	2811	0	0	2549	21	0	5381
1987	2638	0	0	2984	19	0	5641
1988	3757	0	0	3078	20	0	6855
1989	3908	0	0	3131	10	0	7049
1990	2475	0	0	4813	0	0	7288
1991	2286	0	0	6439	0	0	8725
1992	1567	0	0	6437	0	0	8004
1993	1329	0	0	4746	0	0	6075
1994	1212	0	0	4612	0	0	5824

YEAR	FAROE	DENMARK	GERMANY	ICELAND	NORWAY	UK	TOTAL
1995	979	0	1	5245	0	0	6225
1996	872	0	1	5226	3	0	6102
1997	575	0	0	4819	0	0	5394
1998	1052	0	1	4118	0	0	5171
1999	1035	0	2	5794	391	2	7224
2000	1154	0	0	4714	374	2	6244
2001	1125	0	1	3392	285	5	4808
2002	1269	0	0	3840	372	2	5483
2003	1163	0	1	4028	373	2	5567
2004	1478	0	1	3126	214	2	4821
2005	1157	0	3	3539	303	41	5043
2006	1239	0	2	5054	299	2	6596
2007	1250	0	0	5984	300	1	7535
2008	959	0	0	6932	284	0	8175
2009	997	0	0	6955	300	0	8252
2010	1794	0	0	6919	263	0	8976
2011	1347	0	0	5845	198	0	7390
2012	1203	0	0	6341	217	0	7761
2013	1092	0.12	0	4973	192	0	6257
2014	728	0	0	4995	306	0	6029
2015	625	0	0	4000	198	0	4823
2016	543	0	0	2649	302	0	3494
2017	492	0	0	1833	216	0	2540
2018	517	0	0	2097	326	0	2940
2019	549	0	0	2579	316	0	3444
2020	558	0	0	2590	272	0	3420

Table 5.1.3. Tusk in 5.a and 14. Nominal landings by nations in 14.

YEAR	FAROE	DEN-MARK	GREEN-LAND	GER-MANY	ICE-LAND	NOR-WAY	RUSSIA	SPAIN	UK	TOTAL
1980	0	0	0	13	0	0	0	0	0	13
1981	110	0	0	10	0	0	0	0	0	120
1982	0	0	0	10	0	0	0	0	0	10
1983	74	0	0	11	0	0	0	0	0	85
1984	0	0	0	5	0	58	0	0	0	63
1985	0	0	0	4	0	0	0	0	0	4
1986	33	0	0	2	0	0	0	0	0	35
1987	13	0	0	2	0	0	0	0	0	15
1988	19	0	0	2	0	0	0	0	0	21
1989	13	0	0	1	0	0	0	0	0	14
1990	0	0	0	2	0	7	0	0	0	9
1991	0	0	0	2	0	68	0	0	1	71
1992	0	0	0	0	3	120	0	0	0	123
1993	0	0	0	0	1	39	0	0	0	40
1994	0	0	0	0	0	16	0	0	0	16
1995	0	0	0	0	0	30	0	0	0	30
1996	0	0	0	0	0	157	0	0	0	157
1997	0	0	0	0	10	9	0	0	0	19
1998	0	0	0	0	0	12	0	0	0	12
1999	0	0	0	0	0	8	0	0	0	8
2000	0	0	0	0	11	11	0	3	0	25
2001	3	0	0	0	20	69	0	0	0	92
2002	4	0	0	0	86	30	0	0	0	120
2003	0	0	0	0	2	88	0	0	0	90
2004	0	0	0	0	0	40	0	0	0	40
2005	7	0	0	0	0	41	8	0	0	56
2006	3	0	0	0	0	19	51	0	0	73
2007	0	0	0	0	0	40	6	0	0	46

YEAR	FAROE	DEN-MARK	GREEN-LAND	GER-MANY	ICE-LAND	NOR-WAY	RUSSIA	SPAIN	UK	TOTAL
2008	0	0	33	0	0	7	0	0	0	40
2009	12	0	15	0	0	5	11	0	0	43
2010	7	0	0	0	0	5	0	0	0	12
2011	20	0	0	0	131	24	0	0	0	175
2012	33	0	0	0	174	46	0	0	0	253
2013	1.9	0.3	0	0	0	23.8	0	0	0	26
2014	2	0	0	0	0	26	0	0	0	28
2015	670	0.1	166	0	0	62	0	0	0	898
2016	111	0	182	0	0	178	0	0	0	471
2017	83	0.38	335	0	0	141	0	0	0	559
2018	345	0	108	0	0	228	0	0	0	681
2019	41	0	66	1	0	458	0	0	0	566
2020	0	0	233	2	0	114	0	0	0	349

5.1.2.1 ICES advice

ICES advises that when the Iceland management plan is applied, catches in the fishing year 2020/2021 should be no more than 2 171 tonnes.

5.1.2.2 Management

The Icelandic Ministry of Industries and Innovation (MII) is responsible for management of the Icelandic fisheries and implementation of legislation. Tusk was included in the ITQ system in the 2001/2002 quota year and as such subjected to TAC limitations. At the beginning, the TAC was set as recommended by MFRI but thereafter had often been set higher than the advice. One reason is that no formal harvest advisory rule existed for this stock. Up until the fishing year 2011/2012, the landings, by quota year had always exceeded the advised and set TAC by 30-40%. However, since then the overshoot in landings has decreased substantially, apart from 2014/2015 when the overshoot was 34%. In recent years the TAC has not been filled Table 5.1.4.

The reasons for the large difference between annual landings and both advised and set TACs are threefold: 1) It is possible to transfer unfished quota between fishing years; 2) It is possible to convert quota shares in one species to another; 3) The national TAC is only allocated to Icelandic vessels. All foreign catches are therefore outside the quota system. [However, in recent years managers have to some extent taken into account the foreign catches when setting the national TAC (see below)].

There are bilateral agreements between Iceland, Norway and the Faroe Islands related to fishing activity of foreign vessels in restricted areas within the Icelandic EEZ. Faroese vessels are allowed to fish 5600 t of demersal fish species in Icelandic waters which includes a maximum 1200 tonnes of cod and 40 t of Atlantic halibut. The rest of the Faroese demersal fishery in Icelandic waters is mainly directed at tusk, ling, and blue ling. The tusk advice given by MFRI and ICES for each

quota year is, however, for all catches, including foreign catches. Further description of the Icelandic management system can be found in the stock annex.

Figure 5.1.5 shows the net transfers in the Icelandic ITQ-system. During the 2005/2006–2010/2011 fishing years there was a net transfer of other species quota being converted to tusk quota, this however reversed during the following three fishing years. In the 2015/2016 and 2016/2017 fishing years there was again a small net transfer of other species being changed to tusk quota. In the last four fishing years, 2017/2018-2019/2020, net transfers have been negative again with tusk quota being converted to other species.

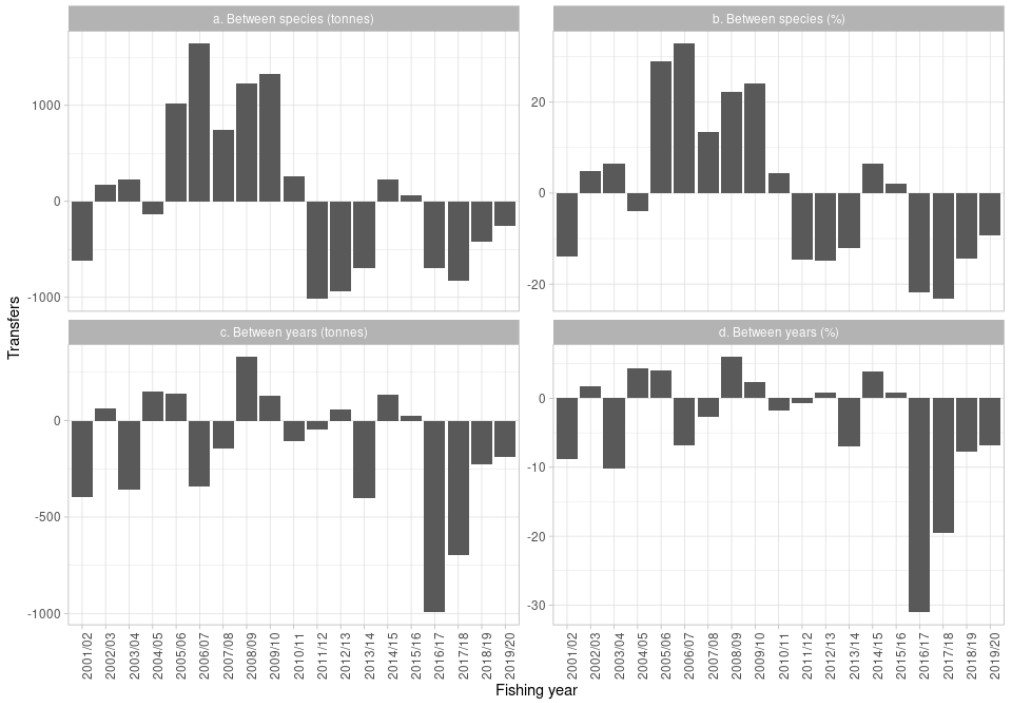

Figure 5.1.5: Tusk in 5.a and 14. Net transfer of quota in the Icelandic ITQ system by fishing year. Between species (upper): Positive values indicate a transfer of other species to tusk, but negative values indicate a transfer of tusk quota to other species. Between years (lower): Net transfer of quota for a given fishing year (may include unused quota).

Table 5.1.4. Tusk in 5.a and 14. TAC recommended for tusk in 5.a by the Marine Research Institute, national TAC and total landings from the quota year 2001/2002.

Fishing Year	MFRI Advice	National TAC	Landings
2001/02		4 500	4 876
2002/03	3 500	3 500	5 046
2003/04	3 500	3 500	4 958
2004/05	3 500	3 500	4 901
2005/06	3 500	3 500	5 928
2006/07	5 000	5 000	7 942
2007/08	5 000	5 500	7 279
2008/09	5 000	5 500	8 162
2009/10	5 000	5 500	8 382

Fishing Year	MFRI Advice	National TAC	Landings
2010/11	6 000	6 000	7 777
2011/12	6 900	7 000	7 401
2012/13	6 700	6 400	6 833
2013/14	6 300	5 900	5 881
2014/15	4 000	3 700	4 958
2015/16	3 440	3 000	3 494
2016/17	3 780	3 380	2 407
2017/18	4 370	4 370	3 139
2018/19	3 776	3 100	2 454
2019/20	3 856	3 856	3 445
2020/21	2 289	2 289	
2021/22	2 171	2 171	

5.1.3 Data available

In general sampling is considered appropriate from commercial catches from the main gear (longlines), although the quantity of samples has decreased substantially in recent years. The sampling does seem to cover the spatial distribution of catches for longlines and trawls. Similarly, sampling does seem to follow the temporal distribution of catches (ICES (2012)). The sampling coverage by gear in 2020 is shown in Figure 5.1.6.

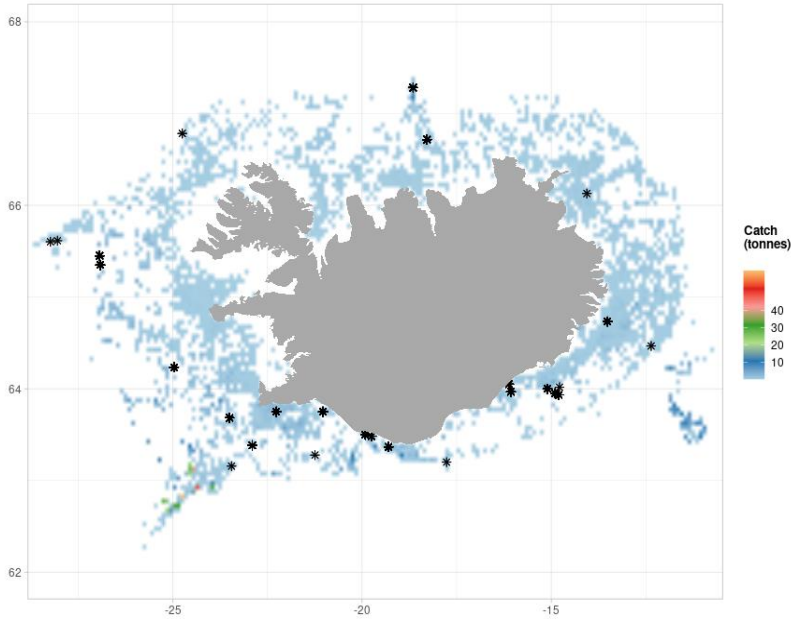

Figure 5.1.6: Tusk in 5.a and 14. Fishing grounds in 2019 as reported by catch in logbooks (tiles) and positions of samples taken from landings (asterisks) by longliners.

5.1.3.1 Landings and discards

Landings by Icelandic vessels are given by the Icelandic Directorate of Fisheries. Landings of Norwegian and Faroese vessels are given by the Icelandic Coast Guard. Discarding is banned by law in the Icelandic demersal fishery, as well as in Norway. Based on limited data, discard rates in the Icelandic longline fishery for tusk are estimated very low (<1% in either numbers or weight) (ICES (2011) :WD02). Measures in the Icelandic management system such as converting quota share from one species to another are used by the Icelandic fleet to a large extent, and this is thought to discourage discards in mixed fisheries. A description of the management system is given in the stock annex and Iceland fisheries overview (ICES (2017b) and ICES (2019)). Landings for tusk in Greenlandic waters are obtained from the STATLANT database. Figures reported by the Greenland Institute of Natural Resources (ICES (2014):WD06) are in agreement. No information is available on discards in Greenlandic waters.

5.1.3.2 Length compositions

An overview of available length measurements from 5.a is given in Table 5.1.6. Most of the measurements are from longlines; number of available length measurements increased in 2007 from around 2500 to around 4000 and were close to that until 2016 when they decreased to around 1700 and have remained roughly at that level. Length distributions from the spring survey data and longline fishery are shown in Figures 5.1.7 and 5.1.8 respectively. In the figures, numbers-at-length are multiplied by the expected proportion mature at that length to split catch numbers into mature and immature components.

No length composition data from commercial catches in Greenlandic waters are available.

Table 5.1.5. Tusk in 5.a and 14. Number of available length measurements from Icelandic (5.a) commercial catches.

Year	Bottom trawl	Demersal seine	Gill net	Long lines	Other
2000	0	0	0	2995	0
2001	0	0	0	3097	151
2002	0	0	0	2843	0
2003	0	0	0	8444	0
2004	150	0	0	3809	0
2005	21	0	0	5820	0
2006	472	0	0	4861	0
2007	150	0	167	11936	0
2008	0	0	0	20963	0
2009	0	0	0	21451	0
2010	0	0	0	9084	0
2011	0	0	0	8158	0
2012	150	0	0	11867	0
2013	0	150	0	6469	0
2014	0	0	0	11748	0

Year	Bottom trawl	Demersal seine	Gill net	Long lines	Other
2015	0	0	0	4821	0
2016	0	0	0	4844	0
2017	0	0	0	1710	0
2018	0	0	0	2781	0
2019	0	0	0	2952	0
2020	1	0	0	2336	0

Figure 5.1.7: Tusk in 5.a and 14. Length distributions (4 cm grouping) from the spring survey since 1985. Red areas are immature tusk and green represent mature tusk. Small numbers to the right refer to mean length (ML).

Figure 5.1.8: Tusk in 5.a and 14. Length distributions from Icelandic commercial longline catches.

5.1.3.3 Age compositions

Table 5.1.6 gives an overview of otolith sampling intensity by gear types from 2000 to 2020 in 5.a. Since 2010, considerable effort has been put into ageing tusk otoliths, so now aged otoliths are available from 1984, 1995, 2008–2018. The age data are used as input for the Gadget assessment. It is expected that the effort in ageing of tusk will continue. Age distributions are shown from the spring survey and commercial longline samples in Figure 5.1.9 and Figure 5.1.10 respectively. No data are available from 14.

Table 5.1.6. Tusk in 5.a and 14. Number of available otoliths from Icelandic (5.a) commercial catches and the Icelandic Spring survey and the number of aged otoliths.

Year	No. samples (catch)	No. otoliths (catch)	No.samples (survey)	No.aged (survey)
2008	14	600	282	475
2009	24	1090	277	434
2010	29	1373	241	363
2011	28	1306	270	728
2012	33	1112	285	750
2012	1	48	285	750
2013	1	20	275	536
2013	22	490	275	536
2014	28	587	241	560
2015	26	505	260	573

Year	No. samples (catch)	No. otoliths (catch)	No.samples (survey)	No.aged (survey)
2016	14	290	259	676
2017	8	152	245	571
2018	9	179	247	549
2019	15	321	251	704
2020	12	236	250	647

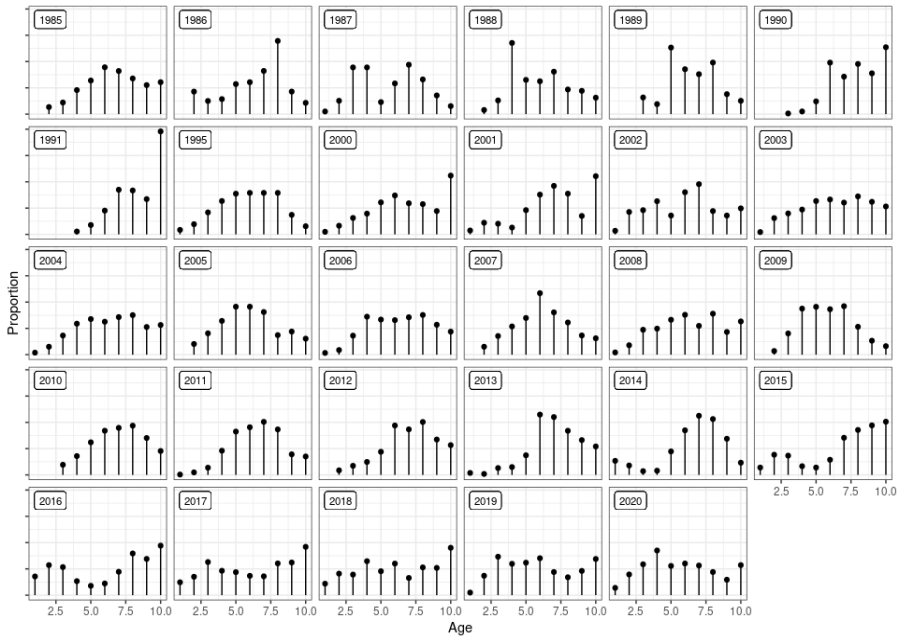

Figure 5.1.9: Tusk in 5.a and 14. Age distributions in proportions in 5.a from the Iceland spring survey.

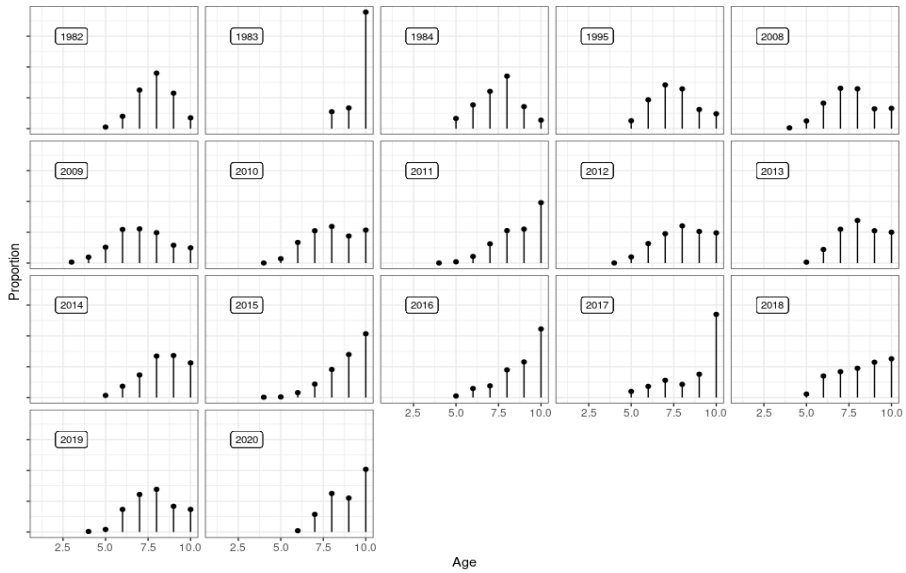

Figure 5.1.10: Tusk in 5.a and 14. Age distributions in proportions in 5.a (from longlines). Samples for 2019 are only from January – March.

5.1.3.4 Weight at age

Weight-at-age data from 5.a are limited to 2008–2021. No data are available from 14.

5.1.3.5 Maturity at age

At 54 cm around 25% of tusk in 5.a is mature, at 62 cm 50% of tusk is mature and at 70 cm 75% of tusk is mature based on the spring survey data.

No data are available for 14.

5.1.3.6 Natural mortality

No information is available on natural mortality of tusk in 5.a or 14. For assessment and advisory purpose the natural mortality is set to 0.1 for all age groups.

5.1.3.7 Catch, effort and research vessel data

Catch per unit of effort and effort data from commercial fisheries

The CPUE estimates of tusk in 5.a are not considered representative of stock abundance.

CPUE estimations have not been attempted on available data from 14.

Icelandic survey data (ICES division 27.5.a)

Information on abundance and biological parameters from tusk in Icelandic waters is available from two surveys, the Icelandic groundfish survey in the spring and the Icelandic autumn survey. The Icelandic spring groundfish survey, which has been conducted annually in March since 1985, covers the most important distribution area of the tusk fishery. In 2011 the 'Faroe Ridge' survey area was included into the estimation of survey indices. In addition, the autumn survey was commenced in 1996 and expanded in 2000; however, a full autumn survey was not conducted in 2011 due to labour strikes and therefore the results for 2011 are not presented. A detailed description of the Icelandic spring and autumn groundfish surveys is given in the Stock Annex (ICES (2017b)). Figure 5.1.11 shows recruitment index and the trends in various biomass indices. No substantial changes in spatial distribution are seen in general although there are spatial gradients in size distribution Figure 5.1.12.

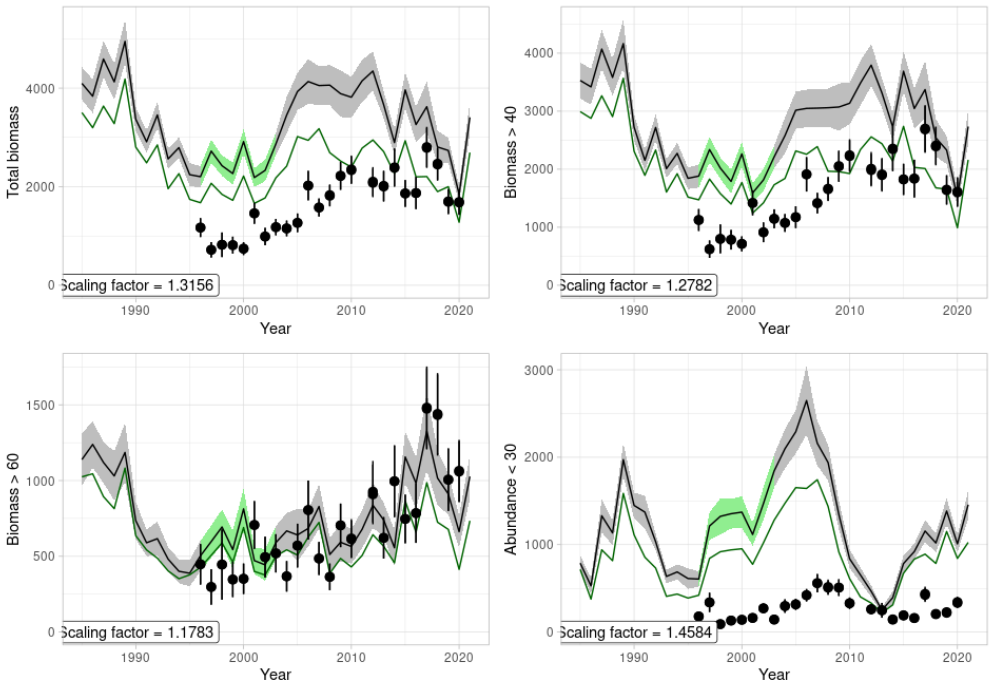

Figure 5.1.11: Tusk in 5.a and 14. Aa) Total biomass indices, b) biomass indices larger than and including 40 cm, c) biomass indices larger than and including 60 cm and d) abundance indices smaller than and including 30 cm. The lines with shaded areas show the spring survey index from 1985 and the points with the vertical lines show the autumn survey from 1997. The shaded area and vertical lines indicate +/- standard error. Green line is the index excluding the Iceland-Faroe Ridge.

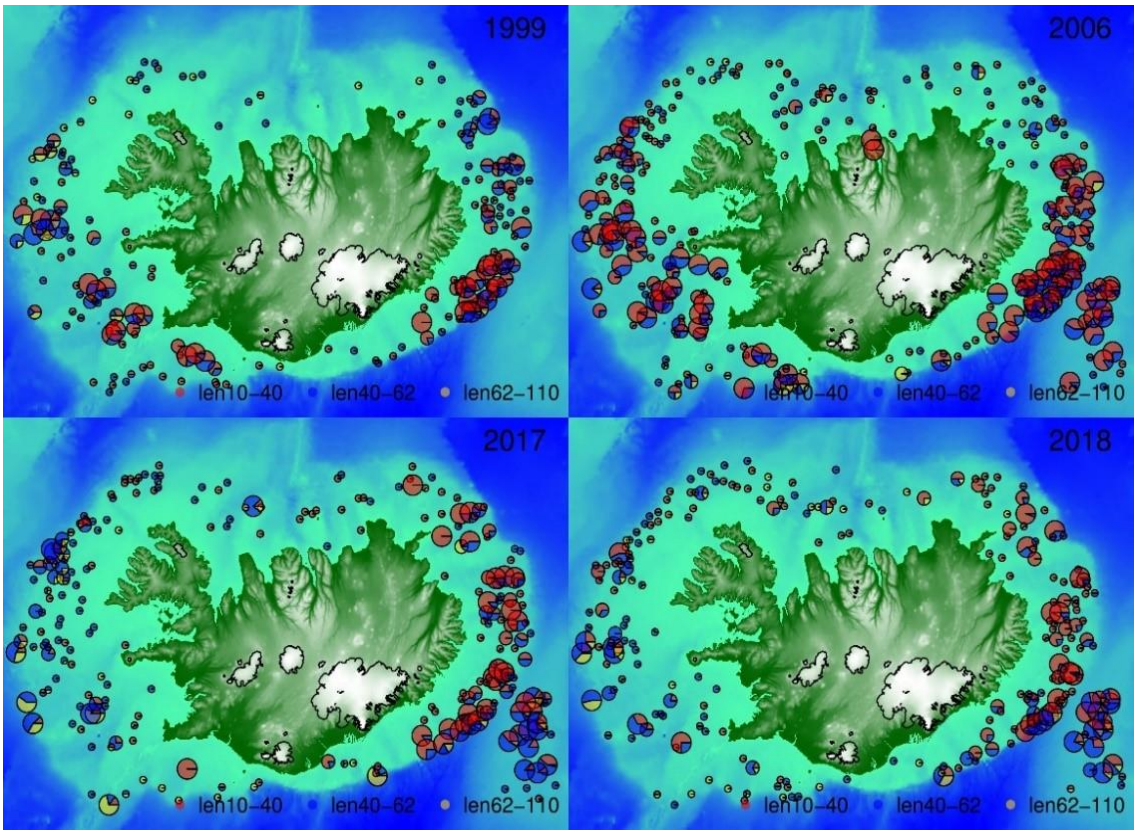

Figure 5.1.12: Tusk in 5.a and 14. Changes in spatial distribution divided by size. Size of pie is indicative of numbers of specimens caught at the tow-station.

German survey data (ICES Subarea 27.14)

The German groundfish survey was started in 1982 and is conducted in autumn. It is primarily designed for cod but covers the entire groundfish fauna down to 400 m. The survey is designed as a stratified random survey; the hauls are allocated to strata off West and East Greenland both according to the area and the mean historical cod abundance at equal weights. Towing time was 30 minutes at 4.5 kn. (Ratz, 1999). Data from the German survey in 14 were available at the meeting up to 2015. The trend in the German survey catches is similar to those observed in surveys in 5.a. It should, however, be noted that the data presented in Figure 5.1.13 is based on total number caught each year so it can't be used directly as an index from East Greenland. Length distributions from the survey in recent years are shown in Figure 5.1.14.

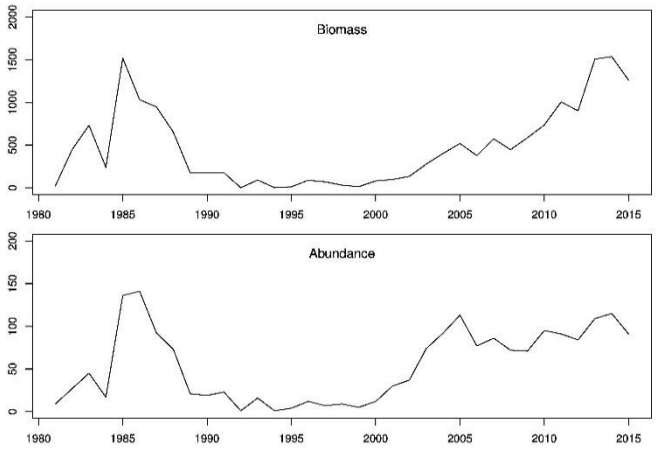

Figure 5.1.13: Biomass and abundance estimates from the Walter Herwig survey in 14. The data are just the total number caught and then converted to weight.

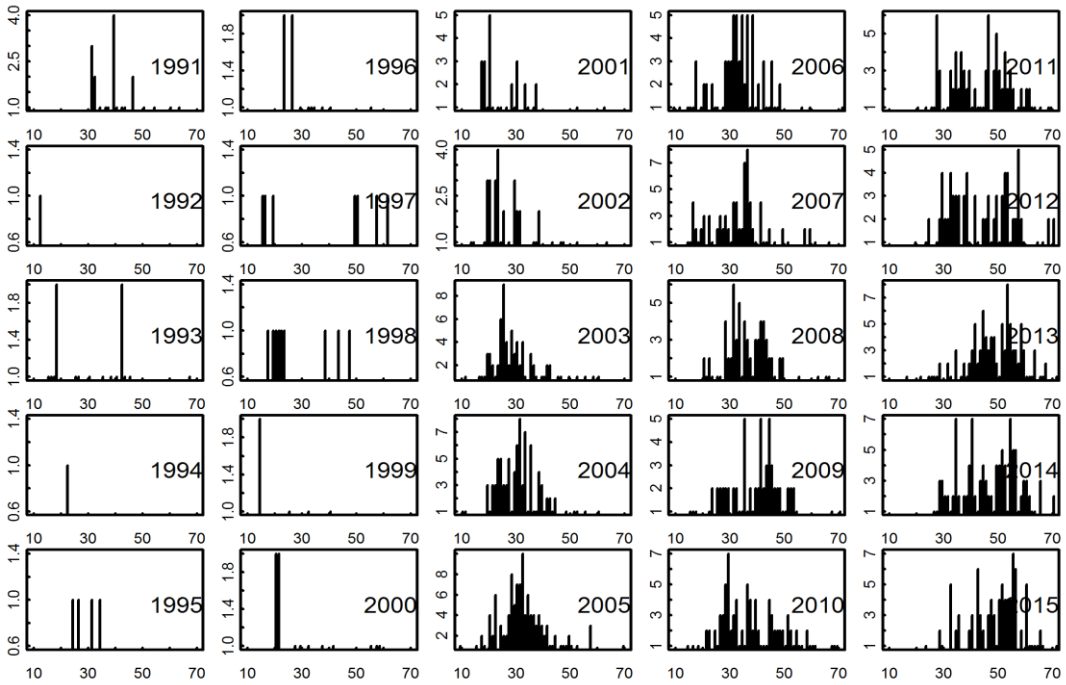

Figure 5.1.14: Length distributions from the Walter Herwig survey in 14.

Greenland survey data (ICES Subarea 27.14)

The Greenland Institute of Natural Resources conducted a stratified bottom trawl survey in East Greenland (ICES 14b) from 1998 to 2016 at depths between 400 to 1500 m (ICES (2019) :WD05). Survey results for tusk show a highly variable but increasing trend over recent years, so results from this survey will be monitored after it resumes in the future as a potential biomass index to be included in the tusk assessment.

5.1.4 Data analyses

There have been no marked changes in the number of boats nor the composition of the fleet participating in the tusk fishery in 5.a. Catches decreased from around 9000 tonnes in 2010 to 3445 tonnes in 2019. This decrease is mainly because of reductions in landings by the Icelandic longline fleet and to a lesser extent Faroese and Norwegian landings (Table 5.1.2 and Table 5.1.3).

This has resulted in less overshoot of landings relative to set TAC (Table 5.1.4). Species conversions in the ITQ system show that other species were converted to tusk last year rather than vice versa.

There are no marked changes in the length compositions since 2004, mean length in the catches ranges between 52.7 and 54.1 (Figure 5.1.7 and Figure 5.1.8). According to the available length distributions and information on maturity only around 29% of catches in abundance and 44% in biomass are mature. There does seem to be a gradual increase in mean age of the age distribution from commercial catches from roughly 7 to 9 (Figure 5.1.10). The reason for this is unknown but given the lack of distinctive cohort structure in the data the first explanation might be a lack of consistency in ageing. Also, tusk have experienced a reduction in fishing mortality over the latter half of this range. Reasons such as difference in sampling, temporal or spatial are highly unlikely.

At WGDEEP 2011 the Faroe-Iceland Ridge was included in the survey index when presenting the results from the Icelandic spring survey for tusk in 5.a. The total biomass index and the biomass index for tusk larger than 40 cm (reference biomass) has decreased substantially over the past 3 years (Figure 5.1.11). The same holds for the index of tusk larger than 60 cm (spawning–stock biomass index). The index of juvenile abundance (<30 cm) decreased by a factor of six between the 2005 survey when it peaked and the 2013 survey when it was at its lowest observed value. Since 2013 juvenile index has increased year on year in the 2014–2017 surveys. The index excluding the Faroe-Iceland Ridge shows similar trends as described above. The result from the shorter autumn survey are by and large similar to those observed from the spring survey except for the juvenile abundance index that is more or less at a constant level compared to the spring survey juvenile index. Due to labour strikes in the fishing industry, the autumn survey did not take place in 2011.

When looking at the spatial distribution from the spring survey around half of the index is from the SE area. However only around 20 to 25% of the catches are caught in this area (Figure 5.1.2 and Figure 5.1.3). The change in juvenile abundance between 2006 and recent years can be clearly seen in Figure 5.1.11 and Figure 5.1.12 where in 2006 juveniles (<40 cm) were all over the southern part of the shelf but can hardly be seen in recent years.

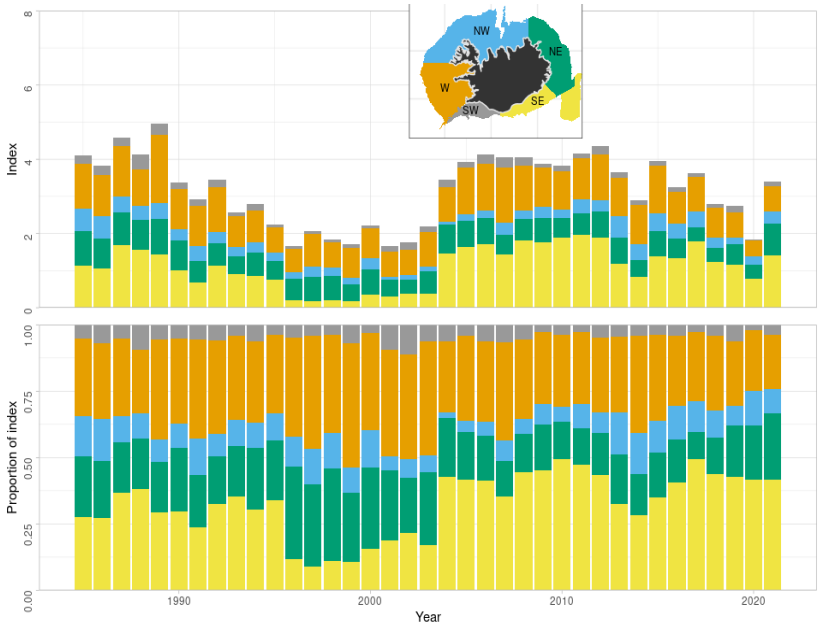

Figure 5.1.15: Tusk in 5.a and 14. Estimated survey biomass in the spring survey by year from different parts of the continental shelf (upper figure) and as proportions of the total (lower figure).

5.1.4.1 Stock assessment on Tusk in 5.a using Gadget

Since 2010 the Gadget model (Globally applicable Area Disaggregated General Ecosystem Toolbox, see www.hafro.is/gadget) has been used for the assessment of tusk in 5.a (See stock annex for details). As part of a Harvest Control Evaluation requested by Iceland this stock was benchmarked in 2017 (ICES (2017a)). Several changes were made to the model setup and settings which are described in the stock annex (ICES (2017b)).

5.1.4.2 Data used by the assessment and model settings

Data used for tuning are given in the stock annex. Model settings used in the Gadget model for tusk in 5.a are described in more detail in the stock annex.

5.1.4.3 Diagnostics

Overall, the fit of the predicted proportional catch length distributions is close to the observed distributions (Figure 5.1.16 and Figure 5.1.17). In general, for the commercial catch distributions the fit is better at the end of the time-series (Figure 5.1.16). The reason for this is there are few data at the beginning of the time-series and the model may be constrained by the initial values. In contrast, the fit of the survey data is not as good toward the end of the time series, mainly due to an absence of fish in the middle size ranges 2015-2018 (5.1.17). The survey age distributions are relatively well-fit (Figure 5.1.18), however, commercial age distributions show some misfits especially toward the end of the time series (Figure 5.1.19).

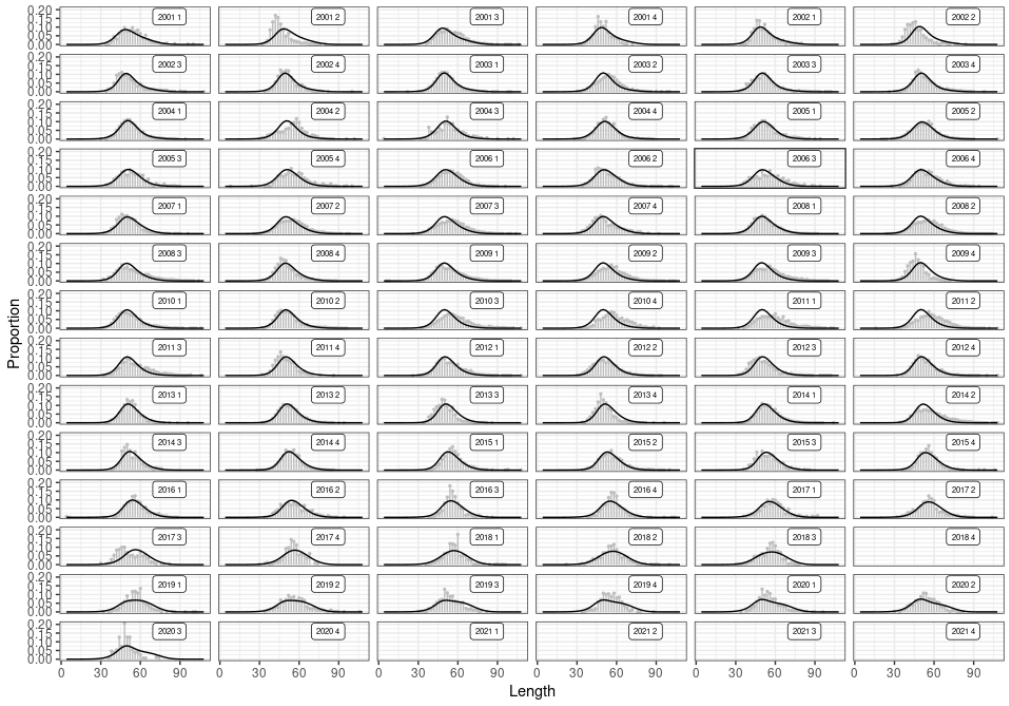

Figure 5.1.16: Tusk in 5.a and 14. Fitted proportions-at-length from the Gadget model (black lines) compared to observed proportions from longline catches (grey lines and dots).

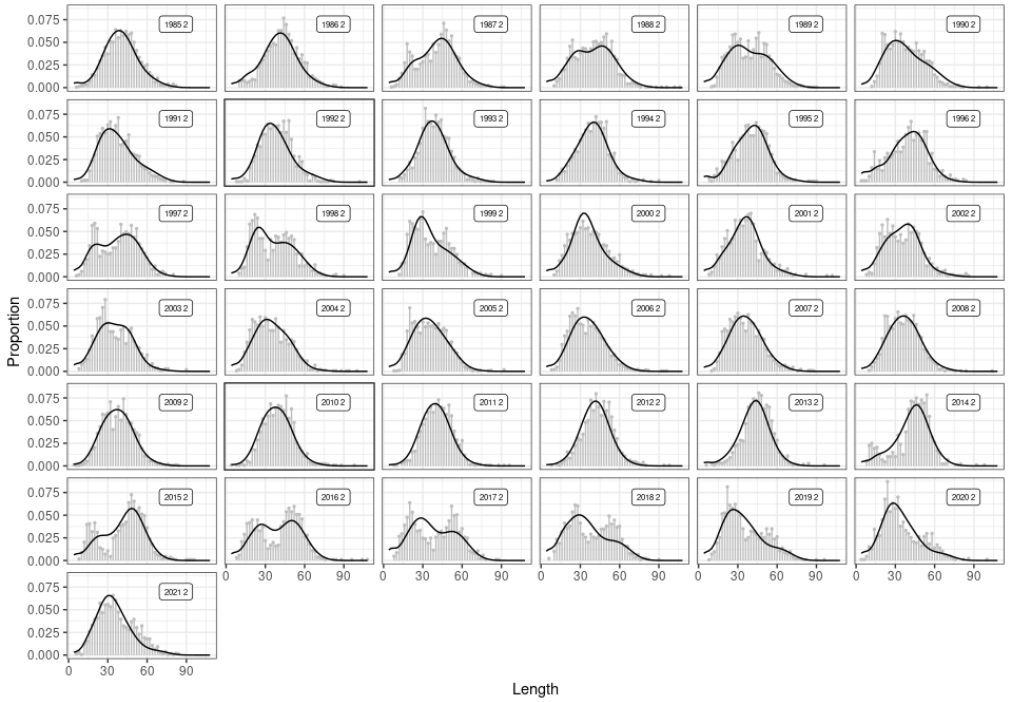

Figure 5.1.17: Tusk in 5.a and 14. Fitted proportions-at-length from the Gadget model (black lines) compared to observed proportions from spring survey catches (grey lines and dots).

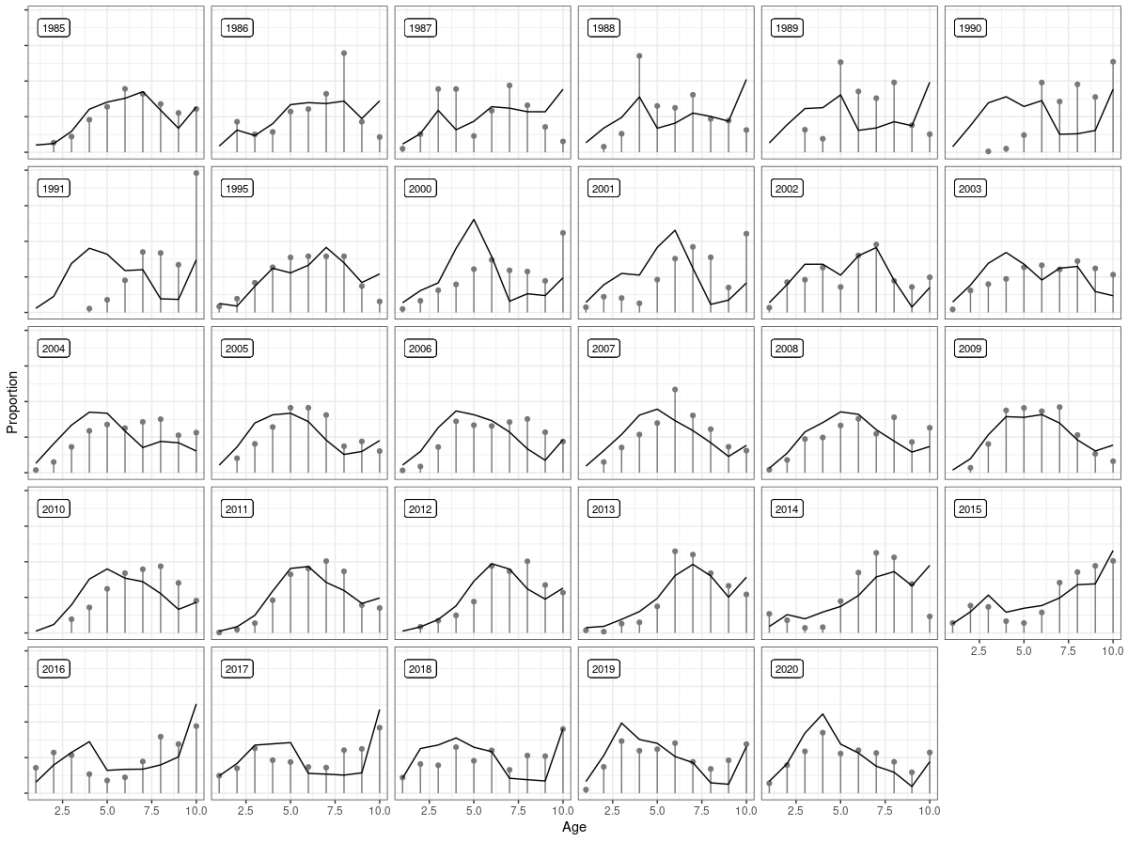

Figure 5.1.18: Tusk in 5.a and 14. Fitted proportions-at-age from the Gadget model (black lines) compared to observed proportions from the spring survey catches (grey lines and dots).

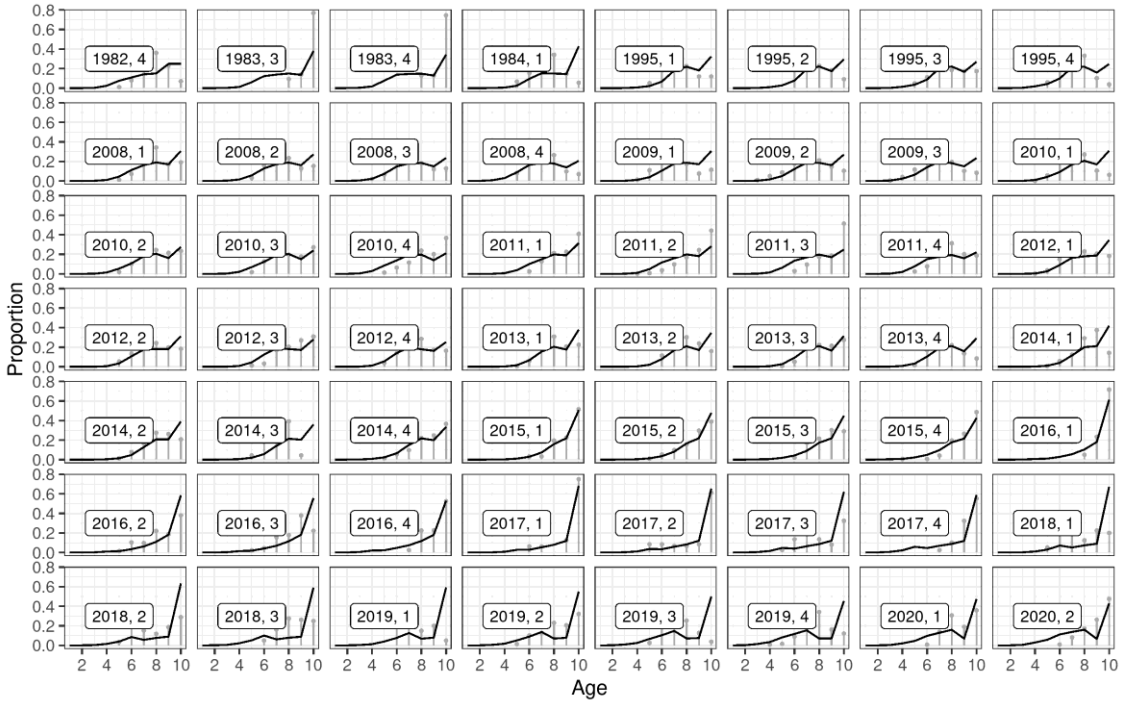

Figure 5.1.19: Tusk in 5.a and 14. Fitted proportions-at-age from the Gadget model (black lines) compared to observed proportions from longline catches (grey lines and dots).

In Figure 5.1.20 the length disaggregated indices are plotted against the predicted numbers in the stock as a time-series. The correlation between observed and predicted is good for the first five length groups (10–19, 20–29, 30–39, 40–49, 50–59 and 60–69), of which the first three to four are the main length groups of tusk caught in the spring survey. In the two larger length groups the fit gets progressively worse.

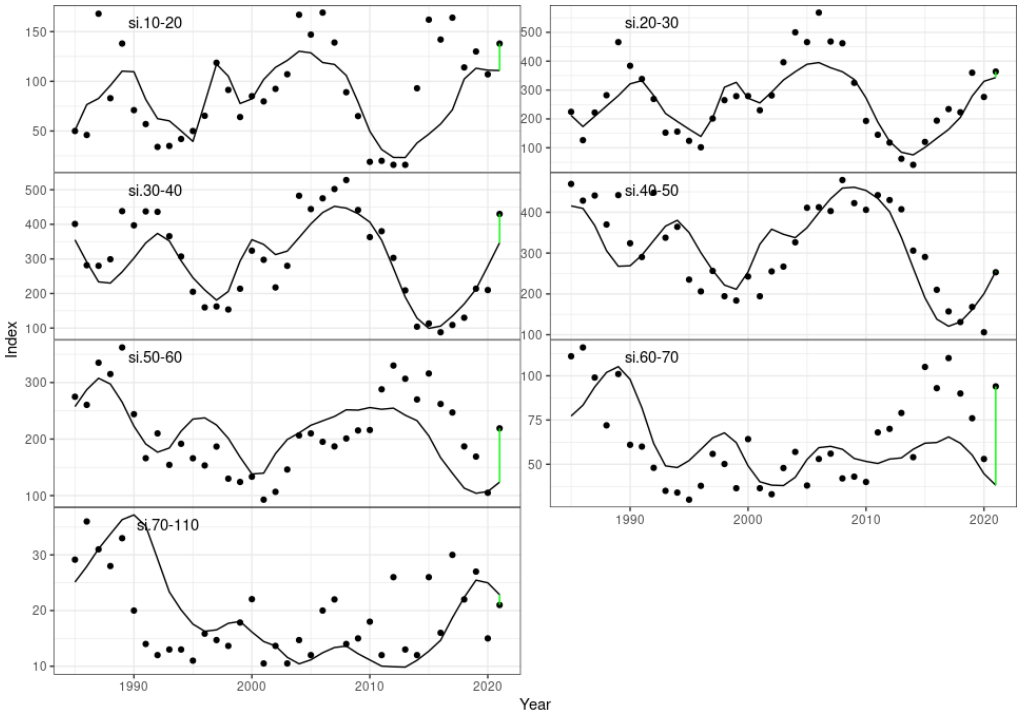

Figure 5.1.20: Tusk in 5.a and 14. Gadget fit to indices from disaggregated abundance by length indices from the spring survey.

5.1.4.4 Model results

The results are presented in Table 5.1.7 and Figure 5.1.21. Total biomass is shown to be decreasing with a slight increase in 2021, and spawning–stock biomass has been stable but only slightly above Bpa since 2005 with a slight decrease observed in the last 2 years.

A large downward revision was observed last year following correction of survey indices used for model tuning and revision of model optimization criteria. The main cause of this revision, in comparison to previous assessments, is that the model is increasingly relying on the three survey indices reflecting the smallest sized tusk, and therefore do not follow the recent peaks in large-sized fish indices (especially since 2010 in indices for 50-60 and 60-70 cm tusk, Figure 5.120. and retrospective plots, next section). It is also possible that errors detected in the survey indices and optimization prevented the detection of smaller incremental downward revisions in previous years.

The same trend can also be seen in length distribution data from surveys beginning 2016 (Figure 5.1.17). Many years prior to 2018 appear bimodal, whereas each year since then has shown a large decrease in the right lobe of the length distribution. Previous years have shown a better fit in the bimodal length distributions observed 2015 - 2018. However, this year, a distinct trough between the two modes of the length distribution can be tracked from 2015 but cannot be fitted by the model. This trough appears to have reached roughly 40 cm this year, thereby presenting a distinct decrease in reference and spawning stock biomass values in a more catchable length range. This suggests that the best model fit to the data this year includes a rather large underestimation of the right lobe of this distribution during the years 2017 - 2020 in order to reconcile these data with the patterns found in 2015 - 2016 and 2020.

There are a few possible explanations for the change in the view of biomass levels. The first is that the underestimation of 40+ tusk in 2017 - 2020 is due to unusually high true catchability during this period. Conversely, unusually low catchability could be currently experienced by the largest sized tusk. However, a shift in catchability by the survey has not been observed in other species, and assuming this is the case could lead to overestimation of the reference biomass and advice. Similarly, time-variable changes in selectivity from the current assumed logistic shape to a dome-shaped curve could potentially cause such a discrepancy. However, further investigations of model fits including time-invariant dome-shaped selectivity did not improve the model fit in these last years, while implementing dome-shaped selectivity for only the last few years could also introduce overestimation of biomass with little grounds for suspecting such a selectivity shift. Finally, unaccounted for changes in past mortality, such as higher natural or discard mortality, or outmigration in the size range of the trough could explain this discrepancy.

In any case, the management strategy evaluation that informed the management plan for this stock was completed with high assessment uncertainty and autocorrelation (CV = 0.3, rho = 0.8, WKICESMSE 2017), so it is unlikely that this downward correction has an effect on reference point calculation or the derived management plan.

Recruitment peaked in 2005 to 2006 but has decreased and is estimated in 2013 to have been the lowest observed. Recruitment in 2014–2020 is estimated to be considerably higher than in 2013. Harvest rate has decreased from 0.29 in 2008 to 0.12 in 2016 and remains close to the target 0.13. Estimates of reference biomass (B40+) have also been stable for the last several years.

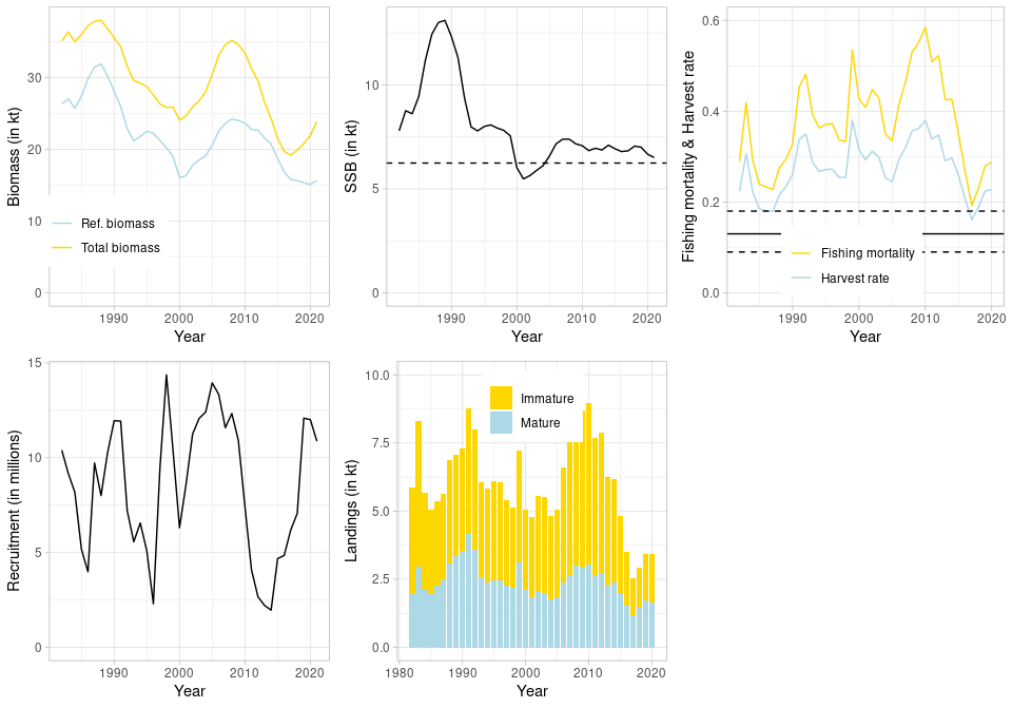

Figure 5.1.21: Tusk in 5.a and 14. Estimates of recruitment, biomass, harvestable biomass and fishing mortality for tusk for the age groups most important in the fishery i.e. ages 7 to 10 (solid line).

5.1.4.5 Retrospective analysis

The results of an analytical retrospective analysis are presented (Figure 5.1.22). Additional plots are provided due to the large downward revision detected last year. The analysis indicates that with each subsequent peel going backwards in time, an upward revision in reference biomass and spawning stock biomass is observed except the fourth and fifth peel giving similar estimates. Consequently, a downward revision of F is observed. Estimates of recruitment shows in increase in the recent two peels leading to a strong retrospective pattern.

Recruitment indices generally tend to be uncertain as there are few repeated observations at larger sizes with which this influence can be tempered. However, the good fit to survey indices in the age 3 recruitment length range (20 - 30 cm, (Figure 5.1.23), suggest that at least recruitment estimates from this peak are reliable. In addition, a peak in these sizes of tusk followed by a sharp decline in 2020 are reflected in length distribution data as a rather large but steep peak in proportions of fish that have begun to shift right (to larger sizes) with no obvious new peaks of small sizes taking its place (Figure 5.1.24). Therefore, it is likely that reference biomass may increase once the current recruitment peak reaches 40+ cm sizes.

The changes in estimation of later peels can also be observed in these plots as progressively worse fits to survey indices of larger sized tusk, as well as underestimation of the right peak of the bimodal length distributions observed in the last 5 years (Figure 5.1.24). It is possible that these misfits reflect an underestimation of the current true spawning stock biomass levels. However, this is difficult to conclude as these misfits generally represent an inconsistency between the model being able to reconcile length distribution and survey data collected after 2018 with the relatively good fits to these data observed in the earliest assessment periods. Trends in catchability estimates across peels indicate that changes to the catchability of the largest two indices, to which the fit of the model has changed, are likely to cause the overall shifts in biomass levels (5.1.25).

Mohn's rho was estimated to be 0.143 for SSB, -0.102 for F, and 0.358 for recruitment.

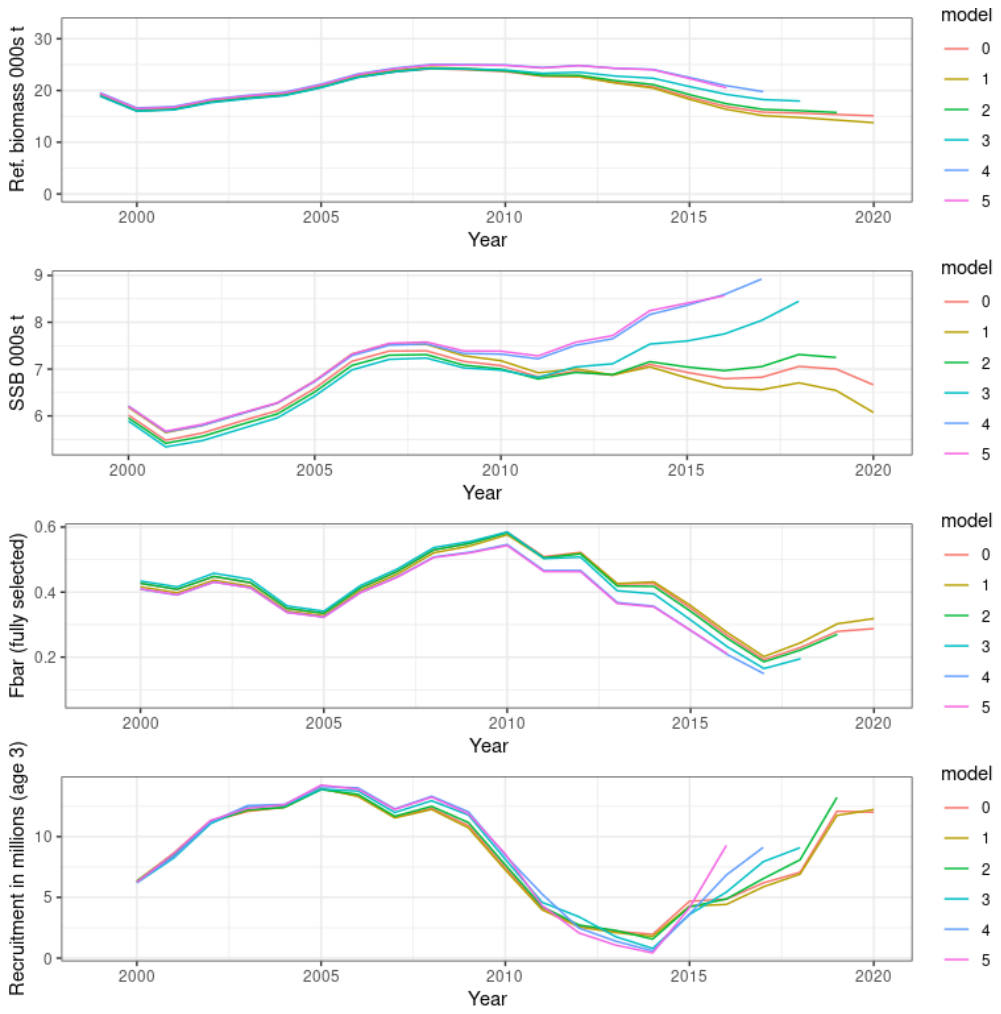

Figure 5.1.22: Tusk in 5.a and 14. Retrospective plots illustrating stability in model estimates over a 5-year 'peel' in data. Results of spawning stock biomass, fishing mortality F, and recruitment (age 3) are shown.

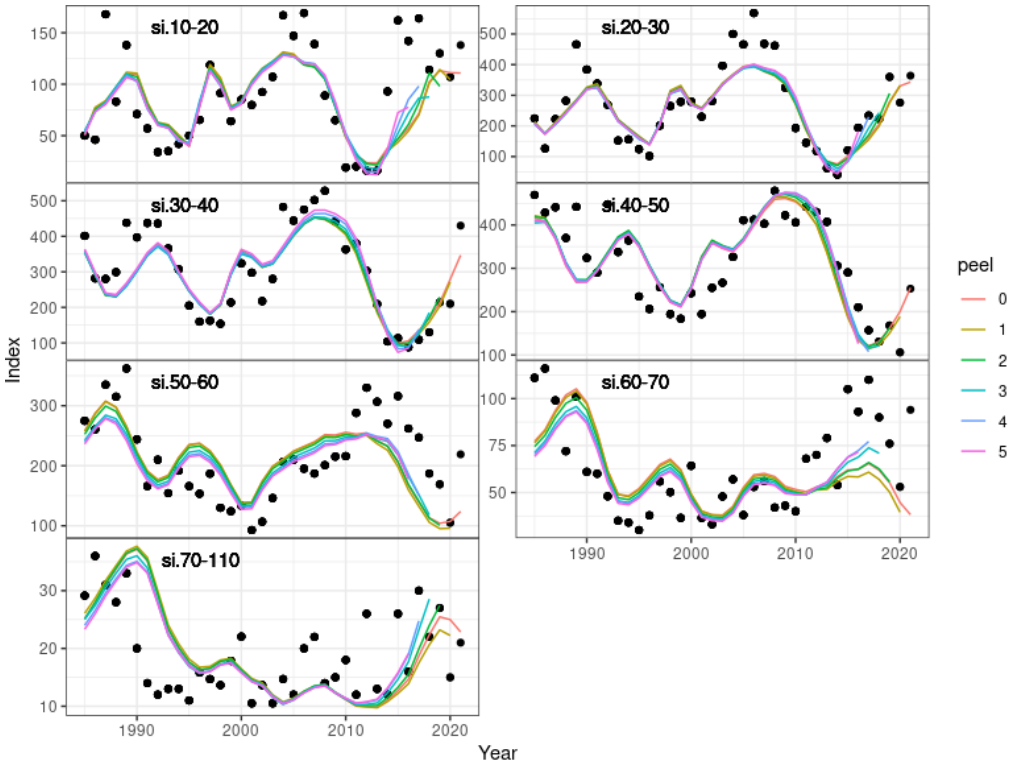

Figure 5.1.23: Tusk in 5.a and 14. Retrospective plots illustrating stability in model fits to survey indices over a 5-year 'peel' in data.

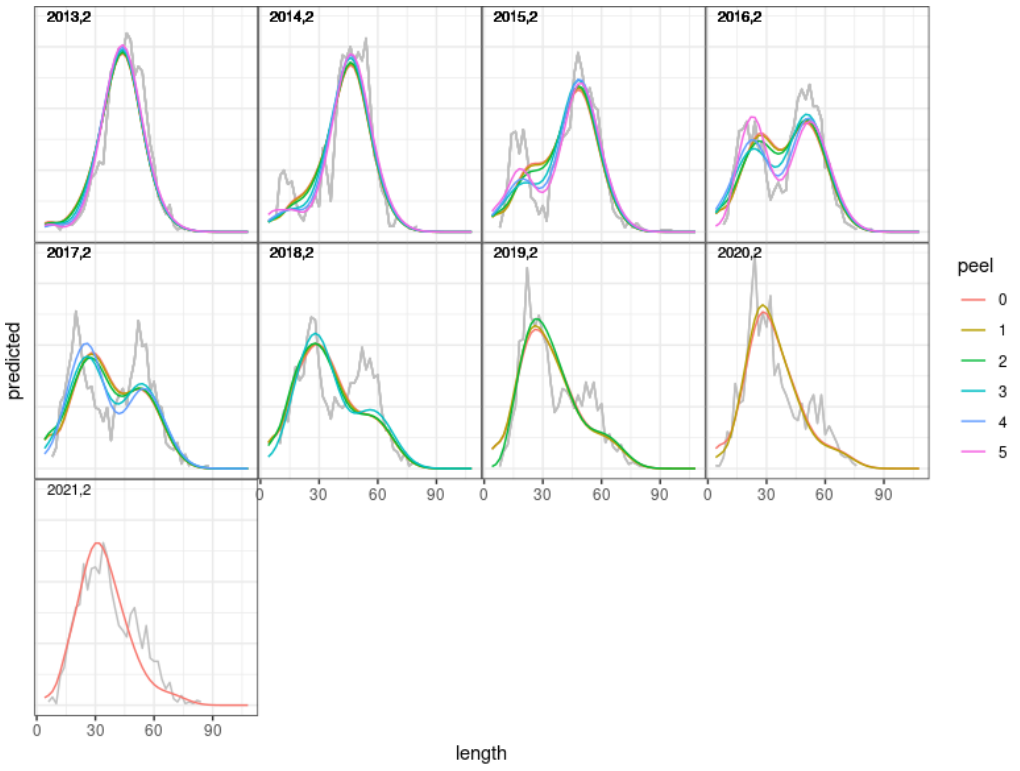

Figure 5.1.24: Tusk in 5.a and 14. Retrospective plots illustrating stability in fit length distribution data from the spring survey over a 5-year 'peel' in data.

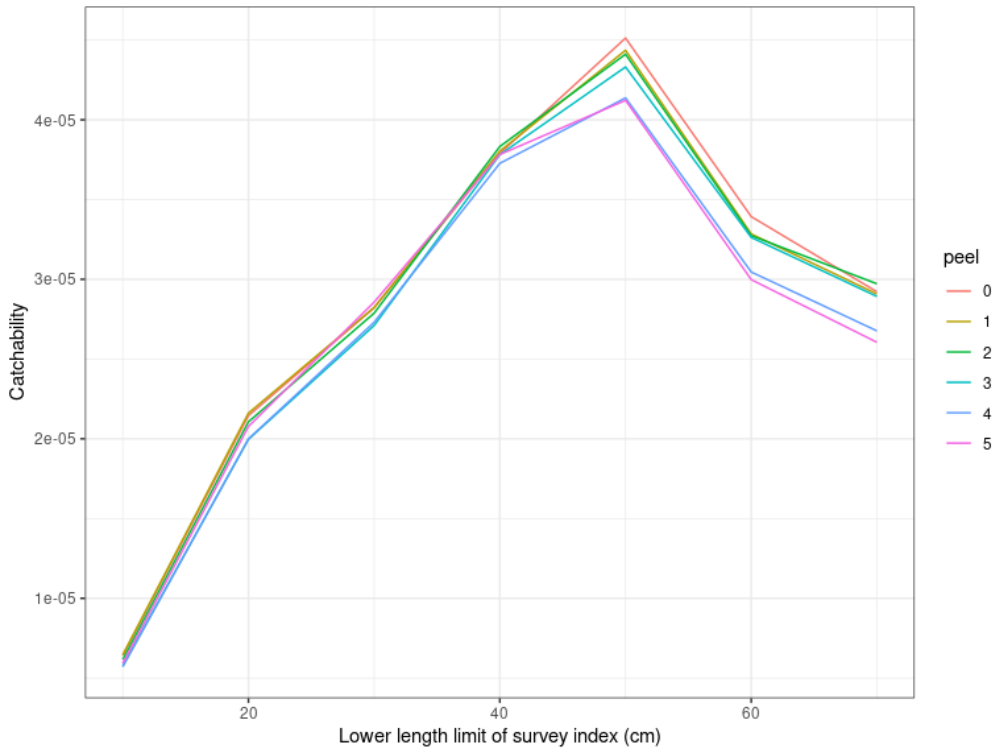

Figure 5.1.25: Tusk in 5.a and 14. Retrospective plots illustrating stability in catchability estimates over a 5-year 'peel' in data.

5.1.5 Current management plan

As part of the WKICEMSE 2017 HCR evaluations (ICES (2017a)), the following reference points were defined for the stock.

Framework	Reference point	Value	Technical basis
MSY approach	MSY $B_{trigger}$	6.24 kt	B_{pa}
	H_{msy}	0.17	The harvest rate that maximises the median long-term catch in stochastic simulations with recruitment drawn from a block bootstrap of historical recruitment scaled according to a hockey stick recruitment function with B_{lim} as defined below.
	F_{msy}	0.226	The median fishing mortality when an harvest rate of H_{msy} is applied.
	$H_{p.05}$	0.371	The harvest rate that has an annual probability of 5% of SSB $< B_lim$.
	$F_{p.05}$	0.356	The median fishing mortality when an harvest rate of $H_{p.05}$ is applied.
Precautionary approach	B_{lim}	4.46 kt	$B_{pa}/e^{1.645\sigma}$ where $\sigma = 0.2$
	B_{pa}	6.24 kt	SSB(2001), corresponding to B_{loss}
	H_{lim}	0.27	H corresponding to 50% long-term probability of SSB $> B_{lim}$
	F_{lim}	0.41	F corresponding to H_{lim}
	F_{pa}	0.27	$F_{lim}/e^{1.645\sigma}$ where $\sigma = 0.25$
	H_{pa}	0.20	H corresponding to F_{pa}
Management plan	H_{mp}	0.13	

The management plan accepted was: The spawning–stock biomass trigger (MGT Btrigger) is defined as 6.24 kt, the reference biomass is defined as the biomass of tusk 40+ cm and the target

harvest rate (HRmgt) is set to 0.13. In the assessment year (Y) the TAC for the next fishing year (September 1 of year Y to August 31 of year Y+1) is calculated as follows:

When SSBy is equal or above MGT Btrigger:

TACy/y+1 = HRmgt*BRef,y

When SSBY is below MGT Btrigger:

TACy/y+1 = HRmgt* (SSBy/MGT Btrigger) * Bref,y

WKICEMSE 2017 concluded that the HCR was precautionary and in conformity with the ICES MSY approach.

5.1.6 Management considerations

Increased catches in 14.b from less than 100 tonnes in previous years to 900 tonnes in 2015, and about 566 tonnes in 2019 are of concern. However, the signs from commercial catch data and surveys indicate that the total biomass of tusk in 5.a is stable. This is confirmed in the Gadget assessment. Recruitment in 5.a is on the increase again after a low in 2013. A reduction in fishing mortality has also led to harvestable biomass and SSB that seem to be either stable or slowly increasing. Due to the selectivity of the longline fleet catching tusk in 5.a and the species relatively slow maturation rate, a large proportion of the catches is immature (60% in biomass, 70% in abundance). The spatial distribution of the fishery in relation to the spatial distribution of tusk in 5.a as observed in the Icelandic spring survey may result in decreased catch rates and local depletions of tusk in the main fishing areas. Tusk is a slow growing late maturing species, therefore closures of known spawning areas should be maintained and expanded if needed. Similarly, closed areas to longline fishing where there is high juvenile abundance should also be maintained and expanded if needed.

5.1.6.1 Ecosystem considerations

Tusk has recently exhibited spatial changes in length distributions (Figure 5.1.12), however, there have been no obvious changes in maturity patterns or growth through time. Demographic patterns of tusk should be monitored as other Icelandic demersal species have exhibited recent changes (e.g., haddock). Tusk biomass levels have recently decreased, possibly as a result of increased natural mortality and environmental factors. However, the causes for this, such as multispecies interactions, are unknown and not currently considered in the assessment.

Table 5.1.7. Tusk in 5.a and 14. Estimates of biomass, biomass 40+ cm, spawning–stock biomass (SSB) in thousands of tonnes and recruitment (millions), harvest rate (HR) and fishing mortality from Gadget.

YEAR	BIOMASS	B40+	SSB	REC3	CATCH	HR	F
1982	36494	28927	11176	10297	5877	0.20	0.28
1983	37690	28796	10850	9135	8286	0.29	0.40
1984	36302	28217	10203	8396	5692	0.20	0.28
1985	37177	30120	11043	5232	5061	0.17	0.23
1986	38415	32196	12209	3765	5381	0.17	0.23
1987	38990	33580	13191	8858	5644	0.17	0.22
1988	39095	33108	13476	7591	6864	0.21	0.27

YEAR	BIOMASS	B40+	SSB	REC3	CATCH	HR	F
1989	37900	31778	13449	10590	7076	0.22	0.29
1990	36635	29620	12679	11867	7296	0.25	0.32
1991	35291	27171	11349	12348	8762	0.32	0.44
1992	32503	24606	9514	7202	7999	0.33	0.47
1993	30390	23498	8300	5883	6074	0.26	0.38
1994	29996	24279	8256	6294	5828	0.24	0.36
1995	29451	24317	8306	5518	6225	0.26	0.37
1996	28146	23536	8259	1819	6101	0.26	0.37
1997	26871	22652	8235	8688	5399	0.24	0.33
1998	26454	21406	8069	14892	5171	0.24	0.33
1999	26471	19444	7341	11071	7225	0.37	0.53
2000	24628	17708	6094	6290	5087	0.29	0.42
2001	25208	18100	5473	8284	4809	0.27	0.41
2002	26435	19921	5841	11127	5551	0.28	0.45
2003	27296	20243	5984	12517	5571	0.28	0.43
2004	28545	20645	6140	12566	4822	0.23	0.35
2005	31029	22598	6697	13958	5041	0.22	0.34
2006	33744	24451	7150	13739	6598	0.27	0.42
2007	35230	25714	7377	11887	7540	0.29	0.47
2008	35908	26647	7493	12729	8626	0.32	0.53
2009	35365	26074	7153	11405	8680	0.33	0.55
2010	34293	25864	7128	7822	8978	0.35	0.58
2011	32191	25187	7026	4365	7702	0.31	0.51
2012	30482	24911	7203	2799	7873	0.32	0.51
2013	27615	23317	7122	2415	6265	0.27	0.41
2014	25489	22147	7391	1548	6163	0.28	0.41
2015	22804	20295	7433	4245	4836	0.24	0.33
2016	21069	18206	7266	4853	3494	0.19	0.25
2017	20591	17778	7633	6097	2541	0.14	0.18

YEAR	BIOMASS	B40+	SSB	REC3	CATCH	HR	F
2018	21410	17316	7712	7202	2940	0.17	0.21
2019	22441	17575	7868	12385	3445	0.20	0.25
2020	23715	17609	7546	13748	3420	0.21	0.29

5.1.7 References

ICES. 2011. "Report of the Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources (Wgdeep), 2 March–8 March, 2011, Copenhagen, Denmark. ICES Cm 2011/Acom:17." International Council for the Exploration of the Seas; ICES publishing.

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2017a. "Report of the Workshop on Evaluation of the Adopted Harvest Control Rules for Icelandic Summer Spawning Herring, Ling and Tusk (WKICEMSE), 21–25 April 2017, Copenhagen, Denmark. ICES CM 2017/ACOM:45." International Council for the Exploration of the Seas; ICES publishing.

2017b. "Tusk in ICES Subarea 14 and Division 5.a." International Council for the Exploration of the Seas; ICES publishing.

2019. "11.2 Icelandic Waters ecoregion – Fisheries overview." International Council for the Exploration of the Seas; ICES publishing. https://doi.org/10.17895/ices.advice.5706.

5.3 Tusk (*Brosme brosme*) on the Mid-Atlantic Ridge (Subdivisions 12.a1 and 14.b1)

5.3.1 The fishery

Tusk is bycatch in the gillnet and longline fisheries in Subdivisions 12.a1 and 14.b1. During 1996 and 1997 Norway also had a fishery in this area.

5.3.2 Landings trends

Landing statistics by nation in the years 1988 to 2020 are shown in Table 5.3.1.

The reported landings are generally very low in these areas. Russia reported some landings of tusk in 2005, 2006, 2007 and 2009 and no landings were reported by the Russians for 2010 and 2011. In 2012 Norway reported 17 tonnes in Area 14.b1 and the Faroe Islands, 1 ton. No landings have been reported in 2013, 2014, 2016 to 2020, while in 2015 Greenland reported 2 tons.

5.3.3 ICES Advice

Advice for **2020 to 2024:** ICES advises that when the precautionary approach is applied, there should be zero catches in each of the years from 2020 to 2024.

5.3.3.1 Management

In 2014 NEAFC (Rec 03 2014) recommends the effort in areas beyond national jurisdiction shall not exceed 65 percent of the highest effort level for deep-water fishing in the past.

5.3.4 Data available

5.3.4.1 Landings and discards

Landings were available for all the relevant fleets. No discard data were available.

5.3.4.2 Length compositions

No length compositions were available.

5.3.4.3 Age compositions

No age compositions were available.

5.3.4.4 Weight-at-age

No data were available.

5.3.4.5 Maturity and natural mortality

No data were available.

5.3.4.6 Catch, effort and research vessel data

No data were available.

5.3.5 Data analyses

There are insufficient data to assess this stock.

5.3.5.1 Biological reference points

WKLIFE has not yet suggested methods to estimate biological reference points for stocks which have only landings data or are bycatch species in other fisheries. Therefore, no attempt was made to propose reference points for this stock.

5.3.6 Comments on the assessment

No assessment was carried out this year.

5.3.7 Management considerations

Tusk is a bycatch in all fisheries. Advice should consider the advice for the targeted species. Life-history traits for tusk do not suggest it is particularly vulnerable.

5.3.8 Tables

Table 5.3.1. Tusk 12. WG estimate of landings.

Tusk 12

Year	Faroes	France	Iceland	Norway	Scotland	Russia	Total
1988		1					1
1989		1					1
1990		0					0
1991							0
1992							0
1993	29	1	+				30
1994	27	1	+				28
1995	12	-	10				18
1996	7	-	9	142			158
1997	11	-	+	19			30
1998				-			1
1999				+	1		1
2000				5	+		5
2001		1		51	+		52
2002				27			27
2003				83			83
2004		2		7		5	14
2005	2	1					3

Year	Faroes	France	Iceland	Norway	Scotland	Russia	Total
2006						64	64
2007						19	19
2008						0	0
2009						2	2
2010							0
2011							0
2012	1						1
2013							0
2014							0
2015							0
2016							0
2017							0
2018							0
2019							0
2020*							0

*Preliminary.

Tusk 14.b1

Year	Faroes	Iceland	Norway	E & W	Russia	GREENLAND	Total
2012			17				17
2013							0
2014							0
2015						2	2
2016							0
2017							0
2018							0
2019							0
2020							0

Table 5.3.1. (Continued). Tusk, total landings by subareas or division.

Year	12	14.b1	All areas
1988	1		1
1989	1		1
1990	0		0
1991	0		0
1992	0		0
1993	30		30
1994	28		28
1995	18		18
1996	158		158
1997	30		30
1998	1		1
1999	1		1
2000	5		5
2001	52		52
2002	27		27
2003	83		83
2004	14		14
2005	3		3
2006	64		64
2007	19		19
2008	0		0
2009	2		2
2010	0		0
2011	0		0
2012	1	17	18
2013	0		0
2014	0		0
2015	0	2	2
2016	0		0

Year	12	14.b1	All areas
2017			0
2018			0
2019			0
2020			0

***Preliminary.**

5.4 Tusk (*Brosme brosme*) in 6.b

5.4.1 The fishery

Tusk are only caught as bycatch and not targeted in the trawl, gillnet and longline fisheries in Subarea 6.b. Norway has traditionally landed the largest catch of tusk in area 6.b. In particular, during the period 1988–2020 Norwegian vessels have reported 70-80% of the total landings. Small bycatches of tusk were also taken in 6.b by trawlers in the haddock fishery. Since January 2007 parts of the Rockall Bank have been closed to fishing which were the traditional areas fished by the Norwegian longline fleet.

The Norwegian longline fishery

The Norwegian longline fleet increased from 36 in 1977 to a peak of 72 in 2000, and afterwards the number decreased and then stabilized around 25-27 since 2014. The number of vessels declined mainly because of changes in the law concerning the quotas for cod. The total number of days the fleet has been fishing in area 6.b per year was a maximun of 464 fishing days in 2002 to 60 days in 2020 (Figure 5.4.1)..

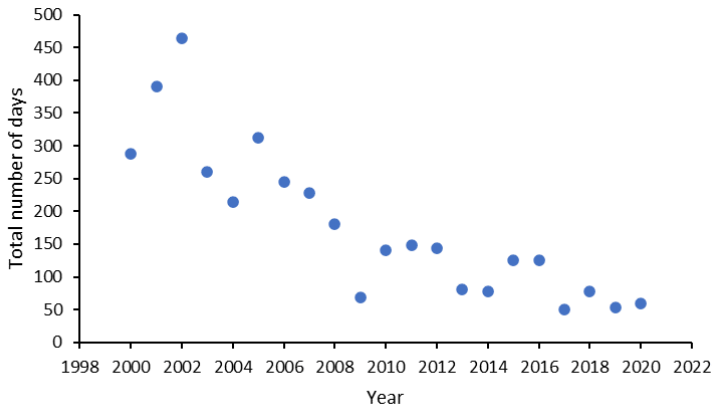

Figure 5.4.1. Estimated total number of days the Norwegian longline fleet fished for tusk (bycatch) during the period 2000 to 2020 based on logbooks.

5.4.2 Landings trends

Landing statistics by nation in the period 1988–2020 are in Table 5.4.1.

Landings varied considerably between 1988 and 2000; peaked at 2344 t in 2000, and since 2000 were low with a declining trend. In 2014 the catch was 38 tons, an all-time low during this period, while in 2015 the total catch increased to 226 tons, in 2020 the landings decreased to 91 tons (Figure 5.4.1).

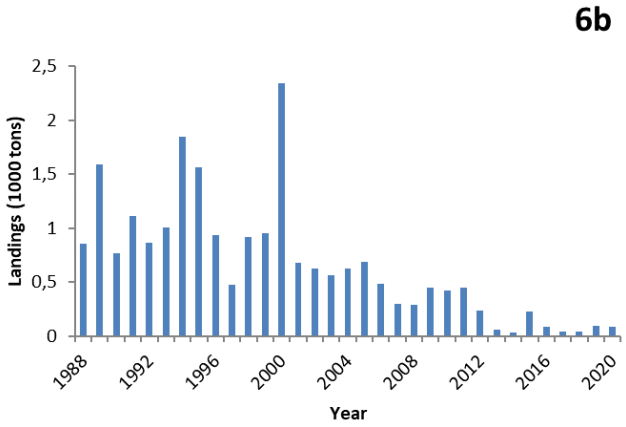

Figure 5.4.1. The international total landings of tusk from Subarea 6.b.

5.4.3 ICES Advice

Advice for 2021 to 2022: ICES advises that when the precautionary approach is applied, catches should be no more than 280 tonnes in each of the years 2021 and 2022

5.4.4 Management

Apart from the closed areas, there are no management measures that apply exclusively to 6.b.

Norway, which also has a licensing scheme, had a catch allocation in EU waters (Subareas 5, 6 and 8 There are ongoing negotiations between EU, UK and Norway and The TACs for 2021 are, therefore, not available. NEAFC recommended in 2009 that the effort in the NEAFC regulatory area shall not exceed 65 percent of the highest effort level of the deep fishing levels in previous years.

5.4.5 Data available

5.4.5.1 Landings and discards

Landings were available for all relevant countries. An overview over landings and discards are shown in Table 5.4.2.

Table 5.4.2. Landings, discards, total catch and percentage discards of the total catch of tusk in 6.b.

Year	Landings	Discards	Total catches	% discards
2016	90	7	97	7
2017	47	14	61	23
2018	47	21	68	31
2019	100	12	112	11
2020	91	24	116	21

5.4.5.2 Length compositions

The length distributions of tusk based on data provided by the Norwegian reference fleet for the period 2002–2017 are in Figures 5.4.3 and 5.4.4. The average length during this period fluctuated without any obvious trends (no data are available for 2004, 2011, 2014, 2017 to 2020).

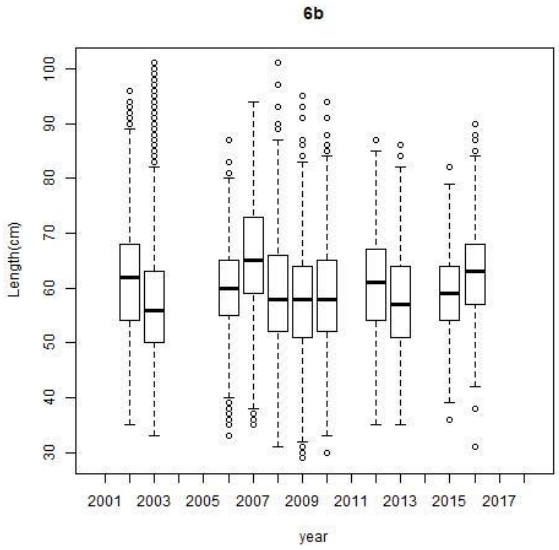

Figure 5.4.3. The length distribution of tusk based on data provided by the Norwegian reference fleet for 2002–2016 (no data are available for 2004, 2011, 2014 and 2017–2020).

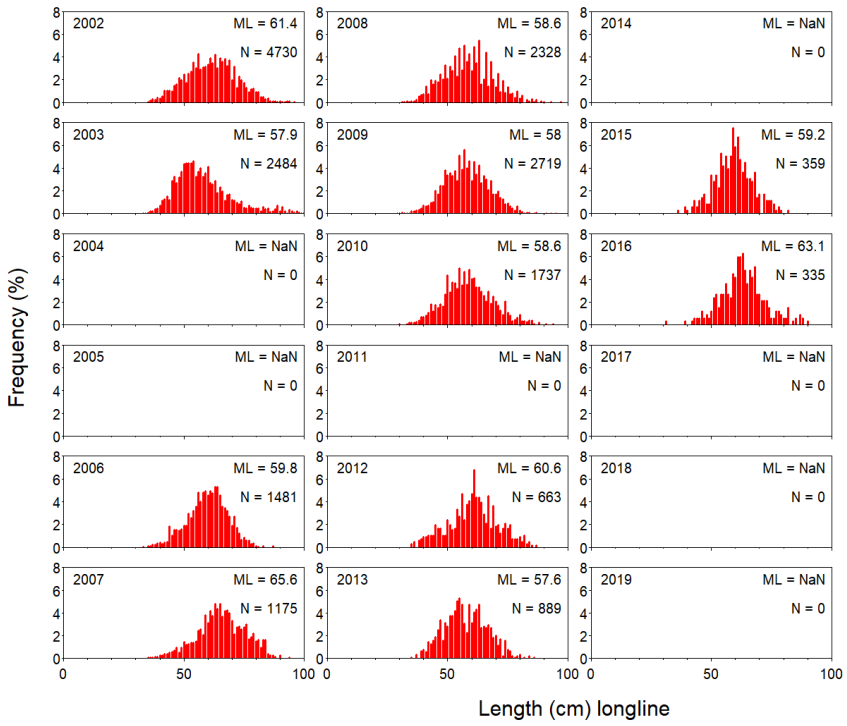

Figure 5.4.4. The length distribution of tusk based on data provided by the Norwegian reference fleet for 2002–2016 (no data are available for 2004, 2005, 2011, 2014, 2017–2020).

5.4.5.3 Age compositions

No new age composition data were available.

5.4.5.4 Weight-at-age

No new data were presented.

5.4.5.5 Maturity and natural mortality

No new data were presented.

5.4.5.6 Catch, effort and research vessel data

Norway began in 2003 collecting and entering data from official logbooks into an electronic database, and data are now available for 2000–2020. Vessels were selected that had a total landed catch of ling, tusk and blue ling exceeding 8 t in each year. The logbooks contain records of the daily catch, date, position, and number of hooks used per day.

5.4.6 Data analyses

No analytical assessments were carried out.

Norwegian longline cpue

The CPUE series based on the Norwegian longliners show a decrease from 2000 to 2007. After this the CPUE had been at a low but stable level. (Figure 5.4.5).

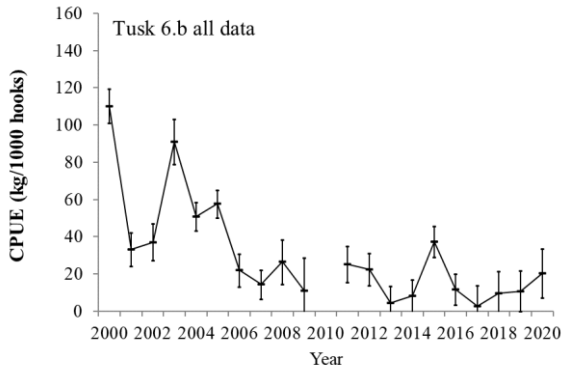

Figure 5.4.5. Estimated cpue (kg/1000 hooks) series for tusk in Subarea 6.b based on skipper's logbooks (during the period 2000–2020). The bars denote the 95% confidence intervals.

5.4.6.1 Biological reference points

No new data were presented.

5.4.7 Comments on the assessment

There are no assessments for tusk in this area.

5.4.8 Management considerations

The landings since 2001 have been low with a decreasing trend. With the exception of 2015, the landings have been very low since 2013. The decreasing size of the fleet was caused by several factors including; closed areas, increasing fuel costs and larger quotas of Arcto Norwegian cod.

The total number of days the fleet were fishing in area 6.b per year has decreased from a maximun of 464 fishing days in 2002 to 60 days in 2020 (Figure 5.4.1). When all available data are combined, the cpue series also shows a decreasing trend until 2007 after this it has been at a stable but low level.

The main fishing grounds traditionally exploited by the Norwegian fleet in 6.b were closed to bottom contacting gears in 2007 and this may be the reason for the low estimates of cpue.

As always, it should be emphasized that commercial catch data are typically observational data; that is, there were no scientific controls on how or from where the data were collected. Therefore, it is not known with certainty if the tusk cpue series tracks the population and/or how accurate the measures of uncertainty associated with the series are (see, for example, Rosenbaum, 2002). Consequently, one must usually hope and pray that a cpue series, which is based only on commercial catch data, truly tracks abundance.

In general, any assessment method based only on commercial catch data needs to be applied with caution. The reason that assessments using only commercial data are problematic is because the relation between the commercial catch and the actual population is normally unknown and probably varies from year to year.

5.4.9 Application of MSY proxy reference points

Length-based indicator method (LBI)

There is not enough length data or other biological data to apply this indicator LBI. Background data for L_{mat} are not available for the Rockall area and have been earlier "borrowed" parameters based on the Faroese data. The tusk on Rockall are genetically different from the tusk in neighbouring areas (Knutsen *et al*. 2009), and it is very likely that values like L_{mat} also are different from other areas. Until these values have been established for area 6.b, the method and results must be evaluated accordingly. No new length data or other biological data are available for 2020.

5.4.10 References

Helle, K., M. Pennington, N-R. Hareide and I. Fossen. 2015. Selecting a subset of the commercial catch data for estimating catch per unit of effort series for Ling (*Molva molva* L.). Fisheries Research 165: 115–120.

Helle, K. and Pennington, M. 2021. The development of the Norwegian longline fleet's fishery for ling and tusk during the period 2000-2020. Working Document to the ICES Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources (WGDEEP).21 pp.

Knutsen, H., Jorde, P. E., Sannæs, H., Hoelzel, A. R., Bergstad, O. A., Stefanni, S., Johansen, T., et al. 2009. Bathymetric barriers promoting genetic structure in the deepwater demersal fish tusk Brosme brosme. Molecular Ecology, 18: 3151 –3162.

Pennington, M., and Strømme, T. (1998). Surveys as a research tool for managing dynamic stocks. Fisheries Research 37, 97–106.Rosenbaum, P.R.2002. Observational Studies (second ed.), Springer-Verlag, New York, NY (2002) (377 pp.)

Rosenbaum, P.R. 2002. Observational Studies (second ed.), Springer-Verlag, New York, NY (2002) (377 pp.)

Table 5.4.1. Tusk 6.b. WG estimate of landings.

Year	Faroes	France	Germany	Ireland	Iceland	Norway	E & W	N.I.	Scot.	Russia	Total
1988	217		-	-		601	8	-	34		860
1989	41	1	-	-		1537	2	-	12		1593
1990	6	3	-	-		738	2	+	19		768
1991	-	7	+	5		1068	3	-	25		1108
1992	63	2	+	5		763	3	1	30		867
1993	12	3	+	32		899	3	+	54		1003
1994	70	1	+	30		1673	6	-	66		1846
1995	79	1	+	33		1415	1		35		1564
1996	0	1		30		836	3		69		939
1997	1	1		23		359	2		90		476
1998		1		24	18	630	9		233		915
1999				26	-	591	5		331		953
2000		2		22		1933	14		372	1	2344
2001	1	1		31		476	10		157	6	681
2002		8		3		515	8		88		622
2003		7		18		452	11		72	1	561
2004		9		1		508	4		45	60	627
2005		5		9		503	5		33	137	692
2006	10	1		16		431	2		25	2	487
2007	4	0		8		231	1		30	25	299
2008	41	0		2		190	0		16	44	293
2009	70			4		358			17	3	452
2010	57			1		348			13		419
2011	3					433			14		450
2012	15					209			9		233
2013		1				46			11		57
2014	6					26			6		38
2015	1					218	7		7		226
2016				1		80			9		90

Year	Faroes	France	Germany	Ireland	Iceland	Norway	E & W	N.I.	Scot.	Russia	Total
2017				2		37			8		47
2018				2		35			10		47
2019				9		70			21		100
2020*				9		51			31		91

*Preliminary.

Table 5.4.1. (Continued).

Tusk, total landings in Subarea 6.b.

Year	6.b	All areas
1988	860	860
1989	1593	1593
1990	768	768
1991	1108	1108
1992	867	867
1993	1003	1003
1994	1846	1846
1995	1564	1564
1996	939	939
1997	476	476
1998	915	915
1999	953	953
2000	2344	2344
2001	681	681
2002	622	622
2003	561	561
2004	627	627
2005	692	692
2006	487	487
2007	299	299
2008	293	293

Year	6.b	All areas
2009	452	469
2010	419	419
2011	450	450
2012	233	233
2013	57	57
2014	38	38
2015	226	226
2016	90	90
2017	47	47
2018	47	47
2019	100	100
2020	91	91

*Preliminary.

5.5 Tusk (*Brosme brosme*) in Subareas 1 and 2

5.5.1 The fishery

Tusk are primarily bycatch in the ling and cod fisheries in Subareas 1 and 2. Currently the major fisheries in Subareas 1 and 2 are the Norwegian longline and gillnet fisheries, but there are also bycatches by other gears, e.g. trawls and handlines. The total Norwegian landings are usually around 85% from longlines, 10% from gillnets and the remainder by other gears. For other nations, tusk is bycatch in trawl and longline fisheries.

Figure 5.5.1 shows the spatial distribution of the total catch by the Norwegian longline fishery from 2013 to 2020. 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 decreased to 26 in 2018. However, the number of vessels have increased to 30 in 2020. The number of vessels declined mainly because of changes in the law concerning the quotas for cod.

The average number of days that the longliners operated in ICES Subareas 1 and 2 has declined since the peak in 2011. During the period 1974 to 2018 the total number of hooks per year has varied considerably, but with a downward trend since 2002 (For more information see Helle and Pennington, WD 2021).

Since the total number of hooks per year takes into account the number of vessels, the number of hooks per day, and the number of days each vessel participated in the fishery, it follows that it may be a suitable measure of changes in applied effort. Based on this gauge, it appears that the average effort for the years 2011–2020 is 40% less than the average effort during the years 2000–2003. It should be noted that the annual fishery covers the entire distribution of tusk in Subareas 1 and 2 (see Figure 5.5.1), so that the catch produced by the applied effort is likely proportional to the actual population.

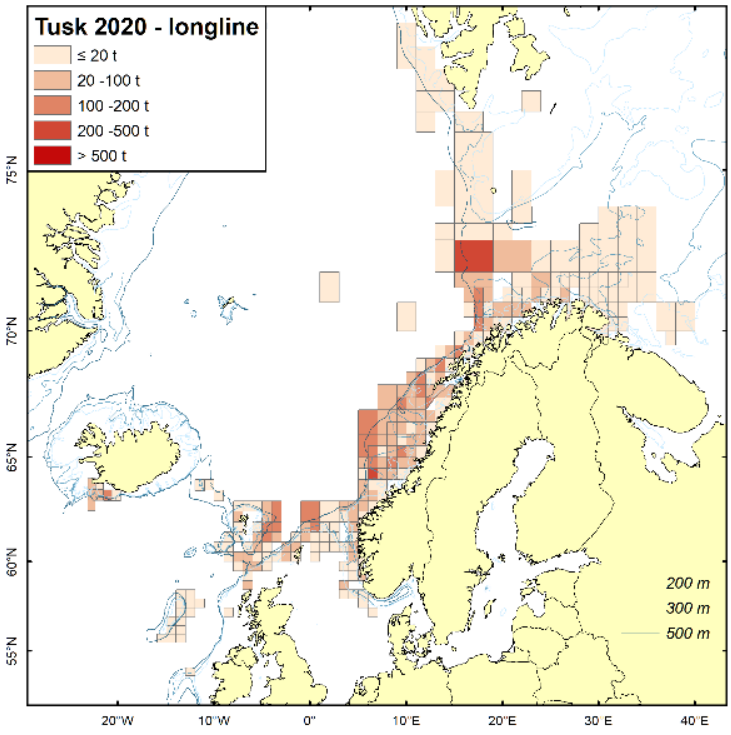

Figure 5. 5.1. Distribution of catches for the Norwegian longline fishery in Subareas 1 and 2 in 2013 to 2020.

5.5.2 Landings trends

Landing statistics by nation from 1988 to 2020 are given in Table 5.5.1a–d. Landings declined from 1989 to 2005, afterwards the landings increased and varied around 10.000 t. (Figures 5.5.2 and 5.5.3). The preliminary landings for 2020 are 9 122t.

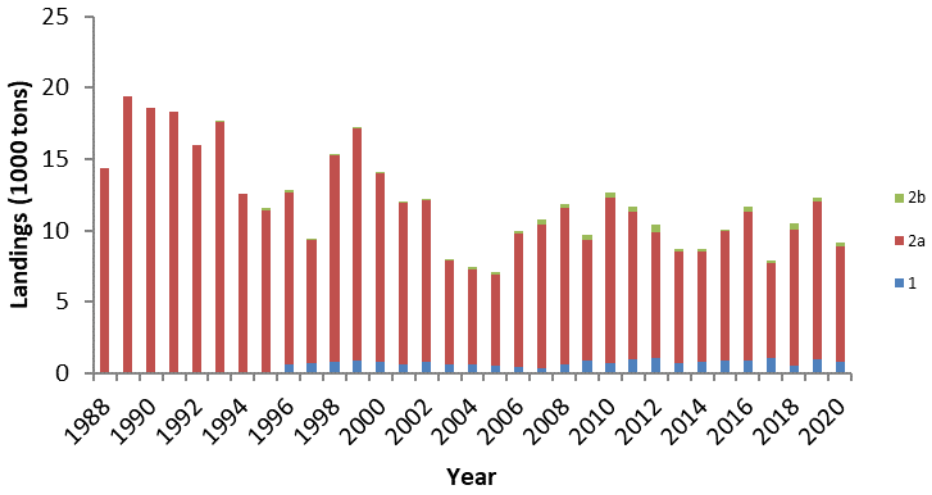

Figure 5.5.2. Total yearly landings of tusk in Areas 1 and 2 for 1988–2020.

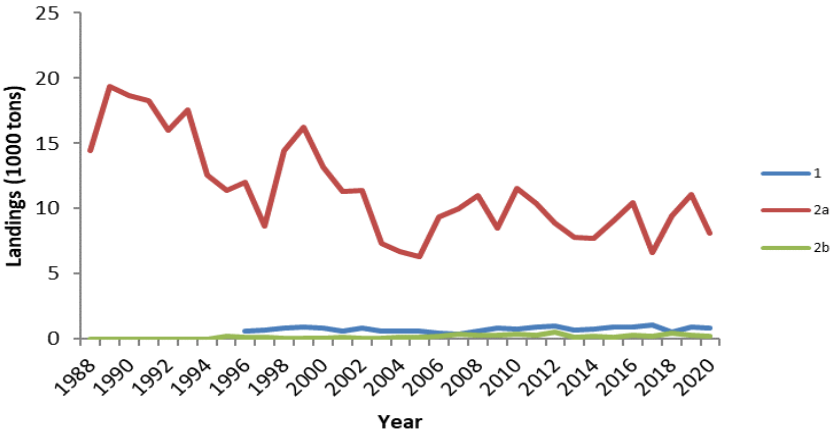

Figure 5.5.3. Total yearly landings of tusk in Areas 1 and 2 for 1988–2020.

5.5.3 ICES Advice

ICES advises that when the precautionary approach is applied, catches should be no more than 11 077 tonnes in each of the years 2020 and 2021. All catches are assumed to be landed.

5.5.4 Management

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

There are ongoing negotiations between EU, UK and Norway and the TACs are therefore not available.

5.5.5 Data available

5.5.5.1 Landings and discards

The amount landed is available for all the relevant fleets. The Norwegian fleets are not regulated by TACs, and there is a ban on discarding. The incentive for illegal discarding is believed to be small. No discards were reported in 2020. The landings statistics are regarded as being adequate for assessment purposes.

5.5.5.2 Length compositions

Figures 5.5.4 and 5.5.5 show the length distributions and Figure 5.5.6 shows the length–weight relationship for tusk based on data provided by the Norwegian reference fleet for the period 2001–2020.

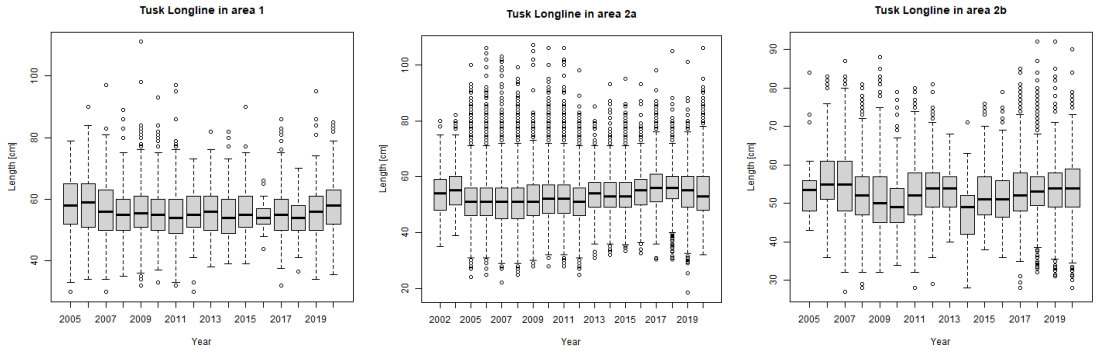

Figure 5.5.4. Box and whisker plots showing the length distribution of tusk. The data were provided by the Norwegian reference fleet for the period 2001–2020.

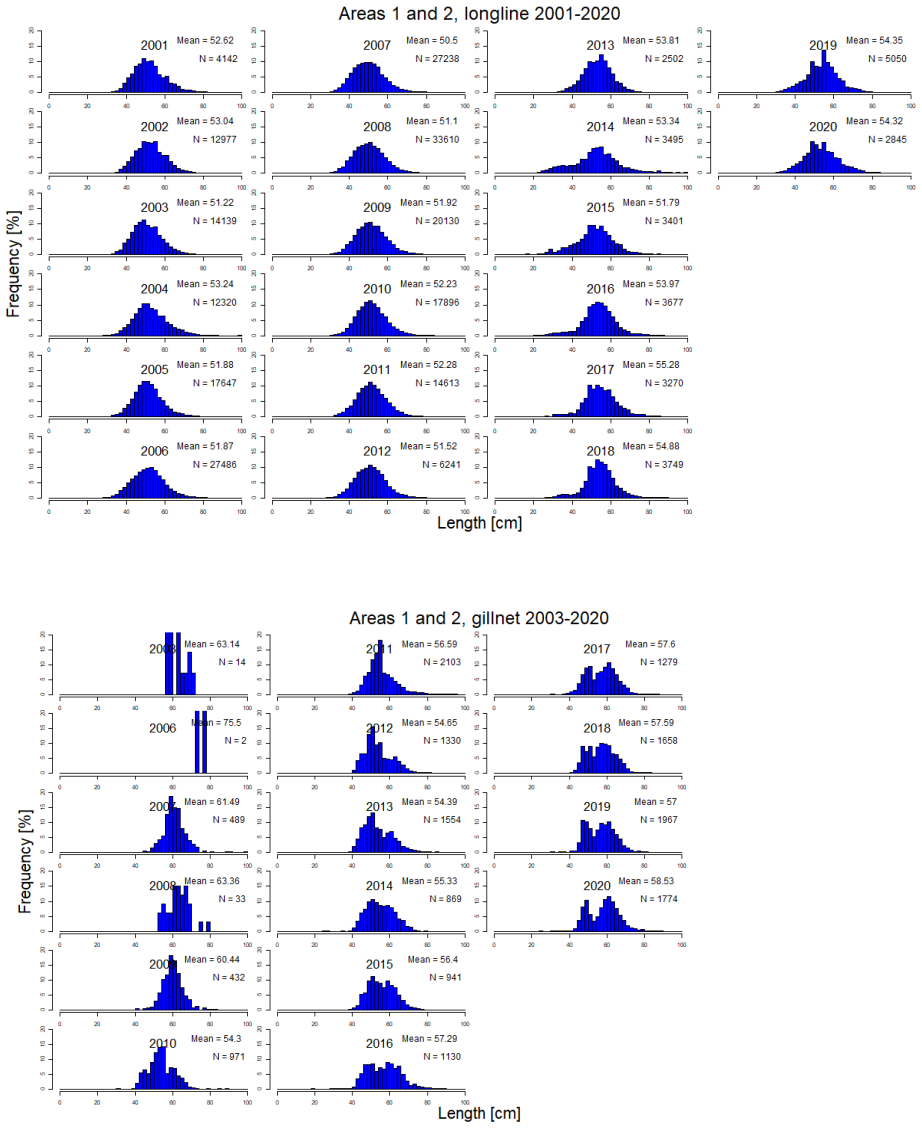

Figure 5.5.5. The estimated length distributions of the catch of tusk by Norwegian longliners and gillnetters combined for the Areas 1, 2.a and 2.b.

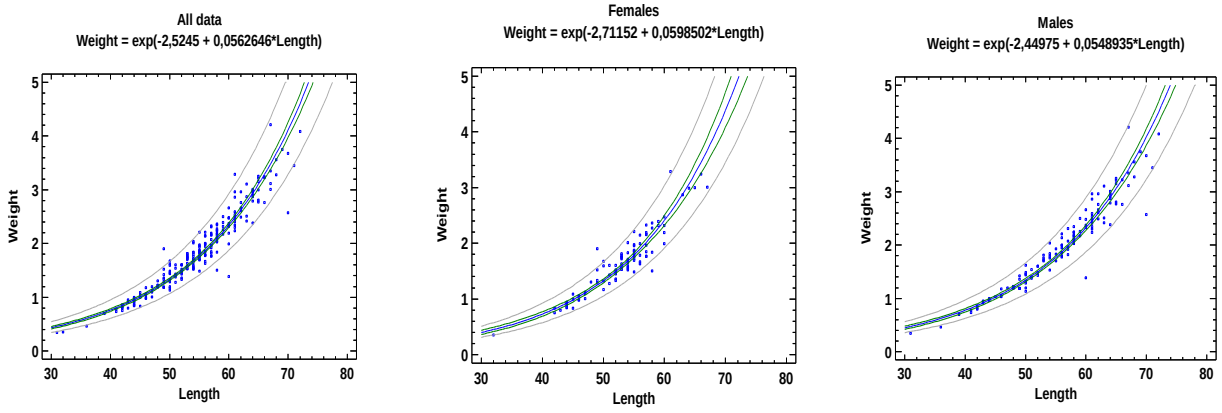

Figure 5.5.6. Length–weight relationship for tusk.

5.5.5.3 Age compositions

No new data are available.

5.5.5.4 Maturity and natural mortality

Maturity ogives for tusk are in Figure 5.5.9 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

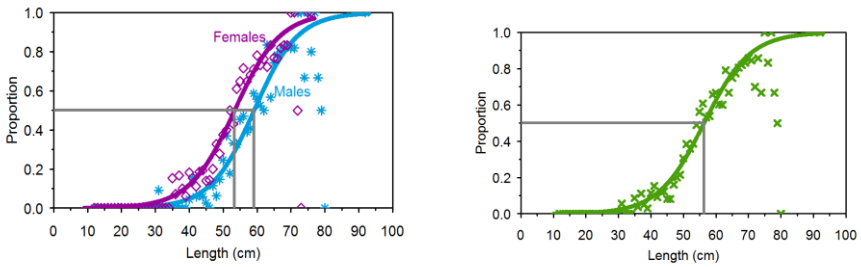

Figure 5.5.7. Tusk Area 1 and 2, Maturity ogive on length for males and females, and all data combined.

5.5.5.5 Catch, effort and research vessel data

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 2000–2020. 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, 2021. Two cpue series, one based on all data and one when tusk was targeted were presented (Figure 5.5.8). No research vessel data are available.

5.5.6 Data analyses

Length distribution

In Figures 5.5.4 and 5.5.5 are plots of the length distributions in Area 1 and 2 for 2001 to 2020. It appears that the mean length in Area 1 has varied slightly, while the mean length in Areas 2a and 2b has been very stable. The average length is slightly higher in the gillnet fishery than in the longline fishery. In 2020 the average length was 54.3 cm in the longline fishery and 58.5 cm in the gillnet fishery

Assessment

No analytical assessments were possible due to lack of age-structured data and/or tuning series.

CPUE

Two standardized GLM-based cpue series using all the data and based only when tusk made up more than 30% of the catches are in Figure 5.5.9. Both cpue series have been relative stable since 2011, but with a declining trend the last three years for the targeted fishery (Figure 5.5.8).

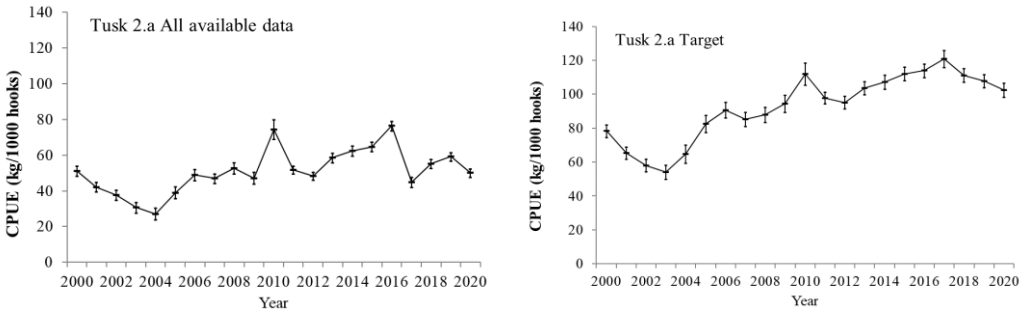

Figure 5.5.8. Estimates of cpue (kg/1000 hooks) of tusk based on skipper's logbook data for 2000–2020. The bars denote the 95% confidence interval.

Biological reference points

No traditional biological reference points are established for tusk. Life history parameters are in Table 5.5.2.

5.5.7 Comments on the assessment

It appears more likely that the cpue series for tusk based only on data from the targeted fishery reflects the population trends than does the series based on all the catch data.

5.5.8 Management considerations

The fishing pressure on tusk has decreased considerably. The number of longline vessels fishing for tusk has decreased by about 65 percent from 2000 to 2018, but with a sharp increase in 2019.

The cod stock in the Barents Sea was very abundant for many years, but now there is a downward trend resulting in lower quotas. Because of lower quotas for cod the fishing pressure on tusk has increased considerably.

As always, it should be emphasized that commercial catch data are observational data; that is, there were no scientific controls on how or from where the data were collected. Therefore, it is not known with certainty if the tusk cpue series tracks the population and/or how accurate the measures of uncertainty associated with the series are (see, for example, Rosenbaum, 2002). Consequently, one must usually hope and pray that a cpue series, which is based only on commercial catch data, truly tracks abundance.

An infamous example of a misleading cpue series based on commercial data was a cpue series for Newfoundland cod that incorrectly indicated that the abundance of the cod stock was increasing greatly. Advice based on this cpue series ultimately caused the collapse of the stock (see, e.g. Pennington and Strømme, 1998).

In general, any assessment method based only on commercial catch data needs to be applied with caution. The reason that assessments using only commercial data are problematic is because the relation between the commercial catch and the actual population is normally unknown and probably varies from year to year.

5.5.9 Application of MSY proxy reference points

Summary of SPiCT from benchmark meeting; for tusk in Subareas 1 and 2

It was not possible for the group to recommend or approve a SPiCT assessment for this stock. The reason for this was primarily the construction of the CPUE index; the CPUE index itself was not disregarded but it was not regarded suitable for the SPiCT model. Two points were pointed out as problematic; the targeting effect and technological creep. Especially handling the targeting effect; the spatial-time interactions must be solved before data can be used by SPiCT.

The recommendations from the benchmark were to enhance the standardization of the CPUE and either try an integrated model or try SPiCT again with the new CPUE. The stock should continue to be assessed as category 3 stock.

Input data for tusk arctic was the landings time series with historical landings back to 1908-2020. The abundance index was the CPUE index from the longline fishery from 2000-2020. Two variants of the CPUE index were used; one with all catches and one with only catches with more than 30% tusk.

The model was run with priors on initial depletion level and on the shape of the production curve.

The catch series is almost stable at the end of the series; this together with the very steep increase in the 30% CPUE made the CPUE to drive the model. The increase in all catches CPUE is not as pronounced as the targeted CPUE and that is probably why the model fits better to this scenario.

The very steep increase in CPUE over the short time period is problematic as the model estimate the stock to be 2–4 times BMSY and to have F below FMSY. The very high r (0,3–1,0) seems to be unrealistic as the expected value for r should be 0.12 for tusk (SPMpriors from Fish-Life). The very long catch time series (with low and high catches) and the short CPUE time series by the end of the catch time series period probably entails alternative states that are hidden to current SPiCT runs.

Stock status assessed by SPiCT indicated that B was above BMSY and F below FMSY. Other models were tried that came to contradictory conclusions. The development on B and F from SPiCT were to the assessors not totally unrealistic as the result plots to some extent resembled the history of the fishery and the believed present stock status for tusk in this area. The problem is that F probably was higher in the 1970–1980s than the model estimate. Together with the increase in CPUE this probably makes the results from the SPiCT model to be too optimistic.

The assessments on SPiCT could not be approved according to the uncertainty in the CPUE index and due to the observed inconsistencies described above. Link to the benchmark report: https://www.ices.dk/sites/pub/Publication%20Reports/Forms/DispForm.aspx?ID=37488

Results for the LBI, WGDEEP 2021

Information and data

The input parameters and the catch's length distribution for the period 2001-2020 are in the following tables and figures. The length data used in the LBI model are from the Norwegian longliner fleet. The length data are not raised to total catch.

Table 5.5.2 **Tusk in arctic waters (1, 2.a, 2.b). Input parameters for LBI.**

Data type	Years/Value	Source	Notes
Length frequency distribution	2001-2020	Norwegian long-liners (Reference fleet)	
Length-weight relationship	0.0106* length $^{3.0168}$	Norwegian long-liners (Reference fleet) and survey data.	combined sex
L_{MAT}	56 cm	Norwegian long-liners (Reference fleet) and survey data.	
L_{inf}	119 cm (L_{max})	Norwegian long-liners (Reference fleet) and survey data.	

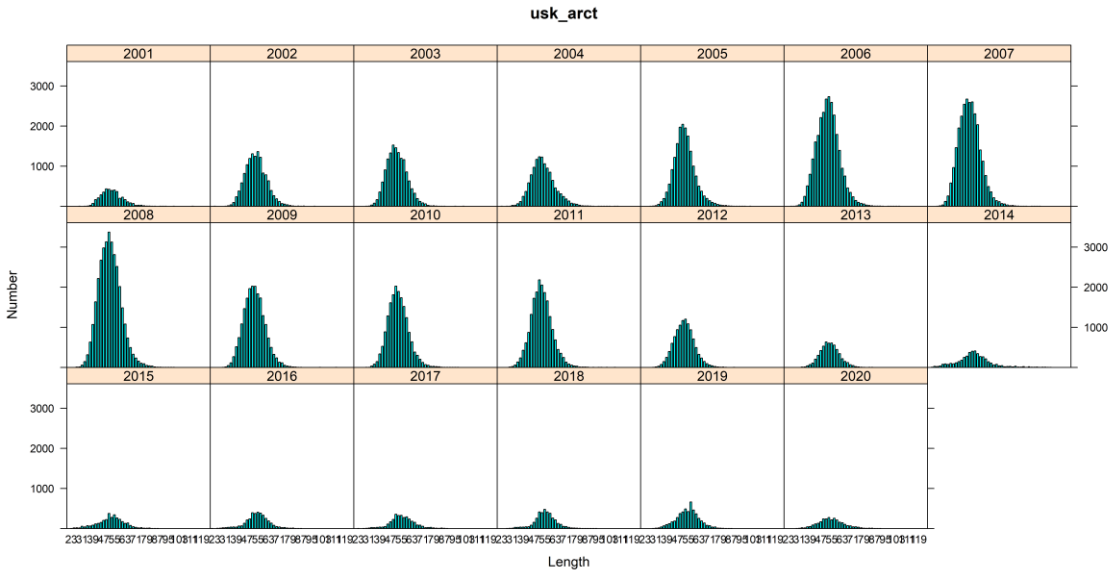

Figure 5.5.9 **Tusk in arctic waters (1, 2a, 2b). The length distribution (2 cm length bins) based on data from the Norwegian longline fleet for the period 2001–2020 (sex combined).**

Outputs

The length indicator ratios for combined sexes were examined for three scenarios: (a) Conservation, (b) Optimal yield, and (c) maximum sustainable yield are presented in the following figures.

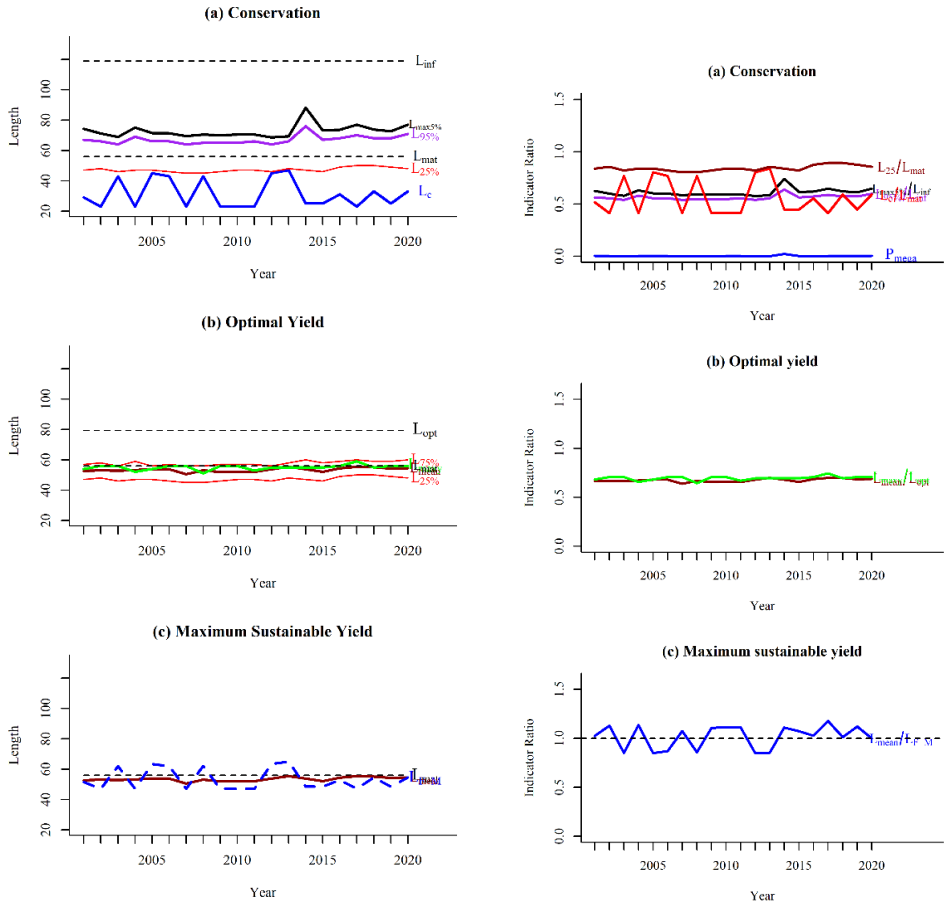

Figure 5.5.10 Tusk in arctic waters (1, 2.a, 2.b). Using length indicators ratios for sex combined to examine three scenarios: (a) Conservation, (b) Optimal yield, and (c) maximum sustainable yield.

Analysis of results

The conservation model for immature tusk shows that both L_c/L_{mat} and $L_{25\%}/L_{mat}$ are less than one, but $L_{25\%}/L_{mat}$ is still usually greater than 0.8 (Figure 6.510, Table 6.5.3). Regarding the sensitivity of L_{mat}, there appears to be little or no overfishing of immature individuals.

The conservation model for large individuals estimates that the indicator ratio, $L_{max5\%}/L_{inf}$ is between 0.61 and 0.65 in 2018-2020 (Table 6.5.10), which is less than the cut-off point.0.8. Since the VBF results gave an unusual low L_{inf}, the value used in the model was L_{max}. This could be the reason that the indicator ratio is less than 0.8. If we had used a smaller L_{inf} - the indicator ratio would be higher. Since tusk is a slow growing, deep-water species, the P_{mega} and L_{mean}/L_{opt} values are unreliably.

The MSY indicator ($L_{mean}/L_{F=M}$) is greater than 1 for almost the whole period (Figure 4.3.10), which indicates that tusk in arctic waters are fished sustainably. Regarding model sensitivity, the MSY value was always greater than 0.90.

Conclusion: The overall perception of the stock during the period 2018–2020 is that tusk in arctic waters seems to be fished sustainably (Table 6.5.3). However, the results are very sensitive to the assumed values of L_{mat} and L_{inf}.

Table 5.5.3 **Tusk in arctic waters (1, 2.a, 2.b). The results from the LBI method**

	Conservation				Optimizing Yield	MSY
	Lc/Lmat	L25%/Lmat	Lmax5%/Linf	Pmega	Lmean/Lopt	Lmean/$L_{F=M}$
Ref	**>1**	**>1**	**>0.8**	**>30%**	**~1 (>0.9)**	**≥1**
2018	0,59	0,89	0,62	0 %	0,70	1,01
2019	0,45	0,88	0,61	0 %	0,68	1,12
2020	0,59	0,86	0,65	0 %	0,69	1,00

Table 5.5.4 **Tusk in arctic waters (1, 2.a, 2.b). Stock status inferred from LBI for MSY. Green tick marks for MSY are provided because the $L_{mean}/L_{F=M}$ > 1 in each year. Stock size is unknown as this method only provides exploitation status.**

Fishing pressure				
	2017	2018	2019	
MSY (F/F_{MSY})	✓	✓	✓	Fished sustainably
Stock size				
	2016	2017	2018	
MSY $B_{trigger.}(B/B_{MSY})$	?	?	?	Unknown

5.5.10 References

Helle, K., M. Pennington, N-R. Hareide and I. Fossen. 2015. Selecting a subset of the commercial catch data for estimating catch per unit of effort series for Ling (*Molva molva* L.). Fisheries Research 165: 115–120.

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https://www.ices.dk/sites/pub/Publication%20Reports/Forms/DispForm.aspx?ID=37488

5.5.11 Tables

Table 5.5.1 a. Tusk in subarea 1. Official landings.

Year	Norway	Russia	Faroes	Iceland	Ireland	France	Total
1996	587						587
1997	665						665
1998	805						805
1999	907						907
2000	738	43	1	16			798
2001	595	6		13			614
2002	791	8	n/a	0			799
2003	571	5			5		581
2004	620	2			1		623
2005	562						562
2006	442	4					446
2007	355	2					357
2008	627	7					634
2009	869	1					870
2010	725	1				1	727
2011	941						941
2012	1024						1024
2013	692						692
2014	766	5					771
2015	904						904
2016	890	2					892
2017	1036	1					1037
2018	555	2					557
2019	944	1		1			946
2020*	813	4					817

*Preliminary.

Table 5.5.1 b. Tusk in Division 2.a. Official landings.

Year	Faroes	France	Germany	Greenland	Nor-way	E & W	Scotland	Russia	Ireland	Iceland	Total
1988	115	32	13	-	14 241	2	-				14 403
1989	75	55	10	-	19 206	4	-				19 350
1990	153	63	13	-	18 387	12	+				18 628
1991	38	32	6	-	18 227	3	+				18 306
1992	33	21	2	-	15 908	10	-				15 974
1993	-	23	2	11	17 545	3	+				17 584
1994	281	14	2	-	12 266	3	-				12 566
1995	77	16	3	20	11 271	1					11 388
1996	0	12	5		12 029	1					12 047
1997	1	21	1		8642	2	+				8667
1998		9	1		14 463	1	1	-			14 475
1999		7	+		16 213		2	28			16 250
2000		8	1		13 120	3	2	58			13 192
2001	11	15	+		11 200	1	3	66	5		11 301
2002		3			11 303	1	4	39	5		11 355
2003	6	2			7284		3	21			7316
2004	12	2			6607		1	61	1		6684
2005	29	6			6249			37	3		6324
2006	33	9			9246	1		51	11		9351
2007	54	7			9856	0	5	85	12		10 019
2008	52	6			10 848	1	3	56	0		10 966
2009	59	3			8354		1	82			8499
2010	39	6			11 445		1	49			11 540
2011	59	5			10 290		1	41			10 405
2012	54	7	1		8764	2		48		1	8877
2013	24	13	3		7729		7	52		2	7830
2014	10	9	1		7682		7	38			7743
2015	19	5			8906	1		90			9021

Year	Faroes	France	Germany	Greenland	Nor-way	E & W	Scotland	Russia	Ireland	Iceland	Total
2016	61	2	1	2	10332		1	57		3	10459
2017	14	4	2	3	6521		2	106		3	6655
2018	12	2	5	1	8651		1	63		731	9466
2019	13	3	3		10980			70		1	11070
2020*	18	1	1	1	7964			92		2	8079

*Preliminary.

(1) Includes 2.b.

Table 5.5.1 c. Tusk in Division 2.b. Official landings.

Year	Norway	E & W	Russia	Ireland	France	Total
1988		-				0
1989		-				0
1990		-				0
1991		-				0
1992		-				0
1993		1				1
1994		-				0
1995	229	-				229
1996	161					161
1997	92	2				94
1998	73	+	-			73
1999	26		4			26
2000	15	-	3			18
2001	141	-	5			146
2002	30	-	7			37
2003	43					43
2004	114		5			119
2005	148		16			164
2006	168		23			191
2007	350		17	1		368

Year	Norway	E & W	Russia	Ireland	France	Total
2008	271		11	0		282
2009	249		39			288
2010	334		57			391
2011	299		20		5	324
2012	453		40			493
2013	121	3	16			140
2014	185		41			226
2015	97		69			166
2016	165		144			309
2017	153		81			234
2018	427		37			464
2019	241		53			294
2020*	200		26			226

Table 5.5.1 d. Tusk in subareas 1 and 2. Official landings by Subarea and divisions.

Year	1	2a	2b	All areas
1988		14 403	0	14 403
1989		19 350	0	19 350
1990		18 628	0	18 628
1991		18 306	0	18 306
1992		15 974	0	15 974
1993		17 584	1	17 585
1994		12 566	0	12 566
1995		11 388	229	11 617
1996	587	12 047	161	12 795
1997	665	8667	94	9426
1998	805	14 475	73	15 353
1999	907	16 250	26	17 183
2000	798	13 192	18	14 008
2001	614	11 301	146	12 061

Year	1	2a	2b	All areas
2002	799	11 355	37	12 191
2003	581	7316	43	7940
2004	623	6684	119	7426
2005	562	6324	164	7050
2006	446	9351	191	9988
2007	357	10 019	368	10 744
2008	634	10 966	282	11 882
2009	870	8499	288	9657
2010	727	11 540	391	12 658
2011	941	10 386	319	11 646
2012	1024	8862	493	10 394
2013	692	7830	140	8662
2014	771	7745	226	8742
2015	904	9021	166	10 091
2016	892	10459	309	11660
2017	1037	6655	234	7926
2018	557	9466	464	10487
2019	946	11070	294	12310
2020*	817	8079	226	9122

***Preliminary.**

5.6 Tusk (*Brosme brosme*) in areas 3.a, 4, 5.b, 6.a, 7, 8, 9 and other areas of 12

5.6.1 The fishery

Tusk is bycatch in the trawl, gillnet and longline fisheries in areas 3.a, 4, 5.b, 6.a, 7, 8, 9 and 12. Norway has traditionally landed the major proportion of the landings. Around 90% of the Norwegian and Faroese landings are taken by longliners.

When landings from Areas 3–4 and 6.a–12 are pooled over the period 1988–2020, 35% of the landings have been in Area 4, 47% in Division 5.b, and 16% in Area 6.a.

In Division 5.b, tusk was mainly fished by longliners (about 90% of the catch), and the rest of the catch of tusk was taken by large trawlers. The main fishing ground for tusk are on the slope around the Faroes Plateau and on the Faroe Bank in areas deeper than approximately 200 m. The Norwegian longline fishery decreased from an average 15 days per vessel in 2019 to 11 days per vessel in 2020.

5.6.2 Landings trends

Landing statistics by nation in 1988–2020 are in Table 5.6.1 and are shown by year in Figure 5.6.1.

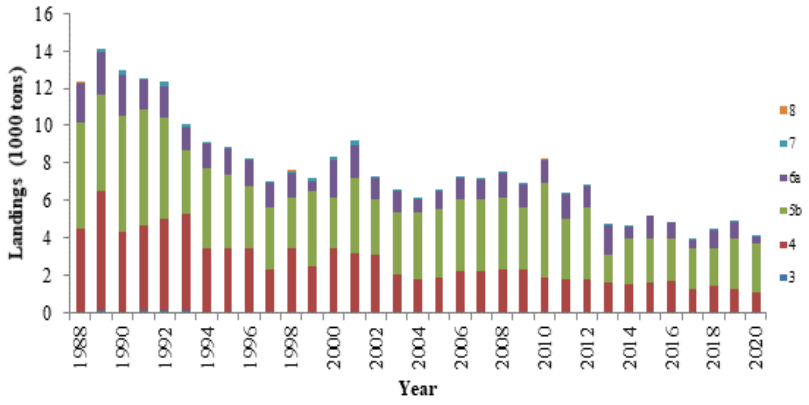

Figure 5.6.1. Landings of tusk per year for 1988–2020.

For all subareas/divisions, the catches were relatively stable from 2002 to 2012, afterwards the total catch declined and stabilized at about 4 500 tons. The total catch was 4 065 tons in 2020 (Figures 5.6.1 and 5.6.2).

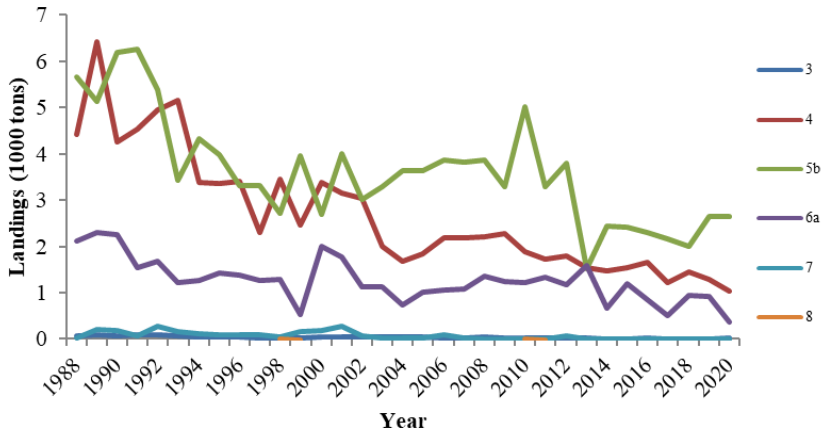

Figure 5.6.2. Landings of tusk by area for 1988–2020.

5.6.3 ICES Advice

Advice for 2020 and 2021: ICES advises that when the precautionary approach is applied, catches should be no more than 8627 tonnes in each of the years 2020 and 2021.

5.6.4 Management

There are a licensing scheme and effort limitation in Division 5.b. The minimum landing length for tusk in Division 5.b is 40 cm. Norway has a bilateral quota with Faroe Islands in 5.b, which is 2 000 t tusk for 2021.

In 2021, the Faroese Government will allow five Russian vessels to undertake experimental fishing in the Faroese Fishing Zone at depths deeper than 700 meters, provided that a Russian scientific observer is onboard. No more than three vessels can simultaneously be operating. Two of these vessels can undertake experimental fishery in deep waters around Outer Bailey and Bill Baileys Banks, at depth between 500 and 700 meters, provided that catches in this area do not exceed 500 tonnes of deep-sea species.

The quota for the EU in the Norwegian zone (Subarea 4) is set at 75 t, but only three vessels can be operating simultaneously.

EU TACs for 2015-2020 are given in table 5.6.2. *There are ongoing negotiations between EU, UK and Norway and The TACs for 2021 are, therefore, not available.

Table 5.6.2. TACs tusk in subareas 4 and 7–9, and in divisions 3.a, 5.b, 6.a. All weights are in tonnes.

Year	TAC EU Subarea 3	TAC EU Subarea 4 (EU waters)	TAC EU Subarea 4 (Norwegian waters)	TAC EU, Subareas 5,6, 7	TAC Norway2.a and 5.b,4, 6 and 7
2015	29	235	170	937	2923
2016	29	235	170	937	2923
2017	29	235	170	937	2923
2018	31	251	170	1207	2923

Year	TAC EU Subarea 3	TAC EU Subarea 4 (EU waters)	TAC EU Subarea 4 (Norwegian waters)	TAC EU, Subareas 5,6, 7	TAC Norway2.a and 5.b,4, 6 and 7
2019	31	251	170	1207	2923
2020	31	251	170	1207	2923
2021					

NEAFC recommended that in 2009 the effort in areas beyond national jurisdictions should not exceed 65% of the highest level of effort for deep-water fishing used in the past.

5.6.5 Data available

5.6.5.1 Landings and discards

The total landings and discards of tusk were available for all the relevant fleets. The Norwegian and Faroese fleet are not allowed to discard tusk, and incentives for illegal discarding are believed to be low. The landing statistics and logbooks are therefore regarded as being adequate for assessment purposes.

Discards by countries for the years 2013–2020 (Table 5.6.3), and by area and country for 2020 (Table 5.6.4).

Table 5.6.3 Total discards of tusk by country for 2013 to 2020.

	Spain	Ireland	France	UK (Scotland)	Denmark	Germany	Total landings	Total discards	Total catches	% discards
2013	40	12					4673	52	4725	1.1
2014	0	0					4585	0	4585	0.0
2015			6	12			5155	18	5173	0.3
2016			1	152			4820	153	4973	3.1
2017			8	130	5		3916	143	4059	3.5
2018	1	6	4	80		6	4411	96	4507	2.1
2019			5	63		5	4862	73	4931	1.5
2020		2		67			4065	69	4134	1.7

Table 5.6.4. Discards of tusk in 2020 by area on country.

Area	Country	Discards
27.4	UK(Scotland)	61
27.5.b.1.b	UK(Scotland)	1
27.6.a	Ireland	2

Area	Country	Discards
27.6.a	UK(Scotland)	5
Total		69

5.6.5.2 Length compositions

Norwegian reference fleet data

Figure 5.6.3a and b shows the estimated length distributions of tusk in divisions 4.b, 5.b and 6.a based on data provided by the Norwegian reference fleet for 2001–2020, and Figure 5.6.4 shows the estimated length distributions of the catch of tusk by Norwegian longliners, combined, for divisions 4.a, 5.b and 6.a.

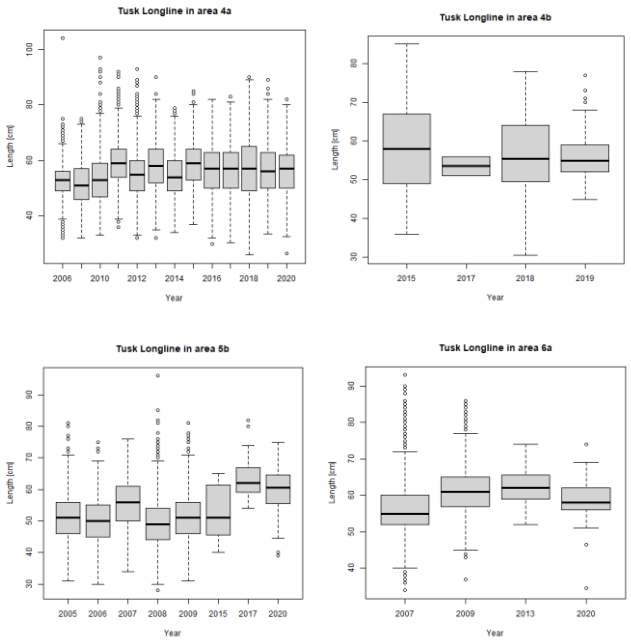

Figure 5.6.3a. Length distributions of tusk in Areas 4.a, 4.b, 5.b and 6.a for 2001–2020, based on longline data from the Norwegian reference fleet.

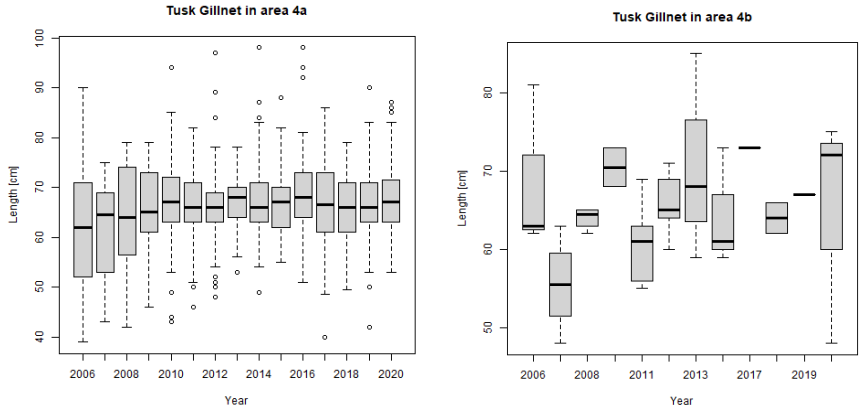

Figure 5.6.3b. Length distributions of tusk in Areas 4.a, 4.b, 5.b and 6.a for 2001–2020, based on gillnet data from the Norwegian reference fleet.

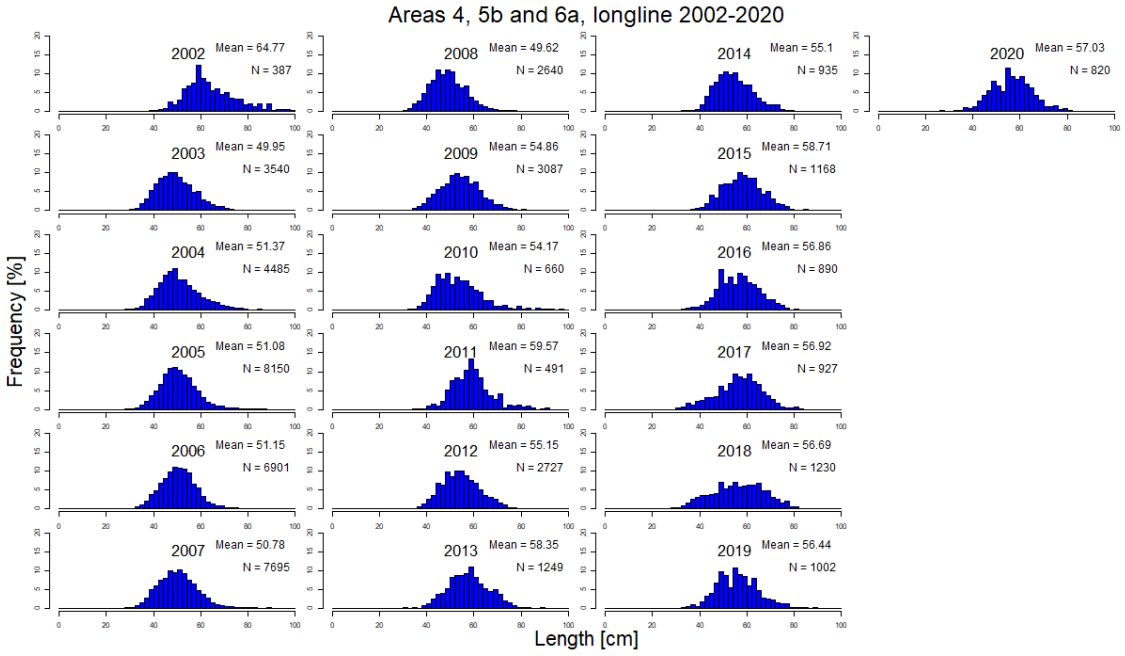

Figure 5.6.4. The estimated length distributions of the catch of tusk by Norwegian longliners, combined, for Areas 4.a, 5.b and 6.a.

Faroese length data

In Division 5.b is the length distributions of tusk based on the commercial catches by Faroese longliners since 1994 are in Figure 5.6.5.

The length data are from the annual spring- and summer groundfish surveys conducted on the Faroe Plateau are presented in Figures 5.6.6 and 5.6.7. In WGDEEP Report 2020 length distributions of tusk caught in other surveys in Division 5.b such as deep water survey (2014- present), Greenland halibut survey (1995- present), redfish trawl survey (2003-2011) and blue ling trawl survey (2000-2003) was presented.

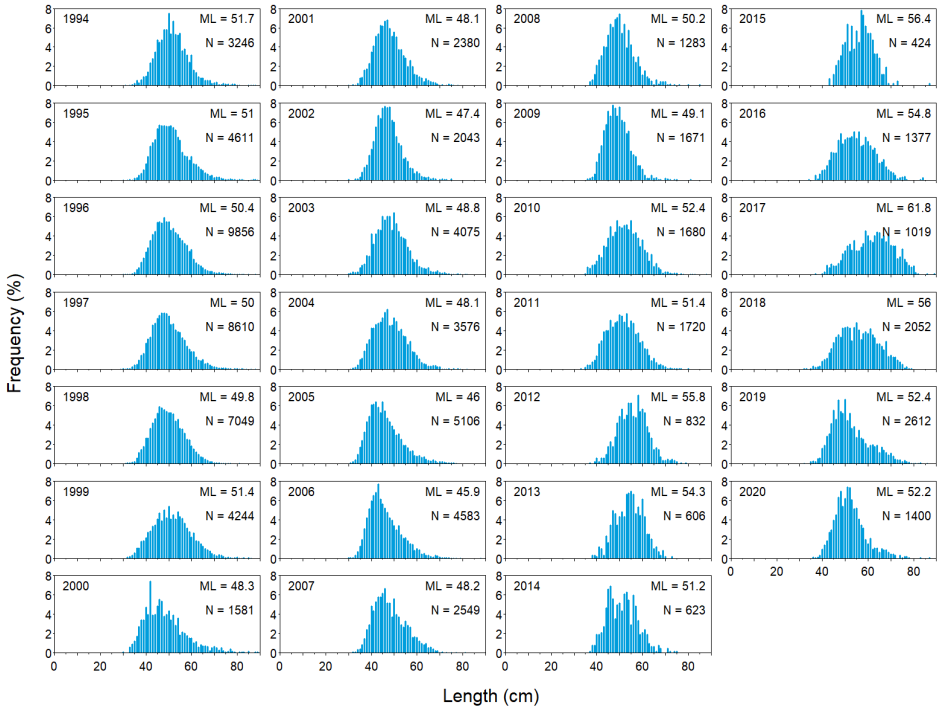

Figure 5.6.5. Length distributions of the catch of tusk by Faroese longliners (>100 BRT) in Division 5.b.

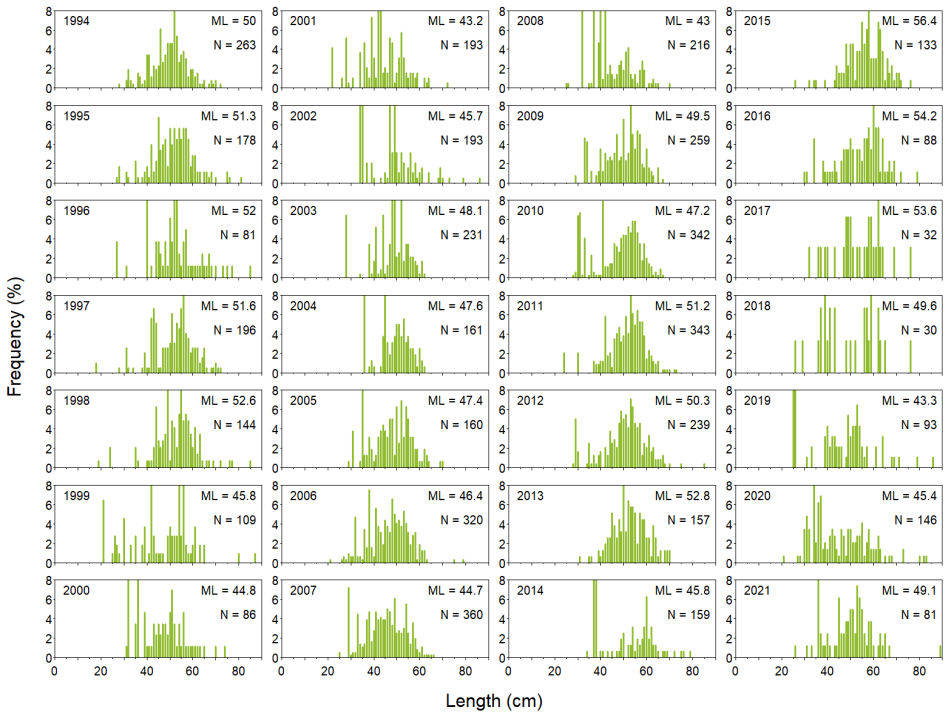

Figure 5.6.6. Length distributions of tusk in Division 5.b based on data from the Faroese spring groundfish surveys. ML- mean length, N- number of calculated length measures. Small tusk are often sampled from a subsample of the total catch, so the values are multiplied to total catch.

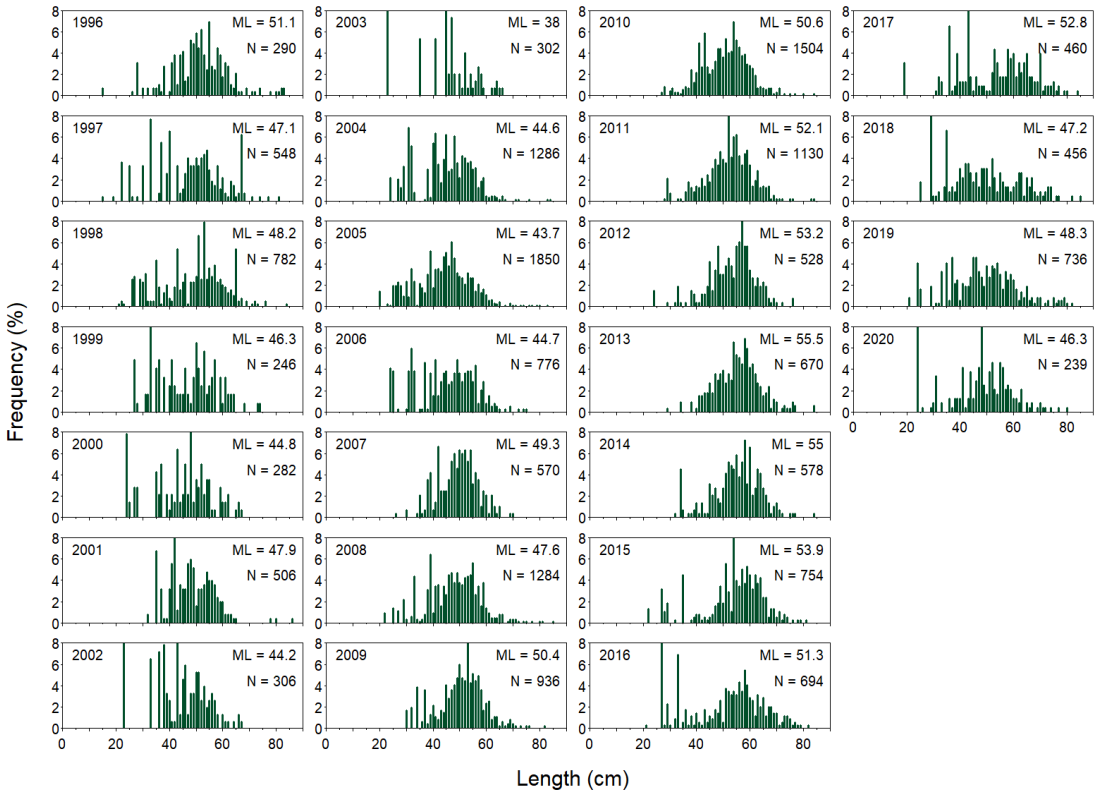

Figure 5.6.7. Length distributions of tusk in Division 5.b based on data from the Faroese summer groundfish surveys. ML- mean length, N- number of calculated length measures. Small tusk are often sampled from a subsample of the total catch, so the values are multiplied to total catch.

5.6.5.3 Age and growth compositions

No new data are available (See stock annex for current estimates).

5.6.5.4 Weight-at-age

No new data are available.

5.6.5.5 Maturity and natural mortality

No new data are available (See stock annex for current estimates).

5.6.5.6 Catch, effort and research vessel data

Commercial cpue series

Norway started in 2003 to collect and enter data from official logbooks into an electronic database, and data are now available for 2000–2020. Vessels were selected that had a total landed catch of ling, tusk and blue ling exceeding 8 t in every year. The logbooks contain records of the daily catch, date, position, and number of hooks used per day. The quality of the Norwegian logbook data is poor in 2010 due to the switch from paper to electronic logbooks. Since 2011, data quality has improved considerably and data from the entire fleet were available.

The cpue data for tusk from Norwegian longliners fishing in Division 5.b are described in the stock annex for tusk in 2.a (Section tusk in 1 and 2) and in Helle *et al*., 2015. The cpue series was based on sets where tusk was greater than 30% of the total catch.

Fisheries independent cpue series

Estimates of the cpue series (kg/hour) for tusk are available from two annual Faroese groundfish trawl surveys on the Faroe Plateau that were designed for cod, haddock and saithe. The annual survey on the Faroe Plateau covers the main fishing areas and mainly the larger part of the spatial distributional area (Ofstad, WD WGDEEP 2017). Information on the surveys and standardization of the data are described in the stock annex.

5.6.6 Data analyses

Length distributions

Norwegian length distributions, based on data provided by the longline reference fleet from divisions 4.a, 5.b and 6.a, have varied slightly with no obvious trends (Figures 5.6.3 and 5.6.4). The average length of tusk caught by Norwegian longliners in the combined Areas 4.a, 5.b and 6.a was 56.4 cm in 2019 and 57 cm in 2020.

Faroese length distributions, based on data from Faroese longliners fishing in Division 5.b, varied mainly between 48 and 56 cm (average 51 cm), and there was no downward trend. In 2020, the mean length was 52.2 cm, the maximum was 88 cm and most of the landings were between 40 and 60 cm (Figure 5.6.5).

The mean length of tusk sampled in the Faroese spring and summer groundfish surveys varied between 43 and 55 cm (Figures 5.6.6 and 5.6.7). The length distributions are noisy, and the reason is that small tusk are often sampled in a subsample of the total catch, so the values are multiplied to total catch. Few tusks smaller than 30 cm are reported to be caught in these surveys.

Cpue trends

4.a

Two cpue series for tusk in Division 4.a based: Norwegian longline data were on all the catches and data when tusk appeared to be the target species. The series based on all the catches indicates at first a stable cpue and then a slightly decreasing trend for the last four years. The series based on the targeted fishery shows a clear and positive upward trend from 2002 until 2013, after 2013 there was a declining trend, this trend is especially clear for the targeted fishery (Figure 5.6.8).

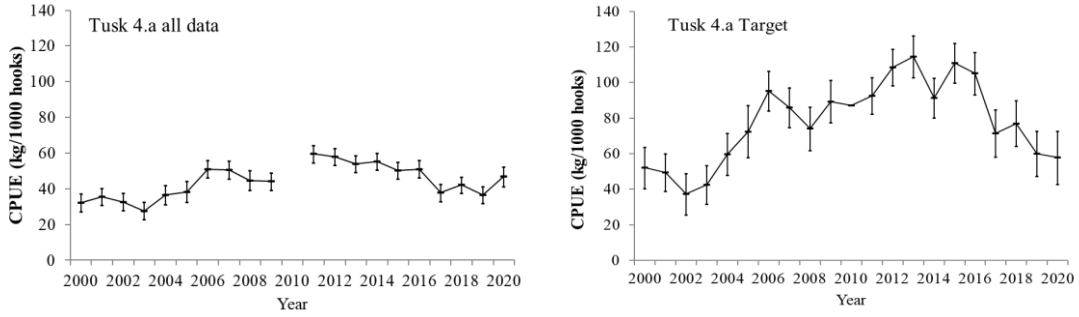

Figure 5.6.8. Tusk cpue series in 4.a for 2000–2020 based on all available data and when tusk appeared to be targeted. The bars denote the 95% confidence intervals.

5.b

The standardized cpue from the annual Faroese groundfish surveys in spring (1994-present) and summer (1996-present) are in Figure 5.6.9. In addition, a CPUE series for the spring survey, 1983-

1993, based on non-stratified data, are in Figure 5.6.9. The cpue series for the annual groundfish surveys show a downward trend during the last years. These surveys are only conducted in waters less than 530 m, so these estimates are not covering the whole distribution area of tusk.

Abundance indices for tusk < 40 cm, generated by the Faroese groundfish survey on the Plateau, are around mean level in the last years (Figure 5.6.10).

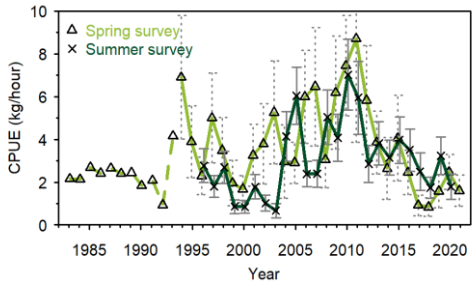

Figure 5.6.9. Tusk 5.b. Standardized cpue from the annual trawl groundfish surveys. The spring survey data from 1983–1993 are not stratified.

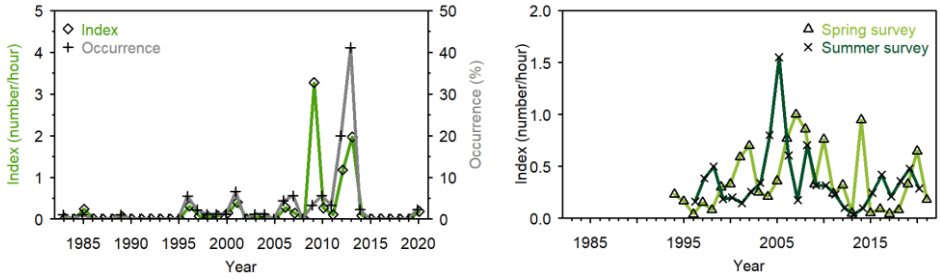

Figure 5.6.10. Tusk 5.b. Abundance index for tusk (2–3 cm in length in number/hour) on the Faroe Plateau based on the 0-group survey (left figure) and abundance index for tusk <40 cm from the annual spring and summer trawl survey on the Faroe Plateau (right figure).

The cpue series based on the Norwegian longline data shows a stable trend from 2000 to 2008, increased until 2012, decreased until 2017, a relatively large increase in 2018 and then decreased in 2019 and 2020 (Figure 5.6.11).

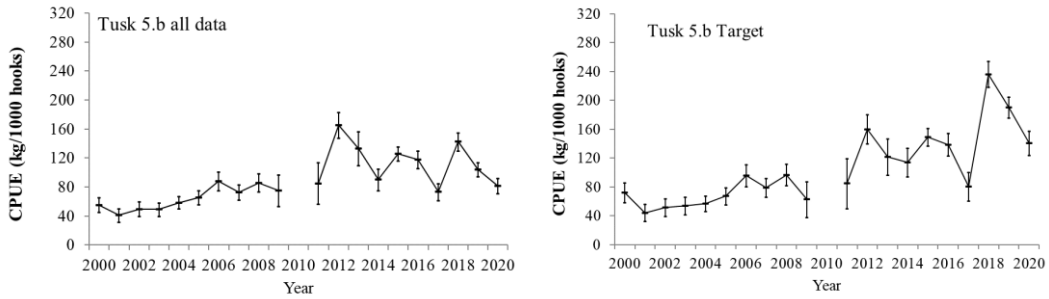

Figure 5.6.11. Tusk cpue series in 5.b for 2000–2020 based on all available data and when tusk appeared to be targeted. The bars denote the 95% confidence intervals.

6.a

In Division 6.a, a cpue series based on the Norwegian longline data shows an increase in cpue from 2004 to 2008, afterwards it has remained at a high, but slightly increasing level when all data are used (Figure 5.6.12).

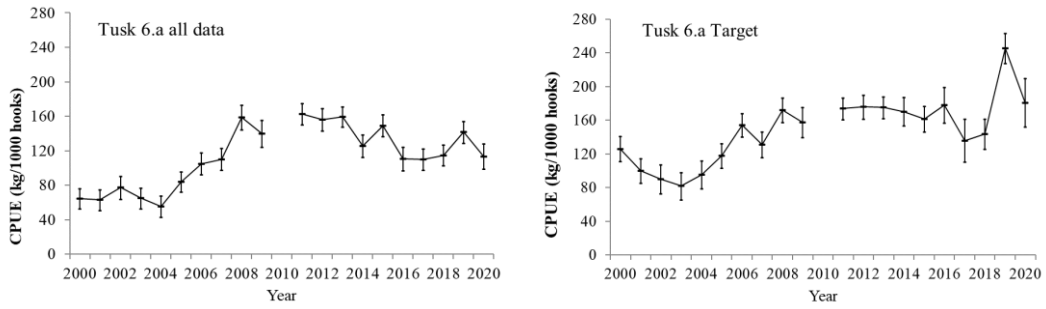

Figure 5.6.12. Two cpue series for tusk in area 6.a from 2000–2020 based on all available data and when tusk appeared to be targeted. The bars denote the 95% confidence intervals.

Combined cpue series for "Tusk areas 4, 5b and 6a"

A cpue series for merging all areas, data from the Norwegian longline fleet was combined with divisions 4.a, 4.b, 5.b and 6.a.

Two cpue series were estimated: based on using all available data and when tusk was targeted (daily catches when tusk made up more than 30% of the total catch, Figure 5.6.13).

The combined Norwegian longline cpue series shows an increasing trend from 2000 to 2010, after 2010 cpue was at a high and stable level (Figure 5.6.13).

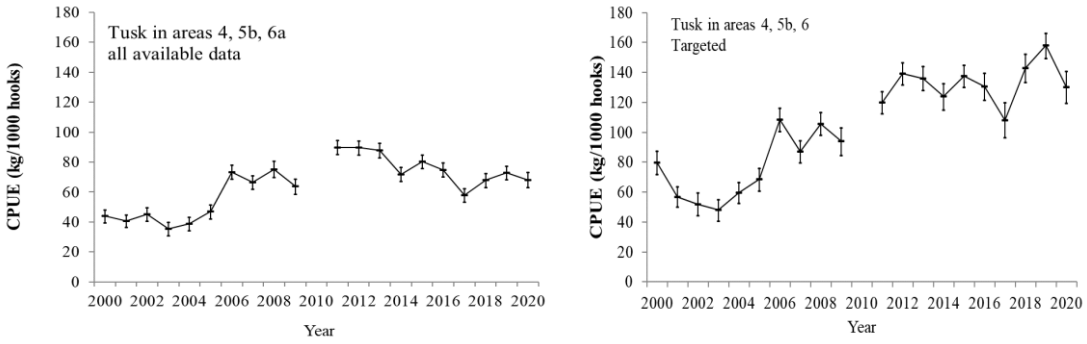

Figure 5.6.13. A combined cpue series for all "other tusk" areas for 2000–2019 based on data from the Norwegian longline fleet when tusk was targeted (>30% of total catch). The bars denote the 95% confidence intervals.

5.6.6.1 Biological reference points

See Section 5.6.9.

5.6.7 Comments on the assessment

The tusk stocks in Areas 3.a, 4, 5b, 6a, 7, 8, 9, 10, 12, 14 were best covered by the Norwegian longline fleet. WGDEEP decided that a combined cpue series should be made to give advice for the entire area, and that the data from the targeted fishery should be used.

5.6.8 Management considerations

Tusk landings from all subareas have been relatively stable since 2013. A cpue series, based on the Norwegian longline fishery when all areas are combined, shows a stable or positive trend

since 2003. The combined Norwegian longline cpue series shows an increasing trend from 2000 to 2010, after 2010 the cpue series based on targeted catches shows a high and stable level. The two CPUE series show very different trends, and the series will be recalculated. For more information, see section 5.6.9.

As always, it should be emphasized that commercial catch data are typically observational data; that is, there were no scientific controls on how or from where the data were collected. Therefore, it is not known with certainty if the tusk cpue series tracks the actual population and/or how accurate the measures of uncertainty associated with the series are (see, for example, Rosenbaum, 2002). Consequently, one must usually hope that a cpue series, which is based only on commercial catch data, truly tracks abundance.

An infamous example of a misleading cpue series based on commercial data was a cpue series for Newfoundland cod that incorrectly indicated that the abundance of the cod stock was increasing greatly. Advice based on this cpue series ultimately caused the collapse of the stock (see, e.g. Pennington and Strømme, 1998).

In general, any assessment method based only on commercial catch data needs to be applied with caution. The reason that assessments using only commercial data are problematic is because the relation between the commercial catch and the actual population is normally unknown and probably varies from year to year.

5.6.9 Application of MSY proxy reference points

Summary of SPiCT from benchmark meeting; tusk in Areas 3.a, 4, 5b, 6a, 7, 8, 9, 10, 12, 14

It was not possible for the group to recommend or approve a SPiCT assessment for this stock. The reason for this was primarily the construction of the CPUE index; the CPUE index itself was not disregarded but it was not regarded suitable for the SPiCT model. Two points were pointed out as problematic; the targeting effect and technological creep. Especially handling the targeting effect; the spatial-time interactions must be solved before data can be used by SPiCT.

The recommendations from the benchmark was to enhance the standardization of the CPUE and either try an integrated model or try SPiCT again with the new CPUE. The stock should continue to be assessed as category 3 stock.

Input data for tusk arctic was the landings time series with historical landings back to 1950-2020. The abundance index was the CPUE index from the longline fishery from 2000-2020. Two variants of the CPUE index were used; one with all catches and one with only catches with more than 30% tusk.

The model was run with priors on initial depletion level and on the shape of the production curve.

The catch series is almost stable at the end of the series; this together with the very steep increase in the 30% CPUE made the CPUE to drive the model. The increase in all catches CPUE is not as pronounced as the targeted CPUE and that is probably why the model fits better to this scenario.

The very steep increase in CPUE over the short time period is problematic as the model estimate the stock to be 2–4 times BMSY and to have F below FMSY. The very high r (0.3–1.0) seems to be unrealistic as the expected value for r should be 0.12 for tusk (SPMpriors from Fish-Life). The very long catch time series (with low and high catches) and the short CPUE time series by the end of the catch time series period probably entails alternative states that are hidden to current SPiCT runs.

Stock status assessed by SPiCT indicated that B was above BMSY and F below FMSY. Other models were tried that came to contradictory conclusions. The development on B and F from

SPiCT were to the assessors not totally unrealistic as the result plots to some extent resembled the history of the fishery and the believed present stock status for tusk in this area. The problem is that F probably was higher in the 1970–1980s than the model estimate. Together with the increase in CPUE this probably makes the results from the SPiCT model to be too optimistic.

The assessments on SPiCT could not be approved according to the uncertainty in the CPUE index and due to the observed inconsistencies described above. Link to the benchmark report: https://www.ices.dk/sites/pub/Publication%20Reports/Forms/DispForm.aspx?ID=37488

Results for the LBI, WGDEEP 2021

Information and data

The input parameters and the catch length composition for the period 2002-2020 are presented in the following tables and figures. The length data used in the LBI model are data from the Faroese- and Norwegian longliners. The length data are not raised to total catch.

Table 5.6.5. Tusk in other areas (3.a, 4.a, 5.b, 6.a, 7, 8, 9, 12). Input parameters for LBI.

Data type	Years/Value	Source	Notes
Length frequency distribution	2002–2018	Faroese long-liners fishing in Division 5.b	Data combined from both sources
	2002-2020	Norwegian long-liners fishing in divisions 4.a, 4.b, 5.b, 6.a	Lengths grouped into 2 cm bins
Length-weight relationship	$0.0161 * \text{length}^{2.9101}$	Norwegian long-liners (Reference fleet) and survey data.	combined sexes
L_{MAT}	51 cm	Faroese survey data	
L_{inf}	125 cm (L_{max})	Norwegian long-liners (Reference fleet)	

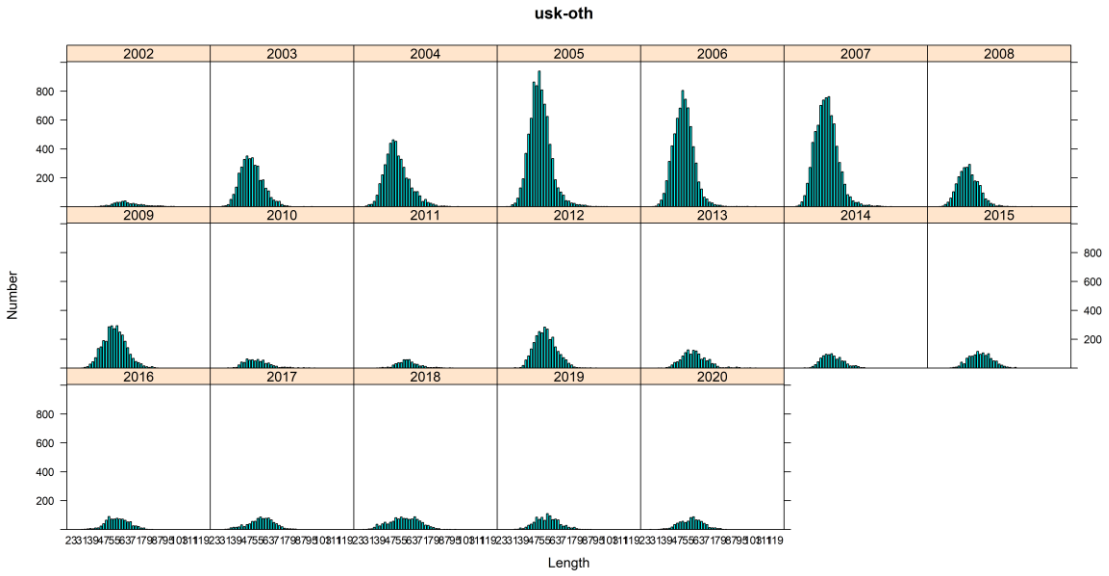

Figure 5.6.14. Tusk in other areas (3.a, 4.a, 5.b, 6.a, 7, 8, 9, 12). Catch length distributions (2 cm bins) have not been raised to total catch for the period 2002–2020 (combined sexes).

Outputs

The length indicator ratios for combined sexes were examined for three scenarios: (a) Conservation, (b) Optimal yield, and (c) maximum sustainable yield are presented in the following Figure 5.6.15.

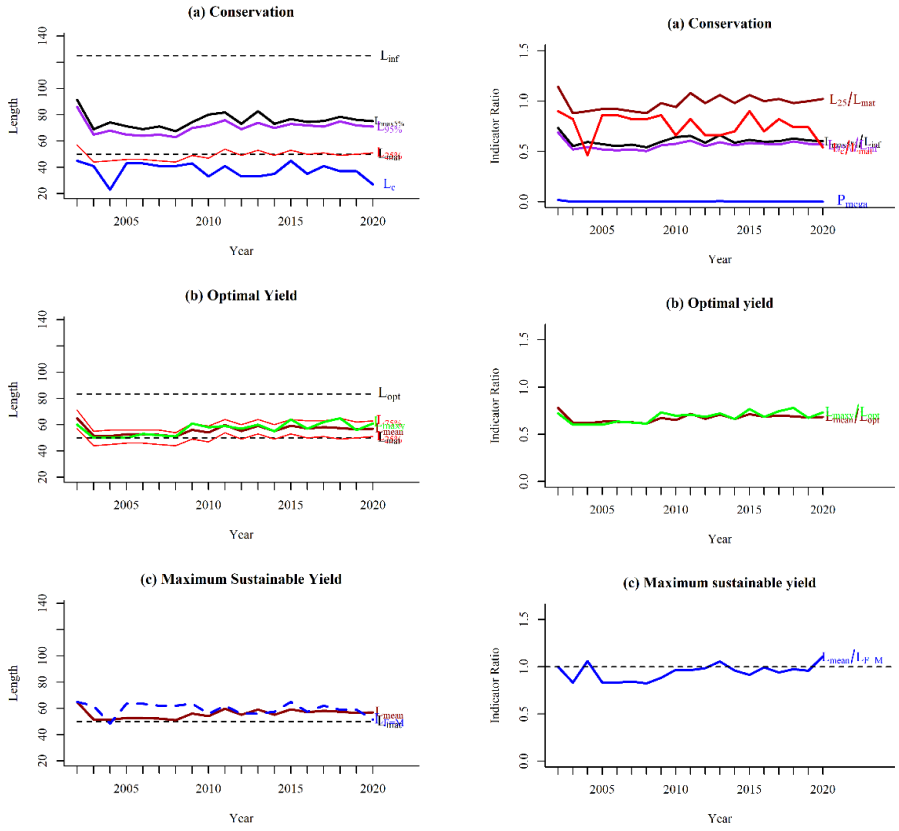

Figure 5.6.15 Tusk in other areas (3.a, 4.a, 5.b, 6.a, 7, 8, 9, 12). Screening of length indicators ratios for sexes combined under three scenarios: (a) Conservation, (b) Optimal yield, and (c) maximum sustainable yield.

Analysis of results

The conservation model for immature tusk shows that both L_c/L_{mat} and $L_{25\%}/L_{mat}$ is around or above 1 (Figure 5.6.19). In 2019-2020, the ratios were between 0.98 and 1,20 (Table 5.6.6). Regarding the sensitivity of L_{mat}, there appears to be little or no overfishing of immature individuals. The estimate of L_{mat} is based on data from Division 5.b, so L_{mat} may differ in the other areas.

The conservation model for large individuals shows that the indicator ratio of $L_{max5\%}/L_{inf}$ was around 0.6 for the whole period (Figure 5.6.20), and between 0.6 and 0.63 during the period 2019-2020 (Table 5.6.20), which is less than the baseline, 0.8. The reason that the VBF results gave unusually low values of L_{inf}, was because the value used in the model was L_{max}. If we had used a smaller value of L_{inf}, then the indicator ratio would be higher. Since tusk is a deep-water and slow-growing species, the P_{mega} and L_{mean}/L_{opt} values used were probably incorrect.

The MSY indicator, $L_{mean}/L_{F=M}$, was less than 1 for the entire period except for the last year (Figure 5.6.19), which indicates that tusk in other areas were fished unsustainably but has in 2020 been fished sustainably. It should be noted that if L_{inf} were set equal to L_{max}, then MSY would always have been greater than 0.8.

Table 5.6.6. Tusk in other areas (3.a, 4.a, 5.b, 6.a, 7, 8, 9, 12). The results based on the LBI method.

	Conservation				Optimizing Yield	MSY
	Lc/Lmat	L25%/Lmat	Lmax5%/Linf	Pmega	Lmean/Lopt	Lmean/$L_{F=M}$
Ref	**>1**	**>1**	**>0,8**	**>30%**	**~1 (>0,9)**	**≥1**
2018	0,74	0,98	0,63	0 %	0,69	0,97
2019	0,74	1,00	0,61	0 %	0,68	0,96
2020	0,54	1,20	0,60	0 %	0,68	1,11

Conclusions

The overall perception of the tusk stock in these areas during the period 2018–2020, based on the LBI results, is that tusk seems to be overexploited in the beginning, but that the stock had been fished sustainably during the last year (Table 5.6.7.). However, the results are very sensitive to the assumed values of L_{mat} and L_{inf}.

Table 5.6.7. Tusk in other areas (3.a, 4.a, 5.b, 6.a, 7, 8, 9, 12). Stock status inferred from LBI for MSY. Red tick marks for MSY are provided because the $L_{mean}/L_{F=M} < 1$ in each year. The MSY ($L_{mean}/L_{F=M}$). Stock size is unknown as this method only provides the exploitation status.

Fishing pressure				
	2018	2019	2020	
MSY (F/F_{MSY})	✗	✗	✓	Fished sustainably

Stock size				
	2018	2019	2020	
MSY $B_{trigger.}(B/B_{MSY})$	?	?	?	Unknown

5.6.10 References

Helle, K., M. Pennington, N-R. Hareide and I. Fossen. 2015. Selecting a subset of the commercial catch data for estimating catch per unit of effort series for Ling (*Molva molva* L.). Fisheries Research 165: 115–120.

Helle, K. and Pennington, M. 2021. The development of the Norwegian longline fleet's fishery for ling and tusk during the period 2000-2020. Working Document to the ICES Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources (WGDEEP).21 pp.

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Pennington, M., and Strømme, T. (1998). Surveys as a research tool for managing dynamic stocks. Fisheries Research 37, 97–106.Rosenbaum, P.R.2002. Observational Studies (second ed.), Springer-Verlag, New York, NY (2002) (377 pp.)

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https://www.ices.dk/sites/pub/Publication%20Reports/Forms/DispForm.aspx?ID=37488

5.6.11 Tables

Table 5.6.1. Tusk 3.a, 4, 5.b, 6, 7, 8, 9. WG estimates of amount landed.

Tusk 3.a

Year	Denmark	Norway	Sweden	Total
1988	8	51	2	61
1989	18	71	4	93
1990	9	45	6	60
1991	14	43	27	84
1992	24	46	15	85
1993	19	48	12	79
1994	6	33	12	51
1995	4	33	5	42
1996	6	32	6	44
1997	3	25	3	31
1998	2	19		21
1999	4	25		29
2000	8	23	5	36
2001	10	41	6	57
2002	17	29	4	50
2003	15	32	4	51
2004	18	21	6	45
2005	9	30	5	44
2006	4	21	4	29
2007	1	19	1	21
2008	0	43	3	46
2009	1	17	1	19
2010	1	17	3	21
2011	1	14	3	17
2012	1	17	2	20
2013	1	20	1	22

Year	Denmark	Norway	Sweden	Total
2014	1	7	1	9
2015	1	7	1	9
2016	1	12	1	14
2017	1	8	1	10
2018	2	5	1	8
2019	1	7	0	8
2020*	1	12	0	13

*Preliminary.

Tusk 4.a

Year	Denmark	Faroes	France	Germany	Norway	Sweden[(1)]	E & W	N.I.	Scotland	Ireland	Total
1988	83	1	201	62	3998	-	12	-	72		4429
1989	86	1	148	53	6050	+	18	+	62		6418
1990	136	1	144	48	3838	1	29	-	57		4254
1991	142	12	212	47	4008	1	26	-	89		4537
1992	169	-	119	42	4435	2	34	-	131		4932
1993	102	4	82	29	4768	+	9	-	147		5141
1994	82	4	86	27	3001	+	24	-	151		3375
1995	81	6	68	24	2988		10		171		3348
1996	120	8	49	47	2970		11		164		3369
1997	189	0	47	19	1763	+	16		238	-	2272
1998	114	3	38	12	2943		11		266	-	3387
1999	165	7	44	10	1983		12		213	1	2435
2000	208	+	32	10	2651	2	12		343	1	3259
2001	258		30	8	2443	1	11		343	1	3095
2002	199		21		2438	1	8		294		2961
2003	217		19	6	1560		4		191		1997
2004	137	+	14	3	1370	+	2		140		1666
2005	123	17	11	4	1561	1	2		107		1826
2006	155	8	14	3	1854		5		120		2159
2007	95	0	22	4	1975	1	6		74	3	2180

Year	Denmark	Faroes	France	Germany	Norway	Sweden[1]	E & W	N.I.	Scotland	Ireland	Total
2008	57	0	16	2	1975		3		85	1	2139
2009	48		8	1	2108	7	3		93		2268
2010	36		10	2	1734		8		71		1861
2011	52		24		1482	1	6		72		1636
2012	28		14	1	1635	1	3		67		1749
2013	42		11	3	1375		3		76		1510
2014	21		13	3	1365		3		58		1463
2015	24		6	2	1448	1	5		44		1530
2016	33		5	3	1565	1	4		39		1650
2017	37		5	2	1121				41		1206
2018	37		6	1	1341	1			53		1439
2019	46		9	2	1139	1	4		46		1247
2020*	46		8		898	5	2		65		1024

[1]) Includes 4.b 1988–1993.

***Preliminary.**

Table 5.6.1. (Continued).

Tusk 4.b

Year	Denmark	France	Norway	Germany	E & W	Scotland	Ireland	Sweden	Total
1988		n.a.		-	-				
1989		3		-	1				4
1990		5		-	-				5
1991		2		-	-				2
1992	10	1		-	1				12
1993	13	1		-	-				14
1994	4	1		-	2				7
1995	4	-	5	1	3	2			15
1996	4	-	21	4	3	1			33
1997	6	1	24	2	2	3			38
1998	4	0	55	1	3	3			66
1999	8	-	21	1	1	3			34

Year	Denmark	France	Norway	Germany	E & W	Scotland	Ireland	Sweden	Total
2000	8		106	+	-	2			116
2001	6		45[(1)]	1	1	3			56
2002	6		61	1	1	2			71
2003	2		5	1					8
2004	2		19	1		1			23
2005	2		4	1					7
2006	2		30						32
2007	1		6				8		15
2008	0		69			0	2		71
2009	1		3			0	0	13	17
2010	1		13						15
2011	1		95						96
2012	2		43					2	47
2013	3		28						31
2014	2		9						11
2015	3		14	1					18
2016	2		5		2				9
2017	1		16					1	18
2018	1		15	1					17
2019	1		31	1					33
2020*	1		8						9

[(1)] Includes 4.c.

***Preliminary.**

Tusk 5.b1

Year	Denmark	Faroes[4]	France	Germany	Norway	E & W	Scotland [1]	Russia	Total
1988	+	2827	81	8	1143	-			4059
1989	-	1828	64	2	1828	-			3722
1990	-	3065	66	26	2045	-			5202
1991	-	3829	19	1	1321	-			5170
1992	-	2796	11	2	1590	-			4399
1993	-	1647	9	2	1202	2			2862
1994	-	2649	8	1 [2]	747	2			3407
1995		3059	16	1 [2]	270	1			3347
1996		1636	8	1	1083				2728
1997		1849	11	+	869		13		2742
1998		1272	20	-	753	1	27		2073
1999		1956	27	1	1522		11[3]		3517
2000		1150	12	1	1191	1	11[3]		2367
2001		1916	16	1	1572	1	20		3526
2002		1033	10		1642	1	36		2722
2003		1200	11		1504	1	17		2733
2004		1705	13		1798	1	19		3536
2005		1838	12		1398		24		3272
2006		2736	21		778		24	1	3559
2007		2291	28		1108	2	2	37	3431
2008		2824	18		816	18	13	109	3689
2009		2553	14		499	4	31	34	3135
2010		3949	16		866		58		4889
2011		3288	3		1		1		3293
2012		3668	23		102				3793
2013		1464	36		0				1500
2014		1764	32		511		3		2310
2015		1338	26		717				2081
2016		1494	17		747		3		2261

Year	Denmark	Faroes[4]	France	Germany	Norway	E & W	Scotland [1]	Russia	Total
2017		1472	18		544		1		2035
2018		1119	14		849		1		1983
2019		1110	13		835		2		1960
2020		1302	18		1139		3		2462

[1] Included in 5.b2 until 1996.

[2] Includes 5.b2.

[3] Reported as 5.b.

[4] 2000–2003 5.b1 and 5.b2 combined.

* Preliminary.

Table 5.6.1. (Continued).

Tusk 5.b2

Year	Faroe	Norway	E & W	Scotland [1]	France	Total
1988	545	1061	-	+		1606
1989	163	1237	-	+		1400
1990	128	851	-	+		979
1991	375	721	-	+		1096
1992	541	450	-	1		992
1993	292	285	-	+		577
1994	445	462	+	2		909
1995	225	404	-2	2		631
1996	46	536				582
1997	157	420				577
1998	107	530				637
1999	132	315				447
2000		333				333
2001		469				469
2002		281				281
2003		559				559
2004		107				107
2005		360				360
2006		317				317

Year	Faroe	Norway	E & W	Scotland [1]	France	Total
2007		344				344
2008		61				61
2009		164				164
2010		127				127
2011		0				0
2012		0				0
2013					12	12
2014		123			6	129
2015		323			1	324
2016		42				42
2017		135				135
2018		21				21
2019	71	611			2	684
2020*	161	30				191

[1]Includes 5.b1.

[2]See 5.b1.

[3]Included in 5.b1.

***Preliminary.**

Table 5.6.1. (Continued).

Tusk 6a

Year	Denmark	Faroes	France [(1)]	Germany	Ireland	Norway	E & W	N.I.	Scot.	Spain	Netherlands	Total
1988	-	-	766	1	-	1310	30	-	13			2120
1989	+	6	694	3	2	1583	3	-	6			2297
1990	-	9	723	+	-	1506	7	+	11			2256
1991	-	5	514	+	-	998	9	+	17			1543
1992	-	-	532	+	-	1124	5	-	21			1682
1993	-	-	400	4	3	783	2	+	31			1223
1994	+		345	6	1	865	5	-	40			1262
1995		0	332	+	33	990	1		79			1435
1996		0	368	1	5	890	1		126			1391
1997		0	359	+	3	750	1		137	11		1261
1998			395	+		715	-		163	8		1281
1999			193	+	3	113	1		182	47		539
2000			267	+	20	1327	8		231	158		2011
2001			211	+	31	1201	8		279	37		1767
2002			137		8	636	5		274	64		1124
2003			112		4	905	3		104	0		1128

Year	Denmark	Faroes	France (1)	Germany	Ireland	Norway	E & W	N.I.	Scot.	Spain	Netherlands	Total
2004		1	140		22	470			93	0		726
2005		10	204		7	702			96	0		1019
2006		5	239		10	674	16		115	0		1059
2007		39	261		3	703	9		70	0		1085
2008		30	307		1	964	0		44	0		1346
2009		33	217		4	898	0		88	2		1242
2010		41	183		5	939			48			1216
2011		87	173		1	1060			25			1337
2012		106	166		1	860			41			1174
2013		46	191		1	1204			66	86		1594
2014		0	193			393			60	16		662
2015			200			866	1		63	62	1	1193
2016		41	178		1	499			42	82	1	844
2017		5	136			274			59	37		511
2018			144		0	658			81	57		940
2019			130		7	669			71	50		927
2020*		6	110		17	114			54	58		359

Not allocated by divisions before 1993.

*** Preliminary.**

Tusk 7.a

Year	France	E & W	Scotland	Total
1988	n.a.	-	+	+
1989	2	-	+	2
1990	4	+	+	4
1991	1	-	1	2
1992	1	+	2	3
1993	-	+	+	+
1994	-	-	+	+
1995	-	-	1	1
1996	-	-		
1997	-	-	1	1
1998	-	-	1	1
1999	-	-	+	+
2000		-	+	+
2001		-	1	1
2002	n/a	-	-	-
2003		-	-	-
2004				
2005				
2006				
2007				
2008				
2009				
2010				
2011				
2012				
2013				
2014				
2015				

Year	France	E & W	Scotland	Total
2016				
2017				0
2018				
2019				
2020*				

*Preliminary.

Tusk 7.b,c

Year	France	Ireland	Norway	E & W	N.I.	Scotland	Total
1988	n.a.	-	12	5	-	+	17
1989	17	-	91	-	-	-	108
1990	11	3	138	1	-	2	155
1991	11	7	30	2	1	1	52
1992	6	8	167	33	1	3	218
1993	6	15	70	17	+	12	120
1994	5	9	63	9	-	8	94
1995	3	20	18	6		1	48
1996	4	11	38	4		1	58
1997	4	8	61	1		1	75
1998	3		28	-		2	33
1999	-	16	130	-		1	147
2000	3	58	88	12		3	164
2001	4	54	177	4		25	263
2002	1	31	30	1		3	66
2003	1	19		1			21
2004	2	19					21
2005	4	18				1	23
2006	4	23	63			0	90
2007	2	4	7				13
2008	2	2	0				4

Year	France	Ireland	Norway	E & W	N.I.	Scotland	Total
2009	0	4	0				4
2010		5					5
2011		1					1
2012			63				63
2013	3	1					4
2014		1					1
2015							0
2016							0
2017						1	1
2018						3	3
2019	2	1					3
2020*	1						4

*Preliminary.

Table 5.6.1. (Continued).

Tusk 7.g–k

Year	France	Germany	Ireland	Norway	E & W	Scotland	Spain	Total
1988	n.a.		-	-	5	-		5
1989	3		-	82	1	-		86
1990	6		-	27	0	+		33
1991	4		-	-	8	2		14
1992	9		-	-	38	-		47
1993	5		17	-	7	3		32
1994	4		12	-	12	3		31
1995	3		8	-	18	8		37
1996	3		20	-	3	3		29
1997	4	4	11	-		+	0	19
1998	2	3	4	-		1	0	10
1999	2	1	-	-		+	6	8
2000	2		5	-	-	+	6	13

Year	France	Germany	Ireland	Norway	E & W	Scotland	Spain	Total
2001	3		-	9	-	+	2	14
2002	1				1		3	5
2003	1		1				1	3
2004	1						0	1
2005	1						1	2
2006	1		1				1	3
2007	1						1	1
2008	0						0	0
2009	0		0		0	0	0	0
2010	0							0
2011	0							0
2012	0					2		2
2013	0							0
2014								0
2015								0
2016								0
2017								0
2018								0
2019								0
2020*	1							1

***Preliminary.**

Tusk 8.a

Year	E & W	France	Spain	Total
1988	1	n.a.		1
1989	-	-		-
1990	-	-		-
1991	-	-		-
1992	-	-		-
1993	-	-		-
1994	-	-		-
1995	-	-		-
1996	-	-		-
1997	+	+		+
1998	-	1		1
1999	-	-		0
2000	-			-
2001	-			-
2002	-	+		+
2003	-	-		-
2004		1		
2005				
2006				
2007				
2008				
2009				
2010		4		4
2011		0		0
2012				0
2013				0
2014				0
2015				0
2016				0

Year	E & W	France	Spain	Total
2017				0
2018				0
2019*			1	01

*Preliminary.

Table 5.6.1. (Continued).

Tusk, total landings by subareas or division.

Year	3	4.a	4.b	5.b1	5.b2	6.a	7.a	7.b,c	7.g-k	8.a	All areas
1988	61	4429		4059	1606	2120		17	5	1	12 298
1989	93	6418	4	3722	1400	2297	2	108	86		14 130
1990	60	4254	5	5202	979	2256	4	155	33		12 948
1991	84	4537	2	5170	1096	1543	2	52	14		12 500
1992	85	4932	12	4399	992	1682	3	218	47		12 370
1993	79	5141	14	2862	577	1223		120	32		10 048
1994	51	3375	7	3407	909	1262		94	31		9136
1995	42	3348	15	3347	631	1435	1	48	37		8904
1996	44	3369	33	2728	582	1391		58	29		8234
1997	31	2272	38	2742	577	1261	1	75	19		7016
1998	21	3387	66	2073	637	1281	1	33	10	1	7510
1999	29	2435	34	3517	447	539		147	8	0	7156
2000	36	3260	116	2367	333	2011		164	13		8300
2001	57	3095	56	3526	469	1767	1	263	14		9248
2002	50	2961	71	2722	281	1124		66	5		7280
2003	51	1997	8	2733	559	1128		21	3		6500
2004	45	1666	23	3536	107	726		21	1		6125
2005	44	1826	7	3272	360	1019		23	2		6553
2006	29	2159	32	3560	317	1059		90	3		7249
2007	21	2180	15	3468	344	1077		13	1		7119
2008	46	2139	71	3798	61	1347		4	0		7466
2009	19	2268	17	3135	164	1242		4	0		6849

Year	3	4.a	4.b	5.b1	5.b2	6.a	7.a	7.b,c	7.g-k	8.a	All areas
2010	21	1861	15	4889	127	1216		3	0	4	8136
2011	17	1623	96	3287	0	1337		5	0	0	6361
2012	20	1749	47	3793	0	1174		63	2		6848
2013	22	1510	31	1500	12	1594		4	0		4673
2014	9	1463	11	2310	129	662		1			4585
2015	9	1530	18	2081	324	1193		0			5155
2016	14	1650	9	2261	42	844		0			4820
2017	10	1206	18	2035	135	511		1			3916
2018	8	1439	17	1983	21	940		3			4411
2019	8	1247	33	1960	684	927		3			4862
2020*	13	1024	9	2462	191	359		5	1	1	4065

***Preliminary.**