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.

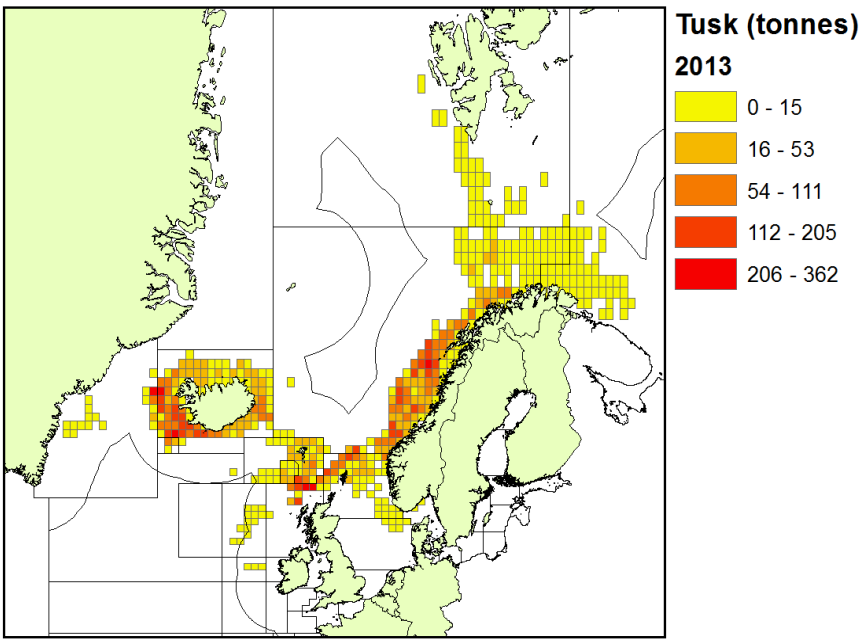


Figure 5.1. Reported landings of tusk in the ICES area by statistical rectangle in 2013. Data are from Norway, Faroes, Iceland, France, UK (England and Wales) and Spain. Landings shown in account for 99% of all reported landings in the ICES area.

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

5.2.1 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 95% of catches in tonnes, is caught by longlines, and this proportion has been relatively stable since 1992 (Table 5.2.2).

Table 5.2.1. Tusk in 5.a. Number of Icelandic boats with tusk landings in 5.a and total landings in 5.a

	Number of Boats			Catch (Tonnes)				
Year	Bottom trawl	Gill nets	Longlines	Bottom trawl	Gill nets	Longlines	Other	Total catch
2000	120	175	368	100	44	4554	29	5114
2001	108	224	348	87	63	3223	24	4838
2002	103	174	303	88	93	3712	17	5563
2003	97	148	304	65	41	3906	11	5598
2004	90	129	303	92	28	3007	8	4830
2005	87	101	324	115	19	3398	7	5044
2006	85	82	337	100	40	4907	7	6601
2007	74	65	308	104	38	5834	11	7537
2008	75	59	254	126	42	6758	7	8629
2009	75	65	239	115	72	6757	9	8469
2010	70	62	228	97	52	6761	9	8713
2011	63	54	221	72	24	5742	9	7701
2012	65	68	228	64	13	6255	13	7872
2013	66	43	230	76	15	4875	12	6302
2014	62	43	235	87	18	4878	12	6163
2015	55	32	214	71	7	3910	13	4835
2016	59	32	193	61	6	2575	7	3494
2017	52	31	166	48	5	1774	5	2540
2018	55	27	144	83	8	2002	4	2940
2019	49	23	142	103	7	2460	9	3445
2020	55	23	116	108	31	2209	9	3187

	Number of Boats				Catch (Tonnes)			
2021	51	18	111	112	12	1920	5	2779
2022	51	26	97	111	17	1801	4	2577

Most of the tusk caught in 5.a by Icelandic longliners is caught at depths less than 300 meters (Figure 5.2.1). The main fishing grounds for tusk in 5.a as observed from logbooks are on the western and, southwestern part of the Icelandic shelf (Figure 5.2.2 and Figure 5.2.3). The proportional catch in the northwest has increased over the years. Around 50–60% of tusk is caught on the southern and western parts of the shelf (Figure 5.2.3). 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.

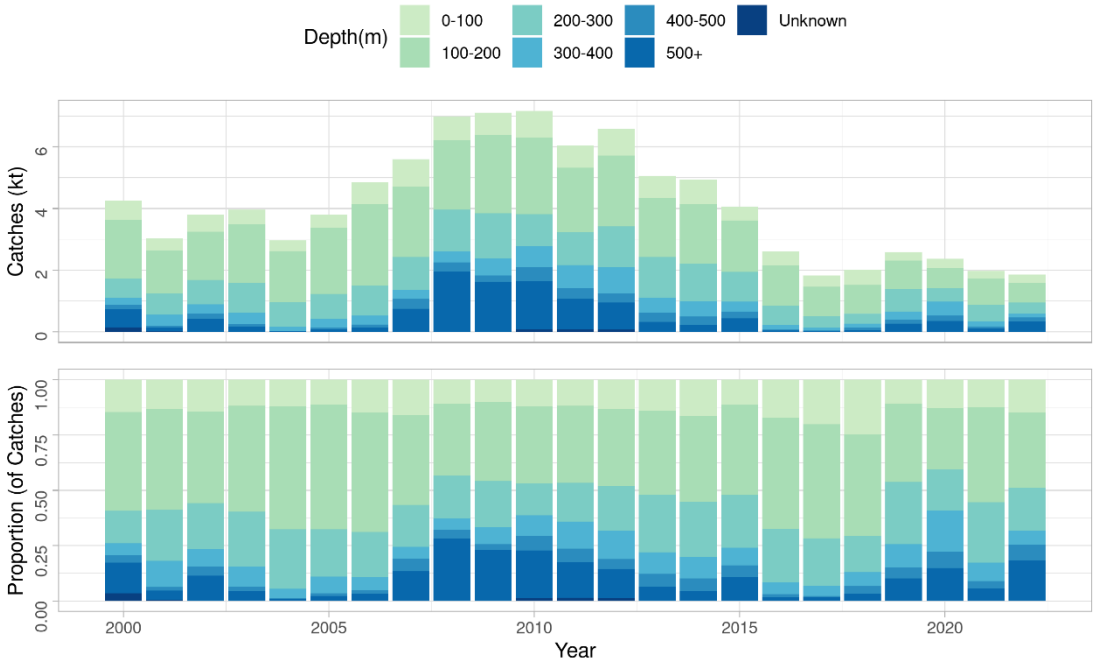


Figure 5.2.1: Tusk in 5.a and 14. Depth distribution of catches in 5.a according to logbooks. All gears combined.

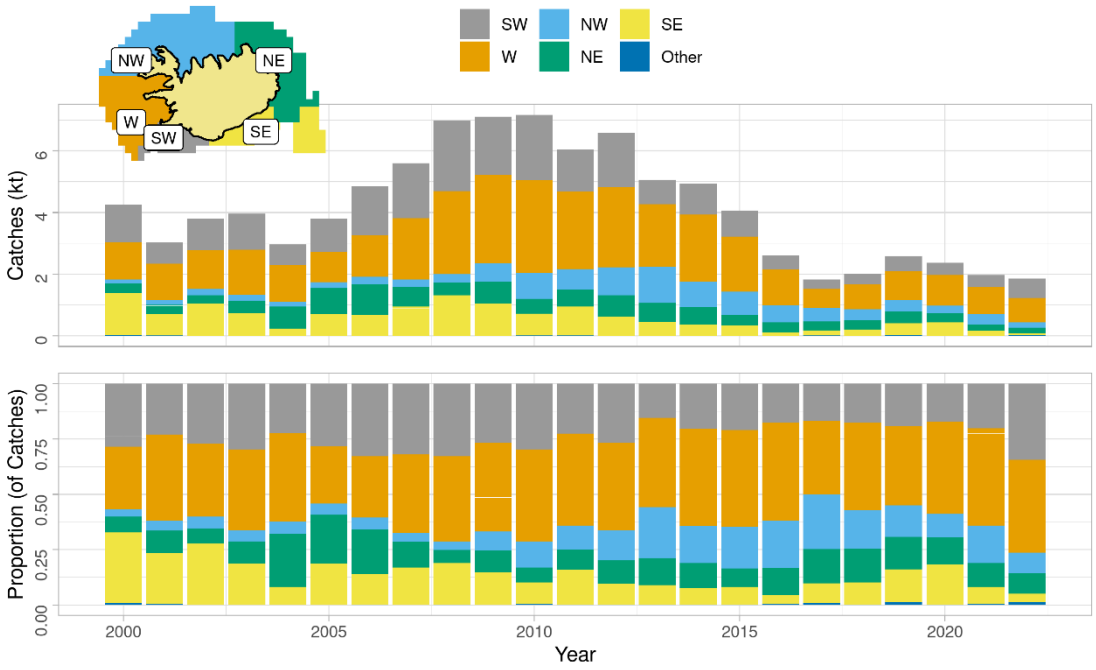


Figure 5.2.2: Tusk in 5.a and 14. Catch distribution and proportions by area according to logbooks. All gears combined.

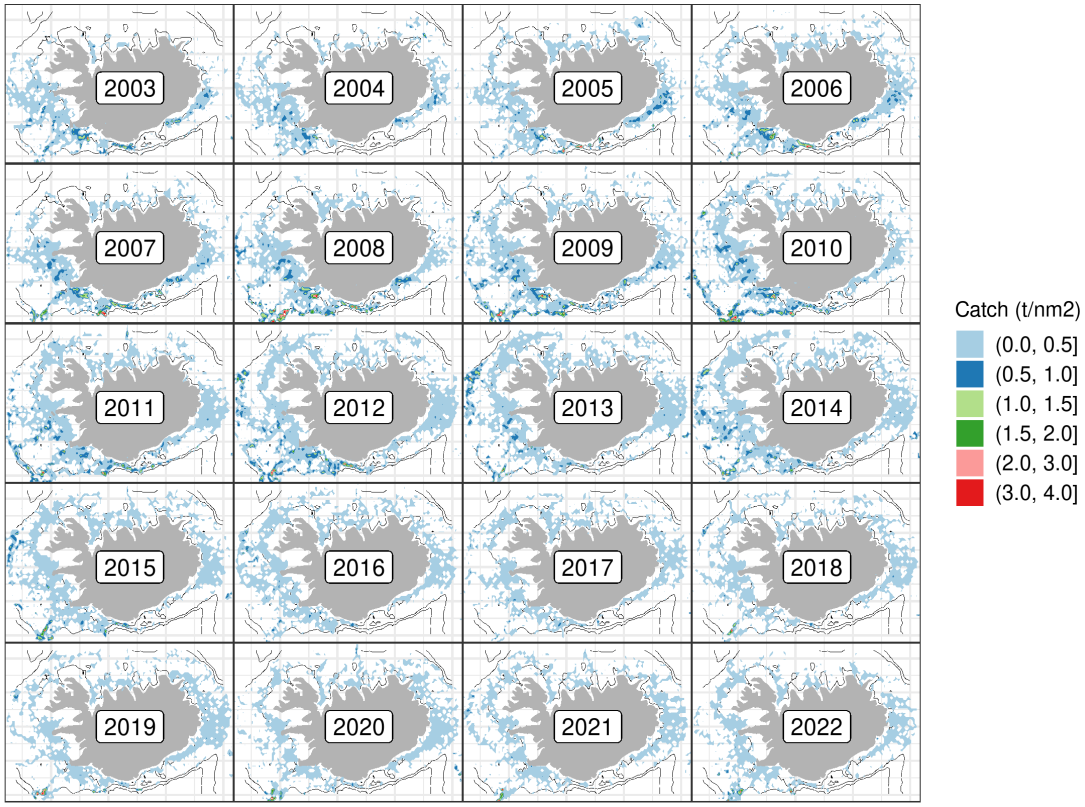


Figure 5.2.3: Tusk in 5.a and 14. Geographical distribution (tonnes) of the Icelandic longline fishery since 2003, as reported in logbooks by the Icelandic fleet.

5.2.2 Landing trends

The total annual landings from ICES Division 5.a were around 2577 tonnes in 2022 (Table 5.2.1), 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 5.2.4).

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 5.2.2).

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 this report) also reflect this trend. Around 566 tonnes in 2019 were caught in the 14.b mainly by Faroese and Greenlandic vessels (Table 5.2.3). This has however increased in 2022 to about 680 tonnes. As the Icelandic TACs were relatively low during this period, this constituted over 20% of the annual catch.

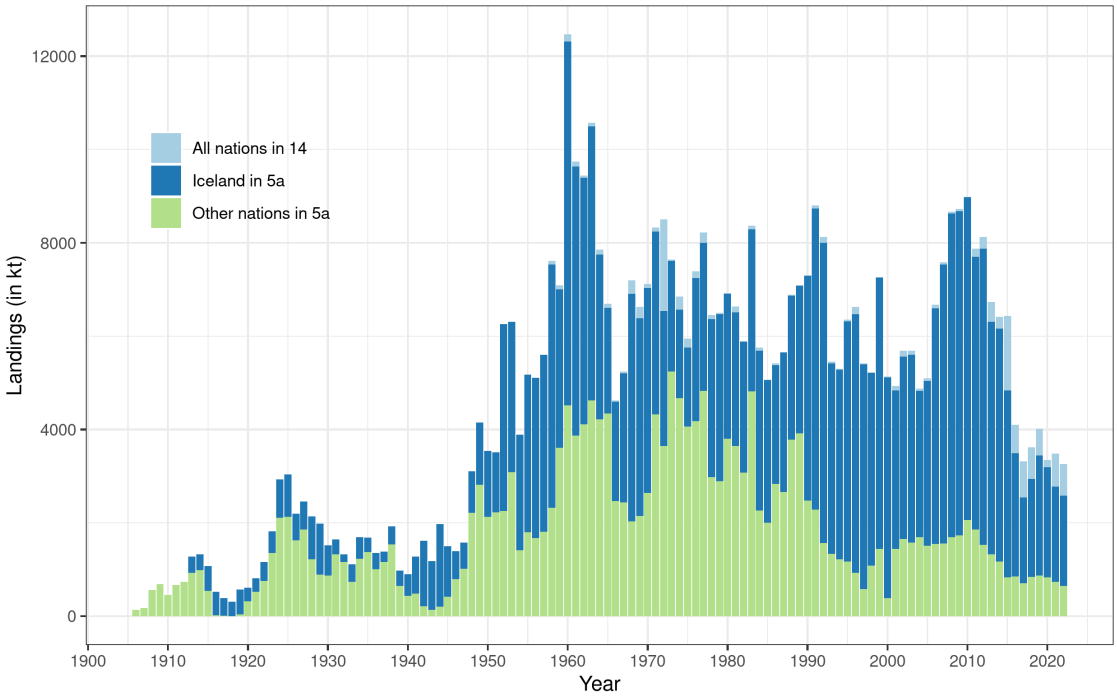


Figure 5.2.4: Tusk in 5.a and 14.Nominal landings within Icelandic waters by Icelandic vessels (light blue) or foreign vessels (dark blue), or within Greenlandic waters (orange). (source for 14: STATLANT).

Table 5.2.2. 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	2987	19	0	5644
1988	3757	0	0	3087	20	0	6864
1989	3908	0	0	3158	10	0	7076
1990	2475	0	0	4821	0	0	7296
1991	2286	0	0	6449	0	0	8735
1992	1567	0	0	6432	0	0	7999
1993	1333	0	0	4086	0	0	5419

YEAR	FAROE	DENMARK	GERMANY	ICELAND	NORWAY	UK	TOTAL
1994	1217	0	0	4065	0	0	5282
1995	1168	0	1	5151	0	0	6320
1996	916	0	1	5540	3	0	6471
1997	579	0	0	4816	0	0	5395
1998	1080	0	1	4130	0	0	5211
1999	1041	0	2	5821	391	2	7257
2000	10	0	0	4727	374	2	5114
2001	1150	0	1	3397	285	5	4838
2002	1279	0	0	3910	372	2	5563
2003	1198	0	1	4024	373	2	5598
2004	1478	0	1	3135	214	2	4830
2005	1157	0	3	3539	303	41	5044
2006	1244	0	2	5054	299	2	6601
2007	1250	0	0	5987	300	1	7538
2008	1398	0	0	6934	298	0	8629
2009	1516	0	0	6953	210	0	8679
2010	1794	0	0	6919	263	0	8976
2011	1655	0	0	5847	198	0	7701
2012	1310	0	0	6344	217	0	7872
2013	1132	0.12	0	4979	192	0	6302
2014	742	0	0	4995	425	0	6163
2015	637	0	0	4001	198	0	4836
2016	543	0	0	2649	302	0	3494
2017	492	0	0	1833	216	0	2541
2018	517	0	0	2097	326	0	2940
2019	549	0	0	2579	316	0	3445
2020	558	0	0	2358	271	0	3187
2021	342	0	0	2049	388	0	2779
2022	288	0	0	1932	357	0	2577

Table 5.2.3. Tusk in 5.a and 14. Nominal landings by nations in 14.

YEAR	FAROE	DEN-MARK	GREEN-LAND	GER-MANY	ICELAND	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	17	0	0	0	17
1995	0	0	0	0	0	30	0	0	0	30
1996	0	0	0	0	0	158	0	0	0	158
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

YEAR	FAROE	DEN-MARK	GREEN-LAND	GER-MANY	ICELAND	NOR-WAY	RUSSIA	SPAIN	UK	TOTAL
2007	0	0	0	0	0	40	6	0	0	46
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	2	0.3	0	0	0	24	0	0	0	427
2014	145	0	0	0	0	35	0	0	0	254
2015	759	0.1	785	0	0	55	0	0	0	1599
2016	243	0	182	0	0	178	0	0	0	606
2017	281	0.38	335	0	0	141	0	0	0	781
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	41	2	0	114	0	0	0	157
2021	260	0	59	2	0	380	0	0	0	701
2022	35	1	87	0	0	558	0	0	0	680

5.2.2.1 Management

The Icelandic Ministry of Food, Agriculture and Fisheries 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 TACs were not filled, until the past two years when the TAC has been exceptionally low (Table 5.2.4).

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 5.2.5 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 out of five fishing years, 2017/2018-2019/2020, net transfers have been negative again with tusk quota being converted to other species, while 2020/2021 and 2021/2022 shows an overshoot of the quota.

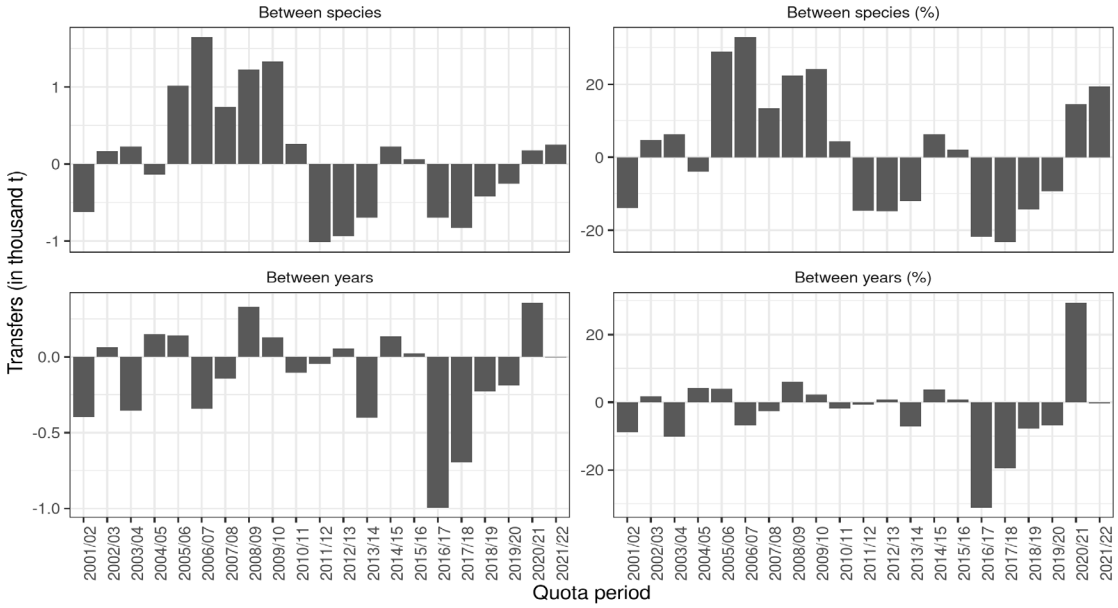


Figure 5.2.5: Tusk in 5.a and 14. Net transfer of quota in the Icelandic ITQ system by fishing year. Between species (upper): Positive values indicate a transfer of other species to tusk, but negative values indicate a transfer of tusk quota to other species. Between years (lower): Net transfer of quota for a given fishing year (may include unused quota).

Table 5.2.4. 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

Fishing Year	MFRI Advice	National TAC	Landings
2009/10	5 000	5 500	8 382
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	3 232
2019/20	3 856	3 856	3 241
2020/21	2 289	2 289	2 949
2021/22	2 172	2 172	2 425
2022/23	4 464		

5.2.3 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 2021 is shown in Figure 5.2.6.

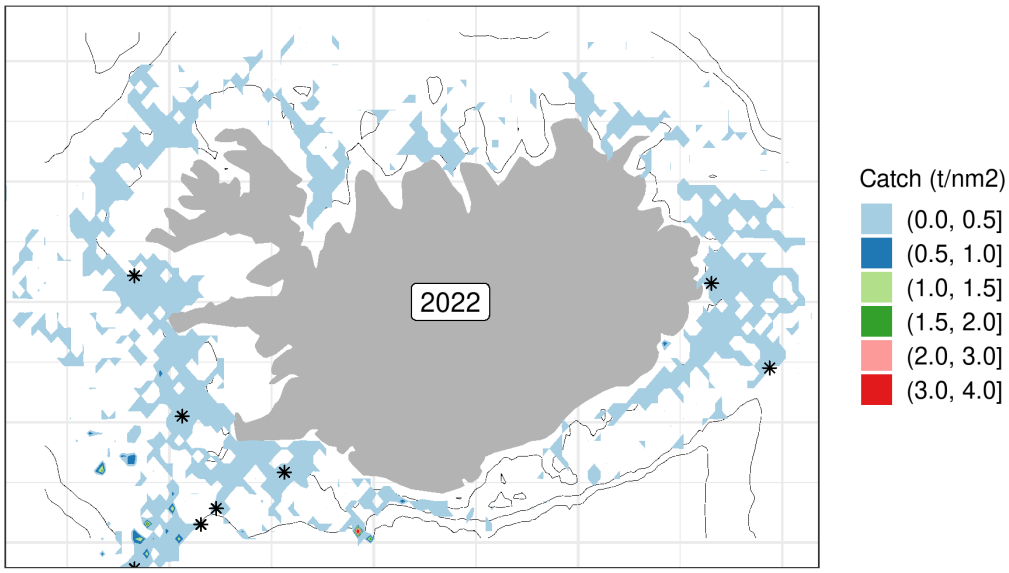


Figure 5.2.6: Tusk in 5.a and 14. Fishing grounds in 2022 as reported by catch in logbooks (tiles) and positions of samples taken from landings (asterisks) by longliners.

5.2.3.1 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.

5.2.3.2 Length compositions

An overview of available length measurements from 5.a is given in Table 5.2.6. 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 5.2.7 and 5.2.8 respectively.

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

Table 5.2.5. 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
2021	0	0	0	1499	26
2022	83	0	0	1023	120

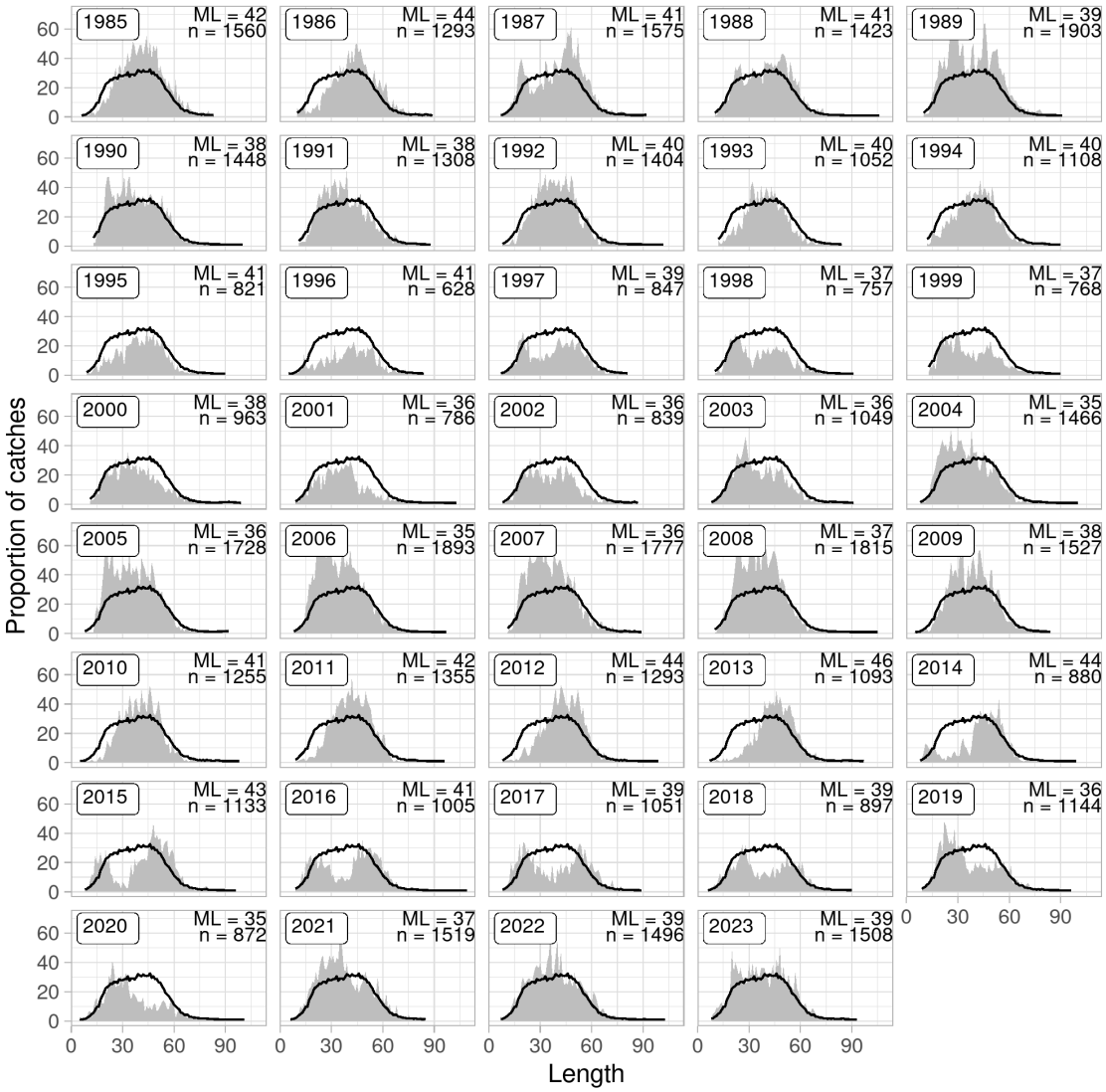


Figure 5.2.7: Tusk in 5.a and 14. Length distributions (4 cm grouping) from the spring survey since 1985. Mean length (ML) and sample sizes (N) are shown.

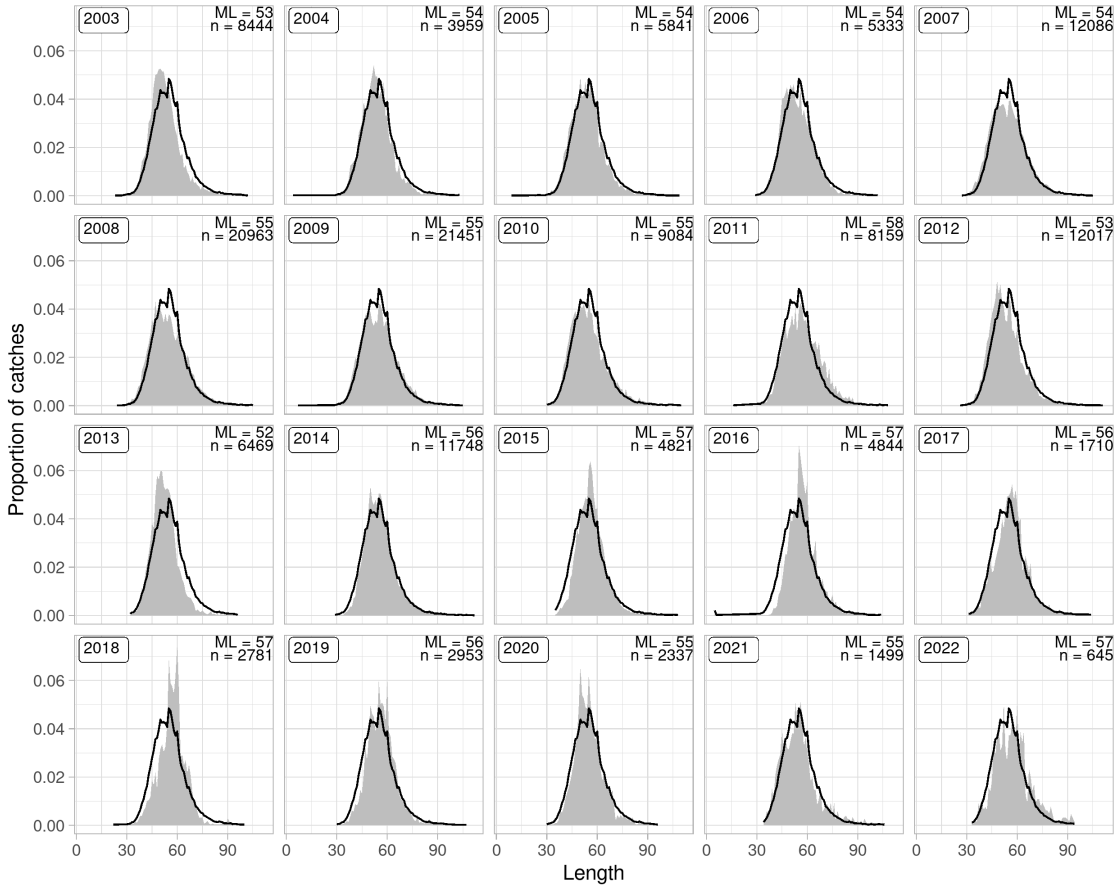


Figure 5.2.8: Tusk in 5.a and 14. Length distributions from Icelandic commercial longline catches.

5.2.3.3 Age compositions

Table 5.2.6 gives an overview of otolith sampling intensity by gear types from 2000 to 2022 in 5.a. Since 2010, considerable effort has been put into ageing tusk otoliths, so now aged otoliths are available from 1984, 1995, 2008–2022. The age data are used as input for the SAM assessment. It is expected that the effort in ageing of tusk will continue.

Table 5.2.6. 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	32	1600	282	475
2009	27	1350	277	434
2010	29	1449	241	363
2011	28	1400	270	728
2012	35	1750	285	750
2013	23	1150	275	536
2014	28	620	241	559
2015	26	555	260	573

Year	No. samples (catch)	No. otoliths (catch)	No.samples (survey)	No.aged (survey)
2016	14	290	259	676
2017	8	160	245	571
2018	9	180	247	549
2019	15	330	251	704
2020	14	290	250	647
2021	15	291	278	811
2022	14	287	313	897
2008	32	1600	282	475
2009	27	1350	277	434

5.2.3.4 Weight at age

Weight-at-age data from 5.a are limited to 2008–2022. No data are available from 14.

5.2.3.5 Maturity at age

In recent years, at 54 cm around 34% of tusk in 5.a is mature, at 62 cm 54% of tusk is mature and at 70 cm 50% of tusk is mature based on the spring survey data.

No data are available for 14.

5.2.3.6 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 0.15 for all age groups.

5.2.3.7 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 5.2.9 shows a 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 5.2.10.

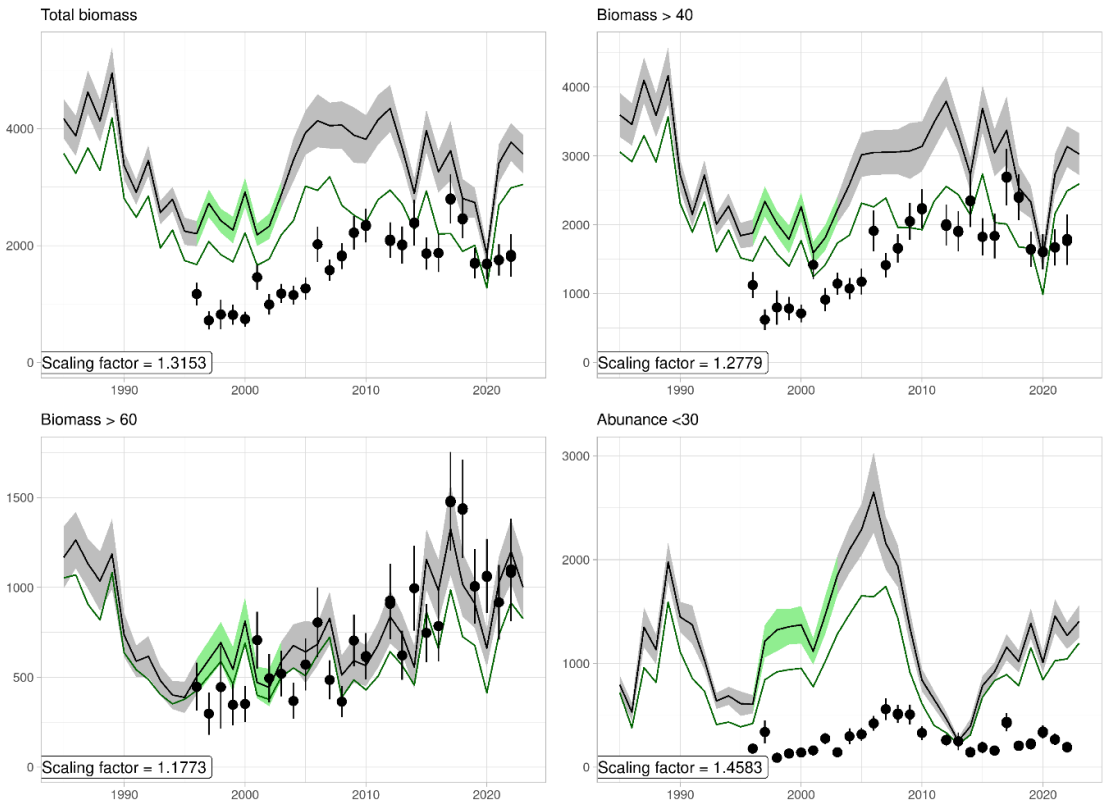


Figure 5.9: Tusk in 5.a and 14. Aa) Total biomass indices, b) biomass indices larger than and including 40 cm, c) biomass indices larger than and including 60 cm and d) abundance indices smaller than and including 30 cm. The lines with shaded areas show the spring survey index from 1985 and the points 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.

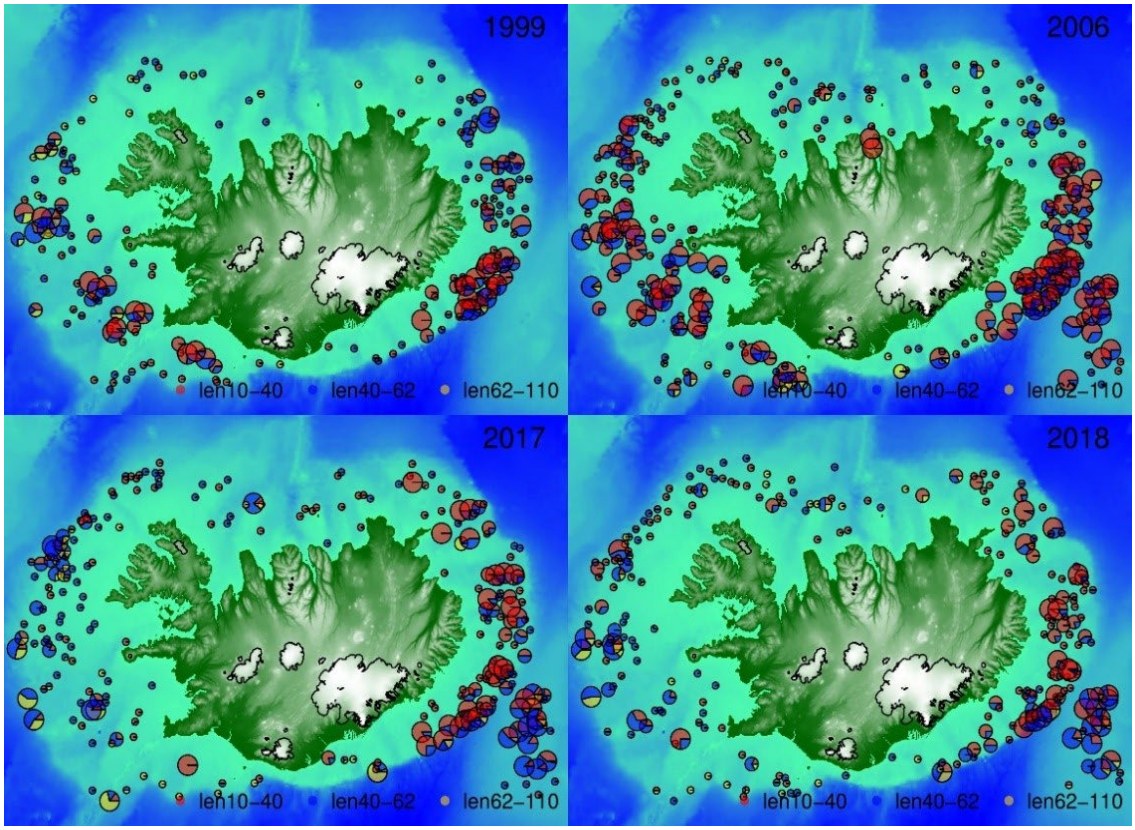


Figure 5.2.10: Tusk in 5.a and 14. Changes in spatial distribution divided by size. Size of pie is indicative of numbers of specimens caught at the tow-station.

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 5.2.11 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 5.2.12.

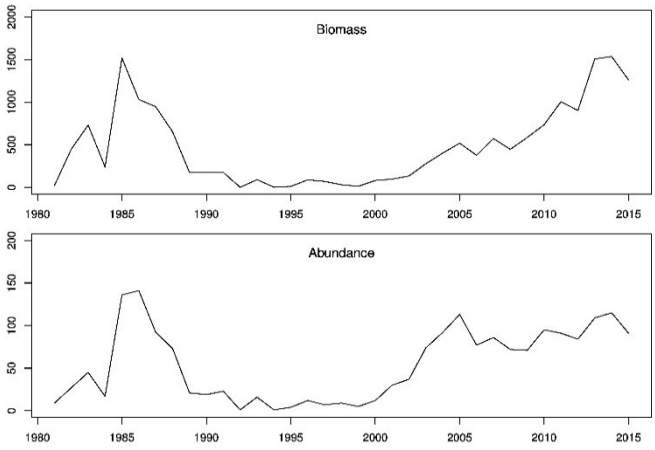


Figure 5.2.11: Biomass and abundance estimates from the Walter Herwig survey in 14. The data are just the total number caught and then converted to weight.

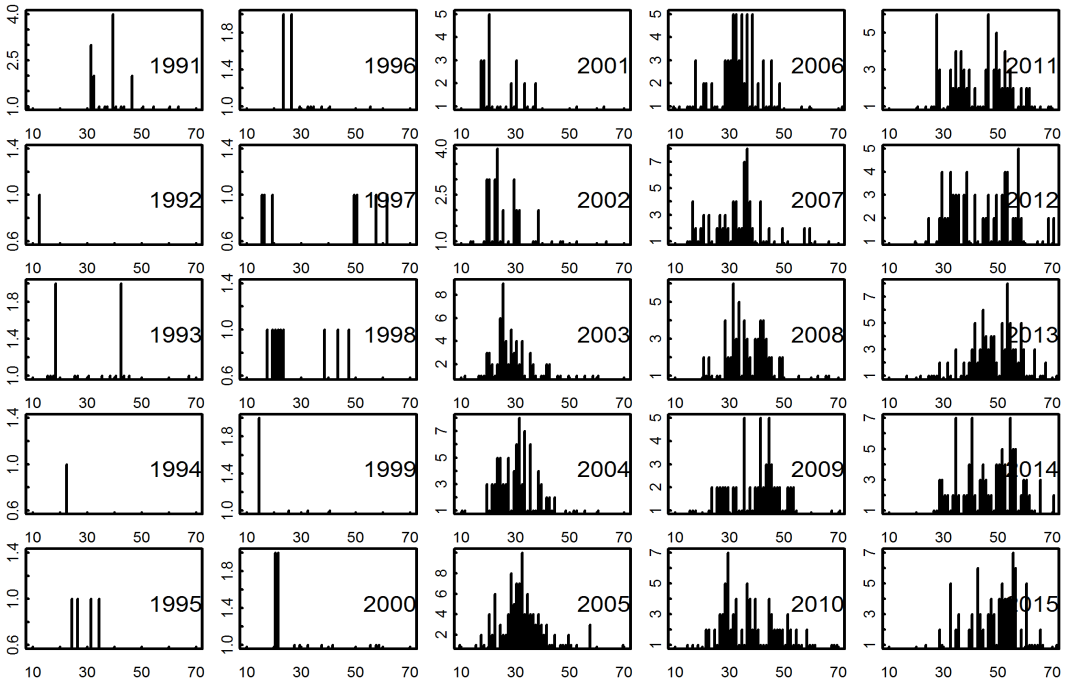


Figure 5.2.12: Length distributions from the Walter Herwig survey in 14.

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.

5.2.4 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 2577 tonnes in 2022. This decrease is mainly because of reductions in landings by the Icelandic longline fleet and to a lesser

extent Faroese and Norwegian landings (Table 5.2.2 and Table 5.2.3). This has resulted in less overshoot of landings relative to set TAC (Table 5.2.4) , except in the last two years when the stock has experienced an all-time low. As this all-time low is more likely due to the low recruitment during 2010–2011 rather than overexploitation, so is expected to increase as subsequent higher recruitment levels grow to fishable sizes.

There are no marked changes in the length compositions since 2004, mean length in the catches ranges between 52 and 58 (Figure 5.2.7 and Figure 5.2.8). Length distributions from the spring survey show a distinct large cohort, or series of consecutive cohorts, appearing in 2014, growing through time, and just beginning to reach fished sizes approximately this year 6. This recruitment peak appears to follow a recruitment low that can also be traced through the length distribution from 2014, and can still be observed this year as slightly lower-than-average frequencies of tusk in the 45 - 50 cm range. According to the available length distributions and information on maturity only around 29% of catches in abundance and 44% in biomass are mature. 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) decreased substantially but increased again and has remained at relatively high similar level as in 2011 (Figure 5.2.11). 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 25% of the index is from the SE area. However only around 4% of the catches are caught in this area (Figure 5.2.2 and Figure 5.2.3). The change in juvenile abundance between 2006 and recent years can be clearly seen in Figure 5.2.9 and Figure 5.2.10 where in 2006 juveniles (<40 cm) were all over the southern part of the shelf but can hardly be seen in recent years.

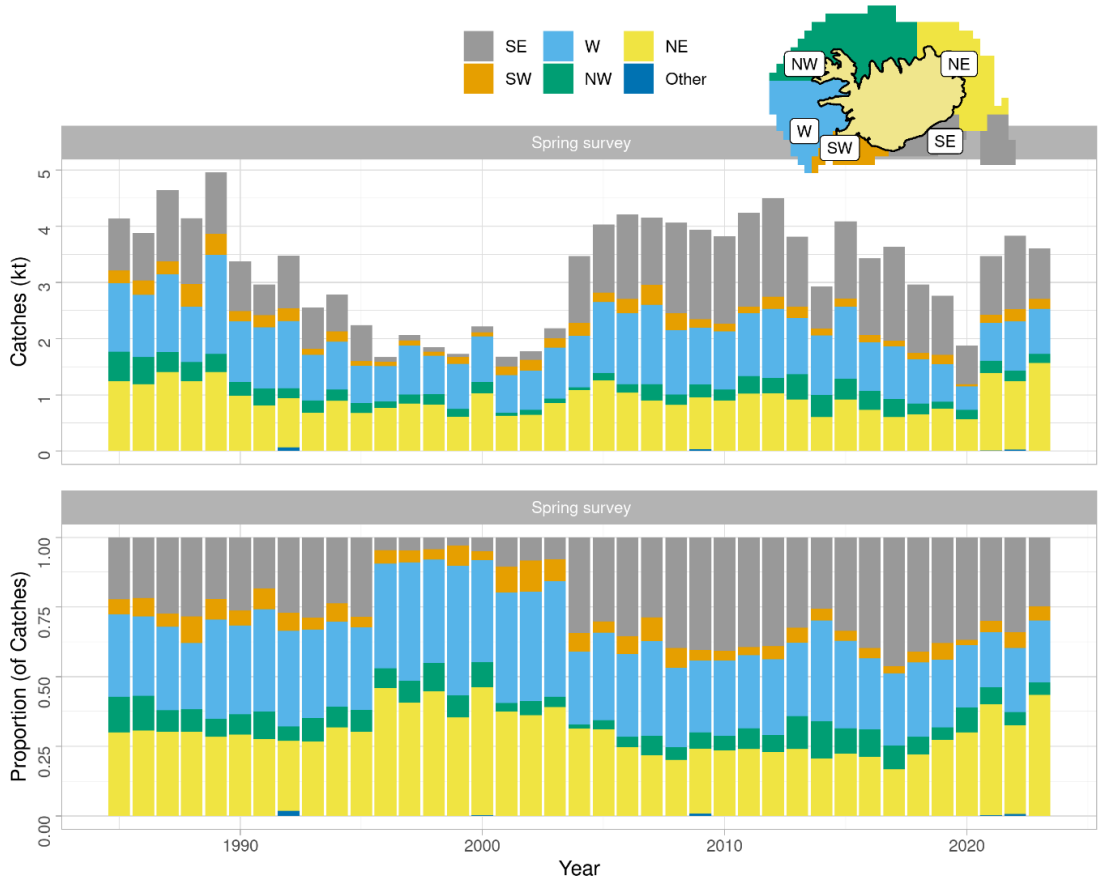


Figure 5.2.13: Tusk in 5.a and 14. Estimated survey biomass in the spring survey by year from different parts of the continental shelf (upper figure) and as proportions of the total (lower figure).

5.2.4.1 Analytical assessment using SAM

Since 2010 the Gadget model (Globally applicable Area Disaggregated General Ecosystem Toolbox, see www.hafro.is/gadget) had 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 (WKICEMSE 2017) and a Gadget model was used for category 1 assessment through 2021. In 2022, Tusk in 5.a and 14 was re-assessed as the previously benchmarked Gadget model had begun to show great instability in retrospective patterns in recent years. As a part of a Harvest Control Evaluation requested by Iceland, the stock was benchmarked (WKICEMSE 2022) which resulted in changes in the assessment method and updated reference points. Model setup and settings are described in the Stock Annex(X).

5.2.4.2 Data used by the assessment and model settings

Data used for tuning and the model configuration are given in the stock annex.

5.2.4.3 Model fit

The model fit to survey indices and catch at age data are shown in Figures 5.2.14 and 5.2.15. Generally, the model closely follows the catch-at-age and spring survey data, which are in good agreeance. The autumn survey is noise but generally follows the same pattern. Fits to the landings (total biomass removals) and April gillnet survey (age 10 abundance) are much noisier.

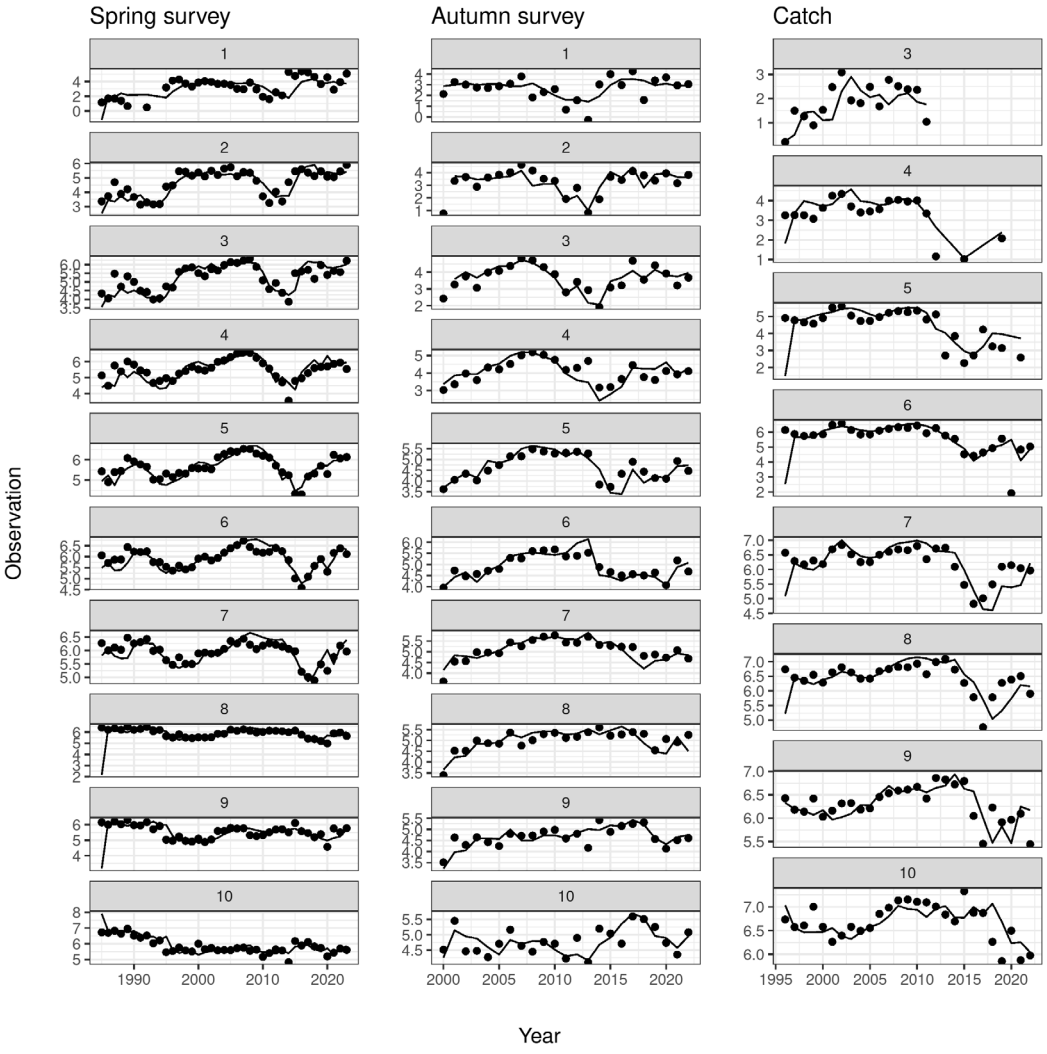


Figure 5.2.14: Tusk in 5.a and 14. Model fit to catches, spring survey and autumn survey indices.

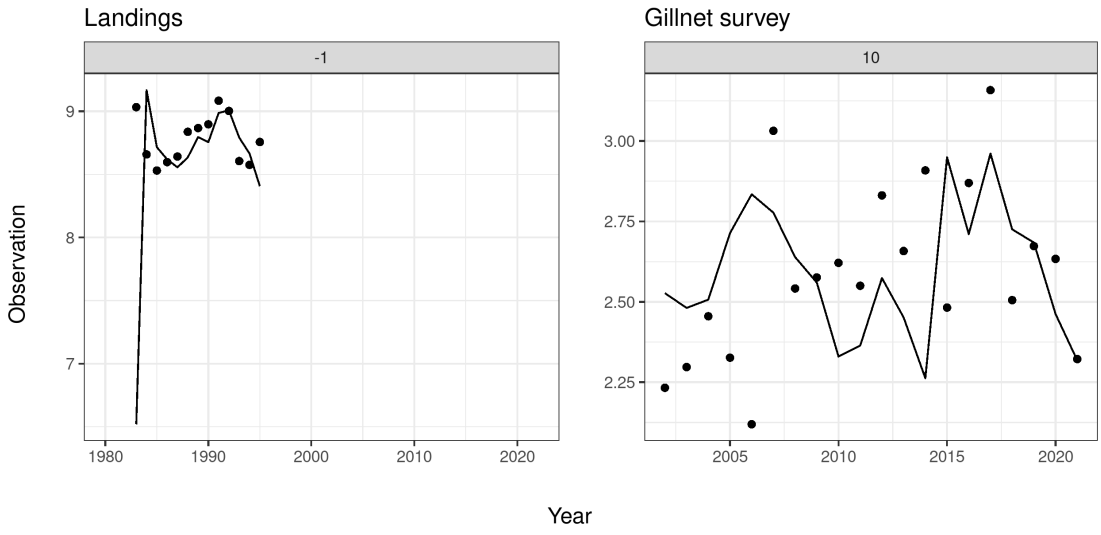


Figure 5.2.15: Tusk in 5.a and 14. Model fit to landings and gillnet indices.

5.2.4.4 Model results

Spawning stock biomass has shown a gradual decline prior to 1995, although prior to 1985 the model is informed by very little data so uncertainty is high. The period 1995 - 2015 was steady, with a gradual decline thereafter that continued until 2022, when biomass levels have started to increase again. This pattern is likely due to a distinctive low point in recruitment in 2011 - 2012, which has since then increased to relatively high levels. Therefore, given moderate fishing levels, spawning stock biomass is expected to increase over the next several years as the newest higher recruitment levels grow into the fishable population. The previous peak in recruitment (2004 - 2005) likely did not increase spawning stock biomass levels substantially during this period due to higher fishing rates and catch values during 2008 - 2010, when these fish would have been entering the fishery (Figure 5.2.16).

Figure 5.2.16: Tusk in 5.a and 14. Model results of population dynamics overview: estimated catch, average fishing mortality over ages 7 - 10 (Fbar), recruitment (age 1), and spawning stock biomass (SSB).

5.2.4.5 Retrospective analysis

The results of an analytical retrospective analysis are presented (Figure 5.2.17). The analysis indicates generally consistent model results over the 5-year peel. Mohn's rho was estimated to be 0.0327 for SSB, -0.00350 for F, and 0.177 for recruitment. 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 at age 1 (Figure 5.2.14), suggests that recent 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

5.2.7). Therefore, it is likely that the increase in biomass observed this year will continue in the next year or so.

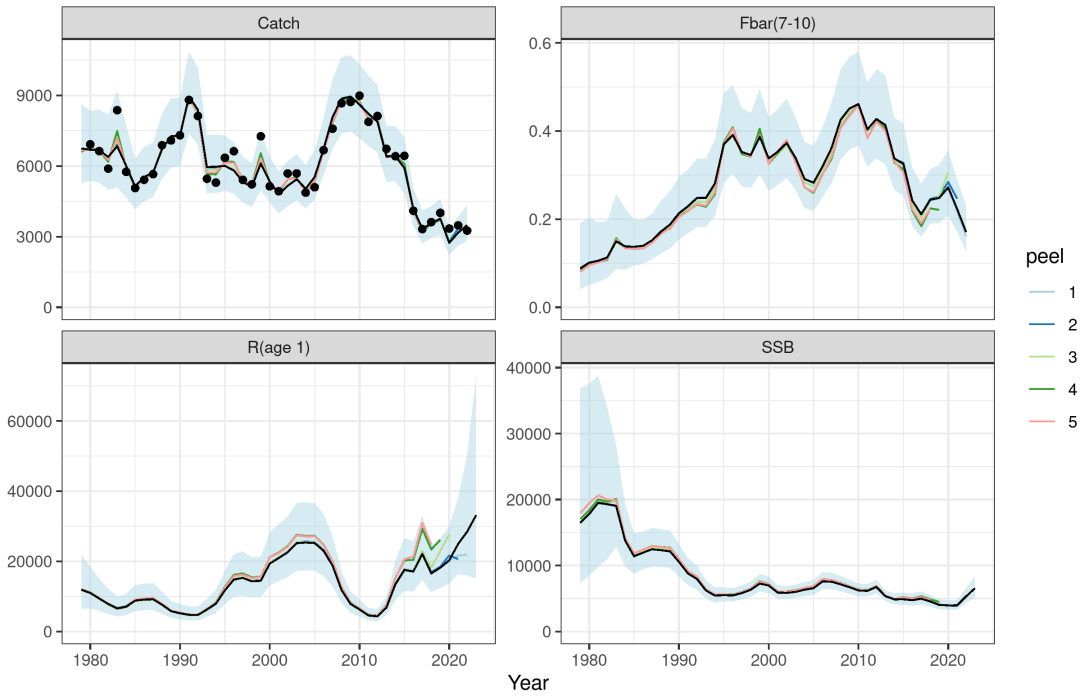


Figure 5.2.17: Tusk in 5.a and 14. Retrospective plots illustrating stability in model estimates over a 5-year 'peel' in data. Results of spawning stock biomass, fishing mortality F, and recruitment (age 3) are shown.

Observation nor process residuals show slight trends in autocorrelation and some blocks of time where the model was consistently over- or underestimating the model. (Figs. 5.2.18 and 5.2.19). However, they a better model configuration could not be found in the benchmark that would remove these patterns, and similar model configurations gave similar model results (WKICEMP 2022).

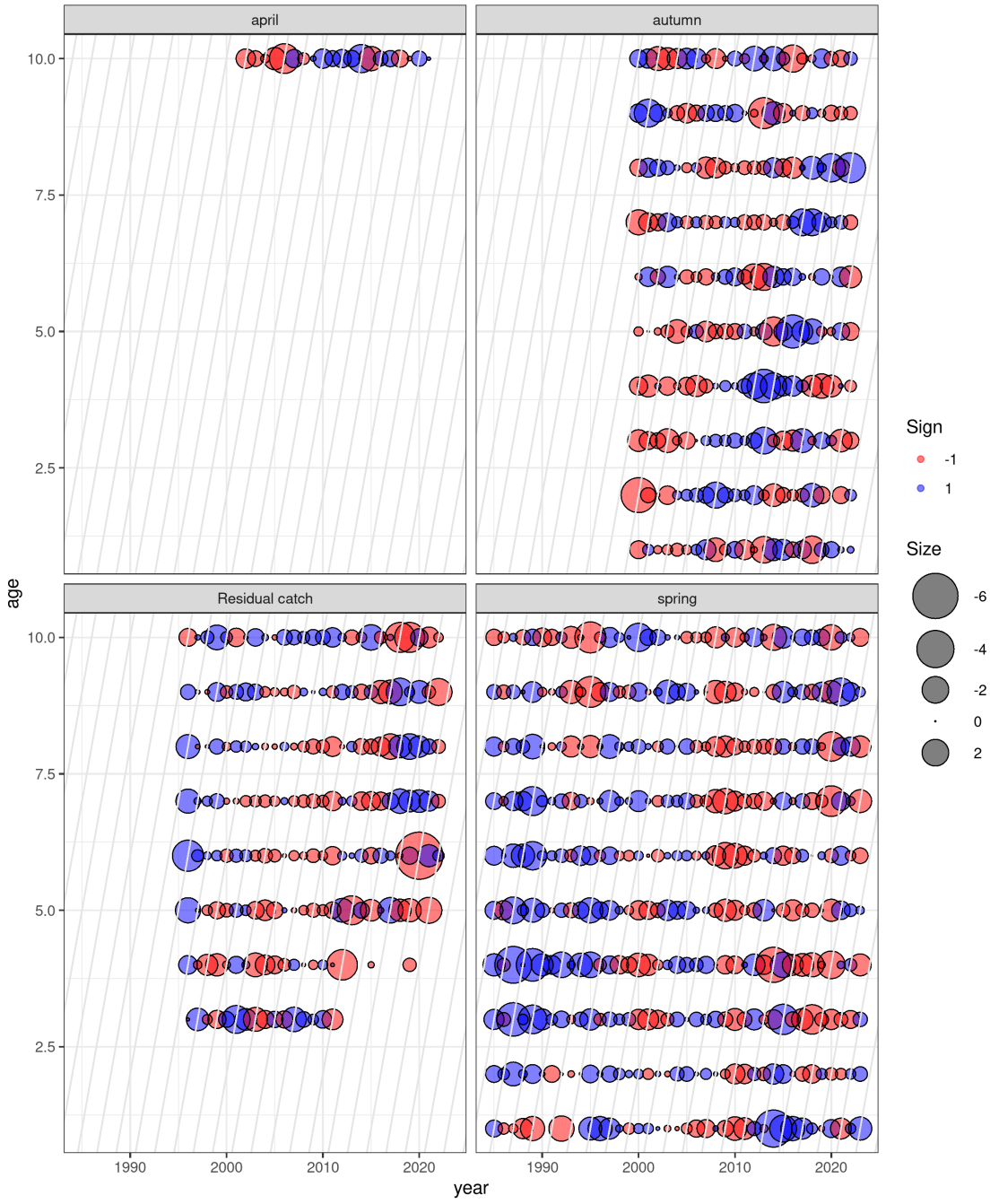


Figure 5.2.18: Tusk in 5.a and 14. Observation error residuals of the SAM model.

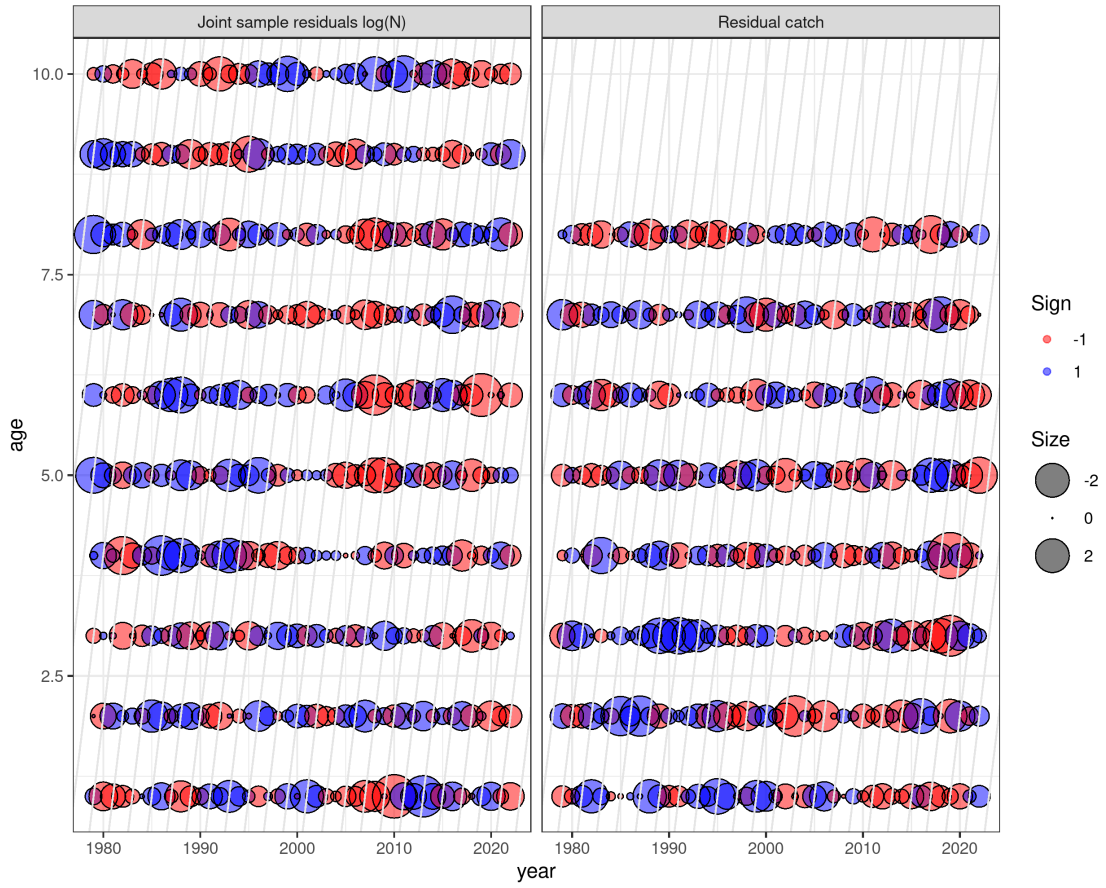


Figure 5.2.19: Tusk in 5.a and 14. Process error residuals of the SAM model.

5.2.4.6 Reference points

In the past, yield-per-recruit-based reference points, estimated as described in the stock annex, were used as proxies for Fmsy. Fmsy from a Y/R analysis is 0.24 and F0.1 is 0.15. WGDEEP 2014 recommended using Fmsy=0.2 as the target fishing mortality rather than F_{max}. This was subsequently used as the basis for the advice in 2014 by ICES. (See stock annex for details). As part of the WKICEMSE 2017 HCR evaluations (ICES (2017a)), the following reference points were defined for the stock. The management plan accepted at that time 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, but the model started to show instability in retrospective patterns and was then benchmarked in 2022.

As part of the WKICEMP 2022, HCR evaluations requested by Iceland the following reference points were defined for the stock.

Table 5.2.7: Tusk in 5.a and 14. Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis
MSY approach	MSY $B_{trigger}$	4800	B_{pa}
	F_{MSY}	0.23	Limited by F_{pa}, maximum F at which the probability of SSB falling below B_{lim} is <5%
Precautionary approach	B_{lim}	3400	$B_{pa} \times e^{-1.645 * \sigma B}$
	B_{pa}	4800	B_{loss} (SSB in 2016)
	F_{lim}	0.44	Fishing mortality that in stochastic equilibrium will result in median SSB at B_{lim}.
	F_{pa}	0.23	Maximum F at which the probability of SSB falling below B_{lim} is <5%
Management plan	MGT $B_{trigger}$	4800	According to the management plan
	F_{MGT}	0.23	According to the management plan

The management plan proposed by Iceland is:

The proposed HCR for the Icelandic Tusk fishery, which sets a TAC for the fishing year y/y+1 (September 1 of year y to August 31 of year y+1) based on a fishing mortality F_{mgt} of 0.23 applied to ages 7 to 10 modified by the ratio SSB_y/MGT $B_{trigger}$ when SSB_y < MGT $B_{trigger}$, maintains a high yield while being precautionary as it results in lower than 5% probability of SSB < B_{lim} in the medium and long term. WKICEMSE 2022 concluded that the HCR was precautionary and in conformity with the ICES MSY approach.

5.2.5 Management considerations

Increased catches in 14.b, and now 14a also, from less than 100 tonnes in previous years to 900 tonnes in 2015, about 566 tonnes in 2019 are of concern. In 2021, catches were also substantial, close to 700 tonnes, roughly 200 tonnes of which were recorded as originating in 14.a. 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 assessment. Recruitment in 5.a shown high levels after a low in 2011. 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.

5.2.5.1 Ecosystem considerations

Tusk has recently exhibited spatial changes in length distributions (Figure 5.2.12), 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, ling, plaice, wolffish, see WKICEMP). Tusk biomass levels have recently decreased, possibly as a result

of increased natural mortality and environmental factors. However, the causes for this, such as multi-species interactions, are unknown and not currently considered in the assessment.

Table 5.2.8. Tusk in 5.a and 14. Estimates of biomass, biomass spawning–stock biomass (SSB) in thousands of tonnes and recruitment at age 1 (millions) and fishing mortality from the SAM model.

YEAR	BIOMASS	SSB	REC3	CATCH	F
1979	39095	16469	11893	6717	0.089
1980	39900	17762	10963	6704	0.102
1981	40053	19407	9388	6670	0.106
1982	39003	19240	7823	6363	0.113
1983	39028	19097	6557	6944	0.152
1984	31889	13847	7040	6005	0.139
1985	28973	11460	8792	5131	0.137
1986	29514	12023	9085	5528	0.139
1987	29817	12539	9172	5719	0.151
1988	29870	12388	7624	6721	0.172
1989	30182	12225	5809	7257	0.187
1990	27324	10605	5193	7306	0.213
1991	24795	8842	4755	8951	0.229
1992	23714	8010	4715	8376	0.247
1993	19339	6261	6246	5919	0.246
1994	17608	5477	7936	5937	0.278
1995	19563	5529	11733	6044	0.372
1996	18589	5483	14819	5846	0.394
1997	19204	5838	15303	5331	0.352
1998	19560	6342	14313	5102	0.344
1999	20959	7299	14446	6151	0.389
2000	19908	7004	19351	5319	0.336
2001	19984	5922	20951	4816	0.352
2002	21045	5876	22600	5197	0.374
2003	22508	6019	25210	5442	0.338
2004	24362	6360	25382	5006	0.289

YEAR	BIOMASS	SSB	REC3	CATCH	F
2005	27626	6601	25197	5502	0.280
2006	30984	7637	22982	6713	0.318
2007	32903	7578	18744	8075	0.359
2008	36377	7181	11810	8876	0.425
2009	35064	6730	7853	8954	0.451
2010	31041	6237	6293	8647	0.462
2011	30000	6171	4567	8187	0.401
2012	30120	6774	4324	7899	0.427
2013	27942	5372	6802	6417	0.414
2014	27448	4883	13506	6406	0.336
2015	23053	4914	17636	5946	0.326
2016	23544	4770	17129	4173	0.240
2017	23044	5017	22144	3328	0.208
2018	21296	4584	16572	3570	0.244
2019	21020	4059	18169	3762	0.248
2020	20637	3979	20280	2740	0.272
2021	22957	3983	24981	3097	0.216
2022	29454	5312	28463	2897	0.142
2023	36901	6665	33123	2990	0.144

Table 3.4.8. Tusk in 5.a and 14. Assumptions made for the interim year and in the forecast.

Variable	Value	Notes
Fages 7–10(2023)	0.22	Assuming status quo F (average over the last three years) for the 2023 part of fishing year 2022/2023 and Fmgt for the remainder of 2023
SSB (2024)	6959	Short-term forecast; in tonnes
Rage 1 (2023)	33172	From the assessment; in thousands
Rage 1 (2024)	25020	Resampled from the years 2014–2023; in thousands
Catch (2023)	4487	Results from Fages 7–10 (2023); in tonnes

5.2.6 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.

2012. "Report of the Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources (WGDEEP), 28 March–5 April, 2012, Copenhagen, Denmark. ICES Cm 2012/Acom:17." International Council for the Exploration of the Seas; ICES publishing.

2014. "Report of the Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources (WGDEEP). ICES Scientific Reports. 1:21., Copenhagen, Denmark. ICES Cm 2014/Acom:17." International Council for the Exploration of the Seas; ICES publishing. https://doi.org/10.17895/ices.pub.5262.

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 2021 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 2021, 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

Year	Faroes	France	Iceland	Norway	Scotland	Russia	Total
2005	2	1					3
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
2021							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

2021*	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

Year	12	14.b1	All areas
2015	0	2	2
2016	0		0
2017			0
2018			0
2019			0
2020			0
2021*			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 trawl, gillnet, or longline fisheries in Subarea 6.b. Norway has traditionally landed the largest catch of tusk in area 6.b. During the period 1988–2020 Norwegian vessels have reported 70-80% of the total landings. 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 Subarea 6.b per year was a maximun of 464 fishing days in 2002 to 60 days in 2020. In 2021 and 2022, , there was no fishing by Norwegian vessels in Subarea 6.b. (Figure 5.4.1).

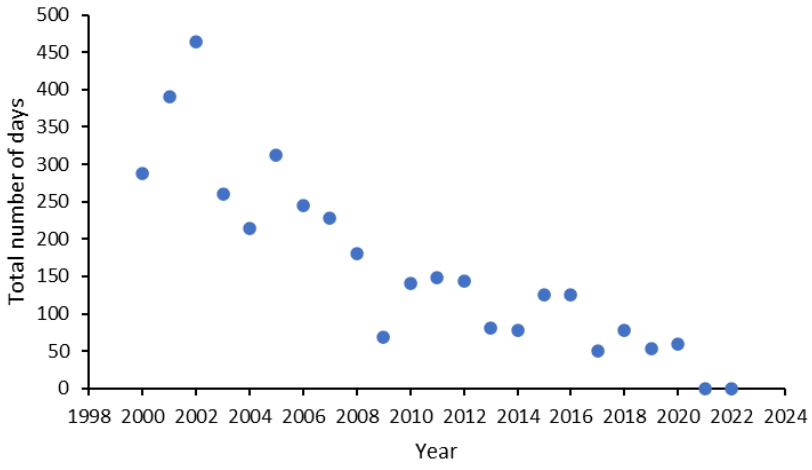


Figure 5.4.1. Estimated total number of days the Norwegian longline fleet fished for tusk (bycatch) during the period 2000 to 2022 based on logbooks.

5.4.2 Landings trends

Landing statistics by nation for the period 1988–2022 are in Table 5.4.1.

Landings varied considerably between 1988 and 2000. Landings peaked at 2344 t in 2000, and since 2000 have been much lower, and declining. 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 2022the landings decreased to 36tons (Figure 5.4.2).

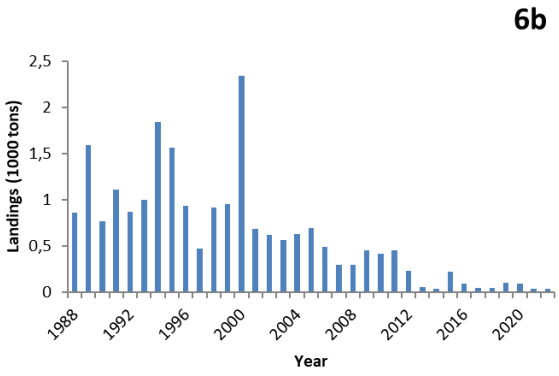


Figure 5.4.2. The international total landings of tusk from Subarea 6.b.

5.4.3 ICES Advice

ICES advises that when the precautionary approach is applied, catches should be no more than 224 tonnes in each of the years **2023 and 2024**. If discard rates do not change from the average of the last three years (2019–2021), this implies landings of no more than 197 tonnes.

5.4.4 Management

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

Norway has a quota in UK waters in area 6 set at 380 t in 2023.

The EU and UK TACs cover Subareas 5, 6, 7 and the EU TAC was in 2023 is set at 3022 t, while the UK TAC was set at 1272t. Total TAC 4297

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. since 2016

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
2021	40	1	41	2.4

2022	40	0.3	40.3	0.8

5.4.5.2 Length compositions

No new length composition data were available.

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 collecting and entering data from official logbooks into an electronic database in 2003, 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.

5.4.6.1 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. No data was available for 2021 and 2022. (Figure 5.4.3).

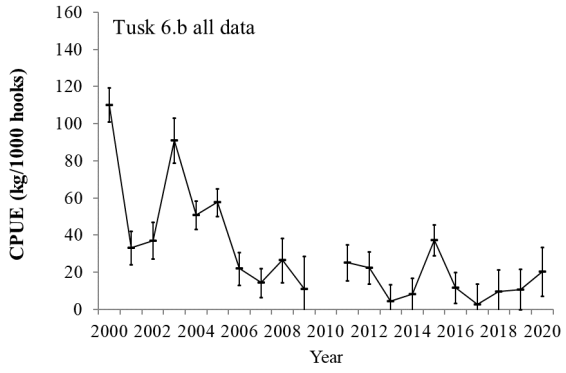


Figure 5.4.3. Estimated cpue (kg/1000 hooks) series for tusk in Subarea 6.b based on skipper's logbooks (during the period 2000–2020). The bars denote the 95% confidence intervals.

5.4.6.2 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

Landings since 2001 have been low and generally decreasing. Except for 2015, landings have been very low (maximum 100 t per year) since 2013 (Table 5.4.1, Figure 5.4.2).

The decreasing fishing effort in Subarea 6.b. 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 Subarea 6.b per year has decreased from a maximun of 464 fishing days in 2002 to 60 days in 2020, no fishery was carried out by Norway in 2021 and 2022 (Figure 5.4.1).

The CPUE series also shows a decreasing trend until 2007, after which bottom contacting gears were banned in Subarea 6.b. Since 2007, CPUE has been generally low but stable (Figure 5.4.3).

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 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 increased caution. Assessments that use only commercial data are problematic because the relationship between trends in commercial catch rates and population size 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 the LBI method. Life history parameters such as L_{mat} have previously been based on tusk caught within Faroese waters. However, Rockall tusk is genetically different from tusk in neighbouring areas (Knutsen *et al*. 2009), and it is very likely that life history parameters like L_{mat} may also be different. Until these values have been established for Subarea 6.b, the use of the LBI method is not considered appropriate. No new length data or other biological data are available for 2022.

5.4.10 References

Helle, K. 2023. The development of the Norwegian longline fleet's fishery for ling and tusk during the period 2000-2022. Working Document to the ICES Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources (WGDEEP).21 p

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.

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
2021		1		5					34		40
2022	3			6					31		40

*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

Year	6.b	All areas
2007	299	299
2008	293	293
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
2021	40	40
2022*	40	40

***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 in 2021. 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 2021.. 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 2021 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 considers 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 2011–2021 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.

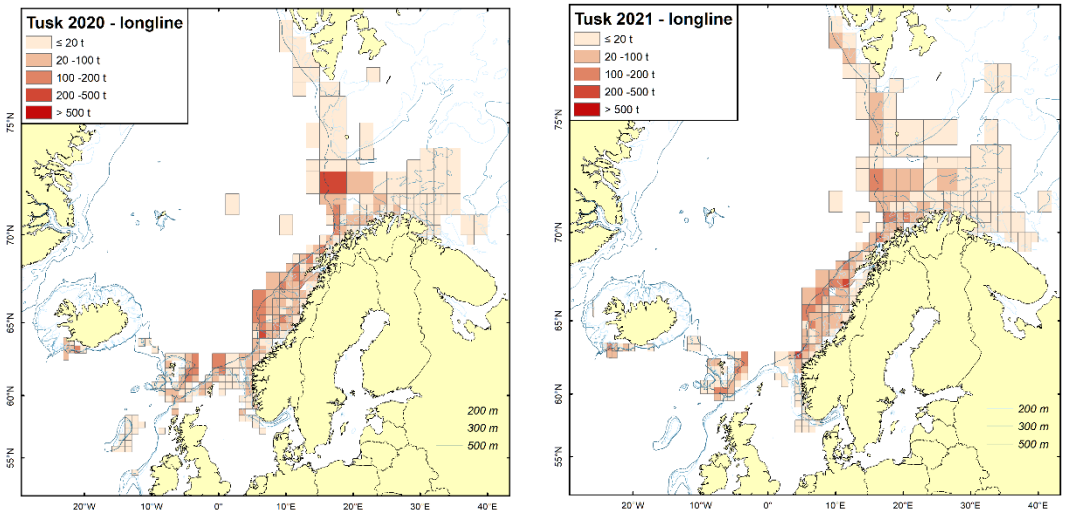


Figure 5. 5.1. Distribution of catches for the Norwegian longline fishery in Subareas 1 and 2 in 2020 and 2021

5.5.2 Landings trends

Landing statistics by nation from 1988 to 2021 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 2021 are 9 227t.

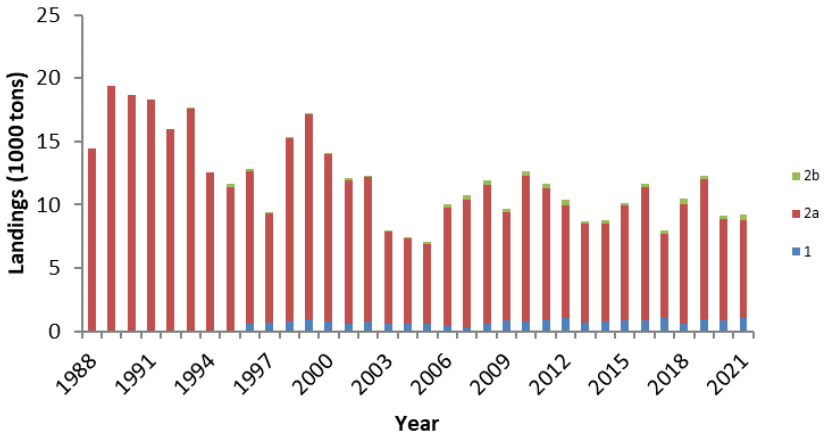


Figure 5.5.2. Total yearly landings of tusk in Areas 1 and 2 for 1988–2021.

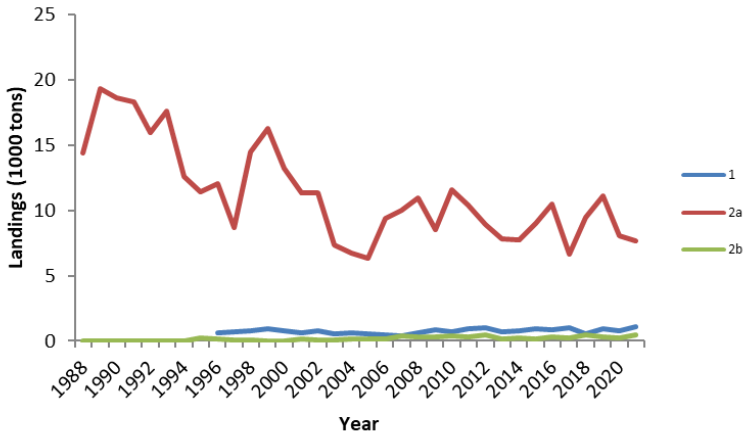


Figure 5.5.3. Total yearly landings of tusk in Areas 1 and 2 for 1988–2021.

5.5.3 ICES Advice

ICES advises that when the precautionary approach is applied, catches should be no more than 8076 tonnes in each of the years **2022 and 2023** 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.

5.5.4 Data available

5.5.4.1 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 2021. The landings statistics are regarded as being adequate for assessment purposes.

5.5.4.2 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 2001–2021.

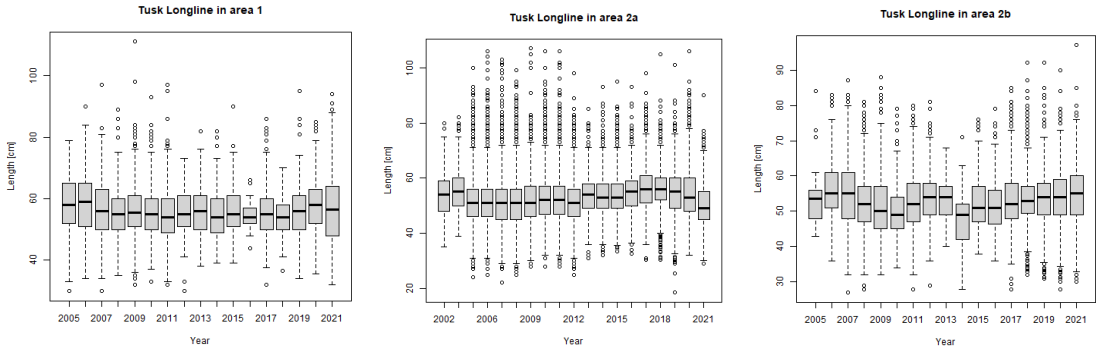
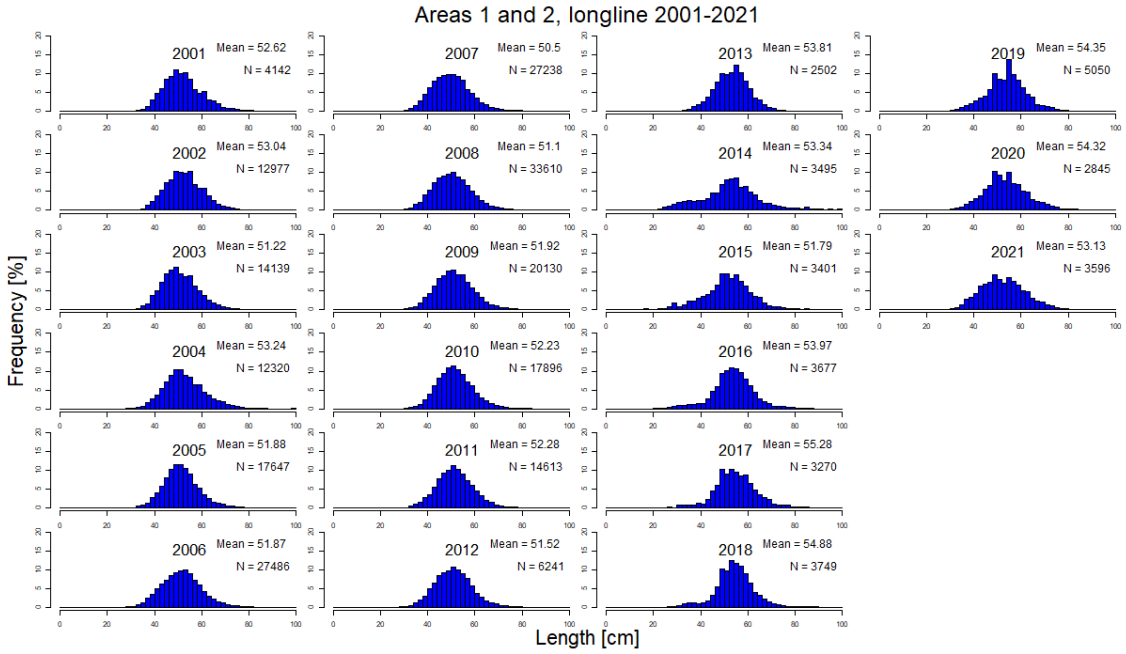


Figure 5.5.4. Box and whisker plots showing the length distribution of tusk. The data were provided by the Norwegian reference fleet for the period 2001–2021.



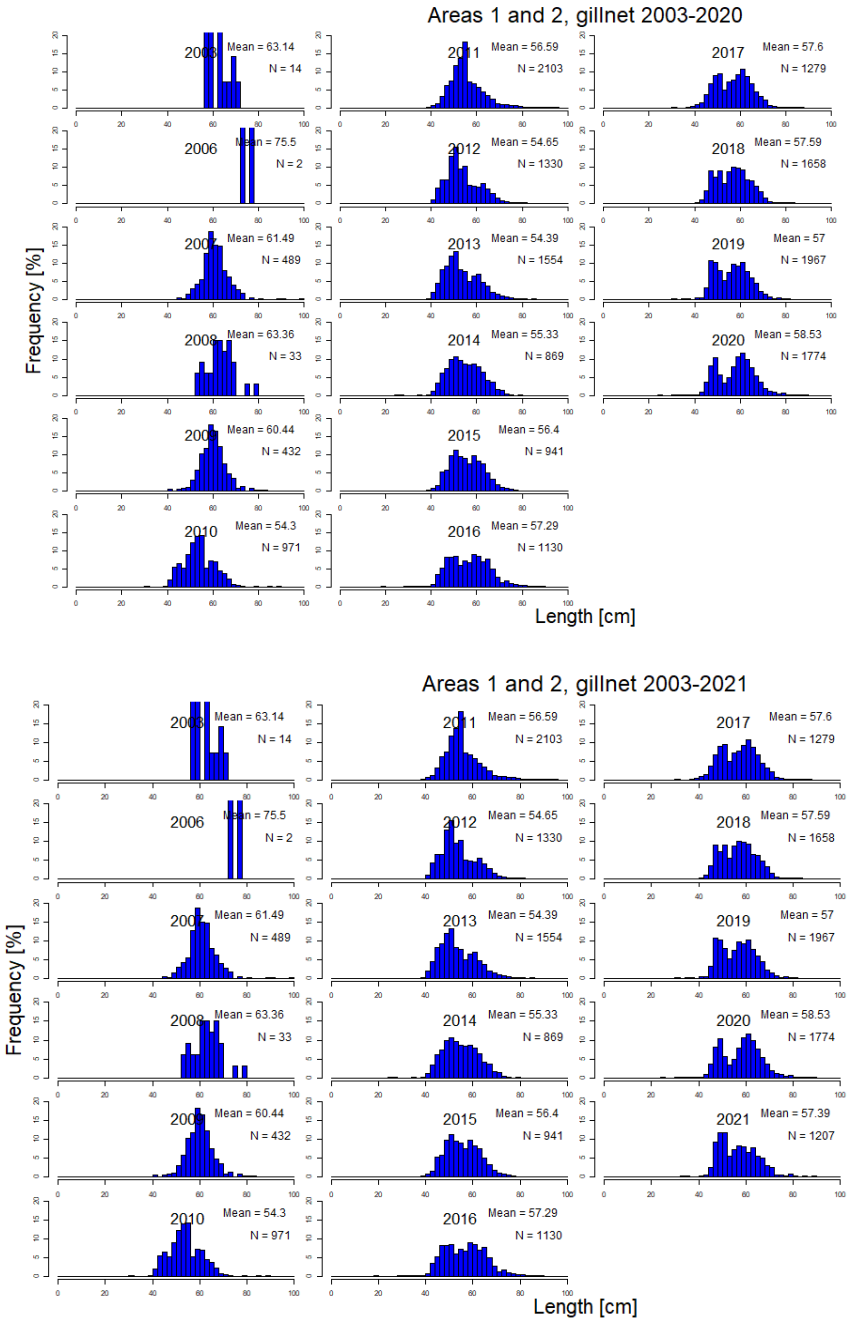


Figure 5.5.5. The estimated length distributions of the catch of tusk by Norwegian longliners and gillnetters combined for the Areas 1, 2.a and 2.b.

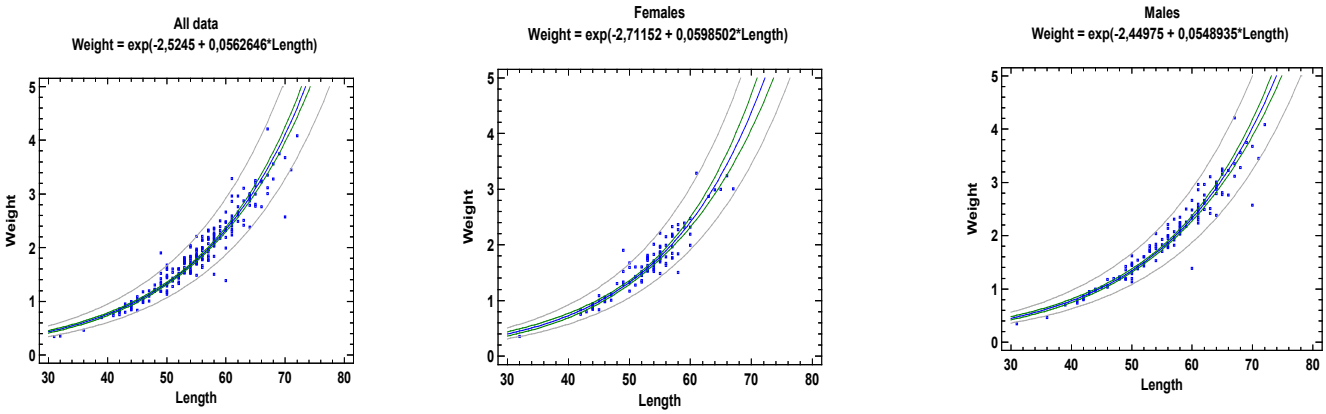


Figure 5.5.6. Length–weight relationship for tusk.

5.5.4.3 Age compositions

No new data are available.

5.5.4.4 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

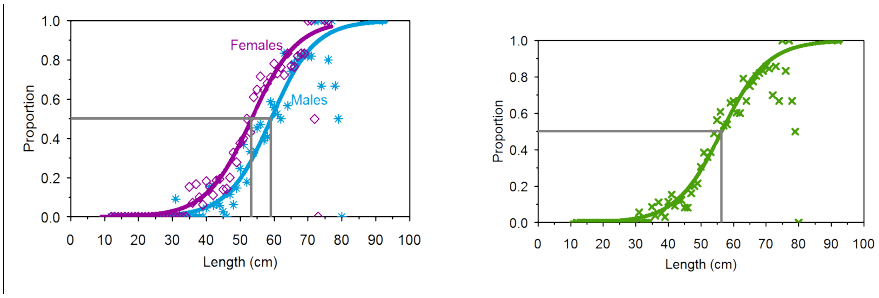


Figure 5.5.7. Tusk Area 1 and 2, Maturity ogive on length for males and females, and all data combined.

5.5.4.5 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 2000–2021. 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.

5.5.5 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 2021. 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 54.1 cm in the longline fishery and 57.4 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 four years for the targeted fishery (Figure 5.5.8).

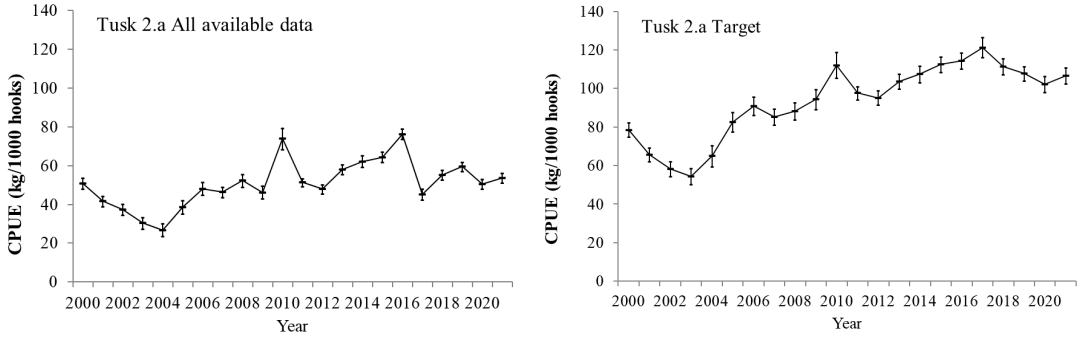


Figure 5.5.8. Estimates of cpue (kg/1000 hooks) of tusk based on skipper's logbook data for 2000–2021. The bars denote the 95% confidence interval.

Biological reference points

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

5.5.6 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.

5.5.7 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.

5.5.8 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 2001-2021 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	2001-2021	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.	

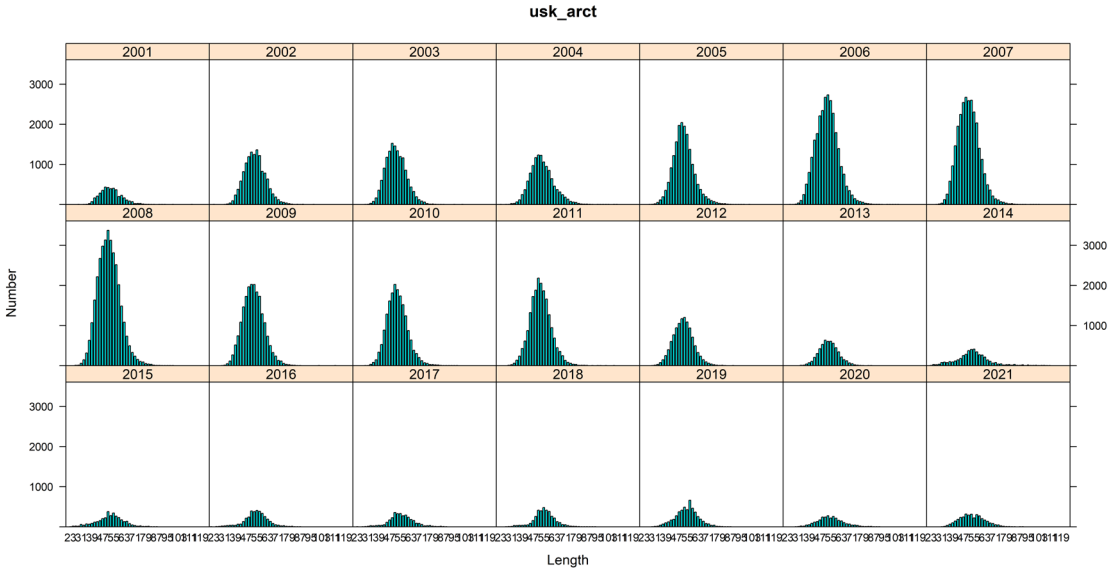


Figure 5.5.9 Tusk in arctic waters (1, 2a, 2b). The length distribution (2 cm length bins) based on data from the Norwegian longline fleet for the period 2001–2021 (sex combined).

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.

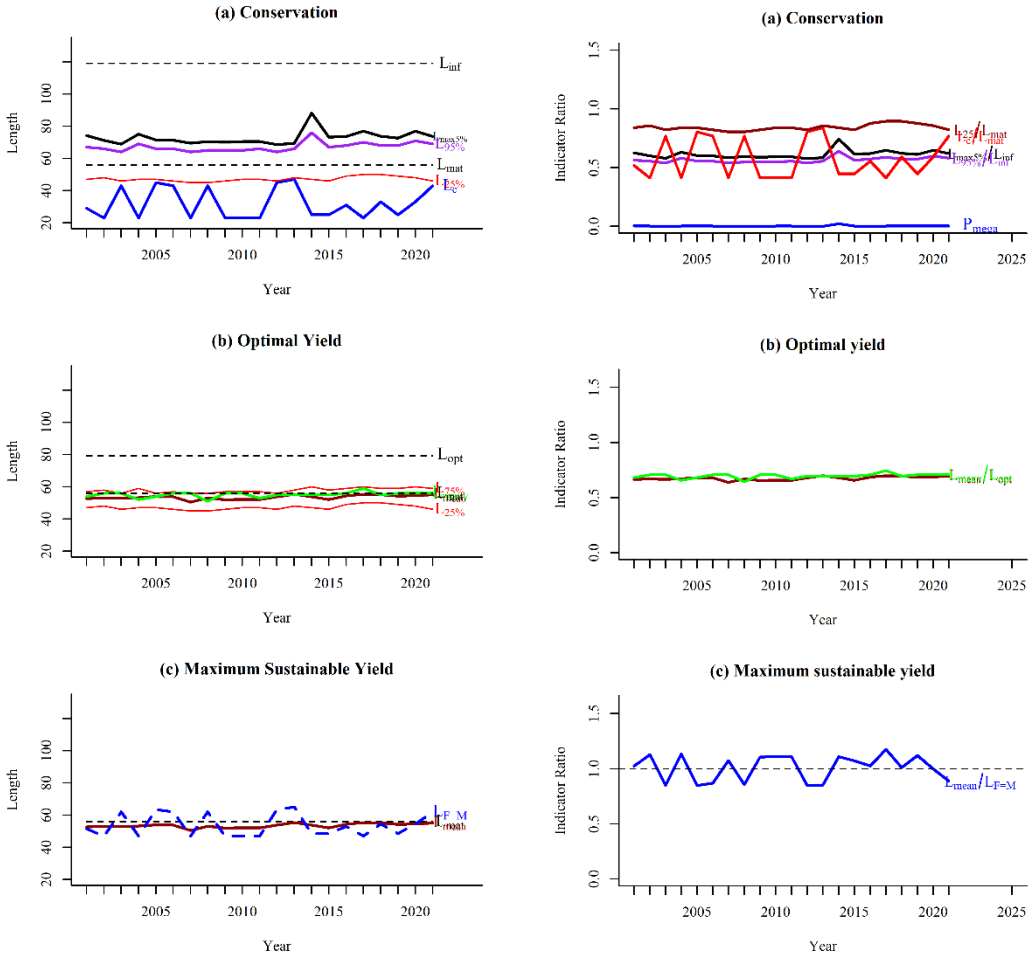


Figure 5.5.10 Tusk in arctic waters (1, 2.a, 2.b). Using length indicators ratios for sex combined to examine three scenarios: (a) Conservation, (b) Optimal yield, and (c) maximum sustainable yield.

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 2019-2021 (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 2019 and 2020 (Figure 4.3.10), which indicates that tusk in arctic waters is fished sustainably for these years, in 2021 the indicator dropped to under 0.90 which should cause concerns.

Conclusion: The overall perception of the stock during the period 2019–2021 is that tusk in arctic waters seems to be fished sustainably for the years 2019 and 2020, for 2021 there is a drop that may indicate that tusk isn't fished sustainably anymore (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**
2019	0,45	0,88	0,61	0 %	0,68	1,12
2020	0,59	0,86	0,65	0 %	0,69	1,00
2021	0,77	0,82	0,62	0 %	0,69	0,89

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				
	2019	2020	2021	
MSY (F/F_{MSY})	✓	✓	✗	Fished unsustainably
Stock size				
	2019	2020	2021	
MSY $B_{trigger.}(B/B_{MSY})$	?	?	?	Unknown

5.5.9 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

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.)

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

5.5.10 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
2021*	1073	9					1082

***Preliminary.**

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

Year	Faroes	France	Ger-many	Green-land	Norway	E & W	Scot-land	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	Ger-many	Green-land	Norway	E & W	Scot-land	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
2021*	5	4			7564	3		98			7674

*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

Year	Norway	E & W	Russia	Ireland	France	Total
2007	350		17	1		368
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
2021*	408		63			471

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

Year	1	2a	2b	All areas
2000	798	13 192	18	14 008
2001	614	11 301	146	12 061
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
2021*	1082	7674	471	9227

***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 1988–2022, 34% of the landings have been in Area 4, 48% in Division 5.b, and 16% in Area 6.a.

In Division 5.b, tusk was mainly fished by longliners (around 90% of the catch), and the rest of the catch of tusk was taken by large trawlers. The main fishing grounds for tusk are on the slope around the Faroe 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 8 days per vessel in 2022.

5.6.2 Landings trends

Landing statistics by nation in 1988–2022 are in Table 5.6.1 and are shown by year in Figure 5.6.1.

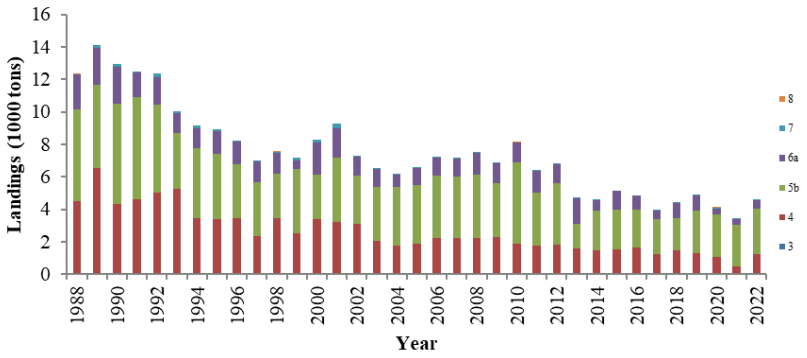


Figure 5.6.1. Landings of tusk per year for 1988–2022.

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 4550 tons in 2022 (Figures 5.6.1 and 5.6.2).

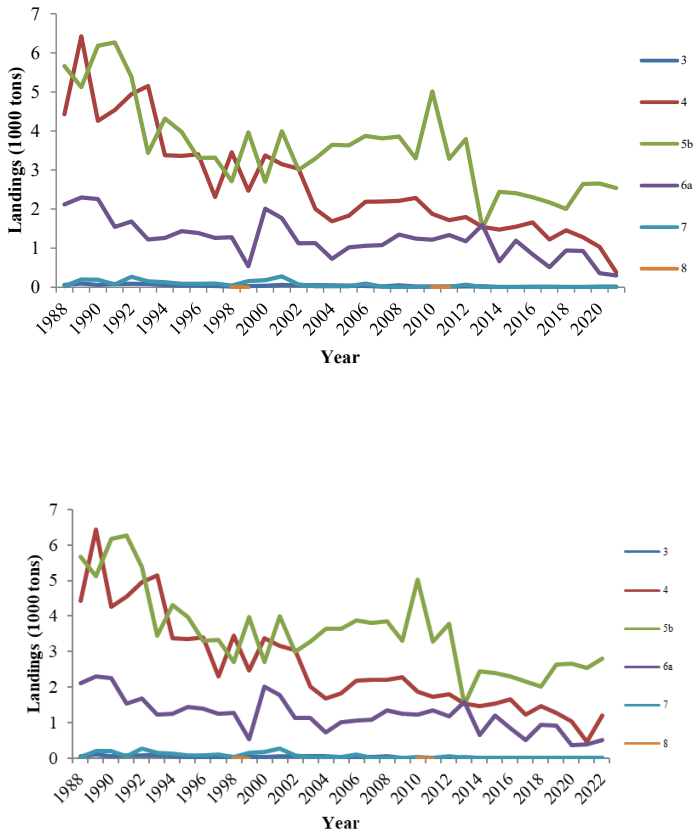


Figure 5.6.2. Landings of tusk by area for 1988–2022.

5.6.3 ICES Advice

Advice for 2022 and 2023: ICES advises that when the precautionary approach is applied, catches should be no more than 7821 tonnes in each of the years 2022 and 2023.

Advice based on the ICES rfb-rule

The assessment is based on ICES rfb-rule for data limited stocks for the first time this year, where life history traits, exploitation characteristics and other relevant parameters for data-limited stocks are considered (ICES 2021). The rfb-rule has the following form:

$$A_{y+1} = A_{y-1}\, r\, f\, b\, m$$

where A_{y+1} is the advised catch, A_{y-1} is last years advice, r corresponds to the trend in biomass index (as in the current ICES "2 over 3" rule), f is a proxy for the exploitation (mean catch length divided by an MSY reference length) and b a biomass safeguard (reducing the catch when biomass index drops below a trigger value).

The former advice when the ICES "2 over 3" rule was set to 7821 tonnes.

r is the ratio of the mean of the last two survey indices and the mean of the three preceding values or:

$$r = \frac{\sum_{i=y-2}^{y-1} I_1 /2}{\sum_{i=y-3}^{y-5} I_1 /3}$$

f is the length-ratio component where:

$$f = \frac{\overline{L}_{y-1}}{L_{F=M}}$$

where $\overline{L}$ is is the mean catch length above $L_{F=M}$. $L_{F=M}$ is calculated as:

$$L_{F=M} = 0.75L_c + 0.25L_\infty$$

where L_c is length at first capture and $L\infty$ is von Bertalanffy $L\infty$. Tusk in this stock has L_∞ of 77.9 cm

b is the biomass safeguard and is used to reduce catch advice when index falls below trigger,

$$b = min\left(1, I_y - 1/I_{trigger}\right)$$

where $I_{trigger} = i_{loss\omega}$

m is a multiplier based on stock growth. K for tusk is < 0.17 and therefore m is 0.95.

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 1500 t tusk for 2023 (sínámillum-fiskiveiðiavtalan-millum-føroyar-og-noreg-fyri-2023.pdf).

In 2023, the Faroese Party will allow 5 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 3 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, if catches in this area do not exceed 500 tonnes of deep-sea species (fiskiveiðiavtala-millum-føroyar-og-russland-fyri-2023.pdf).

There is an agreement between the United Kingdom of Great Britain and Northern Ireland and Faroe Islands for 2023 (sínámillum-fiskiveiðiavtala-millum-føroyar-og-russland-fyri-2023.pdf).

In the North Sea (ICES 4), Norwegian vessels can fish up to 30,000 tons of demersal fish in the UK zone. The quota for the EU in the Norwegian zone (Subarea 4) is set at 75 t, but only three vessels can be operating simultaneously Norwegian vessels have a TAC of 650 tons tusk in ICES 6

EU TACs for 2015-2022 are given in table 5.6.2a and 5.6.2b.

Table 5.6.2.a. TACs tusk in subareas 4 and 7–9, and in divisions 3.a, 5.b, 6.a (Before Brexit). All weights are in tonnes. (2015-2023)

Year	TAC EU Sub-area 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
2019	31	251	170	1207	2923
2020	31	251	170	1207	2923

Year	TAC EU Sub-area 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
2021		251	-	4294	-

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

Year	TAC EU Sub-area 3	TAC EU Subarea 4 (EU waters)	TAC UK Sub-area 4 (UK waters)	TAC EU Sub-area 4 (Norwegian waters)	TAC EU, Subareas, 5, 6 ,7	TAC UK Subareas 5, 6 and 7	TAC Norway Subarea 6	TAC UK waters to Norway Subarea 4 (UK waters)
2021	-	149	102	-	3037	1257	-	-
2022	-	136	92	50 (TAC Not relevant)	3029	1265	650	30 000*
2023		136	92		3022	1272	380	30 000*

*** Norwegian vessels can fish up to 30,000 tons of demersal fish in the UK zone Subarea 4**

.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 2013–2022 (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 2022.

	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

	Spain	Ireland	France	UK (Scotland)	Denmark	Germany	Total landings	Total discards	Total catches	% discards
2020		2		67			4065	69	4134	1.7
2021	1		1	71		3	3408	76	3484	2.2
2022	1			51	1	1	4550	54	4604	1.2

Table 5.6.4. Discards of tusk in 2022 by area on country.

Area	Country	Discards
27.4	UK(Scotland)	48
27.4	Germany	1
27.4.a	Denmark	1
27.6.a	UK(Scotland)	3
27.6.a	Spain	1
Total		**54**

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 2001–2022, 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.

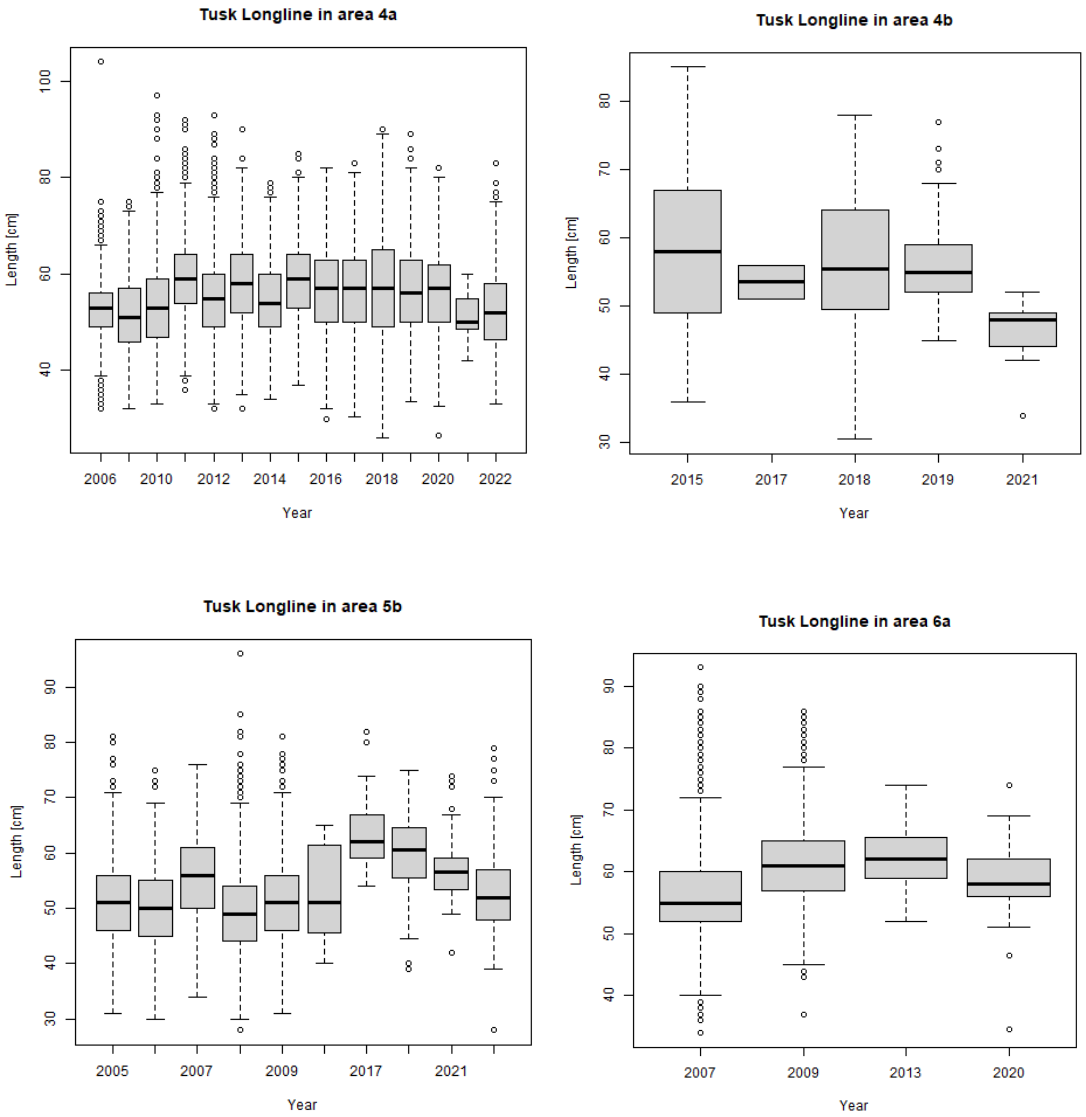


Figure 5.6.3a. Length distributions of tusk in Areas 4.a, 4.b, 5.b and 6.a for 2001–2022, based on longline data from the Norwegian reference fleet.

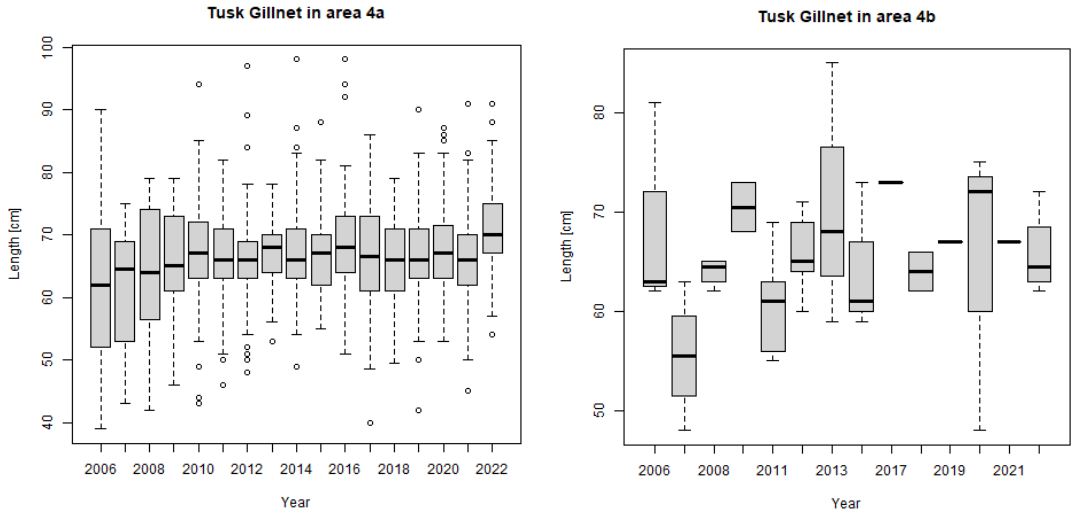


Figure 5.6.3b. Length distributions of tusk in Areas 4.a, 4.b, 5.b and 6.a for 2001–2022, based on gillnet data from the Norwegian reference fleet.

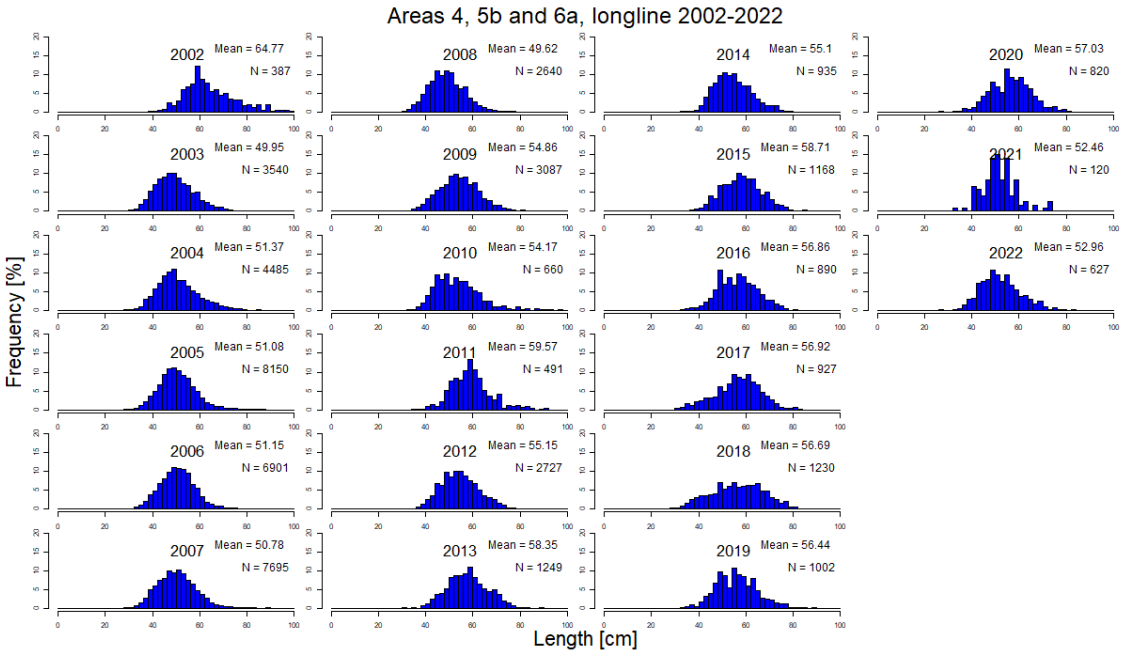


Figure 5.6.4. The estimated length distributions of the catch of tusk by Norwegian longliners, combined, for Areas 4.a, 5.b and 6.a.

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.

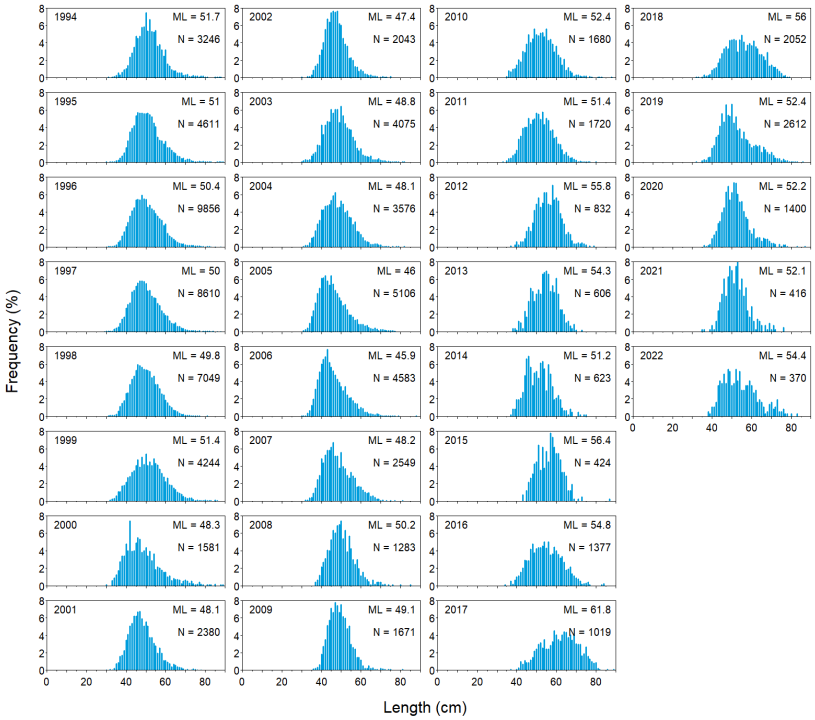


Figure 5.6.5. Length distributions of the catch of tusk by Faroese longliners (>100 BRT) in Division 5.b. ML- mean length in cm, N- number of length measures.

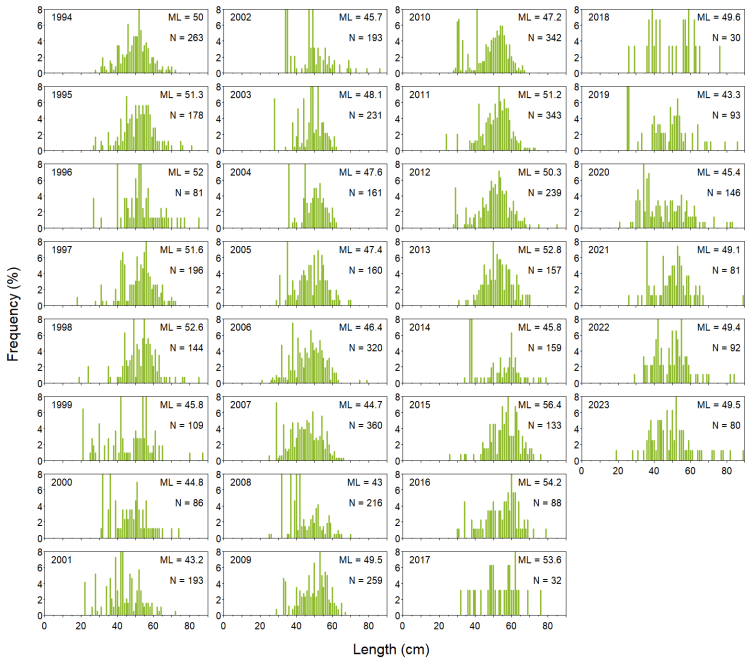


Figure 5.6.6. Length distributions of tusk in Division 5.b based on data from the Faroese spring groundfish surveys. ML- mean length, N- number of calculated length measures. Small tusk are often sampled from a subsample of the total catch, so the values are multiplied to total catch.

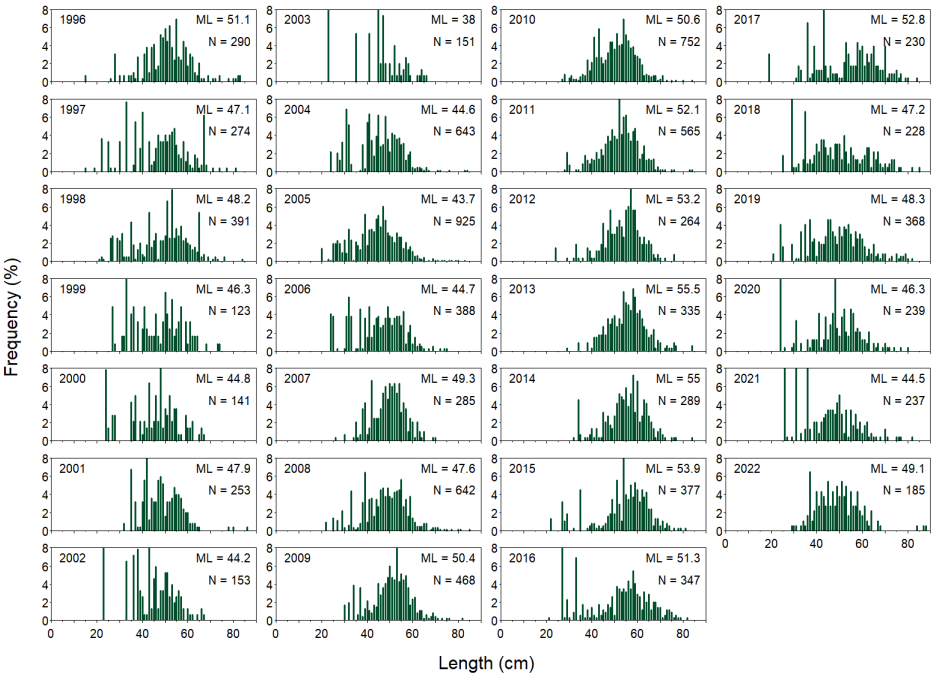


Figure 5.6.7. Length distributions of tusk in Division 5.b based on data from the Faroese summer groundfish surveys. ML- mean length, N- number of calculated length measures. Small tusk are often sampled from a subsample of the total catch, so the values are multiplied to total catch.

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 2000–2022. 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 2022, the mean length was 54.4 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). Due to late agreement on TAC in area 4a the CPUE for 2021 is based on a low number of fishing days and may therefore not show the correct trend.

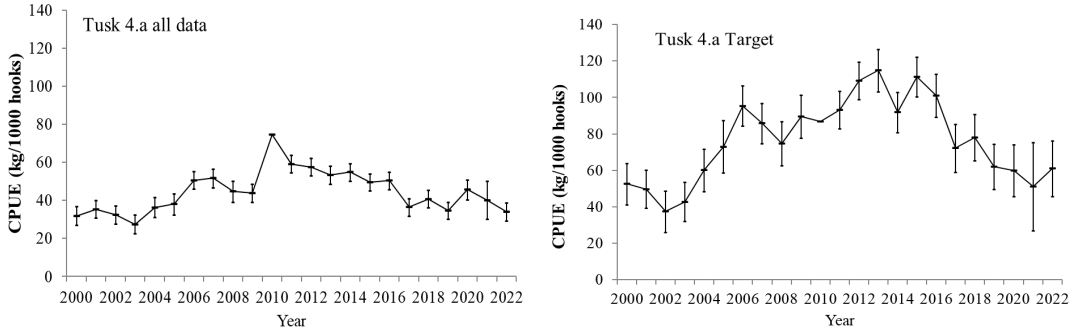


Figure 5.6.8. Tusk cpue series in 4.a for 2000–2022 based on all available data and when tusk appeared to be targeted. The bars denote the 95% confidence intervals.

5.b

The standardized cpue from the annual Faroese groundfish surveys in spring (1994-present) and summer (1996-present) are in Figures 5.6.9.a and 5.6.9.b. In addition, a CPUE series for the spring survey, 1983-1993, based on non-stratified data, are in Figure 5.6.9a. The cpue series for the annual groundfish surveys show a a CPUE of around 2kg/hour in 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 lower than the mean level in the last years (Figure 5.6.10).

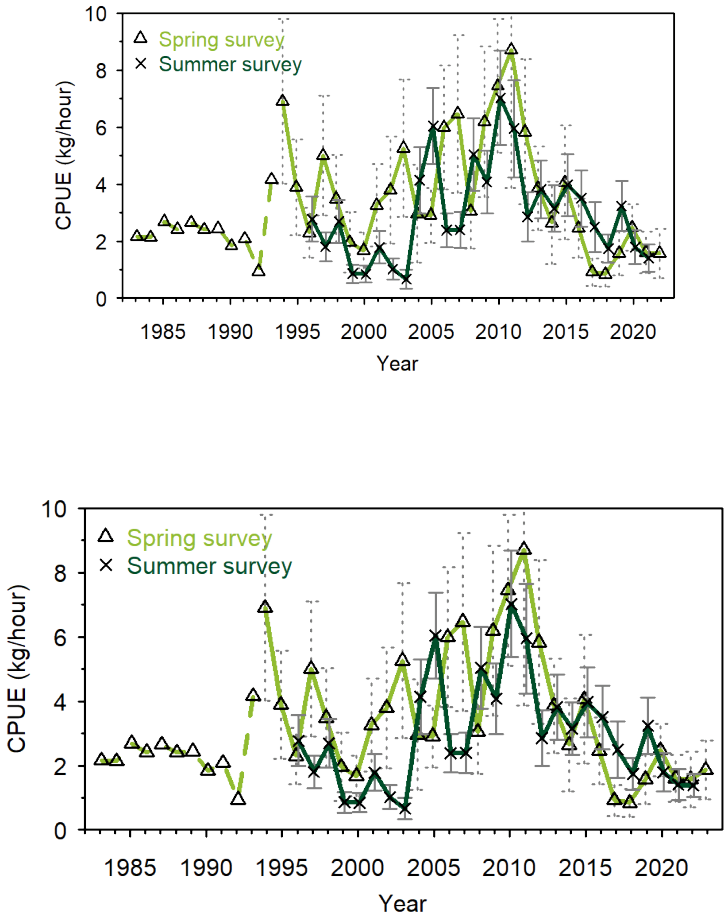


Figure 5.6.9a. Tusk 5.b. Standardized cpue from the annual trawl groundfish surveys. The spring survey data from 1983–1993 are not stratified.

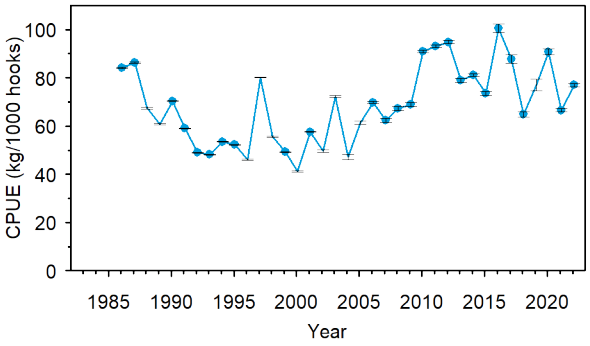


Figure 5.6.9b. Tusk cpue series in 5.b 1986–2022 for Faroese longliners based on tusk >30% of the catch. The bars denote the 95% confidence intervals.

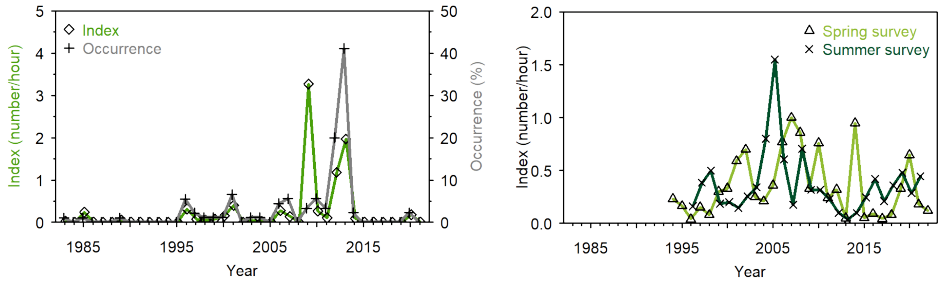


Figure 5.6.10. Tusk 5.b. Abundance index for tusk (2–3 cm in length in number/hour) on the Faroe Plateau based on the 0-group survey (left figure) and abundance index for tusk <40 cm from the annual spring and summer trawl survey on the Faroe Plateau (right figure).

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 2022(Figure 5.6.11).

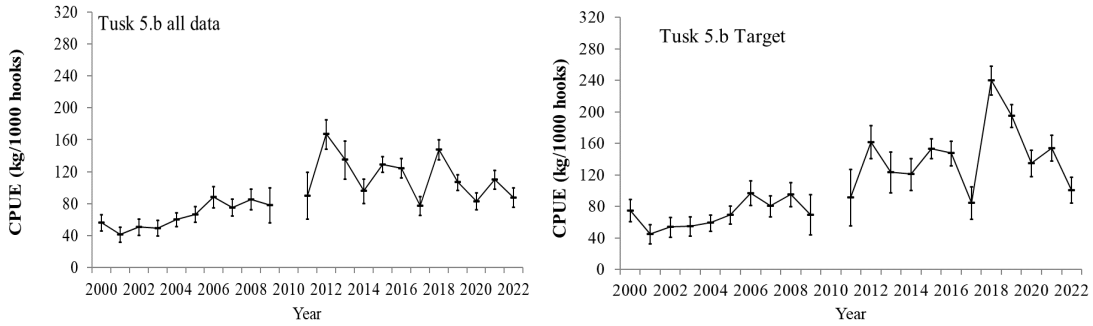


Figure 5.6.11. Tusk cpue series in 5.b for 2000–2022 for the Norwegian longliners based on all available data and when tusk appeared to be targeted. The bars denote the 95% confidence intervals.

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).

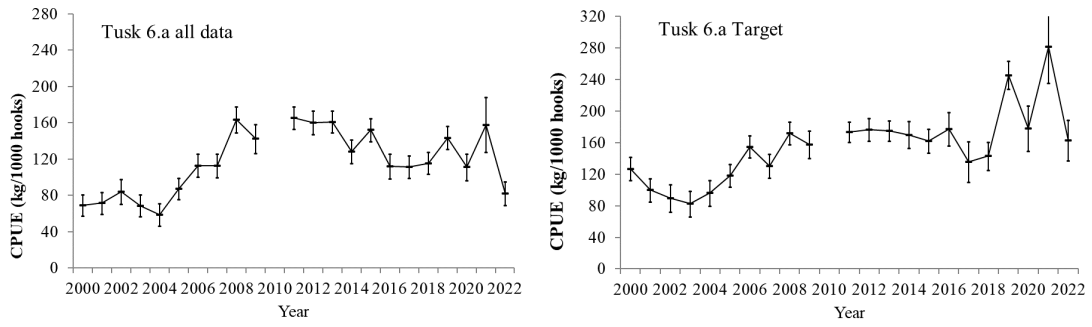


Figure 5.6.12. Two cpue series for tusk in area 6.a from 2000–2022 based on all available data and when tusk appeared to be targeted. The bars denote the 95% confidence intervals.

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). The CPUE from 2021 is very uncertain due to very limited catch data.

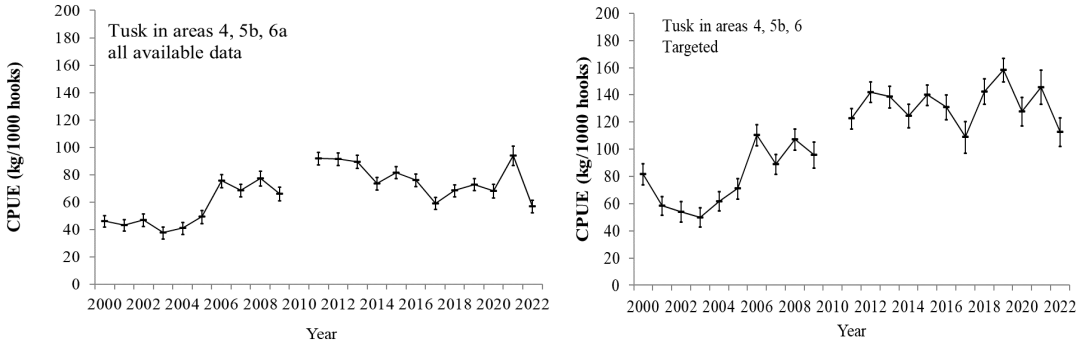


Figure 5.6.13. A combined cpue series for all "other tusk" areas for 2000–2022 based on data from the Norwegian longline fleet when tusk was targeted (>30% of total catch). The bars denote the 95% confidence intervals.

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 are usually best covered by the Norwegian longline fleet and 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. In 2021, there was no agreement on quota sharing between Norway, the UK, and the EU and consequently, there was no fishing by Norwegian vessels in Subarea 6.a. and the UK part of Subarea 4, and hence not enough data calculate a valid CPUE for the entire area.

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 The application of the rfb-rule

This is the first year the rfb-rule is applied for tusk in areas 3.a, 4, 5.b, 6.a, 7, 8, 9 and other areas of 12. Previously the "3 over 2"-rule has been used. The biomass index is based on the CPUE calculated from logbook data from the Norwegian longline fleet 2000-2022. The length data is from the Norwegian longline reference fleet. To get reliable values for K and Linf has been challenging. There is an ongoing work where these issues are being addressed and linf is set to 77.9, but in lieu of an estimate for k, the estimate from COSEWIC. (2012), where K=0.17 has been used.

Rfb-rule:

- r is calculated as the average of last two years values, divided by average of three preceding years values which results in r=0.90 (Figure 5.6.14, Table xxx)

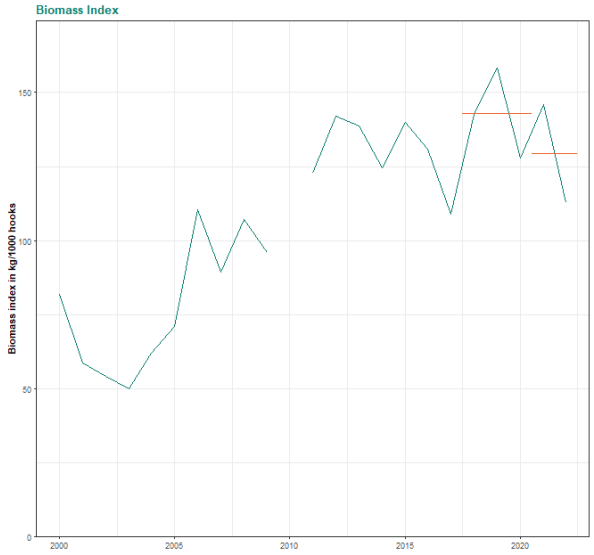


Figure 5.6.14: Tusk in areas 3.a, 4, 5.b, 6.a, 7, 8, 9 and other areas of 12. Biomass index since 2000. The red lines show the average of last two years values and the three preceding years.

- f is the length-ratio component. The mean length of last years´ catch was 54 cm and the target reference length (Lc or length at first capture * 0.75 + length ∞ * 0.25) is **52** (figure 5.6.15).

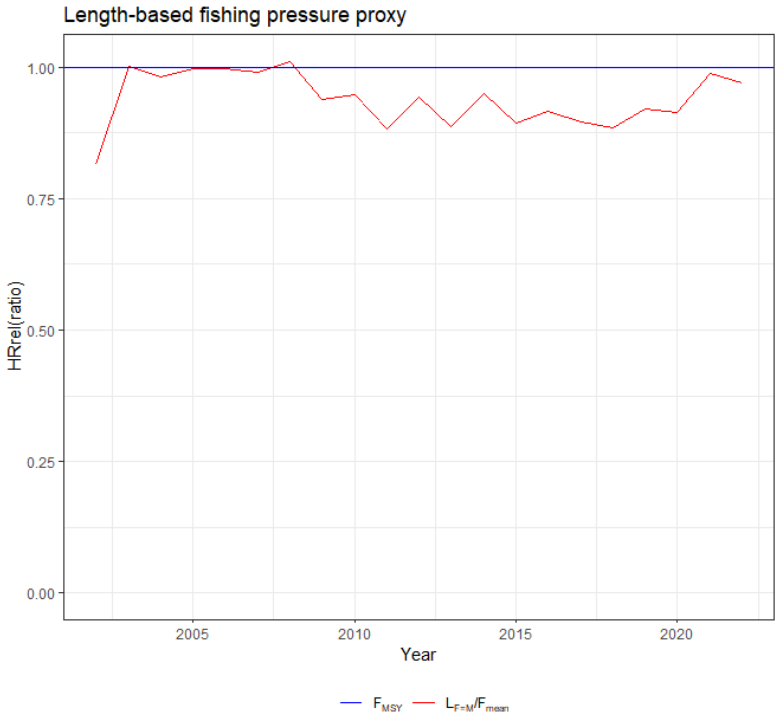


Figure 5.6.15: Tusk in areas 3.a, 4, 5.b, 6.a, 7, 8, 9 and other areas of 12. Index ratio of the average length relative to the expected length when fishing mortality equals natural mortality ($L_{mean}/L_{F=M}$) for the Norwegian longline fleet from the length-based indicator method used for the evaluation of the exploitation status. The exploitation status is below the $F_{MSY\ proxy}$ when the index ratio value is higher than 1.

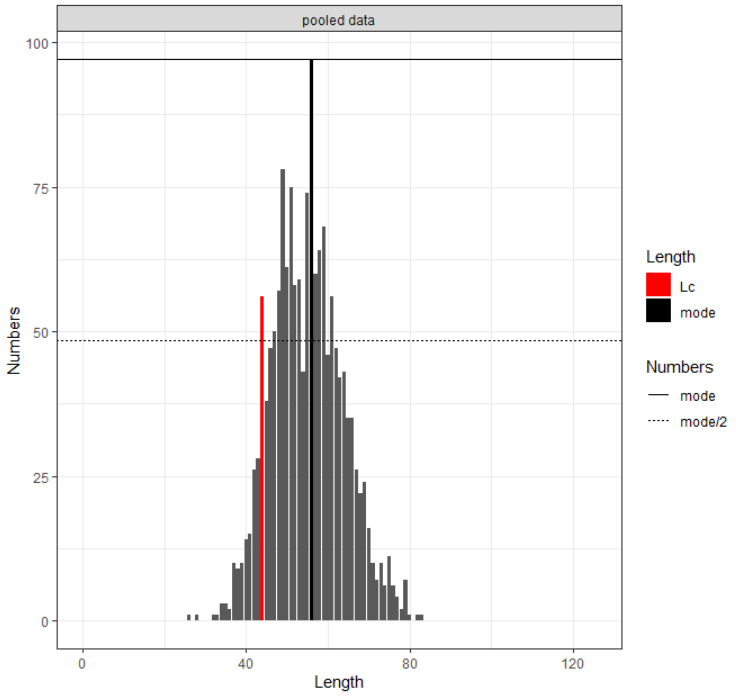


Figure 5.6.16: Tusk in areas 3.a, 4, 5.b, 6.a, 7, 8, 9 and other areas of 12. Length frequency distribution from catches. Black line is the length of modal abundance, the red line is the length at first capture.

- *b* is the biomass safeguard and is used to reduce catch advice when index falls below trigger. The lowest index or the I_{loss} for tusk is 50 and was recorded in the year 2003. $I_{trigger}$ is I_{loss} *1.4 or 70 (Figure 5.6.17). Biomass index this year is above $I_{trigger}$ and *b* is therefore 1.

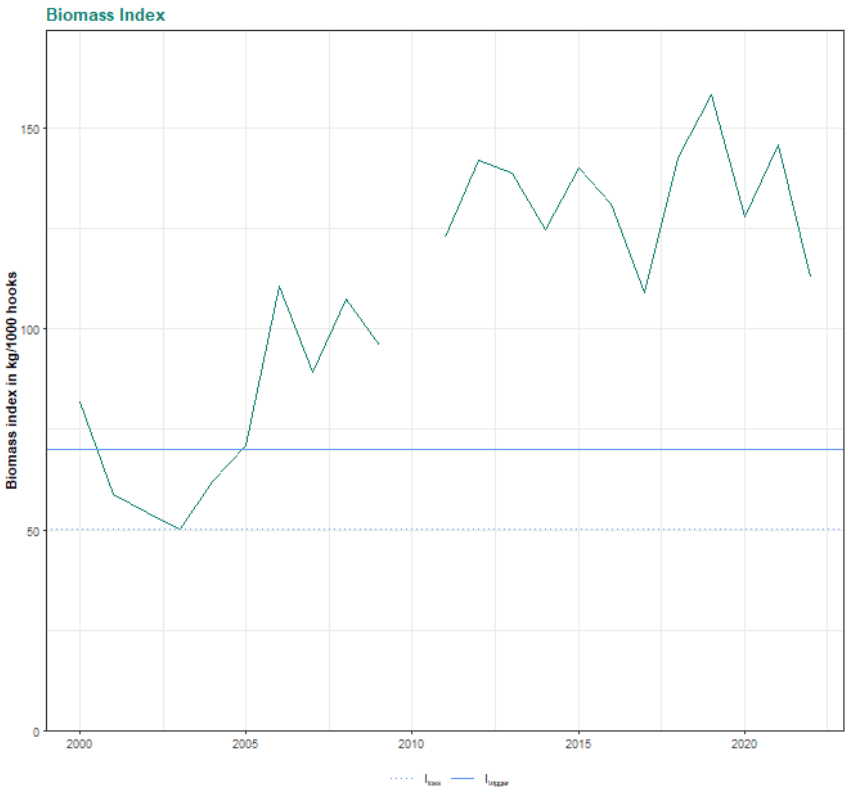


Figure 5.6.17: Tusk in areas 3.a, 4, 5.b, 6.a, 7, 8, 9 and other areas of 12.. Biomass index values since 2000. The blue line is the $I_{trigger}$ and the doted is the lowest observed value (I_{loss}).

- *m* is the tuning parameter and for slow growing species (with von Bertanlaffy K<0.2), *m* equals to 0.95.

Table 5.6.5 Tusk in areas 3.a, 4, 5.b, 6.a, 7, 8, 9 and other areas of 12. The basis for the catch scenarios^. Catches are in tonnes.*

Previous catch advice A_y		7821 tonnes
Stock biomass trend		
Index A (2021, 2022)		129.28
Index B (2018, 2019, 2020)		142.96
r: stock biomass trend (index ratio A/B)		0.90
Fishing pressure proxy		
Mean catch length ($L_{mean} = L_{2022}$)		54cm
MSY proxy length ($L_{F=M}$)		52 cm
f: fishing pressure proxy relative to MSY proxy ($L_{2022}/L_{F=M}$)		1.03
Biomass safeguard		
Last index value (I_{2022})		113
Index trigger value ($I_{trigger} = I_{loss} \times 1.4$)		70
b: index relative to trigger value, min{$I_{2022}/I_{trigger}$, 1}		1
Precautionary multiplier to maintain biomass above B_{lim} with 95% probability		
m: multiplier (generic multiplier based on life history)		0.95
Stability clause (+20%/−30% compared to A_y, only applied if b ≥ 1)	Not applied	
Discard rate		0 %
Catch advice for 2024 and 25**		6924 tonnes
% advice change^		-11.5 %

^ The figures in the table are rounded. Calculations were done with unrounded inputs, and computed values may not match exactly when calculated using the rounded figures in the table.

** Formula [$A_y \times r \times f \times b \times m$]

^ Advice value for 2024/2025 relative to the advice value for 2023 (5 tonnes).

5.6.10 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.

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 2023

Information and data

The input parameters and the catch length composition for the period 2002-2022 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 5.6.6. 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
	2002-2022	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* length $^{2.9101}$	Norwegian long-liners (Reference fleet) and survey data.	combined sexes
L_{MAT}	51 cm	Faroese survey data	
L_{inf}	77.9 cm (L_{max})	Norwegian long-liners (Reference fleet)	

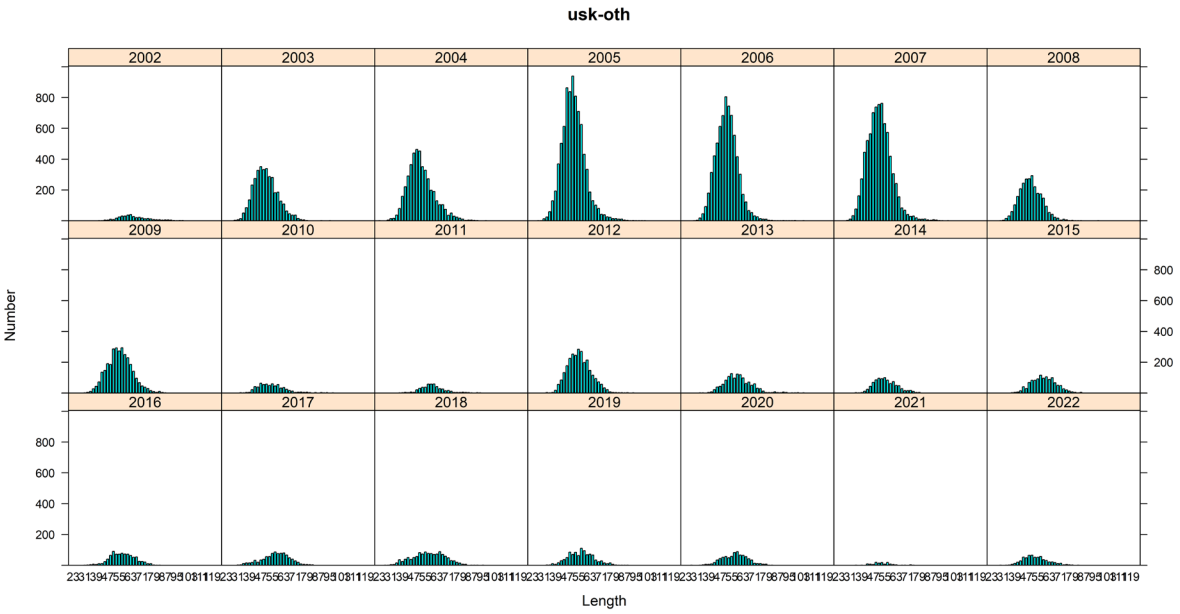


Figure 5.6.18. Tusk in other areas (3.a, 4.a, 5.b, 6.a, 7, 8, 9, 12). Catch length distributions (2 cm bins) have not been raised to total catch for the period 2002–2022 (combined sexes).

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.

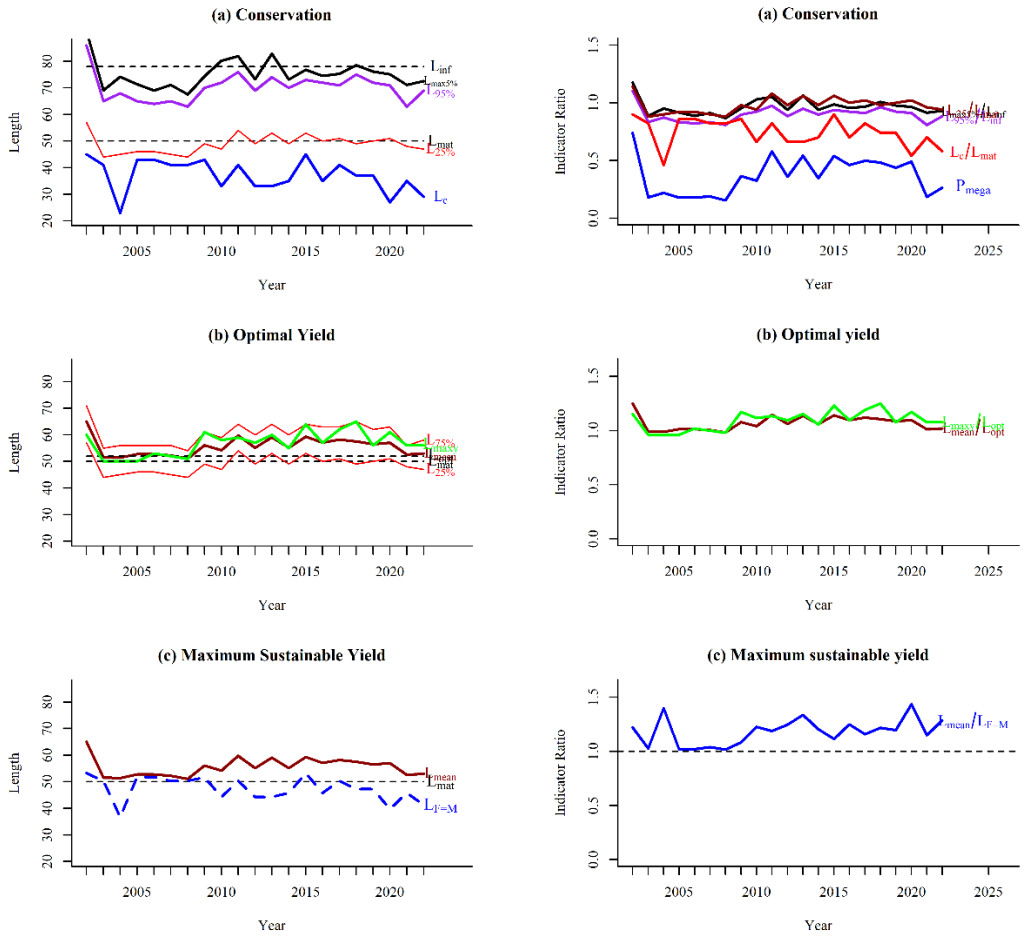


Figure 5.6.19 Tusk in other areas (3.a, 4.a, 5.b, 6.a, 7, 8, 9, 12). Screening of length indicators ratios for sexes combined under three scenarios: (a) Conservation, (b) Optimal yield, and (c) maximum sustainable yield.

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 2020-2022, the ratios were between 0.94 and 1.02 (Table 5.6.7). 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 0.9 for the whole period (Figure 5.6.19), and between 0.57 and 0.60 during the period 2020-2022 (Table 5.6.7), which is above the baseline, 0.8.

The MSY indicator, $L_{mean}/L_{F=M}$, was more than 1 for all three years (Figure 5.6.7), which indicates that tusk in other areas were fished sustainably been fished sustainably.

Table 5.6.7. 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	$L_{mean}/L_{F=M}$
Ref	**>1**	**>1**	**>0,8**	**>30%**	**~1 (>0,9)**	**≥1**
2020	0,54	1,02	0,96	49 %	1,10	1,43
2021	0,70	0,96	0,91	18 %	1,01	1,15
2022	0,58	0,94	0,93	26 %	1,02	1,28

Conclusions

The overall perception of the tusk stock in these areas during the period 2020–2022, based on the LBI results, is that tusk seems to have 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 5.6.8. 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				
	2020	2021	2022	
MSY (F/F_{MSY})	✓	✓	✓	Fished sustainably

Stock size				
	2020	2021	2022	
MSY $B_{trigger}.(B/B_{MSY})$	?	?	?	Unknown

Table 5.6.8. Outcomes from the LBI, based on data from the longline fishery provided by the Norwegian reference fleet.

Year	2020	2021	2022
L75	63	56	58
L25	51	48	47
Lmed	57	52	52
L90	68	60	65
L95	71	63	69
Lmean	57.01	52.57	53.00
Lc	27	35	29
LFeM	39.75	45.75	41.25
Lmaxy	61	56	56
Lmat	50	50	50
Lopt	52	52	52
Linf	78	78	78
Lmax5%	75.12	71.17	72.60
Lmean/LFeM	1.43	1.15	1.28
Lc/Lmat	0.54	0.7	0.58
L25/Lmat	1.02	0.96	0.94
Lmean/Lmat	1.14	1.05	1.06
Lmean/Lopt	1.10	1.01	1.02
L95/Linf	0.91	0.81	0.88
Lmaxy/Lopt	1.17	1.08	1.08
Lmax5%/Linf	0.96	0.91	0.93
Pmega	0.49	0.18	0.26
Pmegaref	0.3	0.3	0.3

5.6.11 References

COSEWIC. 2012. COSEWIC assessment and status report on the Cusk Brosme brosme in Canada.Committee on the Status of Endangered Wildlife in Canada. Ottawa. x + 85 pp. (www.registrelep-sararegistry.gc.ca/default_e.cfm)

Helle, K. 2023. The development of the Norwegian longline fleet's fishery for ling and tusk during the period 2000-2022. Working Document to the ICES Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources (WGDEEP).21 p

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.

Ofstad, L. 2017. Tusk in Faroese waters (Division 5.b). Working Document to the ICES Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources (WGDEEP).14 pp.

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.)

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

5.6.12 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
2021	2	12		14
2022*	1	16		17

***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

Year	Denmark	Faroes	France	Germany	Norway	Sweden[1]	E & W	N.I.	Scotland	Ireland	Total
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
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
2021	26		20		231	4	7		162		450
2022*	22	1	33	2	1069	8	5		73		1212

[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

Year	Denmark	France	Norway	Germany	E & W	Scotland	Ireland	Sweden	Total
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
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
2021	1		9					1	11
2022			2					1	3

[(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

Year	Denmark	Faroes[4]	France	Germany	Norway	E & W	Scotland [1]	Russia	Total
2015		1338	26		717				2081
2016		1494	17		747		3		2261
2017		1472	18		544		1		2035
2018		1119	14		849		1		1983
2019		1110	13		835		2		1960
2020		1302	18		1139		3		2462
2021		1157	14		830				2001
2022		1679	9		706		7		2401

[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

Year	Faroe	Norway	E & W	Scotland [1]	France	Total
2003		559				559
2004		107				107
2005		360				360
2006		317				317
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
2021	235	307				542
2022*	286	113				399

[1]Includes 5.b1.

[2]See 5.b1.

[3]Included in 5.b1.

***Preliminary.**