16 Cod (*Gadus morhua*) in ICES Subarea 14 and NAFO Division 1.F (East Greenland, South Greenland)

16.1 Stock definition

The cod found in Greenland is derived from four separate "stocks" that each is labelled by their spawning areas: I) offshore West Greenland waters; II) West Greenland fiords; III) offshore East Greenland and Icelandic waters and IV) inshore Icelandic waters (Therkildsen *et al.*, 2013), (Figure 16.1).

From 2012 the inshore component (West Greenland, NAFO Subarea 1) was assessed separately from all offshore components. From 2016 the offshore West Greenland (NAFO subdivisions 1A–E) and East Greenland (NAFO Subdivision 1F and ICES Subarea 14) components was assessed separately. The Stock Annex provides more details on the stock identities including the references to primary works.

16.2 Scientific data

16.2.1.1.1.1 Fishery

16.2.1.1.1.2 Historical trends in landings and fisheries

The Greenland commercial cod fishery in East Greenland started in 1954 but started earlier in Southwest Greenland (NAFO Subdivision 1F, Table 16.2.1, Figure 16.2.1). The fishery gradually developed culminating with catch levels above 40 000 tonnes annually in the 1960s. Due to overfishing, deteriorating environmental conditions and emigration to Iceland the stock size declined and the fishery completely collapsed in the early 1990s. More details on the historical development in the fisheries are provided in the stock annex.

16.2.1.1.1.3 The present fishery

TAC for 2019 was set at 20 000 t. The TAC was divided between the following countries and management areas (se section 16.12 for definition of management areas):

Management Area	TAC (tons)	Country
403 (Q1Q2)	9 638	Greenland
404 (Q3Q4)	3 340	Greenland
403+404	4 525	EU (2 000 t), Faeroes Island (1 325 t) and Norway (1 200 t)
415 (Q5Q61F)	2 497	Greenland

In 2019 a total of 18 074 tons with 1 667 tons caught in South Greenland (NAFO 1F + Q5Q6) and 16 406 tons caught in East Greenland (Tables 16.2.1 and 16.2.2).

Trawlers fished 77% of the total catch (Table 16.2.3, Figure 16.2.1) almost exclusively (80%) on Dohrn Bank in a small area between 65–66°N ; 29–31°W on the edge of the continental shelf close to the EEZ to Iceland. The longlining fishery was more evenly distributed than the trawl fishery and extended from Julianehåbs Bight in SouthWest Greenland (60°N, 1F) to Dohrn Bank (66°N, Q1Q2) in East Greenland (Figure 16.2.2 and 16.2.3). A detailed description of the fishery in 2019 is found in Retzel 2020.

16.2.1.1.1.4 Catch-at-age

The 2009 and older YC's dominated the total catches (Table 16.2.4, Figure 16.2.4). Younger fish of yearclass 2014 (age 5) is dominating the catch in SouthWest Greenland (NAFO 1F) whereas the oldest of ages 10+ is dominating the catch on Dohrn Bank (Q1Q2, table 16.2.5). The general pattern is that large fish (> 9 year old, mean length 85 cm) dominate the catch furthest to the north on Dorhn Bank and smaller fish (ages 5-6 years, mean length 64 cm) dominated the catch in South Greenland (Figure 16.2.5).

16.2.1.1.1.5 Weight-at-age

Annual weight-at-age are obtained from sampling on board fishing vessels since 2005, see stock annex for further details.

16.2.1.1.1.6 Maturity-at-age

Maturity at age is fixed for 1973-2017 and is based on samples from an experimental fishery in the spawning areas in 2007 (see stock annex for further details). Since 2018 a separate ogive was estimated based on cod sampled from an experimental fishery in the same spawning area as in 2007 (GINR, 2018). The two maturity ogives were similar.

16.2.1.1.1.7 Surveys

Two offshore bottom trawl surveys (Greenlandic and German) are conducted in the offshore region of Greenland. The German survey targets mainly cod and has since 1982 covered the main cod grounds off both East and West Greenland at depths down to 400 m. The Greenland survey in West Greenland targets shrimp and cod down to 600 m. The Greenland survey is believed to provide a better coverage of the cod distribution in especially East Greenland as the survey has twice as many stations covering both shelf edge and top, whereas the stations in the German survey are usually concentrated at the shelf edge. For details of survey design see stock annex.

16.2.1.1.1.8 Greenland Shrimp and Fish survey

No survey was carried out in 2018 and 2019 as the Greenland research vessel (Paamiut) was scrapped. However West Greenland, including NAFO 1F (South West Greenland), was surveyed by a hired vessel with same gear rigging.

Number of hauls in NAFO 1F was 24 in 2019 compared to 35 in 2018 (table 16.2.6). The abundance and biomass indices in 2019 in NAFO 1F are low compared to the time series (tables 16.2.7 and 16.2.8). The 2015 yearclass (age 4) is dominating the survey in 2019 in NAFO 1F (table 16.2.9). Further results from the survey time series, including 2018 and 2019 results from NAFO 1F, can be seen in table 16.2.10 and figures 16.2.6 and 16.2.7.

16.2.1.1.1.9 German groundfish survey

No survey was carried out in 2018 due to mechanical problems.

In 2019, 78 valid trawl stations were sampled during the autumn in the German Greenland offshore groundfish survey (table 16.2.11). The abundance indices amounted to 15 mill. individuals

and was highest in NAFO 1F (strata 4, table 16.2.12, figure 16.2.8). The 2015 yearclass (age 4) dominated the survey, followed by the 2014 yearclass (age 5, table 16.2.14). The 2015 yearclass dominated the survey especially in SouthGreenland (strata 4 and 5), but on Dohrn Bank (strata 9) much older fish of yearclass 2010 (age 9) and older dominated the survey (table 16.2.15). A detailed description of the survey in 2019 is found in Werner & Fock 2020.

16.2.1.1.1.10 Catch-at-age

During exploration of the survey data for the analytical assessment, it became clear that a substantial discrepancy between the German and the Greenland age-readings of cod otoliths exists. That became obvious, because mean weight-at-age data from both surveys differed systemically between German mean-weights-at-age, which were always considerably higher than the Greenlandic ones. An otolith exchange in order to compare age readings between both Institutes was conducted in the spring 2018 and showed that age readings of the same set of otoliths showed a one-year systemic difference between both institutes. Age readings were on average one year older for the same fish as read by the Greenlandic institute compared to the German institute (Hedeholm, 2018).

To investigate the issue a workshop on age reading of cod in Greenland was arranged with participants from the Greenland Institute of Natural Resources and the Thünen Institute of Sea Fisheries in Germany (Retzel, 2019). The Icelandic Marine and Freshwater Research Institute hosted the workshop that was held January 8-9, 2019, Reykjavik, Iceland. The cause for the discrepancy was identified as the German Institute not reading the last wintering on the edge of the otolith. Afterwards CAA were calculated for the German survey based on Greenland age-length keys in order to identify in which period age readings went wrong by the German Institute (Retzel, 2019). It was recommended that the German Institute reread their survey otolith from 2011 and onwards. By the time of the 2019 NWWG meeting the otoliths from the German surveys in 2016 and 2017 had been reread but there were still considerable differences in weight-at-age (Werner & Fock, 2019). By the time of the 2020 NWWG no further years in the German survey had been reread and the difference in weight-at-age not resolved. It is recommended that a data exchange with updated age readings take place between Germany and Greenland in order to resolve the issue.

16.3 Tagging

An extensive analysis of tagging results from the period 2003–2016 suggest that 50% of cod in East Greenland migrate to Iceland (Hedeholm, 2018). This has been incorporated in the assessment (ICES, 2018).

16.4 Methods

The stock was benchmarked in 2018 (ICES, 2018). It was decided to use the SAM model and perform an analytical assessment. Hence, the assessment was upgraded from a category 3 (Data Limited Stock) to a category 1 stock. This is considered a vast improvement, as all data are now utilized, and the assessment is presented with uncertainty estimates and multiple catch options.

16.5 Reference points

Reference points were defined at IBPGCod (ICES, 2018). The estimations were conducted in EQSIM according to ICES guidelines (see ICES (2018) for details). The reference points are shown in Table 16.5.1.

16.6 State of the stock

The offshore component has been decreasing the last six years. However, the surveys indicate an improvement in recruitment with all year classes since 2002 and estimated at sizes above the very small year classes seen in the 1990s. These YC's has led to a stock increase during the 00s and an increase in catches. Since 2014 the spawning stock biomass (SSB) has decreased and recruitment has been low.

The number of recruits estimated by SAM in 2019 is equal to the number of recruits in 2017 and 2018. The explanation for this is that no survey was carried out in 2018 and that number 1- and 2-years old cod was caught in the German survey in 2019 was zero. SAM handle such a situation that no information are available since 2017 and the value for the latest year with information is applied for the two coming years without new information. Consequently, the confidence limits of the number of recruits increase considerably in these two years.

According to the results from the SAM model $F_{5–10}$ has been below F_{MSY} during the last two to three decades but is above F_{MSY} in 2019. The spawning-stock biomass (SSB) increased to above MSY $B_{trigger}$ from 2005 and has decreased since 2014 but is still above MSY $B_{trigger}$.

16.7 Short term forecast

The State-space model (SAM) was applied for the offshore cod stock in ICES Division 14. and NAFO Division 1F (Riget *et al*., 2020).

16.7.1.1.1.1 Input data

The SAM model provides predictions that carry the signals from the assessment into the short term forecast. The forecast procedure starts from the last year's estimate of the state (log(N) and log(F)). One thousand replicates of the last state are simulated from the estimated joint distribution. Each of these replicates are then simulated forward according to the assumptions and parameter estimates found by the assessment model.

In the forward simulations a 5 year average (up to the assessment year) is used for catch mean weight, stock mean weight, proportion mature, and natural mortality. Recruitment is re-sampled from the entire time series. In each forward simulation step the fishing mortality is scaled, such that the median of the distribution is matching the requirement in the scenario (e.g. hitting a specific mean F value, a specific catch or level of SSB).

16.7.1.1.1.2 Results

Number at age and F at age estimated by SAM are shown in Table 16.7.1 and 16.7.2, respectively. The TAC for 2020 are set to 18 824 t and we assumed that managers will keep the already set TAC rather than following the advice. However, catching 18 824 t in 2020 implies a F on 1.333 which may be unrealistic high. Therefore, the catch will be followed through the year and if necessary a new national advice will be given. The forecasts for the assumption Catch = TAC_{2020}(18 824 t) from the different scenarios are presented in Table 16.7.3.

16.8 Long term forecast

No long term forecast was performed for this stock.

16.9 Uncertainties in assessment and forecast

There is no incentive to discard fish or misreport catches under the current management system. In 2018 no survey data were available, and in 2019 German survey data were available but no Greenland survey data. This add uncertainties to the assessment.

The model fits the data relatively well Figure 16.9.1. The retrospective runs show no patterns and all inside the model 95% confidence intervals. However, the Mohn's rho measure of uncertainty were high in case of $F_{5–10}$ (0.387) and recruits (-0.424). It is likely linked to the lack of surveys in 2018 and lack of the Greenland survey in 2019. In the coming years both the Greenland and the German surveys are expected to be performed, and that this will results in decreasing of the Mohn's rho again in future assessments. The Mohn's rho for SSB was estimated as -0.188.

16.10 Comparison with previous assessment and forecast

The analytical assessment model (SAM) was accepted at the benchmark January 2018 (ICES 2018) and only two years of the analytical assessment exist. In the years before the advice was based on a DLS assessment. Compared to last year assessment the SSB annual estimates has been up-scaled for the last 10-12 years equivalent to a year class pass trough the assessment. Some up-scaling has also happened in the number of recruits especially large year class such as the 2003-year class. Furthermore, the values of Mohn's rho of the retrospective has increased considerably in this year assessment. This has resulted in a relative high increase (79%) of the MSY based advice and assuming the catch in 2020 equal to the TAC. These changes are likely linked to the incomplete survey data in 2018 and 2019. In 2018 no survey was performed and in 2019 only the German survey was carried out. In the future years it is expected that both surveys will be performed as earlier, and that the assessment will become more robust again.

16.11 Implemented management measures for 2020

The offshore quota for the total international fishery is set at 18 824 t. The following table shows the distribution of the TAC across management areas and countries

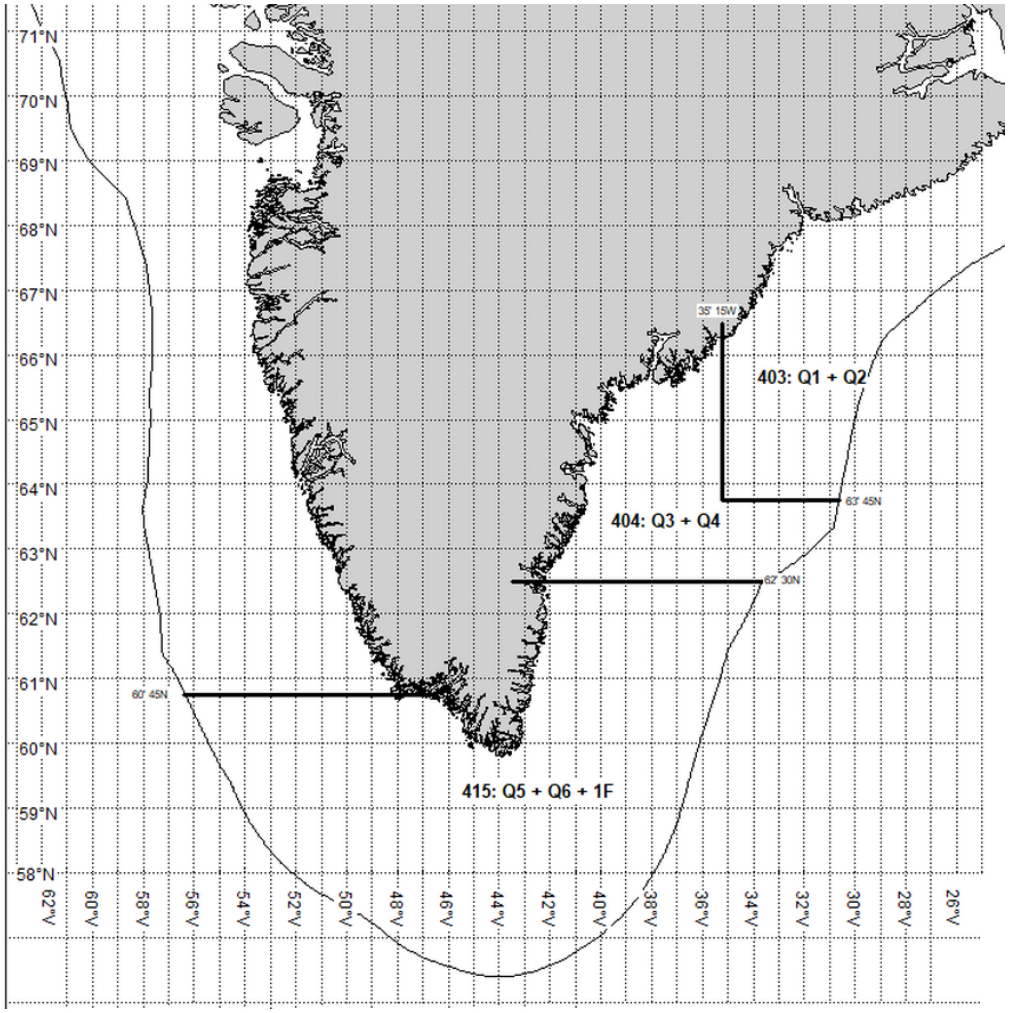
Area	TAC (tons)	Countries
403 (Q1Q2, Dohrn Bank)	9 226	Greenland
404 (Q3Q4, Kleine Bank)	2 524	Greenland
403+404 (Dohrn Bank + Kleine Bank)	4 800	EU (1 950 t) Faeroes Island (1 500 t) Norway (1 350 t)
415 (South Greenland)	2 274	Greenland

To protect the spawning stock no fishing is allowed from 1 March to 31 May in a square in area 404 (Kleine Bank, see figure below).

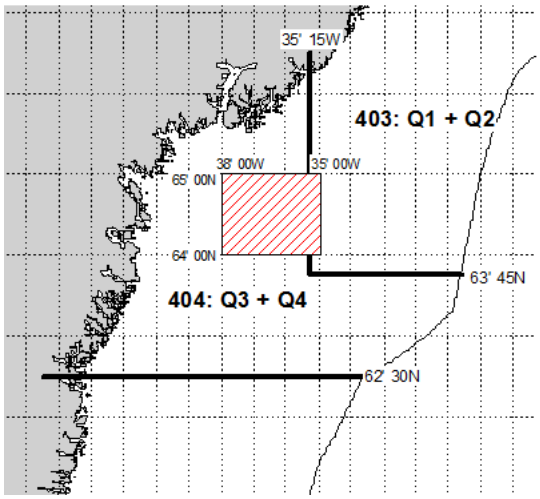
16.12 Management plan

In 2020, a management plan was implemented for the offshore cod fishery in Greenland but it has not been evaluated by ICES. The management plan distinguished between 3 areas: 403 comprising Dohrn Bank, 404 comprising Kleine Bank and 415 comprising South Greenland. The

management plan tries to take the scientific advice, migration to Iceland and protection of spawning grounds into account.



In order to protect the spawning stock it is not allowed to fish from 1 March to 31 May in a square comprising Kleine Bank:



16.13 Management considerations

Larger and older fish (8+ year old) are located furthest to the north on Dohrn Bank, whereas younger fish dominate in the South (5–6 year old). This reflects the eastward migration behaviour towards the spawning grounds in East Greenland and Iceland. Further, the genetic studies combined with tagging results suggest that the spawning stock component in East Greenland is associated with the offshore spawning population in Iceland. Tagging suggest that a substantial part of the cod in East Greenland migrate to Iceland.

16.14 Basis for advice

The State-space model (SAM) was applied for the offshore cod stock in ICES Division 14. and NAFO Division 1F (Riget *et al*., 2020).

16.15 Benchmark 2022

Analytical model (SAM) is used in assessment. A century of tagging studies has documented substantial migration from Greenland to Iceland of mature cod, and especially the East and South Greenland area is highly influenced by the inflow of egg and larvae from the spawning grounds in Iceland. This is currently solved in the model by increasing M. The inflow of recruits from outside the assessment area influences the SSB-R relationship which is characterized as Type 2 and a segmented regression results in a very low B_{lim}. The aim of the benchmark is to investigate if including more years in the assessment (years with stable recruitment from spawning stock in the assessment area) and ree-valuate the SSB-R relationship B_{lim} could be redefined.

Based on genetic analysis it is not possible to distinguish between an East Greenland and Icelandic offshore stock and especially the East and South Greenland area is highly influenced by the inflow of egg and larvae from the spawning grounds in Iceland. The potential for developing a combined assessment model for the East Greenland and Icelandic cod stocks requires robust methods for splitting up or combining catch-at-age and survey at age among areas. To gain further insight into stock structure and migration patterns across areas targeted work using both genetic and tagging data is needed.

The Greenland and German trawl surveys are fundamental to the assessment of cod in East Greenland. The two surveys provide similar signals and similar age compositions, but the mean weights-at-age differ considerably. A workshop in 2019 identified wrong age-readings in the German survey, but even after age-readings in the German survey have been corrected the difference in mean weight-at-age persist. In addition several inconsistencies in survey calculations have been identified in the German survey. A dedicated workshop prior to the benchmark to identify and solve these data issues is16.15 strongly recommended.

16.16 References

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16.17 Tables

Table 16.2.1. Offshore catches (t) divided into NAFO divisions in West Greenland and East Greenland (ICES 14.b). 1924–1995: Horsted 2000, 1995–2000: ICES Catch Statistics, 2001–present: Greenland Fisheries License Control.

Year	NAFO 1A	NAFO 1B	NAFO 1C	NAFO 1D	NAFO 1E	NAFO 1F	Unknown NAFO div.	ICES 14.b	NAFO 1F + ICES 14.b
1924							200		
1925							1871		
1926							4452		
1927							4427		
1928							5871		
1929							22304		
1930							94722		
1931							120858		
1932							87273		
1933							54351		
1934							88422		
1935							65796		

Year	NAFO 1A	NAFO 1B	NAFO 1C	NAFO 1D	NAFO 1E	NAFO 1F	Unknown NAFO div.	ICES 14.b	NAFO 1F + ICES 14.b
1936							125972		
1937							90296		
1938							90042		
1939							62807		
1940							43122		
1941							35000		
1942							40814		
1943							47400		
1944							51627		
1945							45800		
1946							44395		
1947							63458		
1948							109058		
1949							156015		
1950							179398		
1951							222340		
1952	0	261	2996	18188	707	37905	257488		

Year	NAFO 1A	NAFO 1B	NAFO 1C	NAFO 1D	NAFO 1E	NAFO 1F	Unknown NAFO div.	ICES 14.b	NAFO 1F + ICES 14.b
1953	4546	46546	10611	38915	932	25242	98225		
1954	2811	97306	18192	91555	727	15350	60179	4321	23759*
1955	773	50106	32829	87327	3753	4655	68488	5135	11567*
1956	15	56011	38428	128255	8721	4922	66265	12887	19189*
1957	0	58575	32594	62106	29093	16317	47357	10453	30659*
1958	168	55626	41074	73067	21624	26765	75795	10915	46972*
1959	986	74304	10954	30254	12560	11009	67598	19178	35500*
1960	35	58648	18493	35939	16396	9885	76431	23914	39219*
1961	503	78018	43351	70881	16031	14618	90224	19690	40212*
1962	1017	122388	75380	57972	25336	17289	125896	17315	41874*
1963	66	70236	73142	76579	46370	16440	122653	23057	46626*
1964	96	49049	49102	82936	33287	13844	99438	35577	55451*
1965	385	80931	66817	71036	15594	15002	92630	17497	38063*
1966	12	99495	43557	62594	19579	18769	95124	12870	38956*
1967	361	58612	78270	122518	34096	12187	95911	24732	40738*
1968	881	12333	89636	94820	61591	16362	97390	15701	37844*
1969	490	7652	31140	65115	41648	11507	35611	17771	31879*

Year	NAFO 1A	NAFO 1B	NAFO 1C	NAFO 1D	NAFO 1E	NAFO 1F	Unknown NAFO div.	ICES 14.b	NAFO 1F + ICES 14.b
1970	278	3719	13244	23496	23215	15519	18420	20907	40023*
1971	39	1621	28839	21188	9088	20515	26384	32616	59789*
1972	0	3033	42736	18699	7022	4396	20083	26629	32188*
1973	0	2341	17735	18587	10581	2908	1168	11752	14725*
1974	36	1430	12452	14747	8701	1374	656	6553	7950*
1975	0	49	18258	12494	6880	3124	549	5925	9091*
1976	0	442	5418	10704	8446	2873	229	13025	15922*
1977	127	301	4472	7943	8506	2175	35477 1	18000 2	23455*
1978	0	0	11856	2638	3715	549	34563 1	26000 2	27561*
1979	0	16	6561	4042	1115	537	51139 1	34000 2	36775*
1980	0	1800	2200	2117	1687	384	7241 1	12000 2	12724*
1981	0	0	4289	4701	4508	255	0	16000 2	16255
1982	0	133	6143	10977	11222	692	1174	27000 2	27720*
1983	0	0	717	6223	16518	4628	293	13378	18054*
1984	0	0	0	4921	5453	3083	0	8914	11997
1985	0	0	0	145	1961	1927	2402	2112	5187*
1986	0	0	0	2	72	24	1203	4755	5074*

Year	NAFO 1A	NAFO 1B	NAFO 1C	NAFO 1D	NAFO 1E	NAFO 1F	Unknown NAFO div.	ICES 14.b	NAFO 1F + ICES 14.b
1987	0	0	5	815	67	43	3041	6909	7093*
1988	0	0	919	17463	10913	6466	8101	9457	17388*
1989	0	0	0	11071	48092	14248	2	14669	28917
1990	0	0	2	563	21513	10580	7503	33508	46519*
1991	0	0	0	0	104	1942	0	21596	23538
1992	0	0	0	0	0	0	0	11349	11349
1993	0	0	0	0	0	0	0	1135	1135
1994	0	0	0	0	0	0	0	437	437
1995	0	0	0	0	0	0	0	284	284
1996	0	0	0	0	0	0	0	192	192
1997	0	0	0	0	0	0	0	355	355
1998	0	0	0	0	0	0	0	345	345
1999	0	0	0	0	0	0	0	116	116
2000	0	0	0	0	0	0	0	152	152
2001	0	0	0	0	0	0	0	125	125
2002	0	0	0	0	0	0	0	401	401
2003	0	0	0	0	0	0	0	485	485

Year	NAFO 1A	NAFO 1B	NAFO 1C	NAFO 1D	NAFO 1E	NAFO 1F	Unknown NAFO div.	ICES 14.b	NAFO 1F + ICES 14.b
2004	0	0	0	5	3	1	0	774	775
2005	0	0	1	0	0	71	0	819	890
2006	0	0	0	0	0	414	0	2042	2456
2007	0	0	0	31	435	20113	0	3194	5205
2008	0	0	0	23	526	113703	0	3258	14628
2009	0	0	0	0	6	33233	0	1642	4965
2010	0	0	0	0	2	281	0	2388	2669
2011	0	0	0	0	8	542	0	4571	5113
2012	0	0	1	95	236	1470	0	3941	5411
2013	0	0	0	209	270	1405	0	4104	5509
2014	0	0	30	68	18	1833	0	6060	7893
2015	0	0	341	954	3564	3984	0	11771	15755
2016	0	0	67	1911	1762	2335	0	12483	14818
2017	0	1	1442	730	852	2560	0	13740	16300
2018	0	0	1989	678	1520	1819	0	13249	15068
2019	0	0	654	57	186	916	0	17158	18074

1) Estimates for assessment include estimates of unreported catches. The total estimated value for West Greenland (inshore + offshore) was 73 000 t in 1977 and 1978, 1979: 99 000 t, 1980: 54 000 t. The value given in the table are these values minus the inshore catches minus known offshore NAFO Division catches.

2) Estimates for assessment include estimates of unreported catches in East Greenland.

3) Include catches taken with small vessels and landed to a factory in South Greenland (Qaqortoq), 2007: 597 t, 2008: 2262 t, 2009: 136 t.

***) Unknown NAFO Division catches added accordingly to the proportion of known catch in NAFO Division 1F to known total catch in all NAFO divisions.**

Table 16.2.2: Cod catches (t) by area and month. East Greenland (14.b) divided into five areas. NQ1 furthest to the north.

ICES/NAFO	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	%
14.b (NQ1)							3	27	10		4		**44**	0.2%
14.b (Q1Q2)	294	615	344	45	945	2514	1142	1483	1313	794	1391	1276	**12156**	67%
14.b (Q3Q4)	214	569	260	626	517	1859	34	52		12		64	**4207**	23%
14.b (Q5Q6)	18	94	78	80	197	273	10					2	**752**	4%
1F	100	112	53	51	4					58	496	41	**915**	5%
Total	**626**	**1390**	**735**	**802**	**1663**	**4645**	**1189**	**1562**	**1323**	**864**	**1891**	**1383**	**18074**	
%	3%	8%	4%	4%	9%	26%	7%	9%	7%	5%	10%	8%		

Table 16.2.3: Cod catches (t) by gear, area and month. East Greenland (14.b) divided into five areas. NQ1 furthest to the north.

Gear	ICES/NAFO	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Longline	14.b (NQ1)									10		4		**14**
	14.b (Q1Q2)		130	68		3	33	90	360	96	33	130	275	**1218**
	14.b (Q3Q4)	214	10	238	615	79	822	34	51				64	**2127**
	14.b (Q5Q6)	18	94	78	70	49	3	7						**319**
	1F	100	112	53	51	4					23	157	5	**505**
	Total	**332**	**346**	**437**	**736**	**135**	**858**	**131**	**411**	**106**	**56**	**291**	**344**	**4183**
Trawl	14.b (NQ1)							3	27					**30**
	14.b (Q1Q2)	294	484	276	45	942	2479	1053	1123	1217	762	1261	1001	**10937**
	14.b (Q3Q4)		559	22	11	438	1037		1		12			**2080**
	14.b (Q5Q6)				9	149	270	3					2	**433**
	1F										35	340	36	**411**
	Total	**294**	**1043**	**298**	**65**	**1529**	**3788**	**1059**	**1151**	**1217**	**809**	**1601**	**1039**	**13891**

Table 16.2.4. Cod in Greenland. Catch at age ('000) and Weight at age (kg) for offshore fleets in East Greenland (ICES 14.b + NAFO 1F).

Catch at age								
Year/age	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10+**
2005	5	33	57	103	94	57	16	7
2006	232	376	135	175	115	14	1	0
2007	49	1529	668	158	124	120	18	15
2008	77	586	6015	2417	592	44	26	12
2009	307	1287	1231	434	119	28	16	2
2010	10	87	331	193	334	58	8	5
2011	3	70	137	425	355	371	96	31
2012	13	109	471	281	258	253	148	59
2013	0	36	127	615	237	226	153	104
2014	1	4	279	434	658	335	173	131
2015	3	57	457	1554	1324	828	242	182
2016	4	33	343	736	1130	766	427	257
2017	6	15	137	519	1214	1432	527	251
2018	7	27	67	217	498	1023	855	496
2019	0	150	331	358	426	679	948	1090

Weight at age								
2005	0.354	0.717	1.073	1.963	2.737	3.699	5.271	7.366
2006	1.323	1.602	2.349	3.608	4.420	5.440	7.191	8.127
2007	0.387	0.917	1.597	3.294	6.092	8.524	11.114	14.435
2008	0.359	0.644	1.266	1.799	3.025	4.936	5.840	8.290
2009	0.489	0.776	1.396	2.797	4.634	6.453	7.804	9.993
2010	0.699	1.125	1.636	2.494	3.354	5.334	8.063	10.475
2011	0.553	1.026	1.541	2.297	3.377	4.685	6.285	10.022
2012	0.502	0.892	1.440	2.380	3.570	5.142	7.172	11.417
2013	0.480	0.998	1.698	2.272	3.408	4.745	6.827	9.024
2014	0.564	1.163	1.853	2.603	3.636	4.732	6.400	8.841
2015	0.484	0.833	1.435	2.097	3.460	4.699	6.846	9.115
2016	0.406	0.845	1.420	2.135	3.267	4.693	6.693	10.071
2017	0.392	0.711	1.641	2.213	3.063	4.167	6.094	8.034
2018	0.378	0.812	1.258	2.032	2.948	4.561	5.663	7.135
2019	0.307	1.168	1.775	2.687	3.257	4.052	5.291	6.601

Table 16.2.5. Cod in Greenland. Catch at age ('000) for offshore fleets by area (ICES 14b + NAFO 1F). Q1Q2 furthest to the north in East Greenland. NAFO 1F + 14b(Q5Q6) = South Greenland.

Catch at age								
Area/age	3	4	5	6	7	8	9	10+
14.b (Q1Q2)	0	43	93	150	213	399	652	822
14.b (Q3Q4)	0	56	70	87	115	189	223	235
14.b (Q5Q6)	0	13	42	42	41	48	34	24
NAGO 1F	0	38	126	79	57	43	39	9

Table 16.2.6. Number of hauls in the Greenland Shrimp and Fish survey in ICES 14.b and NAFO 1F.

	ICES 14.b						**NAFO**	
Year/Strata	Q1	Q2	Q3	Q4	Q5	Q6	1F	Total
1992							15	
1993							13	
1994							9	
1995							11	
1996							11	
1997							19	
1998							14	
1999							17	

	ICES 14.b						NAFO	
Year/Strata	Q1	Q2	Q3	Q4	Q5	Q6	1F	Total
2000							29	
2001							26	
2002							27	
2003							22	
2004							34	
2005							23	
2006							31	
2007							39	
2008	8	6	12	7	7	11	47	98
2009	22	11	25	20	6	13	48	145
2010	19	14	24	9	6	10	40	122
2011	20	11	21	12	7	14	25	110
2012	20	16	28	13	7	15	26	125
2013	25	12	22	14	5	14	28	120
2014	22	14	12	9	8	16	32	113
2015	26	11	24	12	8	14	36	131

	ICES 14.b						NAFO	
Year/Strata	Q1	Q2	Q3	Q4	Q5	Q6	1F	Total
2016	29	10	26	13	7	16	36	137
2017	2	4	7	6	6	11	35	71
2018	0	0	0	0	0	0	35	
2019	0	0	0	0	0	0	24	

Table 16.2.7 Cod abundance indices ('000) from the Greenland Shrimp and Fish survey by year and strata divisions in ICES 14.b and NAFO 1F. Q1 being the northern strata in East Greenland. * Incomplete coverage in strata Q1–Q4.

	ICES 14.b						NAFO		
Year	Q1	Q2	Q3	Q4	Q5	Q6	1F	Total	CV
1992							8		
1993							18		
1994							0		
1995							39		
1996							107		
1997							0		
1998							3		
1999							0		

	ICES 14.b						NAFO		
Year	Q1	Q2	Q3	Q4	Q5	Q6	1F	Total	CV
2000							189		
2001							313		
2002							457		
2003							211		
2004							1610		
New survey Gear Introduced									
2005							86410		
2006							39475		
2007							32575		
2008	5456	1361	13043	1975	1635	7958	22887	54314	22
2009	14304	2191	28539	4374	548	4753	1776	56486	15
2010	5844	732	30042	3975	115	4633	6557	51897	45
2011	7843	1357	5178	7733	1470	19072	6330	48983	22
2012	5475	2164	3658	2453	352	8635	21238	43975	20
2013	11102	1420	5667	17360	537	27145	49874	113104	32
2014	4168	3445	2622	19267	493	5412	22702	58106	36

	ICES 14.b						NAFO		
Year	Q1	Q2	Q3	Q4	Q5	Q6	1F	Total	CV
2015	6396	4074	6941	3093	231	8322	34032	63090	28
2016	8338	909	9737	1031	233	3412	4393	28052	16
2017*	7429	4559	5242	5816	627	18694	12466	54833	28
2018							5302		
2019							5233		

Table 16.2.8. Cod biomass indices (tonnes) from the Greenland Shrimp and Fish survey by year and strata divisions in ICES 14.b (Q1–Q6) and NAFO 1F. * Incomplete coverage in strata Q1–Q4.

	ICES 14.b						NAFO		
Year	Q1	Q2	Q3	Q4	Q5	Q6	1F	Total	CV
1992							2		
1993							5		
1994							0		
1995							4		
1996							49		
1997							0		
1998							3		
1999							0		
2000							46		
2001							100		
2002							150		
2003							46		
2004							305		
New survey Gear Introduced									
2005							56163		
2006							16828		

2007							23346		
2008	8692	2430	24101	1482	2173	8838	21236	68952	23
2009	10844	8874	27251	7827	252	3094	503	58645	28
2010	16014	3151	81064	6202	23	4203	3142	113799	51
2011	27064	8128	5561	12486	5235	22664	3280	84418	19
2012	24736	10058	9347	5802	160	14322	16213	80638	16
2013	45018	9639	15017	48518	977	40319	47818	207306	22
2014	17182	20637	15574	90795	734	8884	30754	184560	45
2015	33105	13803	27050	11609	513	18724	49931	154735	20
2016	40580	4831	33065	4841	426	5670	4671	94084	18
2017	45774	27405	18257	4777	1749	31635	7823	137420	41
2018							8498		
2019							3841		

Table 16.2.9: Abundance indices ('000) by age from the Greenland Shrimp and Fish survey by year in ICES 14.b + NAFO 1F. *Incomplete coverage. Indices for 2019 is for NAFO 1F only.

East Greenland											
Year/age	0	1	2	3	4	5	6	7	8	9	10+
2008	4355	326	1168	7460	6937	24058	5279	2227	613	1225	671
2009	14970	7642	8019	4504	5378	5664	6610	2537	225	554	385
2010	150	2436	3959	5759	3253	12785	7969	11264	2958	450	914
2011	315	162	5682	8288	16346	5409	4707	2226	3382	1834	634
2012	0	258	1208	12748	7154	12041	4155	2428	1345	1849	790
2013	0	157	1432	1954	44843	25373	26654	5209	3440	1852	2190
2014	692	15	207	1849	1558	21863	8805	12411	2875	3790	4041
2015	0	86	38	1259	4916	11445	29010	7407	4793	1954	2181
2016	279	3847	1818	998	555	2089	2399	6779	4874	3398	1018
2017*	242	111	14938	5234	6797	4470	5791	4307	7746	4352	845
2018					No	survey					
2019					No	survey					
2019 NAFO 1F	0	7	290	847	3043	711	124	10	127	51	24

Table 16.2.10: Mean weight (kg) at age from the Greenland Shrimp and Fish survey by year in ICES 14.b + NAFO 1F.

East Greenland											
Year/age	0	1	2	3	4	5	6	7	8	9	10+
2008	0.003	0.019	0.088	0.262	0.520	1.067	1.982	3.385	5.699	8.447	8.564
2009	0.004	0.059	0.140	0.452	0.976	1.730	2.977	4.186	5.447	7.423	10.800
2010	0.002	0.041	0.206	0.406	0.823	1.728	2.499	3.496	5.480	7.363	10.686
2011	0.001	0.017	0.152	0.366	0.783	1.408	2.209	3.891	5.711	7.218	10.859
2012		0.025	0.201	0.367	0.916	1.519	2.634	4.068	5.658	7.565	10.000
2013		0.020	0.194	0.450	0.771	1.396	2.353	3.663	5.140	7.062	10.354
2014	0.001	0.003	0.129	0.360	0.773	1.402	2.758	4.145	5.173	6.217	9.060
2015		0.017	0.100	0.357	0.697	1.194	1.808	3.241	4.835	6.809	10.000
2016	0.001	0.025	0.116	0.327	0.831	1.623	2.245	3.557	5.299	6.879	9.973
2017	0.001	0.047	0.186	0.369	0.782	1.485	2.338	3.995	5.714	8.168	10.674

2018		No	survey
2019		No	survey

Table 16.2.11 *German survey*. Numbers of valid hauls by stratum in South and East Greenland, stratum 9 furthest to the north.

	NAFO 1 F		ICES 14.b						
year	Str 4.1	Str 4.2	Str 5.1	Str 5.2	Str 7.1	Str 7.2	Str 8.2	Str 9.2	Sum
1981	1	2	2	12	4	12	19	10	62
1982	13	2	.	12	1	9	15	15	67
1983	18	4	1	26	8	14	25	10	106
1984	20	4	4	5	1	5	7	2	48
1985	21	4	5	22	11	26	35	18	142
1986	20	3	2	27	11	14	31	34	142
1987	21	5	16	25	7	21	26	11	132
1988	18	2	20	19	10	13	36	9	127
1989	25	3	37	.	20	.	26	4	115
1990	21	6	15	24	4	6	15	12	103
1991	14	5	9	18	11	7	45	13	122
1992	7	5	.	.	.	.	4	2	18
1993	7	.	9	9	5	5	15	10	60
1994	7	5	.	.	.	.	.	6	18
1995	10	5	8	8	5	4	16	8	64
1996	10	5	7	9	5	3	13	6	58
1997	8	5	5	6	4	1	9	5	43
1998	10	5	5	9	6	2	12	6	55
1999	9	3	5	7	4	4	10	6	48
2000	9	5	6	7	8	4	12	9	60
2001	11	6	5	8	8	2	17	12	69
2002	8	4	6	7	5	2	10	7	49
2003	7	5	5	5	5	1	12	10	50
2004	9	5	7	7	8	3	13	11	63

	NAFO 1 F		ICES 14.b						
year	Str 4.1	Str 4.2	Str 5.1	Str 5.2	Str 7.1	Str 7.2	Str 8.2	Str 9.2	Sum
2005	6	5	6	7	8	4	12	9	57
2006	8	5	3	1	5	4	11	7	44
2007	9	5	4	6	4	3	13	8	52
2008	7	6	6	8	4	3	10	8	52
2009	5	5	2	5	5	4	9	8	43
2010	10	6	1	3	8	3	14	8	53
2011	6	6	5	8	6	4	14	9	58
2012	10	6	6	7	8	3	12	9	61
2013	9	6	5	9	7	5	15	9	65
2014	10	6	5	7	10	6	20	11	75
2015	8	6	6	8	9	10	19	9	75
2016	11	6	5	8	8	6	13	6	63
2017	7	.	3	2	6	6	13	9	46
2018				No survey					
2019	16	7	3	8	8	9	19	8	78

Table 16.2.12 *German survey*. Cod abundance indices ('000) from the German survey in South and East Greenland by year and stratum. Incomplete coverage in 2017.

	NAFO 1F		ICES 14.b							
year	str4_1	str4_2	str5_1	str5_2	str7_1	str7_2	str8_2	str9_2	Sum	SD
1982	8540	1245	.	366	297	1493	664	385	12990	4973
1983	5267	2870	209	715	149	564	529	726	11029	3796
1984	3296	42	1268	413	138	750	173	333	6413	3845
1985	3492	1164	920	166	560	1554	401	310	8567	1978
1986	8967	492	3509	359	776	2641	1207	337	18288	5097
1987	23219	306	5655	4145	399	6298	1293	234	41549	14816
1988	28259	17	2590	2073	302	1175	738	601	35755	16719
1989	31810	31442	9979	.	880	.	2128	639	76878	42682
1990	7052	6306	2808	1155	861	4295	2799	468	25744	7720
1991	1367	233	790	937	122	368	652	510	4979	1548
1992	113	134	.	.	.	.	228	367	842	192
1993	0	.	613	62	127	317	114	148	1381	521
1994	44	12	.	.	.	.	.	234	290	135
1995	27	8	89	25	450	3082	77	91	3849	1314
1996	156	0	109	0	37	279	29	160	770	173
1997	49	0	25	17	200	54	145	1107	1597	479
1998	40	8	97	0	57	57	24	266	549	142
1999	155	0	198	8	165	1267	116	105	2014	582
2000	76	13	348	15	431	180	25	143	1231	251
2001	343	3	319	27	309	299	204	1071	2575	544
2002	1739	0	116	273	769	459	186	875	4417	1352
2003	840	8	199	183	1250	1399	1100	1438	6417	1004
2004	10902	107	1684	133	285	1817	1401	1073	17402	8499
2005	24438	1399	16577	3078	718	7157	1580	2070	57017	11411
2006	28894	486	14733	3686	6044	7378	2779	2700	66700	15653
2007	67049	772	2283	3256	758	5363	2080	2093	83654	56843
2008	18730	292	2036	4898	2203	9460	1285	2678	41582	10268

	NAFO 1F		ICES 14.b							
year	str4_1	str4_2	str5_1	str5_2	str7_1	str7_2	str8_2	str9_2	Sum	SD
2009	1286	283	1017	567	3129	8755	1566	3275	19878	3581
2010	2372	141	532	1703	1101	8875	933	1748	17405	2958
2011	7547	162	3027	1326	868	1971	1243	2816	18960	3196
2012	23964	132	5689	167	901	2117	1114	3982	38066	22168
2013	41722	1947	2193	818	874	3121	1157	1342	53174	43105
2014	73612	111	8612	4013	228	1089	1436	5461	94562	77704
2015	3187	361	1186	267	113	834	2265	3395	11833	3703
2016	2875	361	1186	267	113	793	2152	4086	9114	1647
2017	1499	104	1498	262	336	1126	1126	3307	12421	3727
2018					No survey					
2019	11679	17	416	550	122	350	305	2123	15564	

Table 16.2.13 *German survey*. Cod biomass indices (tonnes) from the German survey in South and East Greenland by year and stratum. Incomplete coverage in 2017.

	NAFO 1F		ICES 14.b							
year	str4_1	str4_2	str5_1	str5_2	str7_1	str7_2	str8_2	str9_2	Sum	SD
1982	14607	3690	.	1201	1036	3342	2576	1900	28352	8415
1983	9797	6219	653	2209	402	2294	2605	4442	28621	8201
1984	5326	82	3115	1444	346	1782	540	2553	15188	6650
1985	2942	1976	1812	803	1393	3875	1187	1605	15593	3099
1986	8005	943	1044	873	2537	3921	2301	709	20333	6054
1987	17186	276	2889	3735	504	10243	4558	1414	40805	16521
1988	26349	17	2812	4605	964	2297	3475	2012	42531	18651
1989	36912	35281	23605	.	2518	.	6889	2174	107379	61579
1990	9212	5897	5361	3215	2517	10386	6551	1620	44759	10905
1991	2088	200	1465	2759	196	1008	2610	2100	12426	4657
1992	79	50	.	.	.	.	171	734	1034	286
1993	0	.	431	73	247	532	254	547	2084	588
1994	2	7	.	.	.	.	.	779	788	514
1995	6	4	32	62	166	11744	250	123	12387	5550
1996	101	0	63	0	109	708	99	511	1591	333
1997	53	0	18	20	358	70	337	4017	4873	1800
1998	12	11	29	0	87	122	123	986	1370	554
1999	39	0	24	1	162	2229	492	201	3148	1184
2000	13	9	132	17	206	616	75	540	1608	366
2001	88	5	130	19	345	382	387	3005	4361	1593
2002	976	0	38	224	1547	531	541	2214	6071	1306
2003	361	17	121	266	3787	2440	1716	4169	12877	2817
2004	1945	177	359	55	957	2319	3264	3240	12316	3070
2005	9055	1870	8135	2537	3155	17882	3590	6806	53030	7772
2006	31616	681	8616	4130	3557	10291	6084	11567	76542	24680
2007	74671	1045	3749	5042	1363	14456	5374	8540	114240	58452
2008	18543	344	3630	9790	5075	26506	3772	11908	79568	12433

	NAFO 1F		ICES 14.b							
year	str4_1	str4_2	str5_1	str5_2	str7_1	str7_2	str8_2	str9_2	Sum	SD
2009	583	277	1361	1726	10145	28613	6351	15520	64576	13358
2010	3629	273	741	5085	5244	31745	4282	10932	61931	11626
2011	12398	385	5839	4364	1658	8051	5735	17487	55917	10240
2012	33871	370	15679	579	2596	6245	5445	26885	91670	30054
2013	74193	6525	6672	2737	2577	9752	4853	7575	114884	75148
2014	132706	428	31885	15935	1060	4322	6480	29358	222174	132209
2015	10777	1534	3938	1804	522	3346	9396	24306	55623	17157
2016	4521	305	7360	1727	2129	6341	4906	9367	36656	6954
2017	5836	.	7687	0	616	9704	4067	31088	58998	20593
2018					No survey					
2019	19292	32	1927	1245	397	685	1610	11072	36260	11857

Table 16.2.14 German survey, South and East Greenland (NAFO 1F and ICES 14.). Age disaggregate abundance indices ('1000). Incomplete coverage in 2017.

Year	0	1	2	3	4	5	6	7	8	9	10	11+
1982		23	214	2500	1760	4451	1952	793	223	927	57	74
1983												
1984	23	8	54	1134	507	2434	582	1242	229	125	17	49
1985	279	2521	242	160	1658	947	1439	344	831	96	27	27
1986		3367	9255	1128	273	1631	603	1300	165	473	31	58
1987		4	10193	24656	2689	720	1368	296	966	80	487	49
1988	6	18	335	9769	23391	876	200	559	83	337	31	146
1989	12	2	111	732	23945	49864	1007	44	756	70	282	76
1990	58	36	58	715	706	11679	12101	139	15	74		148
1991		73	150	171	539	102	2128	1762	31	11	3	9
1992	214	10	196	103	61	53	67	67	51			21
1993		4	15	869	152	95	97	31	83	34		2
1994		71	5	16	84	39	22	38		8		0
1995		1	621	347	260	1399	372	120	403	32	192	102
1996		0	0	353	130	131	110	23	25			0
1997		0	12	17	687	557	191	78	48			5
1998	51	73	39	4	11	173	138	48	10			0

Year	0	1	2	3	4	5	6	7	8	9	10	11+
1999	105	426	389	346	118	257	174	156		29	16	0
2000		202	243	323	208	40	72	20	46	61	15	0
2001		166	568	493	631	362	190	60	50	18	10	2
2002	40	1	395	2119	601	477	454	217	61	21	11	7
2003	579	629	53	553	1761	1026	1015	541	220	37	.	4
2004	386	10687	1770	448	617	1667	921	620	228	39	10	8
2005	80	1603	39549	8091	1250	2819	2549	727	189	40		0
2006	80	439	3375	48140	9269	1328	2404	1309	193	30	9	0
2007	128	154	2007	5149	65974	8166	713	658	634	70		0
2008	14	265	513	8213	4401	22939	4201	516	220	199	44	29
2009	98	322	1057	391	1620	2863	11241	1964	111	134	64	17
2010	22	700	1425	1388	845	2887	2518	5707	1362	236	163	139
2011		120	1246	3475	4874	2402	2949	1179	2324	310	23	49
2012	6	50	1624	10093	10233	9846	2827	1778	1166	379	35	5
2013		17	35	4312	27014	11146	7455	1314	517	291	126	68
2014		7	55	602	20847	58174	9275	3284	1316	494	441	52
2015	105	37	68	341	752	3688	3598	1881	644	187	106	160

Year	0	1	2	3	4	5	6	7	8	9	10	11+
2016	35	419	98	56	255	677	874	3325	1741	1072	199	209
2017		8	1650	479	190	549	1243	2341	3640	1356	533	195
2018						No survey						
2019	52	.	.	679	8296	2301	516	468	554	820	626	2255

Table 16.2.15 *German survey*, The abundance indices ('000) by year class/age, 2019. South and East Greenland (NAFO 1F (Strat 4) and ICES 14.b, Strat 9 furthest to the north).

year	stratum	index0	index1	index2	index3	index4	index5	index6	index7	index8	index9	index10	index11	index12
2019	4.1	50	.	.	682	7821	1742	310	317	227	328	161	26	6
2019	4.2	0	.	.	0	11	3	1	0	1	0	0	0	0
2019	5.1	0	.	.	18	229	55	14	3	16	28	37	12	5
2019	5.2	7	.	.	7	219	140	35	19	29	31	42	13	8
2019	7.1	1	.	.	1	57	25	6	6	6	7	8	4	1
2019	7.2	0	.	.	5	219	110	12	3	1	0	0	0	0
2019	8.2	0	.	.	1	69	45	18	24	34	52	35	25	2
2019	9.2	0	.	.	6	231	292	138	124	274	442	382	159	67

Table 16.5.1. Reference point.

Reference point	Value	Technical basis
F_{MSY}	0.46	Equilibrium scenarios using segmented regression and capped by F_{p05}
F_{LIM}	2.34	Equilibrium scenarios prob (SSB < B_{lim}) < 50% with stochastic recruitment
F_{PA}	1.33	$F_{lim} / e^{1.645\sigma}$, $\sigma = 0.34$
B_{LIM}	10354 t.	Average of SSB 2002, 2003 and 2004
B_{PA}	14803 t	$B_{lim} \times e^{1.645\sigma}$, $\sigma = 0.217$
MSY $B_{trigger}$	14803 t.	B_{PA}

Table 16.7.1. Estimated stock numbers at age.

Year Age	1	2	3	4	5	6	7	8	9	10
1973	44195	11632	7056	4605	20754	3852	2827	678	2625	4183
1974	232950	33645	9524	6372	3310	14486	2417	1442	322	2819
1975	32390	223610	25614	7626	6341	2378	9540	1375	713	1311
1976	13062	25311	214644	19204	5467	4604	1455	5044	677	1001
1977	13071	10278	19780	151998	17363	3747	2448	697	1747	775
1978	30198	10317	8087	16189	91578	13484	1982	841	236	941
1979	7524	27255	8143	8460	11534	45293	7897	1234	257	224
1980	18792	5569	24599	7271	7025	5694	20726	2407	239	76
1981	4640	17025	4122	17794	6083	5385	3547	10126	820	124
1982	5092	3559	15424	3049	14361	5172	3772	2007	3785	330
1983	2573	4944	2636	14604	3137	11497	2597	1137	355	783
1984	4405	1997	4801	2646	9517	1818	5223	704	334	340
1985	168187	4354	1764	4078	2237	6080	771	1895	173	228
1986	126523	146402	4223	1077	3580	1510	3941	381	1049	155
1987	3150	95654	121777	3361	760	2553	828	2261	195	811
1988	2613	3294	62055	103955	2141	429	1690	399	984	421
1989	723	2359	2984	40800	77319	1108	161	763	172	474
1990	1470	688	2162	2428	25873	38781	442	54	251	147
1991	2456	982	590	1800	1221	10684	10869	134	27	78
1992	918	1669	523	436	730	299	2483	1635	36	11
1993	821	692	954	388	226	333	62	226	161	5
1994	3752	707	621	695	263	134	216	30	60	55
1995	239	3161	912	412	599	198	85	151	18	63
1996	313	200	2014	703	340	311	115	50	84	46
1997	1617	242	167	1257	599	260	163	72	28	74
1998	5544	1348	187	152	661	369	157	70	37	55
1999	10944	4276	1261	218	180	325	208	87	35	48
2000	14685	6702	2923	1064	226	155	160	108	57	48
2001	8970	11341	4398	2154	955	251	121	89	54	59

Year Age	1	2	3	4	5	6	7	8	9	10
2002	1594	6645	8780	3141	1671	855	241	85	50	68
2003	38267	1813	4764	6242	2346	1197	633	164	50	66
2004	362919	28665	2310	3676	4509	1602	706	372	88	67
2005	68473	274760	20617	2851	3179	3050	948	311	195	89
2006	35733	43793	167777	18138	2761	2491	1890	395	94	167
2007	15832	27486	25694	83099	13018	2078	1247	963	214	169
2008	22675	12052	19611	14087	37533	8347	1548	556	392	176
2009	54072	21677	11235	13497	9408	13009	3155	501	348	172
2010	57102	31849	15910	7349	9762	5866	7811	1790	322	246
2011	10678	44070	20699	17425	6129	6448	3484	3457	1013	344
2012	6165	10267	40776	20179	17651	5084	3578	1886	1454	654
2013	2764	4886	8545	38742	17299	15604	3725	2090	1062	1016
2014	976	2104	4751	6953	30446	12746	9135	2291	1301	1034
2015	5230	957	2125	4842	7708	18350	8301	4227	1149	1102
2016	50753	5520	1349	1836	3993	5690	9988	4466	2093	1114
2017	3009	41053	5713	1721	2091	3760	5329	6201	2579	1376
2018	3009	2729	26669	5130	1554	1685	2559	3498	3047	1861
2019	3009	2464	2476	21933	4364	1238	1111	1394	1814	2173

Table 16.7.2. Estimated fishing mortality at age.

Year Age	1	2	3	4	5	6	7	8	9	10
1973			0.001	0.022	0.044	0.073	0.141	0.265	0.356	0.356
1974			0.001	0.016	0.032	0.054	0.101	0.202	0.268	0.268
1975			0.003	0.039	0.078	0.114	0.167	0.265	0.253	0.253
1976			0.004	0.047	0.102	0.184	0.28	0.474	0.412	0.412
1977			0.003	0.056	0.135	0.237	0.375	0.627	0.616	0.616
1978			0.002	0.04	0.116	0.182	0.282	0.679	1.016	1.016
1979			0.003	0.059	0.176	0.257	0.549	1.201	1.313	1.313
1980			0.002	0.02	0.05	0.077	0.184	0.464	0.516	0.516
1981			0.001	0.006	0.024	0.064	0.175	0.45	0.504	0.504
1982			0.001	0.01	0.06	0.246	0.669	1.249	1.084	1.084
1983			0.005	0.056	0.215	0.477	0.745	0.855	0.709	0.709
1984			0.015	0.103	0.239	0.451	0.612	0.737	0.608	0.608
1985			0.027	0.098	0.18	0.254	0.265	0.272	0.253	0.253
1986			0.014	0.064	0.131	0.201	0.219	0.206	0.177	0.177
1987			0.008	0.054	0.109	0.184	0.268	0.343	0.432	0.432
1988			0.01	0.105	0.214	0.342	0.426	0.451	0.646	0.646
1989			0.008	0.111	0.242	0.355	0.463	0.459	0.888	0.888
1990			0.012	0.28	0.51	0.639	0.614	0.422	0.909	0.909
1991			0.017	0.512	1.045	1.127	1.3	0.932	1.52	1.52
1992			0.007	0.252	0.659	1.133	1.961	1.94	1.802	1.802
1993			0.003	0.043	0.112	0.206	0.338	0.632	0.637	0.637
1994			0.028	0.1	0.147	0.156	0.158	0.209	0.163	0.163
1995			0.018	0.038	0.063	0.059	0.056	0.083	0.075	0.075
1996			0.013	0.036	0.063	0.062	0.066	0.095	0.08	0.08
1997			0.013	0.049	0.094	0.1	0.115	0.164	0.126	0.126
1998			0.01	0.046	0.093	0.106	0.13	0.19	0.139	0.139
1999			0.004	0.019	0.036	0.04	0.052	0.079	0.061	0.061
2000			0.003	0.018	0.035	0.043	0.062	0.093	0.069	0.069
2001			0.001	0.011	0.021	0.028	0.043	0.064	0.047	0.047

Year Age	1	2	3	4	5	6	7	8	9	10
2002			0.002	0.017	0.037	0.052	0.084	0.12	0.08	0.08
2003			0.001	0.012	0.027	0.041	0.073	0.107	0.068	0.068
2004			0.001	0.011	0.027	0.047	0.096	0.139	0.079	0.079
2005			0	0.01	0.026	0.052	0.123	0.178	0.089	0.089
2006			0.001	0.02	0.05	0.068	0.084	0.062	0.027	0.027
2007			0.002	0.025	0.073	0.109	0.166	0.148	0.09	0.09
2008			0.005	0.062	0.21	0.266	0.316	0.168	0.09	0.09
2009			0.011	0.083	0.145	0.083	0.08	0.061	0.033	0.033
2010			0.001	0.012	0.039	0.043	0.054	0.047	0.029	0.029
2011			0	0.005	0.028	0.067	0.117	0.145	0.11	0.11
2012			0	0.004	0.028	0.07	0.114	0.168	0.137	0.137
2013			0	0.001	0.011	0.041	0.084	0.151	0.155	0.155
2014			0	0.001	0.011	0.041	0.092	0.173	0.177	0.177
2015			0.001	0.01	0.062	0.131	0.204	0.295	0.281	0.281
2016			0.002	0.017	0.096	0.168	0.202	0.27	0.288	0.288
2017			0.001	0.01	0.075	0.174	0.244	0.306	0.295	0.295
2018			0	0.005	0.053	0.167	0.266	0.376	0.398	0.398
2019			0.001	0.008	0.091	0.346	0.552	0.757	0.788	0.788

Table 16.7.3. Short-term forecast for 2020 assuming that Catch = TAC_{2020} (18824 t)

Variable	Value
$F_{ages\ 5–10}$ (2020)	1.33
SSB (2021)	28772
$R_{age\ 1}$ (2021)	6165
Total catch (2020)	18824 t

Rationale	Catch (2021)	F (2021)	SSB (2022)	% SSB change *	% advice change **	% TAC change ***
ICES advice basis						
MSY approach: F_{MSY}	6091	0.46	29918	+4%	+79%	-68%
Other scenarios						
F = 0	0	0	39071	+36%	-100%	-100%
F = F_{2020} (*status quo*)	13813	1.54	19151	-33%	+305%	-27%

16.18 Figures

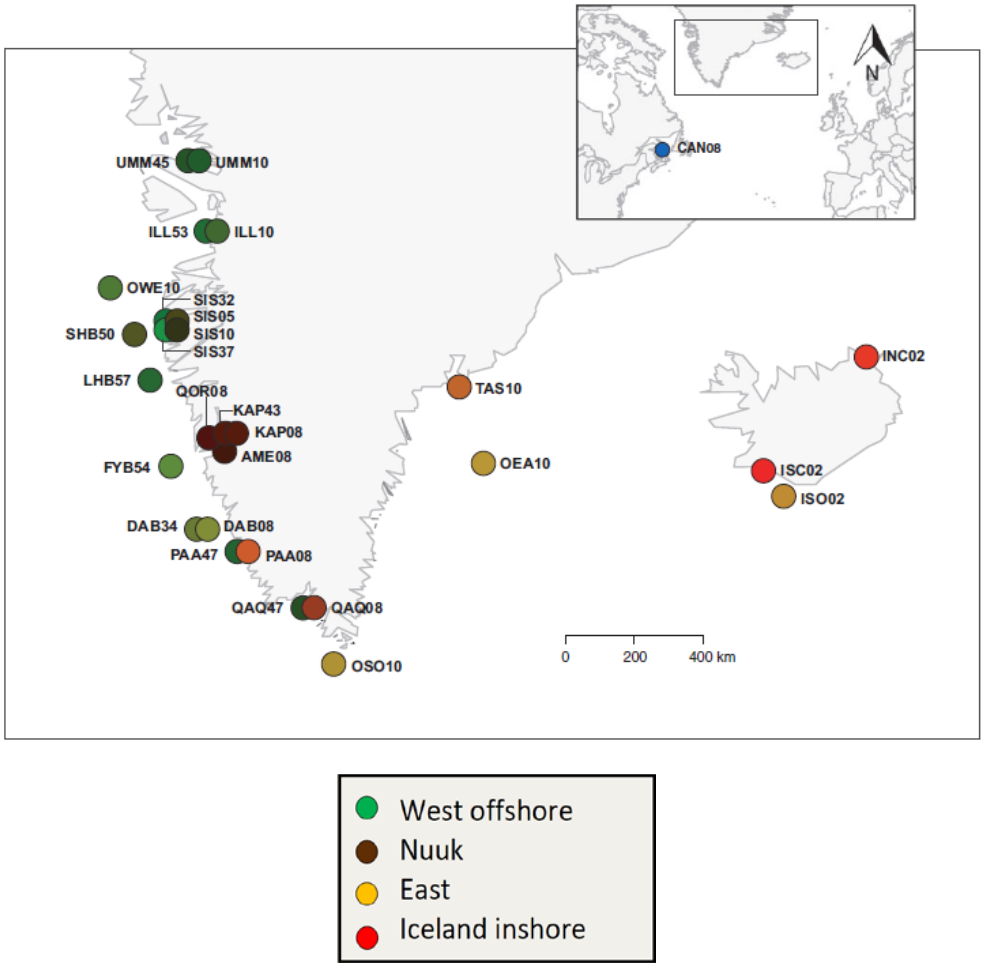


Figure. 16.1. Sampling location of spawning cod in Greenland and Iceland in the genetic project. The colours of the dots represent the blends of sample mean of the different spawning population: West offshore, Nuuk (inshore), East (Greenland and offshore Iceland) and Iceland inshore as signal intensities of green and red respectively. After Therkildsen *et al.*, 2013.

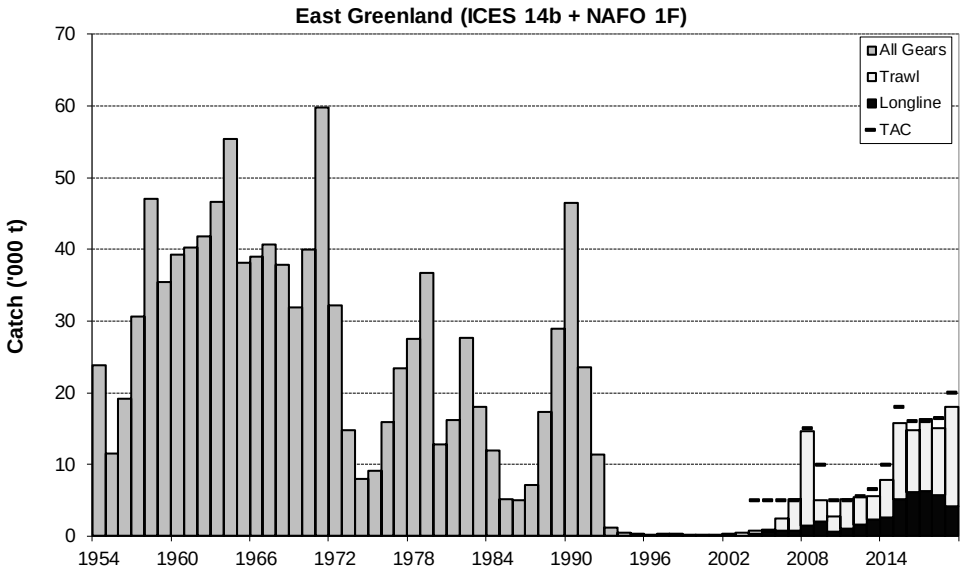


Figure 16.2.1. Annual total catch in South and East Greenland (NAFO Subarea 1F and ICES Subarea 14.b). From 2001 divided into gear. TAC until 2013 is for all the offshore area including West Greenland (NAFO Subarea 1A–1E).

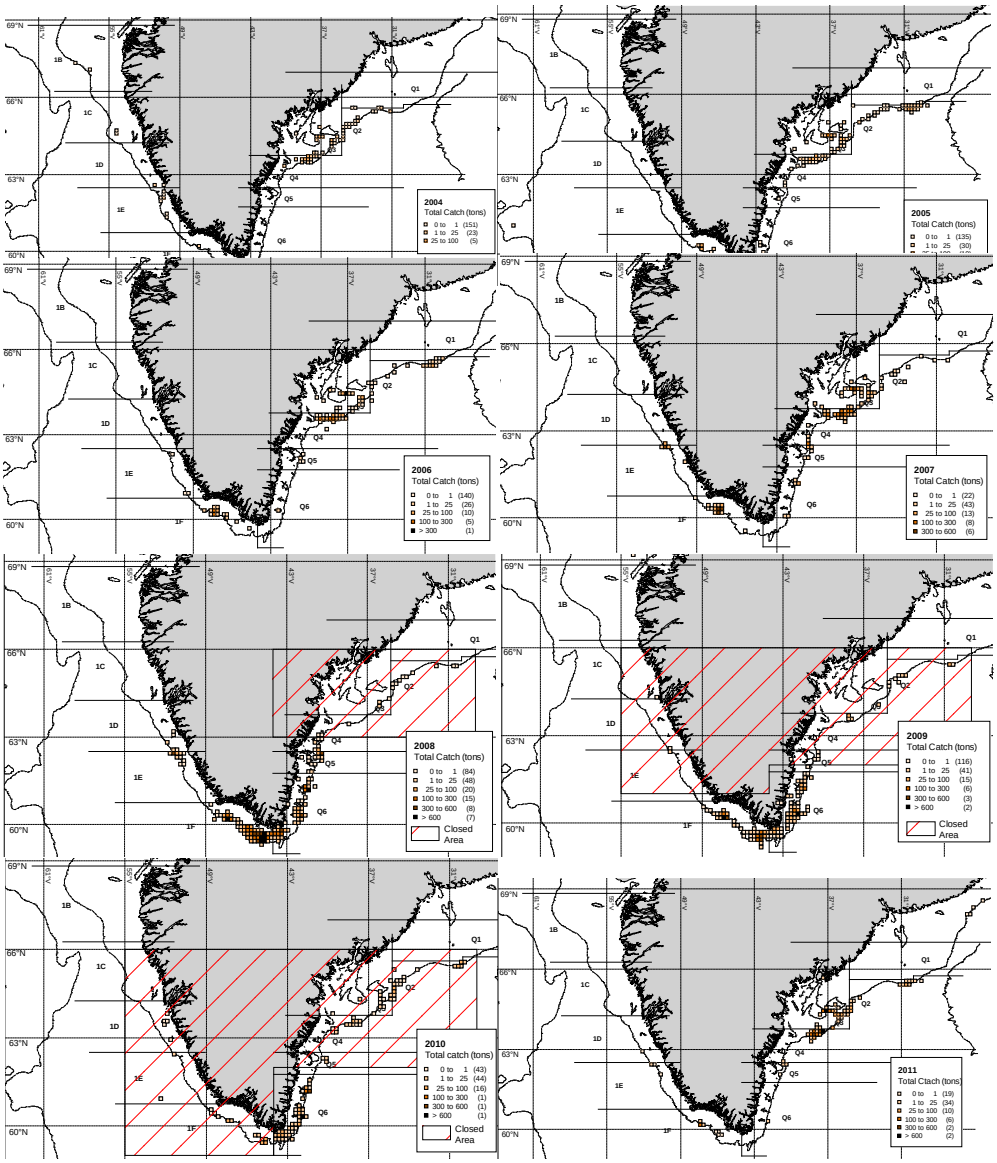


Figure 16.2.2: Annual distribution of total catches of Atlantic cod in West and East Greenland. Q1–Q6 illustrates survey areas (strata) in the East Greenland shrimp and fish survey.

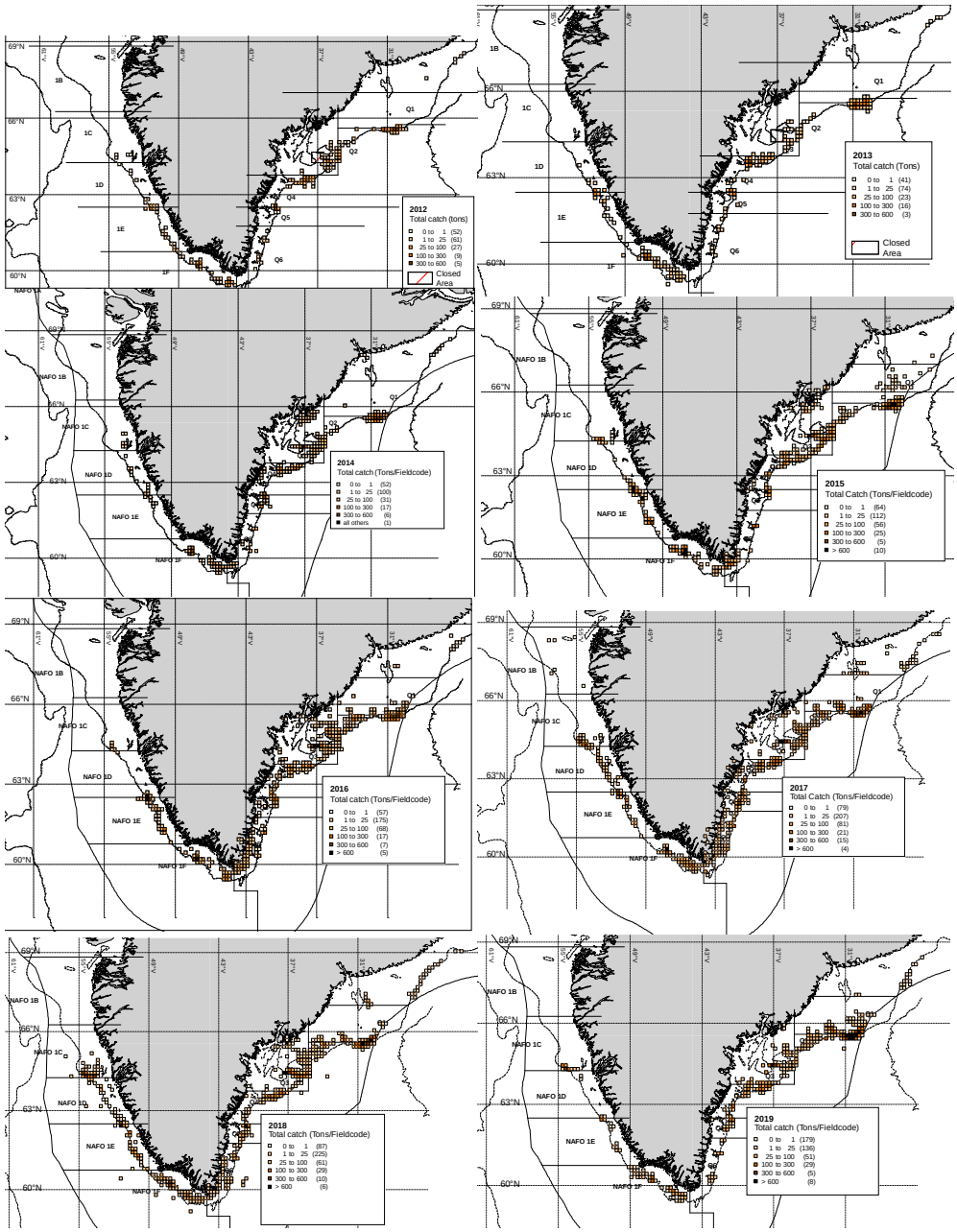


Figure 16.2.2: Continued. Annual distribution of total catches of Atlantic cod in West and East Greenland. Q1–Q6 illustrates survey areas (strata) in the East Greenland shrimp and fish survey.

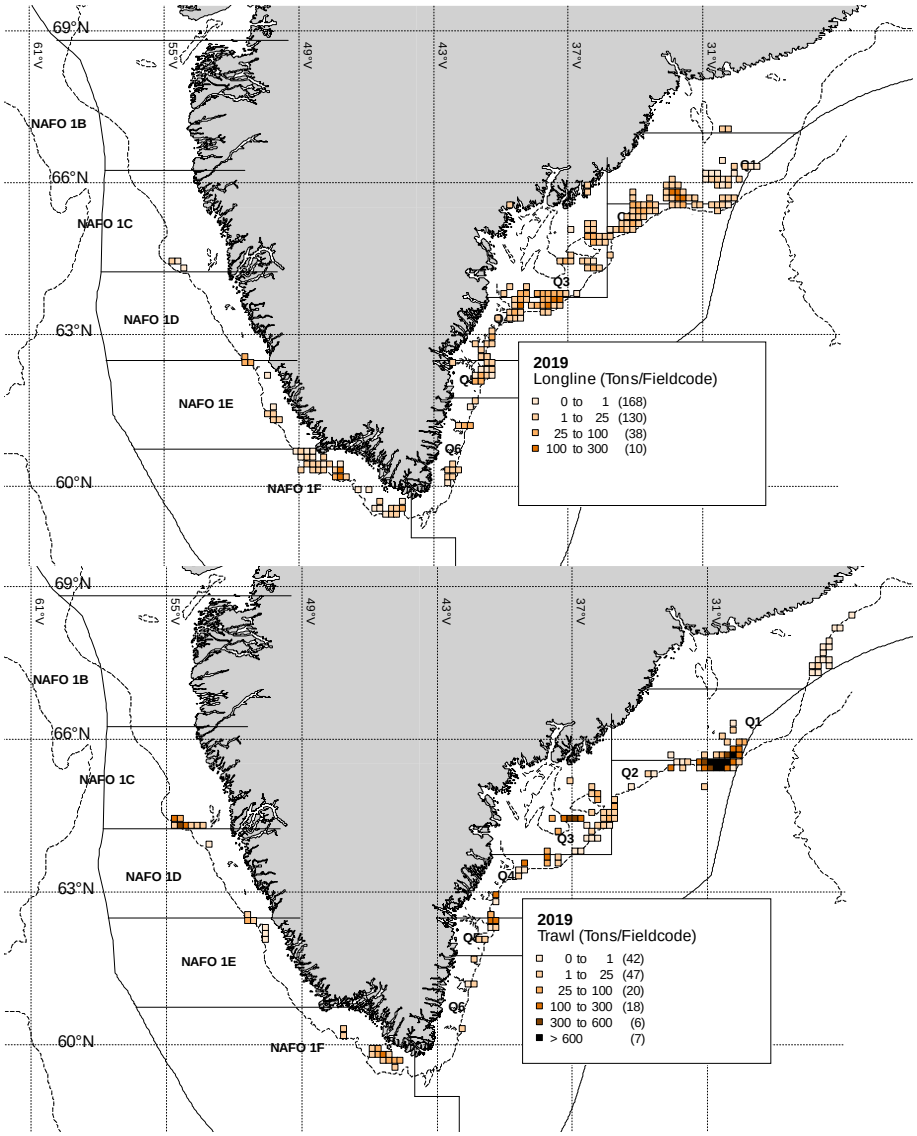


Figure 16.2.3: Distribution of Longline and Trawl catches of Atlantic cod in West and East Greenland. Q1–Q6 illustrates survey areas (strata) in the East Greenland shrimp and fish survey.

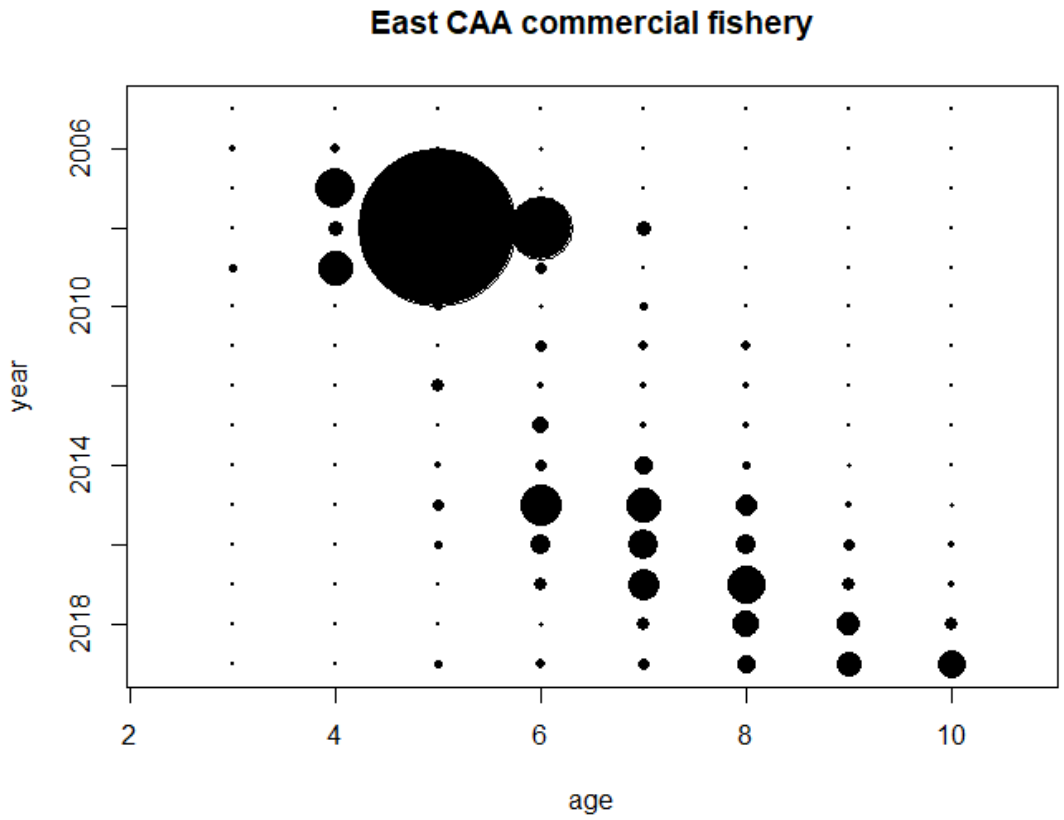


Figure 16.2.4: Catch at Age in the East Greenland (ICES 14. + NAFO 1F) commercial fishery. Size of circles represents size of catch numbers.

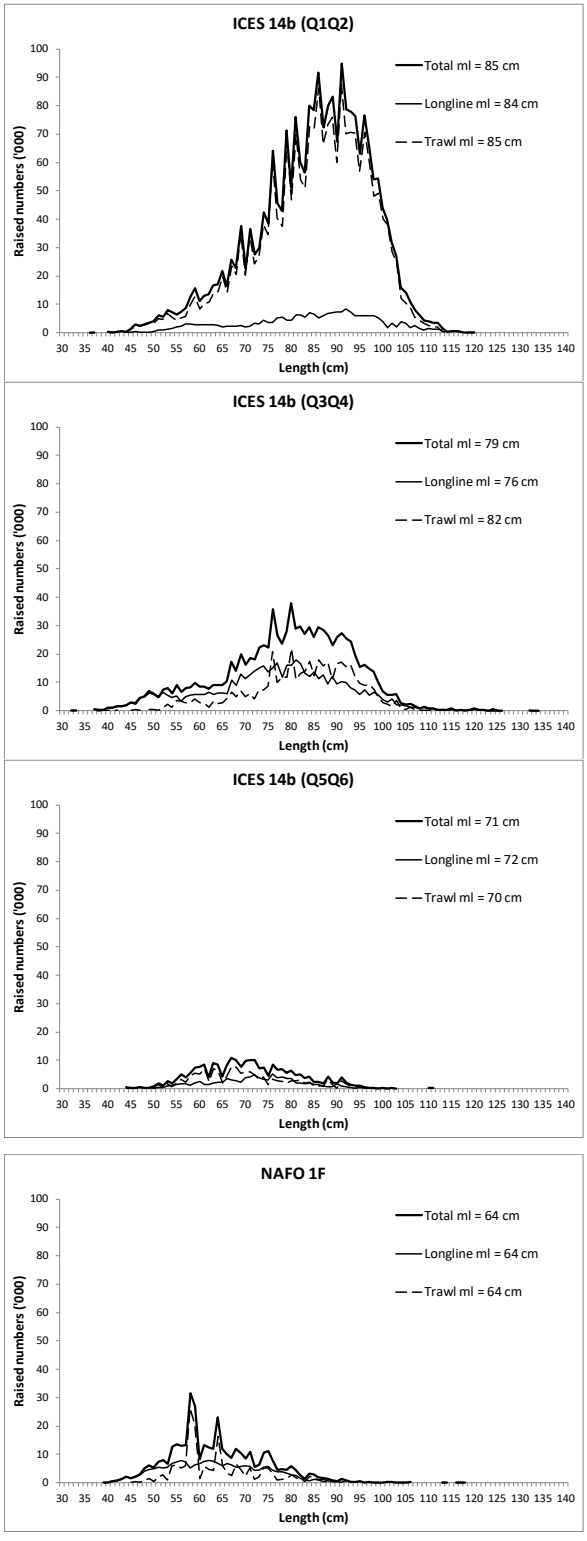
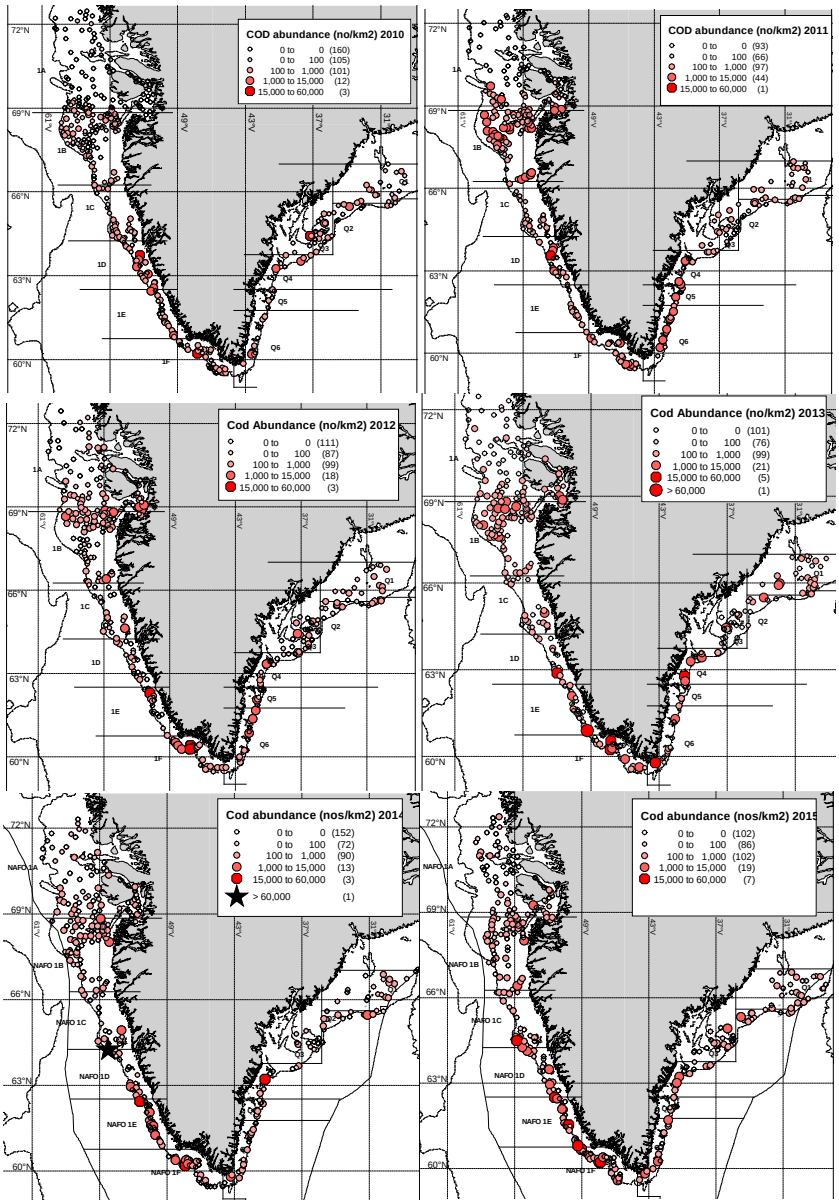


Figure 16.2.5. Length distributions with mean length (ml) of commercial cod catches in three areas in South and East Greenland. Dohrn Bank (Q1Q2) furthest to the north in East Greenland.


COD abundance (no/km2) 2010
0 to 0 (160)
0 to 100 (105)
100 to 1,000 (101)
1,000 to 15,000 (12)
15,000 to 60,000 (3)
COD abundance (no/km2) 2011
0 to 0 (93)
0 to 100 (66)
100 to 1,000 (97)
1,000 to 15,000 (44)
15,000 to 60,000 (1)
Cod Abundance (no/km2) 2012
0 to 0 (111)
0 to 100 (87)
100 to 1,000 (99)
1,000 to 15,000 (18)
15,000 to 60,000 (3)
Cod Abundance (no/km2) 2013
0 to 0 (101)
0 to 100 (76)
100 to 1,000 (99)
1,000 to 15,000 (21)
15,000 to 60,000 (5)
> 60,000 (1)
Cod abundance (nos/km2) 2014
0 to 0 (152)
0 to 100 (72)
100 to 1,000 (90)
1,000 to 15,000 (13)
15,000 to 60,000 (3)
> 60,000 (1)
Cod abundance (nos/km2) 2015
0 to 0 (102)
0 to 100 (86)
100 to 1,000 (102)
1,000 to 15,000 (19)
15,000 to 60,000 (7)
72°N
69°N
66°N
63°N
60°N
NAFO 1A
NAFO 1B
NAFO 1C
NAFO 1D
NAFO 1E
NAFO 1F

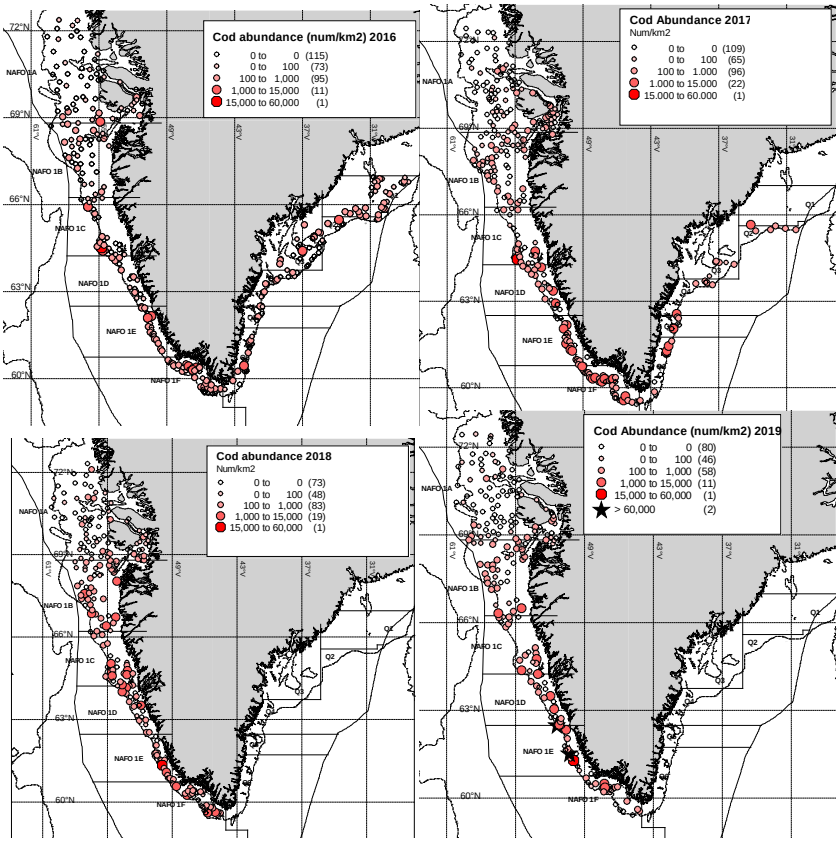
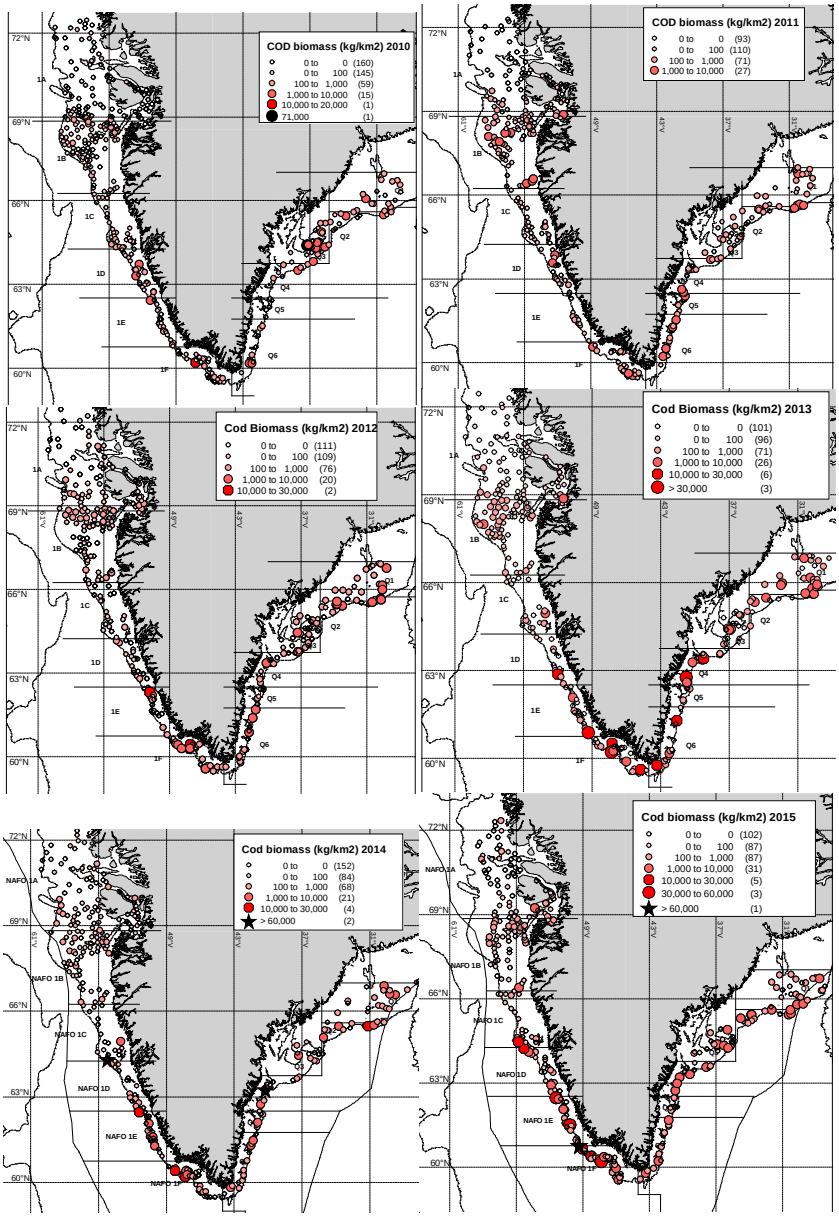


Figure16.2.6. Greenland shrimp and fish survey. Abundance per km².


COD biomass (kg/km2) 2010
0 to 0 (160)
0 to 100 (145)
100 to 1,000 (59)
1,000 to 10,000 (15)
10,000 to 20,000 (1)
71,000 (1)
COD biomass (kg/km2) 2011
0 to 0 (93)
0 to 100 (110)
100 to 1,000 (71)
1,000 to 10,000 (27)
Cod Biomass (kg/km2) 2012
0 to 0 (111)
0 to 100 (109)
100 to 1,000 (76)
1,000 to 10,000 (20)
10,000 to 30,000 (2)
Cod Biomass (kg/km2) 2013
0 to 0 (101)
0 to 100 (96)
100 to 1,000 (71)
1,000 to 10,000 (26)
10,000 to 30,000 (6)
> 30,000 (3)
Cod biomass (kg/km2) 2014
0 to 0 (152)
0 to 100 (84)
100 to 1,000 (68)
1,000 to 10,000 (21)
10,000 to 30,000 (4)
> 60,000 (2)
Cod biomass (kg/km2) 2015
0 to 0 (102)
0 to 100 (87)
100 to 1,000 (87)
1,000 to 10,000 (31)
10,000 to 30,000 (5)
30,000 to 60,000 (3)
> 60,000 (1)
72°N
69°N
66°N
63°N
60°N
1A
1B
1C
1D
1E
1F
Q2
Q4
Q5
Q6
NAFO 1A
NAFO 1B
NAFO 1C
NAFO 1D
NAFO 1E
NAFO 1F

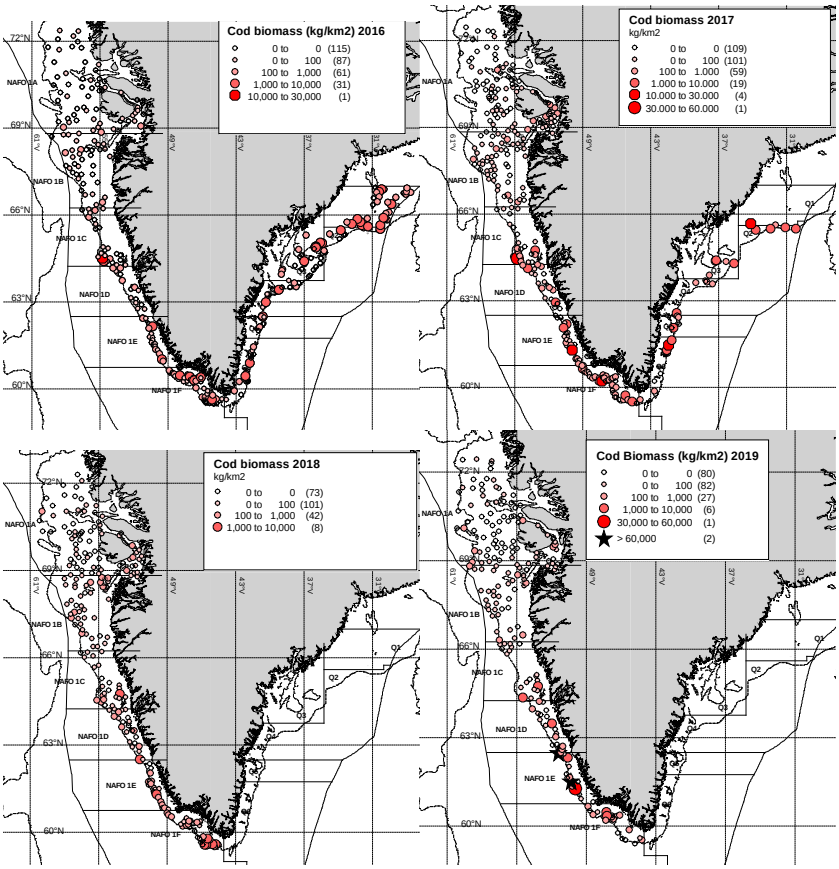


Figure 16.2.7. Greenland shrimp and fish survey. Catch weight kg per km²

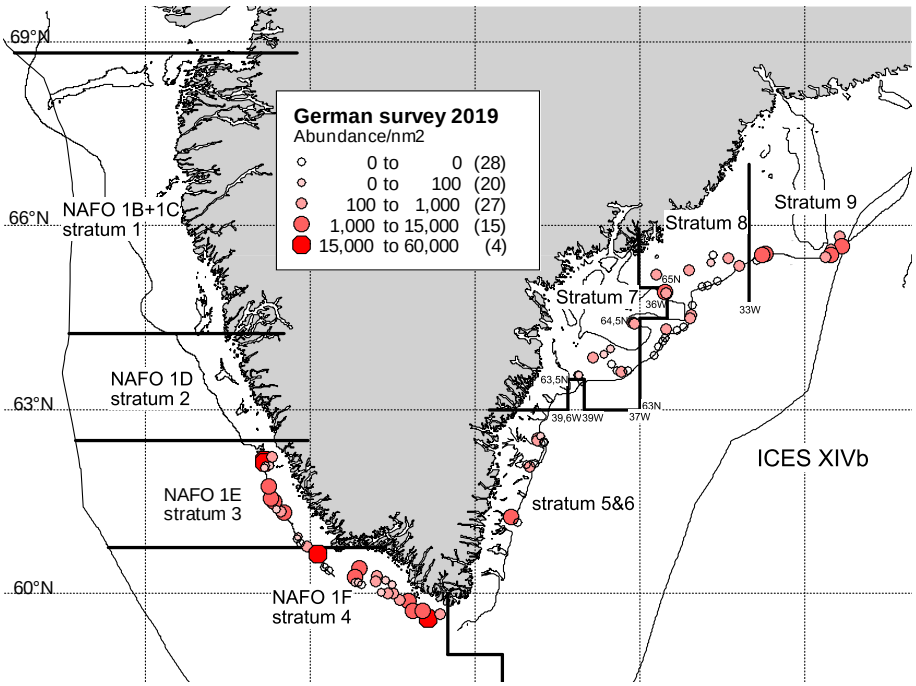


Figure 16.2.8. German ground fish survey. Abundance per nm².

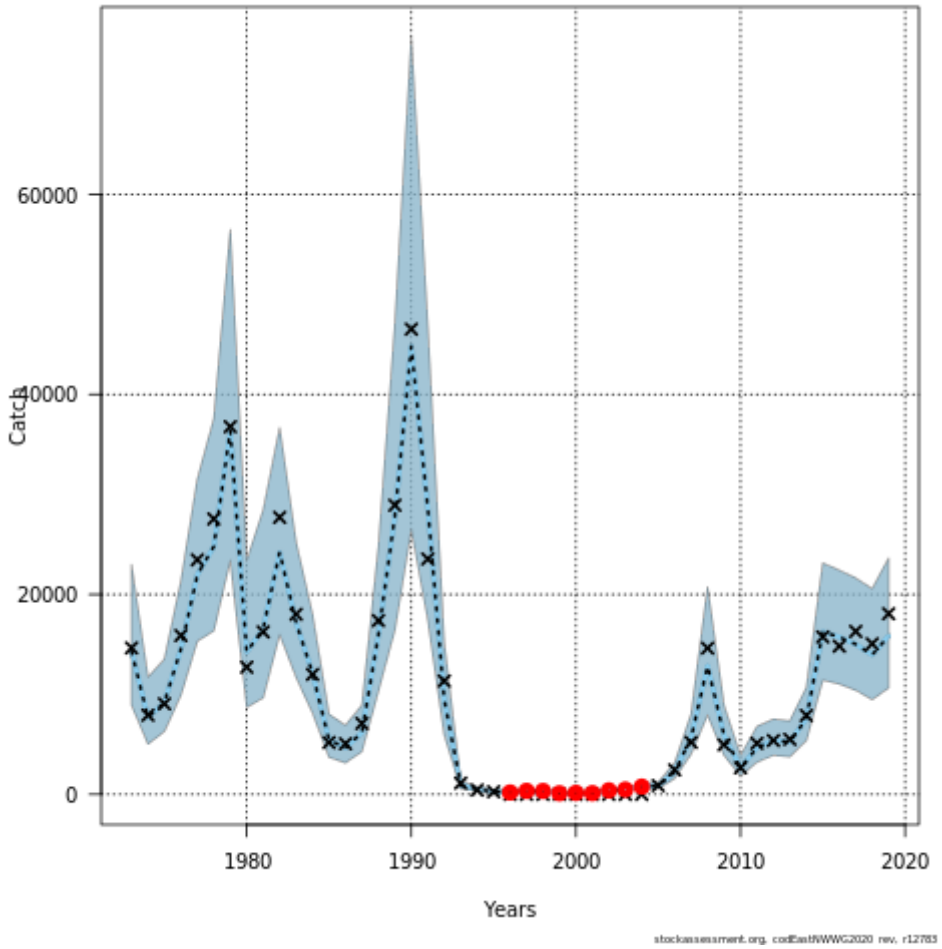


Figure 16.9.1. Estimated catch and with observed catch shown as crosses. Note the period 1996–2004 with near zero catches because no age disaggregated catch data were available.