TUSK - KEILA

Brosme brosme

GENERAL INFORMATION

Tusk, also commonly called cusk, is a gadiform species with variable brown coloration with red or green tones on the dorsal side that fade to a yellow or pale colour on the belly. It is slow-moving demersal species that lives solitarily or in small aggregations in offshore stony or pebbly habitats, mainly at depths less than 400 m. It feeds on crustaceans, shellfishes, and other demersal fishes. In Icelandic waters they grow to sizes close to 100 cm and may attain ages close to 20, but age determination of individuals over 10 years old is highly uncertain.

THE FISHERY

The fishery for tusk in Icelandic waters has not changed substantially in recent years. It 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 >100 kg, but ~100 more vessels have small amounts of bycatch landings (Table 1). Far fewer gillnetters and trawlers participate in the fishery. The number of longliners reporting tusk catches in 2017 decreased to 180 from 206 the previous year (Table 1). Most tusk in Icelandic waters are caught on longlines or around 97% of catches in tonnes and this has been relatively stable proportion since 1992 (Table 1).

Most of the tusk caught by Icelandic longliners is caught at depths less than 300 meters (Figure 1). The main fishing grounds for tusk as observed from logbooks are on the south, southwestern and western part of the Icelandic shelf (Figures 2 and 3). The main trend in the spatial distribution of tusk catches to logbook entries is the decreased proportion of catches caught in the southeast and increased catches on the western part of the shelf. Around 50–60% of tusk is caught on the south and western part of the shelf (Figure 3).

According to ICES, tusk from Icelandic waters and Greenlandic waters (ICES section 14) should be managed as a single unit. Tusk from Greenlandic waters is caught mainly as a bycatch by longliners and trawlers. The main area where tusk is caught in Greenlandic waters is 63°–66°N and 32°–40°W, well away from the Icelandic EEZ.

Table 1. Tusk. Number of Icelandic boats participating in the fishery that land >100 kg tusk, and catches by fleet segment.

Tafla 1. Keila. Fjöldi íslenskra báta sem lönduðu >100 kg af keilu af Íslandsmiðum, og afli eftir flota.

YEAR	NUMBER OF BOATS			CATCHES IN TONNES			SUM
	Trawlers	Gillnetters	Longliners	Trawlers	Longliners	Other	
2000	106	175	370	93	4564	37	4738
2001	83	224	350	73	3248	38	3422
2002	80	174	304	75	3722	30	3920
2003	78	148	305	56	3941	21	4059
2004	74	130	303	85	3007	15	3135
2005	77	101	324	108	3398	14	3540
2006	72	82	338	91	4912	16	5059
2007	64	65	308	95	5834	20	5987
2008	63	59	255	114	6762	19	6937
2009	66	65	239	107	6757	16	6953
2010	59	62	228	92	6761	14	6919
2011	51	54	221	69	5742	12	5847
2012	53	68	228	60	6255	16	6344
2013	53	43	233	74	4911	17	5016
2014	52	43	249	86	6045	14	6163
2015	47	32	228	69	4745	14	4835
2016	54	32	206	61	3420	8	3494
2017	50	31	180	48	2481	6	2540

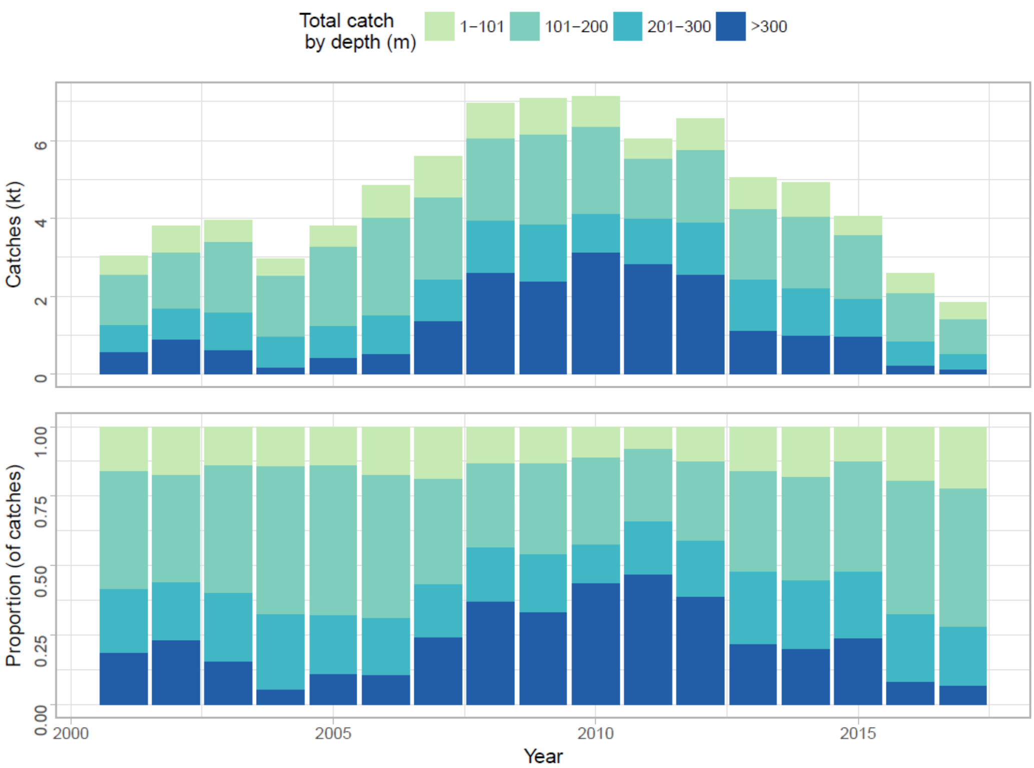

Figure 1. Tusk. Depth distribution of catches according to logbooks by the Icelandic fleet.

Mynd 1. Keila. Dýpi samkvæmt afladagbókum íslenskra skipa.

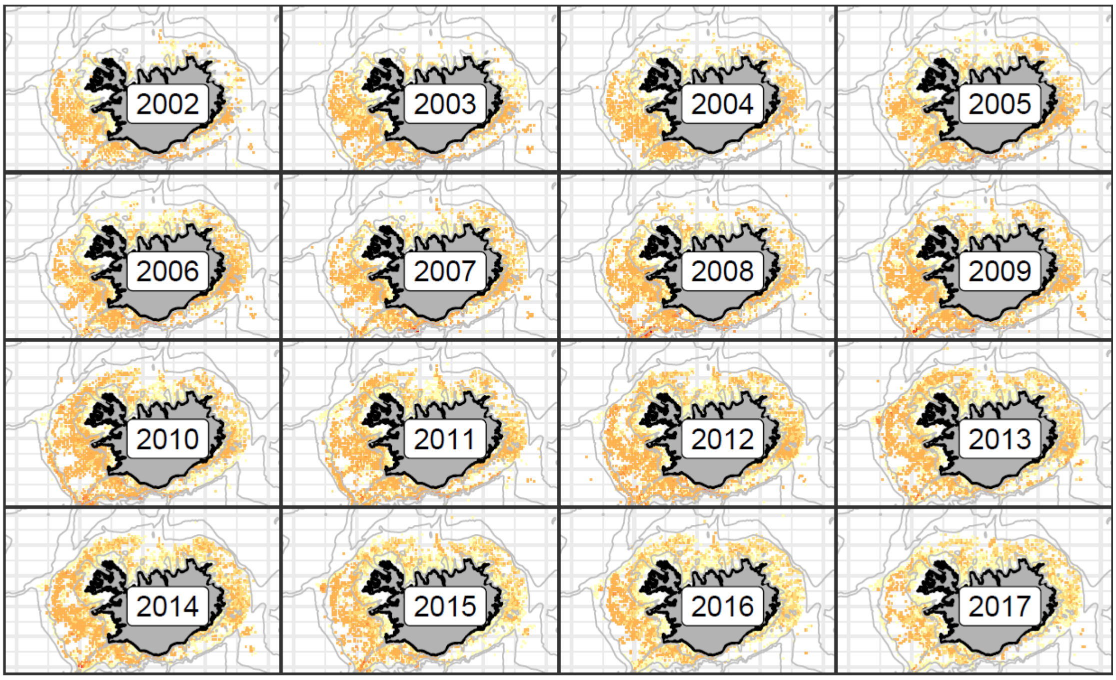

Figure 2. Tusk. Geographical distribution (tonnes/square mile) of the Icelandic longline fishery since 2002, as reported in logbooks by the Icelandic fleet.

Mynd 2. Keila. Útbreiðsla (tonn/sjómílu²) á Íslandsmiðum frá 2002 samkvæmt afladagbókum.

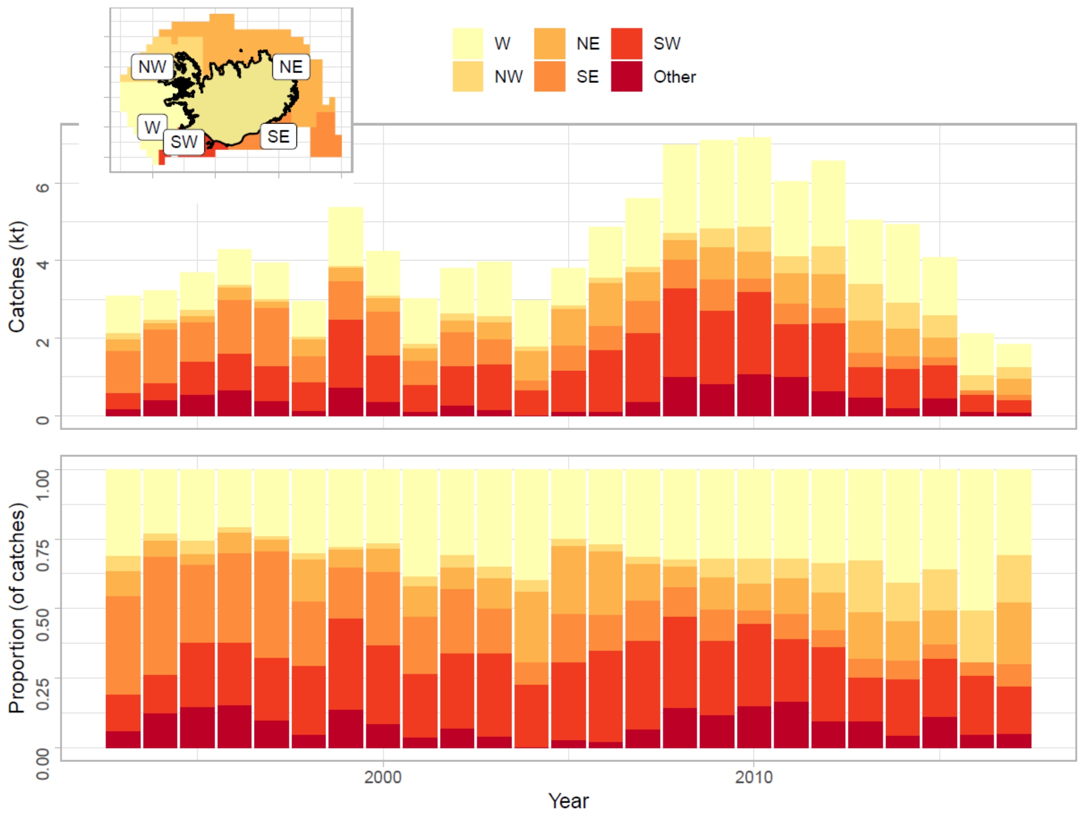

Figure 3. Tusk. Catch distribution and proportions by area according to logbooks.

Mynd 3. Keila. Afli eftir svæðum ásamt hlutfalli innan hvers svæðis samkvæmt afladagbókum.

LANDINGS TRENDS

The total annual landings in Iceland were around 2540 tonnes in 2017 (Table 6.2.7), 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 Icelandic waters to around 9000 tonnes in 2010 (Figure 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 Icelandic waters was caught by foreign vessels but has since then been between 15–25%, mainly from the Faroe Islands (Table 5).

Landings in Greenlandic waters have always been low compared to Icelandic waters, rarely exceeding 100 tonnes. However around 900 tonnes in 2015 and around 418 tonnes in 2017 were caught in the Greenlandic waters mainly by Faroese and Greenlandic vessels (Table 6). The spatial distribution of longline operations in Greenlandic waters in 2015 is shown in Figure 5.

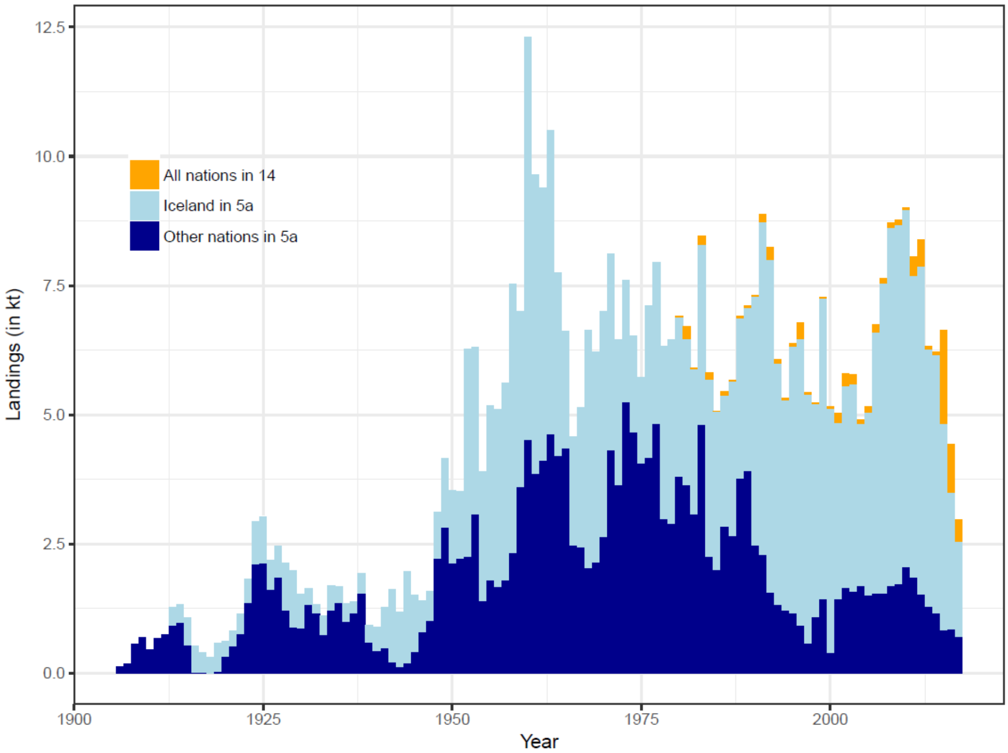

Figure 4. Tusk. Nominal landings within Icelandic waters by Icelandic vessels (light blue) or foreign vessels (dark blue), or within Greenlandic waters (orange).

Mynd 4. Keila. Landaður afli íslenskra skipa við Ísland (ljósblátt), erlendra skipa við Ísland (dökkblátt) og við Grænland (appelsínugult).

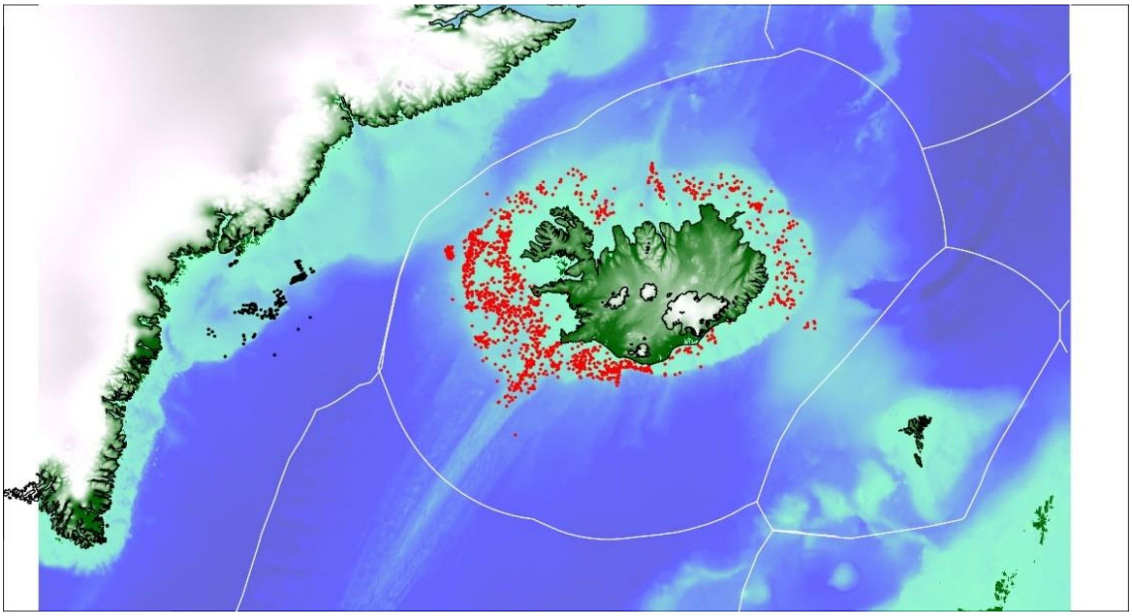

Figure 5. Tusk. Position of longline operations in 14.b and 5.a where tusk was recorded in 2015.

Mynd 5. Keila. Staðsetningar línulagna við Ísland og A Grænland árið 2015 þar sem keila var skráð sem afli.

DATA AVAILABLE

In general sampling is considered appropriate from commercial catches from the main gear (longlines). The sampling does seem to cover the spatial distribution of catches for longlines and trawls but less so for gillnets. Similarly, sampling does seem to follow the temporal distribution of catches (WGDEEP, 2012).

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) (WGDEEP, 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 for tusk in Icelandic and Greenlandic waters.

Landings for tusk in Greenlandic waters are obtained from the STATLANT database. No information is available on discards in Greenlandic waters.

LENGTH COMPOSITIONS

An overview of available length measurements from Icelandic waters is given in Table 2. 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 remained there.

Length distributions from longline fishery are shown in Figure 6.

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

Table 2. Tusk. Number of available length measurements from Icelandic commercial catches.

Tafla 2. Keila. Fjöldi lengdarmælinga úr afla við Ísland.

YEAR	LONGLINE		GILLNETS		TRAWLS	
	Samples	Measured	Samples	Measured	Samples	Measured
2005	12	1775	0	0	0	0
2006	15	2225	0	0	3	450
2007	22	3154	2	167	1	150
2008	32	4722	0	0	0	0
2009	27	3945	0	0	0	0
2010	29	4354	0	0	0	0
2011	28	4141	0	0	0	0
2012	35	5105	0	0	1	150
2013	22	3278	0	0	0	0
2014	28	3384	0	0	0	0
2015	26	3115	0	0	0	0
2016	14	1671	0	0	0	0
2017	8	1710	0	0	0	0

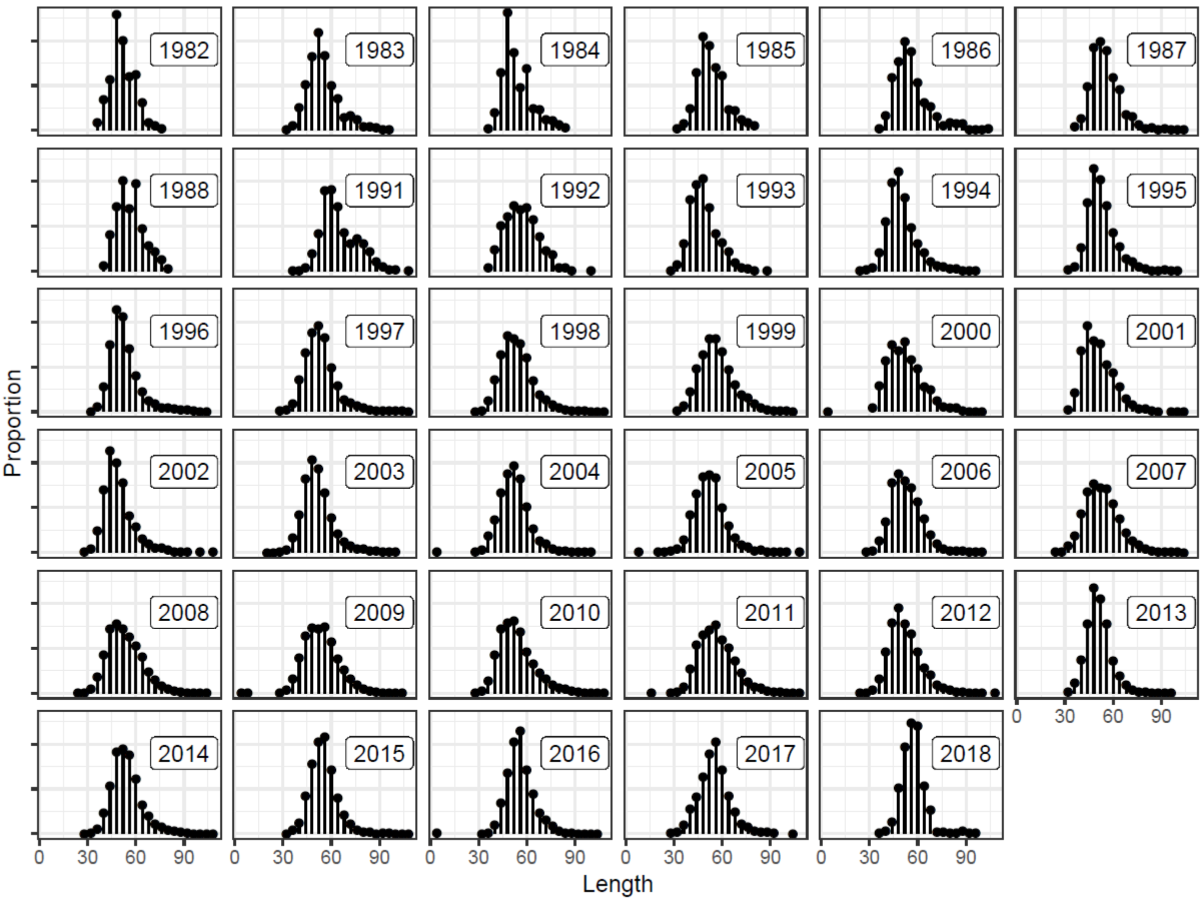

Figure 6. Tusk. Length distributions from Icelandic commercial longline catches.

Mynd 6. Keila. Lengdardreifing úr línuveiðum Íslendinga.

AGE COMPOSITIONS

Table 3 gives an overview of otolith sampling intensity by gear types from 2000 to 2017 in Icelandic waters. Since 2010 considerable effort has been put into ageing tusk otoliths, so now aged otoliths are available from 1984, 1995, 2008–2016. The age data are used as input for the Gadget assessment. It is expected that the effort in ageing of tusk will continue.

No data are available from Greenlandic waters.

Table 3. Tusk. Number of available aged otoliths from the commercial catches.

Tafla 3. Keila. Fjöldi aldursgreindra kvarna úr afla.

YEAR	LONGLINE		GILLNETS		TRAWLS	
	Samples	Measured	Samples	Measured	Samples	Measured
2005	12	1775	0	0	0	0
2006	15	2225	0	0	3	450
2007	22	3154	2	167	1	150
2008	32	4722	0	0	0	0
2009	27	3945	0	0	0	0
2010	29	4354	0	0	0	0
2011	28	4141	0	0	0	0
2012	35	5105	0	0	1	150
2013	22	3278	0	0	0	0
2014	28	3384	0	0	0	0
2015	26	3115	0	0	0	0
2016	14	1671	0	0	0	0
2017	8	1710	0	0	0	0

CATCH, EFFORT AND RESEARCH VESSEL DATA

CATCH PER UNIT OF EFFORT (CPUE) AND EFFORT DATA FROM THE COMMERCIAL FLEETS

CPUE estimates of tusk in Icelandic waters are not considered representative of stock abundance.

CPUE estimations have not been attempted on available data from Greenlandic waters.

ICELANDIC SURVEY DATA

Indices: The Icelandic spring groundfish survey, which has been conducted annually in March since 1985, covers the most important distribution area of the tusk fishery. Detailed description of the spring groundfish survey is given in the stock annex for tusk in Icelandic waters. 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 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. Figure 7 shows both a recruitment index and the trends in various biomass indices. Length distributions from the Icelandic spring survey are shown in Figure 8, where numbers-at-length are multiplied by the expected proportion mature at that length to split catch numbers into mature and immature components. Changes in spatial distribution are shown in Figures 9 and 10.

GERMAN SURVEY DATA (GREENLANDIC WATERS)

Indices: 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 is 30 minutes at 4.5 kn. (Ratz, 1999).

Data from the German survey in Greenlandic waters were available up to 2015. The trend in the German survey catches is similar to those observed in surveys in Icelandic waters. It should however be noted that the data presented in Figure 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 12.

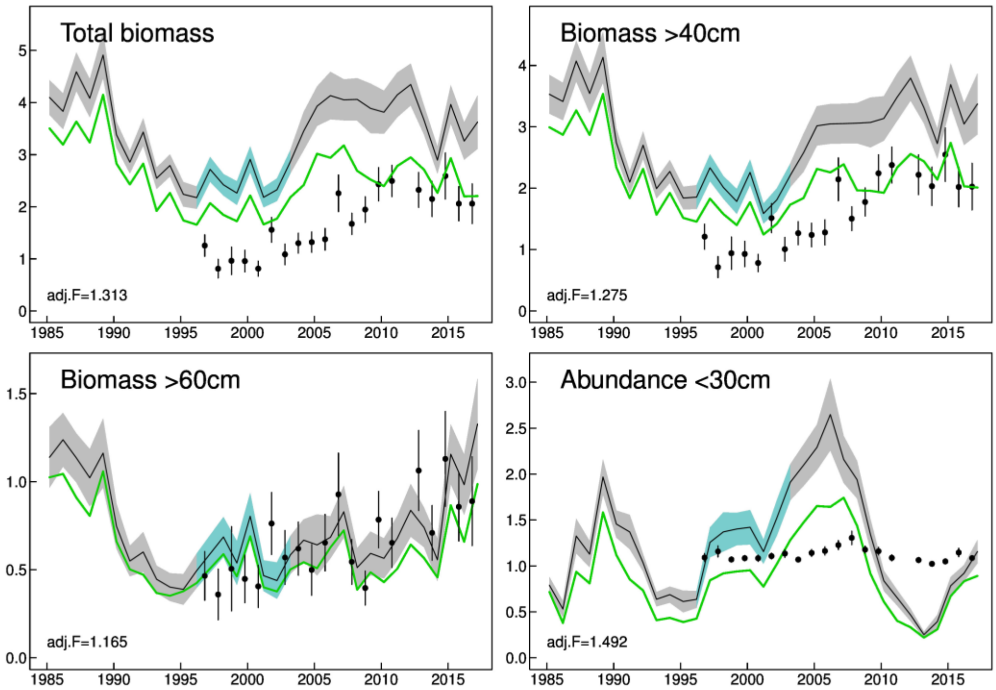

Figure 7. Tusk. a) Total biomass indices, b) biomass indices larger than 40 cm, c) biomass indices larger than 60 cm and d) abundance indices smaller than 30 cm. The lines with shaded areas show the spring survey index from 1985 and the points with the vertical lines show the autumn survey from 1997. The shaded area and vertical lines indicate +/- standard error. Green line is the index excluding the Iceland-Faroe Ridge.

Mynd 7. Keila. a) Heildarlífmassi, b) lífmassi >40 cm, c) lífmassi >60 cm og d) nýliðun (fjöldi undir 30 cm). Línur sýna niðurstöður úr stofnmælingu botnfiska að vori og punktar niðurstöður úr stofnmælingu að hausti. Skyggð svæði og lóðréttar línur sýna staðalskekkju. Græn lína sýnir vísitölur þar sem stöðvar á Íslands-Færeyjahrygg eru ekki teknar með.

Figure 8. Tusk. Length distributions (4 cm grouping) from the spring survey since 1985. Red areas are immature tusk and green represent mature tusk. Small numbers to the right refer to mean length (ML).

Mynd 8. Keila. Lengdardreifing úr stofnmælingu botnfiska að vori (4 cm lengdarhópar) síðan 1985 (rautt = ókynþroska, grænt = kynþroska).

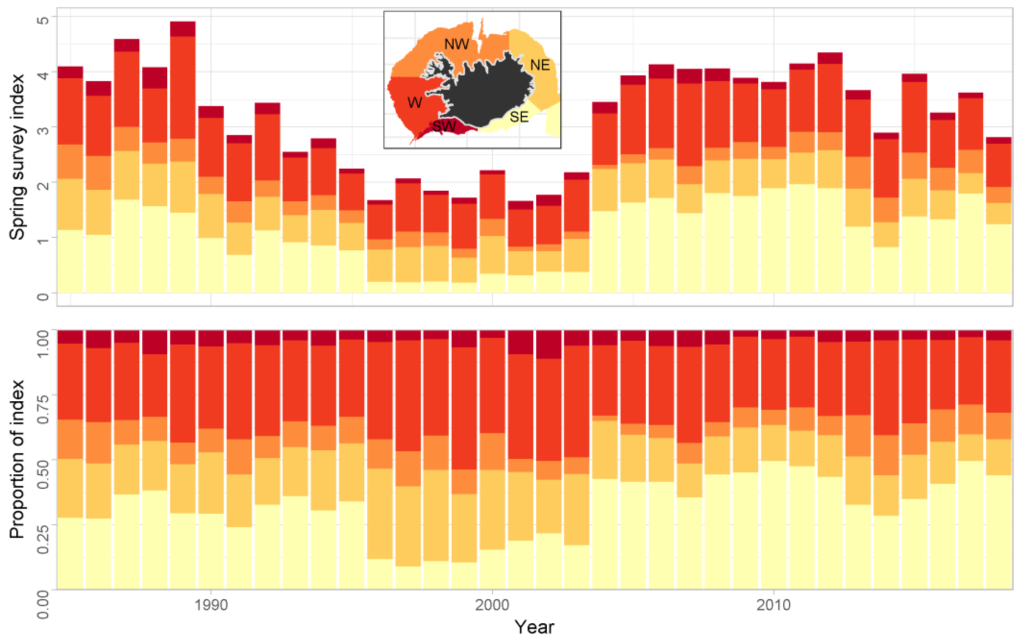

Figure 9. Tusk. Estimated survey biomass in the spring survey by year from different parts of the continental shelf (upper figure) and as proportions of the total (lower figure).

Mynd 9. Keila. Áætluð vísitala úr stofnmælingu botnfiska að vori eftir árum og svæðum landgrunnsins (efri mynd) og hlutfallsleg skipting (neðri mynd).

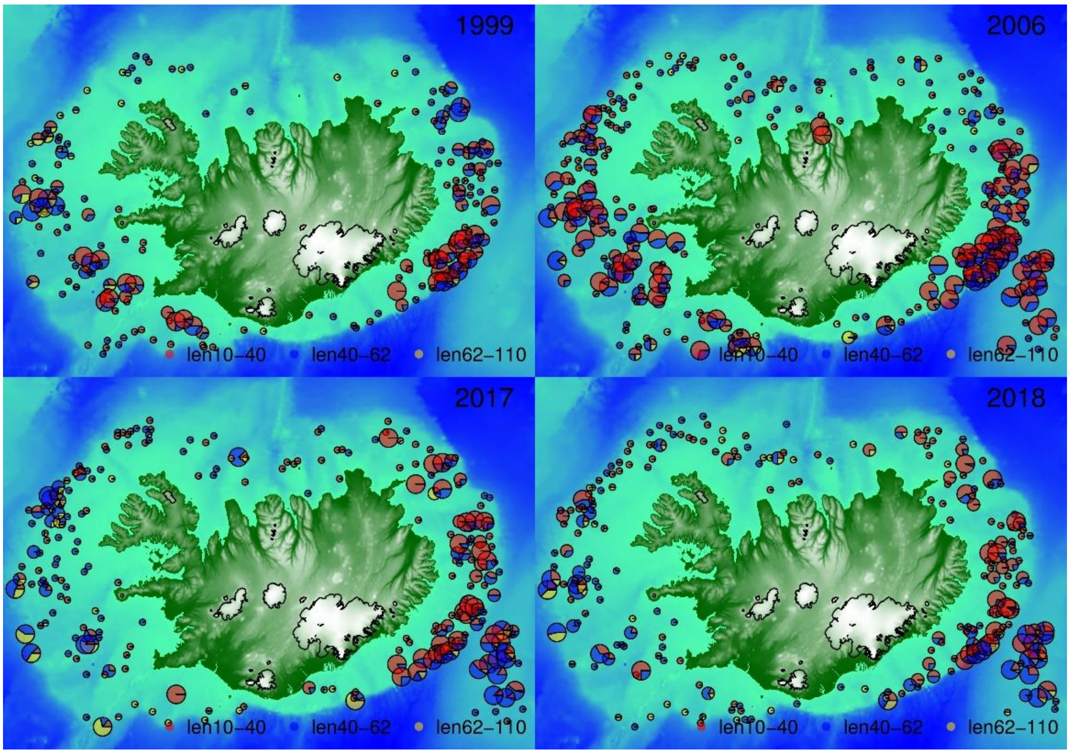

Figure 10. Tusk. Changes in spatial distribution divided by size. Size of pie is indicative of numbers of specimens caught at the tow-station.

Mynd 10. Keila. Breytingar á útbreiðslu keilu í stofnmælingu botnfiska að vori, skipt eftir lengdarflokkum. Stærð hringja fer eftir fjölda einstaklinga á hverri togstöð.

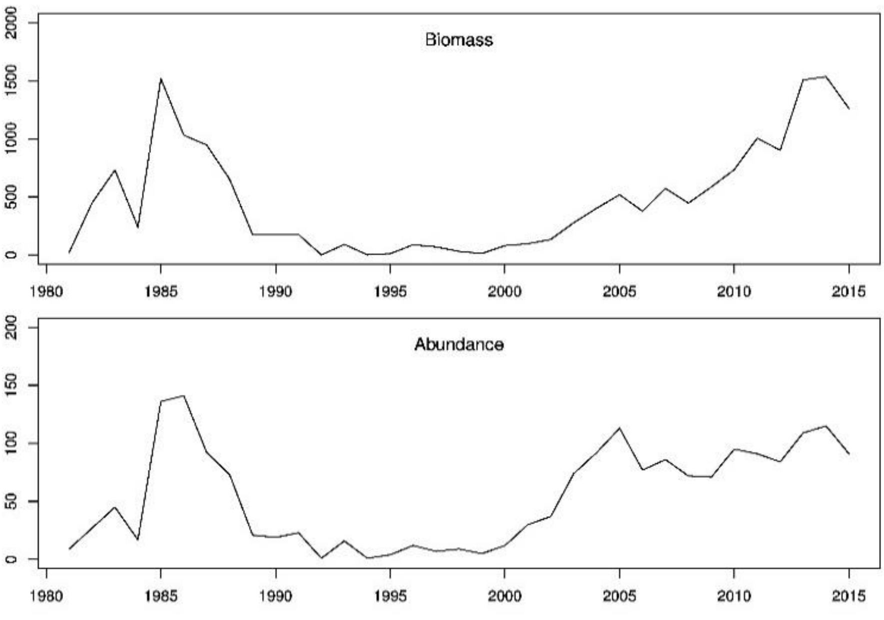

Figure 11. Tusk. Biomass and abundance estimates from the Walter Herwig survey in Greenlandic waters. The data are the total number caught converted to weight.

Mynd 11. Keila. Vísitölur lífmassa og fjölda úr stofnmælingum Þjóðverja við Grænland.

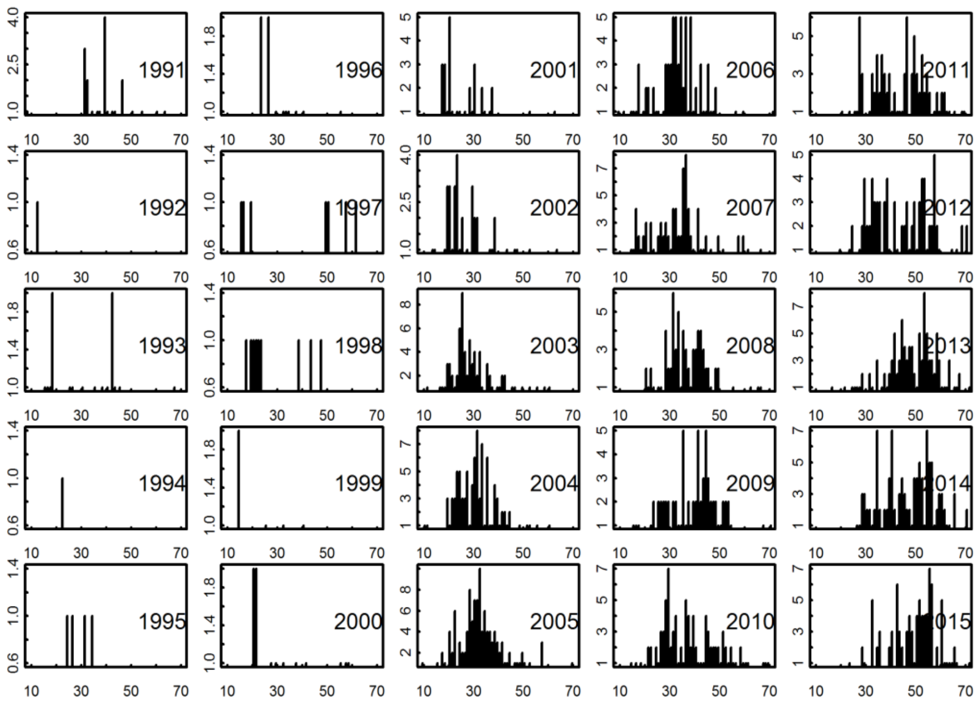

Figure 12. Tusk. Length distributions from the Walter Herwig survey in Greenlandic waters.

Mynd 12. Keila. Lengdardreifingar frá stofnmælingum Þjóðverja við Grænland.

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 Icelandic waters (Table 1). Catches decreased from around 9000 tonnes in 2010 to 2540 tonnes in 2017. This decrease is mainly because of reductions in landings by the Icelandic longline fleet and to a lesser extent Faroese and Norwegian landings (Table 6). This has resulted in less overshoot of landings relative to set TAC (see Management section), but species conversions in the ITQ system show that other species were converted to tusk last year compared to tusk being converted to other species in previous fishing years.

There are no marked changes in the length compositions since 2004, mean length in the catches ranges between 52.7 and 54.1 (Figures 6 and 9). According to the available length distributions and information on maturity only around 29% of catches in abundance and 44% in biomass are mature (Figure 8). There does seem to be a gradual increase in mean age of the age distribution from commercial catches from roughly 7 to 9. The reason for this is unknown, but given they lack a 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 Icelandic waters. Total biomass index and the biomass index for tusk larger than 40 cm (harvestable part of the stock) has remained at similar level as in since 2011 at a relatively high level (Figure 8). The same holds for the index of tusk larger than 60 cm (spawning–stock biomass index) but that index didn't increase by similar factors as the other two biomass indices. 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 industrial action the autumn survey did not take place in 2011.

When looking at the spatial distribution from the spring survey around half of the index is from the SE area (Figures 9 and 10). However only around 20 to 25% of the catches are caught in this area (Figures 2 and 3). The change in juvenile abundance between 2006 and recent years can be clearly seen in Figures 9 and 10 where in 2006 juveniles (<40 cm) were all over the southern part of the shelf but can hardly be seen in recent years.

ANALYTICAL ASSESSMENT ON LING USING GADGET

Since 2010 the Gadget model (**G**lobally applicable **A**rea **D**isaggregated **G**eneral **E**cosystem **T**oolbox, see www.hafro.is/gadget) has been used for the assessment of tusk (See stock annex for details). As part of a Harvest Control Evaluation requested by Iceland this stock was benchmarked in 2017 (WKICEMSE 2017). Several changes were made to the model setup and settings which are described in the stock annex.

DATA USED AND MODEL SETTINGS

Data used for tuning are given in the stock annex.

Model settings used in the Gadget model are described in more detail in the stock annex.

DIAGNOSTICS

OBSERVED AND PREDICTED PROPORTIONS BY FLEET

Overall the fit of the predicted proportional length distributions is close to the observed distributions (Figures 13-16). In general, for the commercial catch distributions the fit is better at the end of the time-series (Figure 15). The reason for this is there are few data at the beginning of the time-series and the model may be constrained by the initial values.

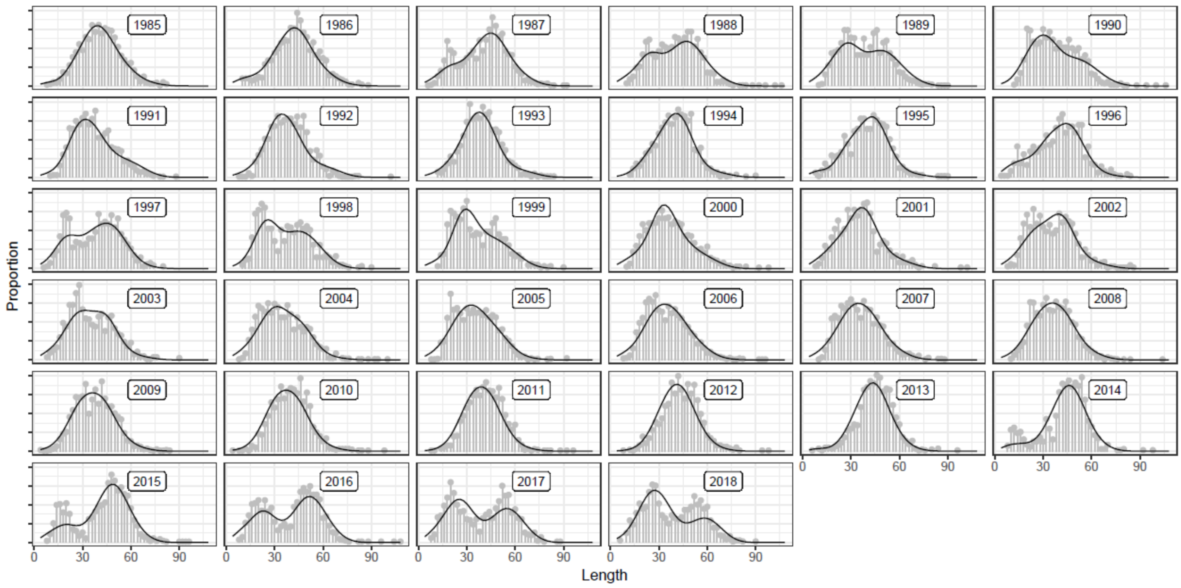

Figure 13. Tusk. Fitted proportions-at-length from the Gadget model (black lines) compared to observed proportions in the spring survey (grey lines and points).

Mynd 13. Keila. Hlutfall eftir lengdarflokkum úr Gadget líkani (svartar línur) samanborið við fengin hlutföll í vorralli (gráar línur og punktar).

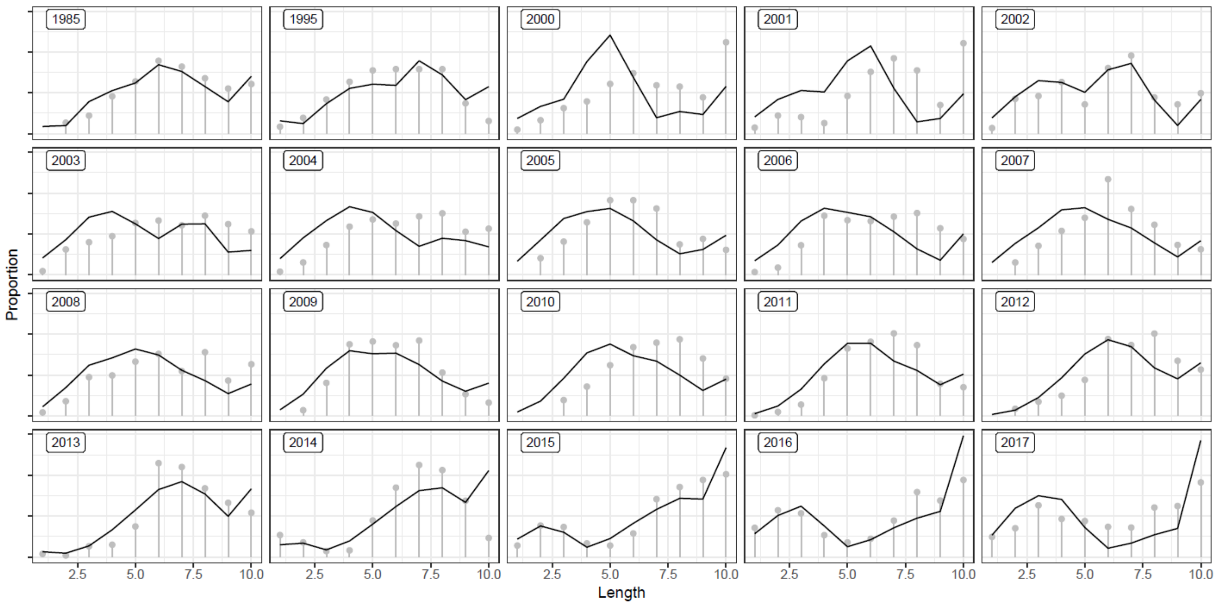

Figure 14. Tusk. Fitted proportions-at-age from the Gadget model (black lines) compared to observed proportions in the spring survey catches (grey lines and points).

Mynd 14. Keila. Hlutfall eftir aldursflokkum úr Gadget líkani (svartar línur) samanborið við fengin hlutföll í vorralli (gráar línur og punktar).

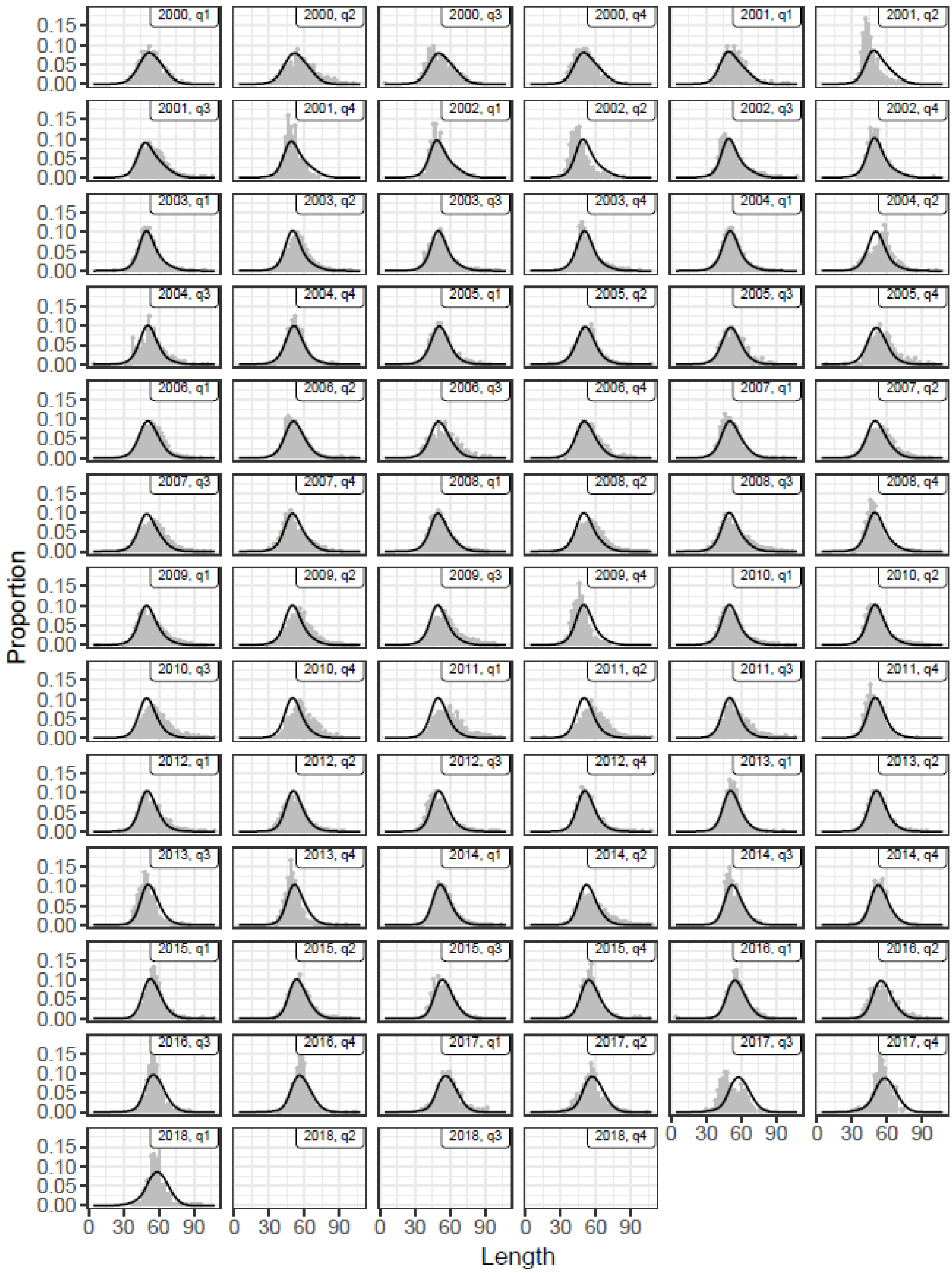

Figure 15. Tusk. Fitted proportions-at-length from the Gadget model (black lines) compared to observed proportions from longline catches (grey lines and dots).

Mynd 15. Keila. Hlutföll eftir lengdarflokkum úr Gadget líkani (svartar línur) samanborið við fengin hlutföll úr línuveiðum (gráar línur og punktar).

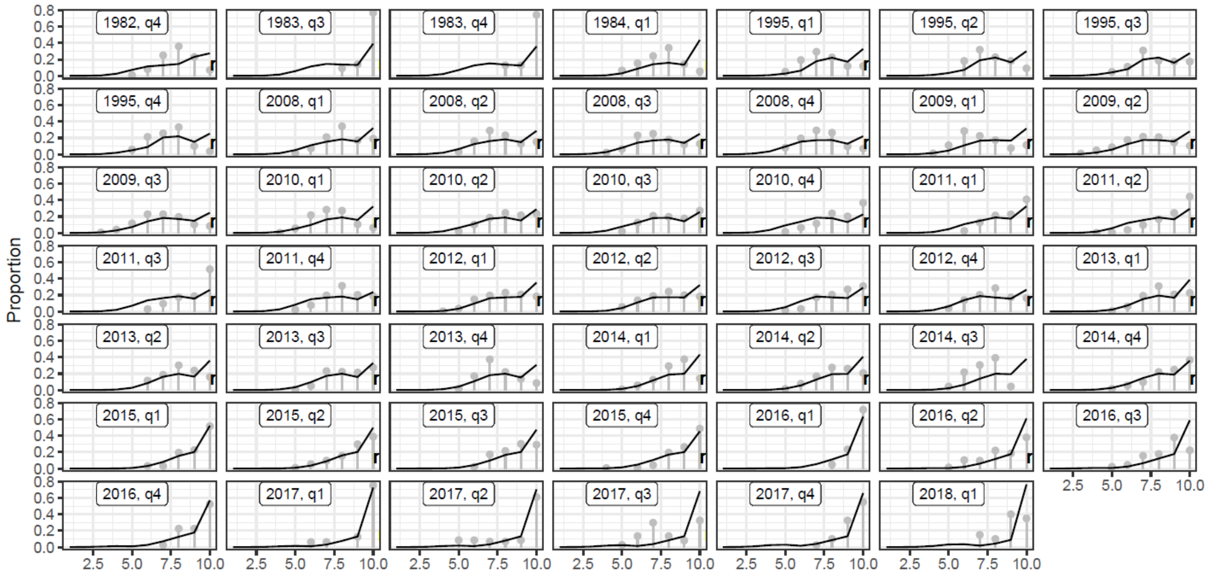

Figure 16. Tusk. Fitted proportions-at-age from the Gadget model (black lines) compared to observed proportions in longline catches (grey lines and points).

Mynd 16. Keila. Hlutfall eftir aldursflokkum úr Gadget líkani (svartar línur) samanborið við fengin hlutföll úr línuveiðum (gráar línur og punktar).

MODEL FIT

In Figure 17 the length disaggregated indices are plotted against the predicted numbers in the stock as a time-series. The correlation between observed and predicted is good for the first five length groups (10–19, 20–29, 30–39, 40–49, 50–59 and 60–69) which the first three to four are the main length groups of tusk caught in the spring survey. In the two larger length groups the fit gets progressively worse. Overall fit, when the disaggregated abundance indices and predictions are converted to biomass and summed over the length intervals is good, however the model is predicting lower biomass than the survey indicates in the terminal year (Figure 17).

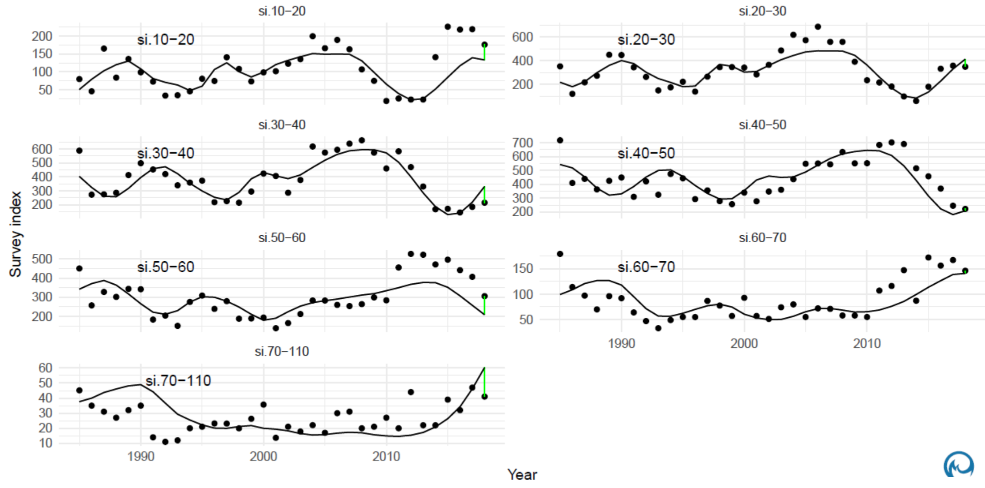

Figure 17. Tusk. Fitted spring survey index by length group from the Gadget model (black line) and the observed number of ling caught in the survey (points). The green line indicates the difference between the terminal fit and the observations.

Mynd 17. Keila. Lífmassavísitala úr Gadget líkani (svartar línur) eftir stærðarflokkum borin saman við fenginn fjölda langa í vorralli (punktar). Grænar línur sýna muninn á samsvörun gagna og líkans við lok tímabilsins.

RESULTS

The results are presented in Table 7 and Figure 18. In comparison with last year, there has been a slight downward revision of biomass levels. Recruitment peaked in 2005 to 2006 but has decreased and is estimated in 2013 to have been the lowest observed. Recruitment in 2014–2016 is estimated to be considerably higher than in 2013. Spawning–stock biomass has increased slowly since 2005. Harvestable biomass is estimated at a fairly high level compared to the rest of the time-series. Harvest rate has decreased from 0.29 in 2008 to 0.12 in 2016. Estimates reference biomass (B40+) have been stable for the last three years.

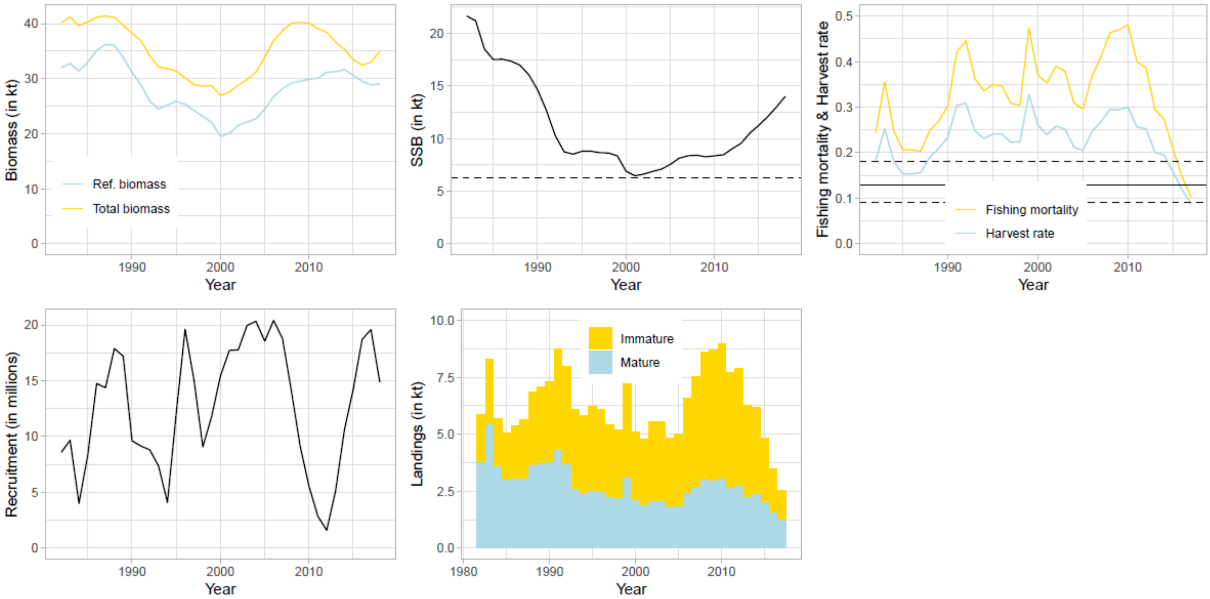

Figure 18. Tusk. Estimated biomass, spawning stock biomass (SSB), fishing mortality for fully selected fish and harvest rate, recruitment and total catches. The dashed line in the SSB plot represents Bpa. The solid line in the harvest rate plot indicates the target harvest rate used in the harvest control rule, whereas the dashed lines indicate the bounds of the realized harvest rates resulting from the harvest control rule given the uncertainty in the assessment.

Mynd 18. Keila. Áætlaður heildarlífmassi, lífmassi hrygningarstofns, dánartala og veiðidánartala, nýliðun og heildarafli. Brotin lína við lífmassa hrygningarstofns sýnir gátmörk (B_{pa}). Heil lína við veiðihlutfall sýnir það gildi sem stefnt er að með aflareglu, en brotnar línur sýna þau mörk sem búast má við vegna óvissu í stofnmati.

REFERENCE POINTS

In the past Yield-per-recruit based reference points estimated as described in the stock annex were used as proxies for F_{MSY}. F_{MAX} from a Y/R analysis is 0.24 and $F_{0.1}$ is 0.15. WGDEEP 2014 recommended using F_{MSY}=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 requested by Iceland the following reference were defined for the stock.

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

The management plan proposed by Iceland is:

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 $B_{trigger}$:

$TAC_{Y/y+1} = HR_{MGT}*B_{Ref,y}$

When SSB_Y is below MGT $B_{trigger}$:

$TAC_{Y/y+1} = HR_{MGT}* (SSB_y/MGT\ B_{trigger}) * B_{ref,y}$

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

COMMENTS ON THE ASSESSMENT

This is the second year that the assessment is conducted in a different manner than previous to the benchmark in 2017, which was done as part of Harvest Control Rule evaluation request to ICES from Iceland.

WKICEMSE 2017 noted regarding tusk in Icelandic waters (5.a) and Greenlandic waters (14):

"Catches of tusk in Greenland, within ICES Subarea 14, were discussed. Minor catches (representing <5% of the total catch of tusk in 5.a+14) have always occurred in the Greenland area and were never included in the stock assessment of tusk. However, these catches increased in 2015 and 2016, representing around 10%–15% of the total catches in those years. None of the work presented to WKICEMSE included these catches, which seem to occur well away from the area where the catches included in the stock assessment take place (i.e. in or around ICES Division 5.a). Information about these catches in the Greenland area is somewhat limited and no biological samples are available; doubts related to population structure, movement and connectivity were also noted during the discussion. It was then decided to conduct a stock assessment run incorporating those catches (just the tonnage), to gain understanding on their potential impact on stock assessment results. Their inclusion in the assessment resulted in minor revisions up-wards of the estimated stock biomass (around 1%–4% revision, on average throughout the years in the stock assessment) and downwards of the estimated harvest rate (around 0%–3% revision, on average throughout the years in the stock assessment, although with an increase of the harvest rates estimated for 2015 and 2016); the results of this run are available at the end of Section 2.2. As there are some doubts in relation to these catch data and population structure of tusk in the area, WKICEMSE did not feel that a decision to include these catches in the stock assessment at this point was appropriate before conducting additional explorations and having a better understanding. It is recommended that appropriate stock experts in WGDEEP should explore this issue further."

This was discussed at WGDEEP-2017 and the following points were raised:

- Stock structure is generally unclear when it comes to deep-water stocks and many of the stock units assessed by WGDEEP are defined based on very limited scientific knowledge.
- The current advice units of tusk are not based on genetic studies except for tusk in Rockall and on the Mid Atlantic Ridge.
- The fishing areas for tusk in Icelandic and Greenlandic waters are widely separated (see sections The Fishery and Landings Trends). However, survey data do show continuous distribution between Greenland, Iceland and the Faroe Islands.
- Genetic studies do not detect difference in tusk populations from the Barents Sea down to the Faroe Islands and over to Iceland and Greenland (Knutsen et al., 2009).
- Knutsen et al. (2009) proposed that the bathymetry over the NE-Atlantic could form a "bridge" between Norway and Greenland. However, they point out that tusk is not believed make extensive migrations and actually to be a sedentary species. Larval dispersal could account for the lack of genetic difference in tusk.
- It is highly plausible that the increased abundance of tusk seen in the Walter Herwig survey is of Icelandic origin that might have been dispersed as larvae to Greenland, similar as has been reported for cod in 5.a. However, unlike cod it is unlikely that tusk would migrate back to Ice-land.
- The tusk population in Greenland is likely to be a "sink" from the Iceland-ic population and as such should not affect the productivity of tusk in Ice-land.

Based on this WGDEEP 2017 concludes that the catches in Greenlandic waters should not be included in the assessment of tusk in Icelandic waters. Additionally, the EG concludes that the division of tusk into different advice units should be reviewed, not only in Icelandic and Greenlandic waters but for all the tusk stocks.

MANAGEMENT

The Icelandic Ministry of Industries and Innovation (MII) is responsible for management of the Icelandic fisheries and implementation of legislation. Tusk was included in the ITQ system in the 2001/2002 quota year and as such subjected to TAC limitations. At the beginning the TAC was set as recommended by MRI but has of-ten been set higher than advice. One reason is that no formal harvest rule exists for this stock. The landings, by quota year, have always exceeded the advised and set TAC but the overshot in landings has decreased from 30–40%. However, since the 2011/2012 fishing year the overshoot in landings has decreased to 6–16% apart from 2014/2015 when it was 34% (Table 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, for the last three fishing years, managers have to some extent taken into account the foreign catches (see below). The tusk advice given by MFRI and ICES for each quota year is, however, for all catches, including foreign catches. During the 2005/2006 to 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 net transfer of other species being changed to tusk quota.

There are agreements between Iceland, Norway and the Faroe Islands relating to a fishery of vessels in restricted areas within the Icelandic EEZ. Faroese vessels are allowed to fish 5600 tonnes of demersal fish species in Icelandic waters which includes maximum 1200 tonnes of cod and 40 tonnes of Atlantic halibut. The rest of the Faroese demersal fishery in Icelandic waters is mainly directed at tusk, ling and blue ling. Further description of the Icelandic management system can be found in the stock annex.

Table 4. Tusk. Advice given by MFRI, set national TAC by the Ministry of Fisheries and Agriculture and landings by fishing year (1st of September–31st of August).

Tafla 4. Keila. Ráðgjöf Hafrannsóknastofnunar, ákvörðun stjórnvalda um aflamark Íslendinga og landaður afli eftir fiskveiðiárum.

FISHING YEAR	MFRI–ADVICE	NATIONAL–TAC	LANDINGS
2001/02		4500	**4876**
2002/03	3500	3500	**5046**
2003/04	3500	3500	**4958**
2004/05	3500	3500	**4901**
2005/06	3500	3500	**5928**
2006/07	5000	5000	**7942**
2007/08	5000	5500	**7279**
2008/09	5000	5500	**8162**
2009/10	5000	5500	**8382**
2010/11	6000	6000	**7777**
2011/12	6900	7000	**7401**
2012/13	6700	6400	**6833**
2013/14	6200	5900	**5881**
2014/15	4000	3700	**4958**
2015/16	3440	3000	**4121**
2016/17	3780	3100	**2418**
2017/18	4370	3770	
2018/19	3776		

MFRI-ADVICE

The advice for 2019 states: MFRI advises on the basis of an MSY approach that catches should be no more than 3776 t. All catches are assumed to be landed.

MANAGEMENT CONSIDERATIONS

Increased catches in Greenlandic waters from less than 100 tonnes in previous year to 980 tonnes in 2015, and about 559 tonnes in 2017 are of concern (see previous section).

The signs from commercial catch data and surveys indicate that the total biomass of tusk in Icelandic waters is stable. This is confirmed in the Gadget assessment. Recruitment is on the increase again after a low in 2013. However due to reduction in fishing mortality harvestable biomass and SSB seem to be either stable or slowly increasing.

Due to the selectivity of the longline fleet catching tusk 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 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.

Table 5. Tusk. Catches by country (Source STATLANT) in Icelandic waters.

Tafla 5. Keila. Afli á Íslandsmiðum flokkað eftir þjóðum.

YEAR	FAROE	DENMARK	GERMANY	ICELAND	NORWAY	UK	TOTAL
1980	2873	0	0	3089	928	0	**6890**
1981	2624	0	0	2827	1025	0	**6476**
1982	2410	0	0	2804	666	0	**5880**
1983	4046	0	0	3469	772	0	**8287**
1984	2008	0	0	3430	254	0	**5692**
1985	1885	0	0	3068	111	0	**5064**
1986	2811	0	0	2549	21	0	**5381**
1987	2638	0	0	2984	19	0	**5641**
1988	3757	0	0	3078	20	0	**6855**
1989	3908	0	0	3131	10	0	**7049**
1990	2475	0	0	4813	0	0	**7288**
1991	2286	0	0	6439	0	0	**8725**
1992	1567	0	0	6437	0	0	**8004**
1993	1329	0	0	4746	0	0	**6075**
1994	1212	0	0	4612	0	0	**5824**
1995	979	0	1	5245	0	0	**6225**
1996	872	0	1	5226	3	0	**6102**
1997	575	0	0	4819	0	0	**5394**
1998	1052	0	1	4118	0	0	**5171**
1999	1035	0	2	5794	391	2	**7224**
2000	1154	0	0	4714	374	2	**6244**
2001	1125	0	1	3392	285	5	**4808**
2002	1269	0	0	3840	372	2	**5483**
2003	1163	0	1	4028	373	2	**5567**
2004	1478	0	1	3126	214	2	**4821**
2005	1157	0	3	3539	303	41	**5043**
2006	1239	0	2	5054	299	2	**6596**
2007	1250	0	0	5984	300	1	**7535**
2008	959	0	0	6932	284	0	**8175**
2009	997	0	0	6955	300	0	**8252**

2010	1794	0	0	6919	263	0	**8976**
2011	1347	0	0	5845	198	0	**7390**
2012	1203	0	0	6341	217	0	**7761**
2013	1092	0.12	0	4973	192	0	**6257**
2014	728	0	0	4995	306	0	**6029**
2015	625	0	0	4000	198	0	**4823**
2016	543	0	0	2649	302	0	**3494**
2017*	**492**	**0**	**0**	**1833**	**216**	**0**	**2540**

***Preliminary.**

Table 6. Catches by country (Source STATLANT) in Greenlandic waters.

Tafla 6. Afli á Grænlandsmiðum flokkað eftir löndum.

YEAR	FAROE	DENMARK	GREENLAND	GERMANY	ICELAND	NORWAY	RUSSIA	SPAIN	UK	TOTAL
1980	0	0	0	13	0	0	0	0	0	**13**
1981	110	0	0	10	0	0	0	0	0	**120**
1982	0	0	0	10	0	0	0	0	0	**10**
1983	74	0	0	11	0	0	0	0	0	**85**
1984	0	0	0	5	0	58	0	0	0	**63**
1985	0	0	0	4	0	0	0	0	0	**4**
1986	33	0	0	2	0	0	0	0	0	**35**
1987	13	0	0	2	0	0	0	0	0	**15**
1988	19	0	0	2	0	0	0	0	0	**21**
1989	13	0	0	1	0	0	0	0	0	**14**
1990	0	0	0	2	0	7	0	0	0	**9**
1991	0	0	0	2	0	68	0	0	1	**71**
1992	0	0	0	0	3	120	0	0	0	**123**
1993	0	0	0	0	1	39	0	0	0	**40**
1994	0	0	0	0	0	16	0	0	0	**16**
1995	0	0	0	0	0	30	0	0	0	**30**
1996	0	0	0	0	0	157	0	0	0	**157**
1997	0	0	0	0	10	9	0	0	0	**19**
1998	0	0	0	0	0	12	0	0	0	**12**
1999	0	0	0	0	0	8	0	0	0	**8**
2000	0	0	0	0	11	11	0	3	0	**25**
2001	3	0	0	0	20	69	0	0	0	**92**
2002	4	0	0	0	86	30	0	0	0	**120**
2003	0	0	0	0	2	88	0	0	0	**90**
2004	0	0	0	0	0	40	0	0	0	**40**
2005	7	0	0	0	0	41	8	0	0	**56**
2006	3	0	0	0	0	19	51	0	0	**73**
2007	0	0	0	0	0	40	6	0	0	**46**
2008	0	0	33	0	0	7	0	0	0	**40**
2009	12	0	15	0	0	5	11	0	0	**43**
2010	7	0	0	0	0	5	0	0	0	**12**
2011	20	0	0	0	131	24	0	0	0	**175**
2012	33	0	0	0	174	46	0	0	0	**253**
2013	1.9	0.3	0	0	0	23.8	0	0	0	**26**
2014	2	0	0	0	0	26	0	0	0	**28**
2015	670	0.1	166	0	0	62	0	0	0	**898**
2016	111	0	182	0	0	178	0	0	0	**471**
2017*	83	0.38	335	0	0	141	0	0	0	**559**

***Preliminary.**

Table 7. Results from the Gadget assessment. Estimates of biomass, biomass 40+ cm, spawning–stock biomass (SSB) in thousands of tonnes and recruitment (millions), harvest rate (HR) and fully selected fishing mortality.

Tafla 7. Niðurstöður úr Gadget stofnmati. Áætlaður heildarlífmassi, lífmassi 40 cm og stærri, hrygningarstofns (SSB) í þúsundum tonna og nýliðun (milljónir), veiðidánartala og dánartala.

YEAR	BIOMASS	B75	SSB	REC3	CATCH	HR	F
1982	40.18	32.02	21.65	12.23	5.88	0.18	0.24
1983	41.19	32.75	21.20	8.57	8.29	0.26	0.36
1984	39.64	31.40	18.50	7.53	5.69	0.18	0.25
1985	40.30	33.00	17.51	7.15	5.06	0.15	0.21
1986	41.17	35.13	17.55	2.96	5.38	0.15	0.21
1987	41.38	36.22	17.36	6.19	5.64	0.15	0.20
1988	41.13	36.07	16.98	10.92	6.86	0.19	0.25
1989	39.68	33.83	16.08	10.64	7.08	0.21	0.27
1990	38.28	31.19	14.64	13.24	7.30	0.24	0.30
1991	36.89	28.86	12.66	12.73	8.76	0.31	0.42
1992	34.15	25.91	10.27	7.12	8.00	0.31	0.45
1993	32.12	24.49	8.74	6.77	6.07	0.24	0.36
1994	31.82	25.23	8.52	6.52	5.83	0.22	0.34
1995	31.36	25.85	8.79	5.44	6.23	0.24	0.35
1996	30.14	25.34	8.80	3.03	6.10	0.24	0.35
1997	28.95	24.20	8.67	8.97	5.40	0.22	0.31
1998	28.62	23.14	8.63	14.52	5.17	0.23	0.30
1999	28.70	22.06	8.37	11.15	7.23	0.34	0.47
2000	26.92	19.49	6.89	6.71	5.08	0.26	0.37
2001	27.56	20.07	6.46	8.75	4.81	0.23	0.35
2002	28.85	21.49	6.62	11.44	5.55	0.25	0.39
2003	29.80	22.12	6.88	13.12	5.57	0.25	0.38
2004	31.19	22.71	7.09	13.15	4.82	0.21	0.31
2005	33.86	24.47	7.55	14.78	5.01	0.20	0.30
2006	36.89	26.76	8.14	15.05	6.60	0.24	0.37
2007	38.77	28.17	8.37	13.73	7.54	0.27	0.41
2008	40.02	29.20	8.42	15.11	8.63	0.29	0.46
2009	40.24	29.51	8.27	13.90	8.68	0.30	0.47
2010	40.12	29.92	8.36	10.46	8.98	0.30	0.48
2011	39.09	30.06	8.46	6.76	7.70	0.25	0.40
2012	38.48	31.17	9.04	4.11	7.87	0.25	0.39
2013	36.63	31.27	9.54	2.11	6.26	0.20	0.29
2014	35.35	31.65	10.53	1.18	6.16	0.20	0.27
2015	33.43	30.63	11.26	3.79	4.84	0.16	0.21
2016	32.47	29.53	12.09	7.84	3.49	0.12	0.15
2017	32.98	28.85	13.01	10.55	2.54	0.088	0.10
2018	34.85	29.05	14.02	13.85			