ICES Advice on fishing opportunities, catch, and effort
Greenland Sea and Icelandic Waters ecoregions
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Cod (*Gadus morhua*) in ICES Subarea 14 and NAFO Division 1F (East Greenland, Southwest Greenland)

ICES advice on fishing opportunities

ICES advises that when the MSY approach is applied, catches in 2021 should be no more than 6091 tonnes.

Note: This advice sheet is abbreviated due to the Covid-19 disruption. The previous advice issued for 2020 is attached as Annex 1.

Stock development over time
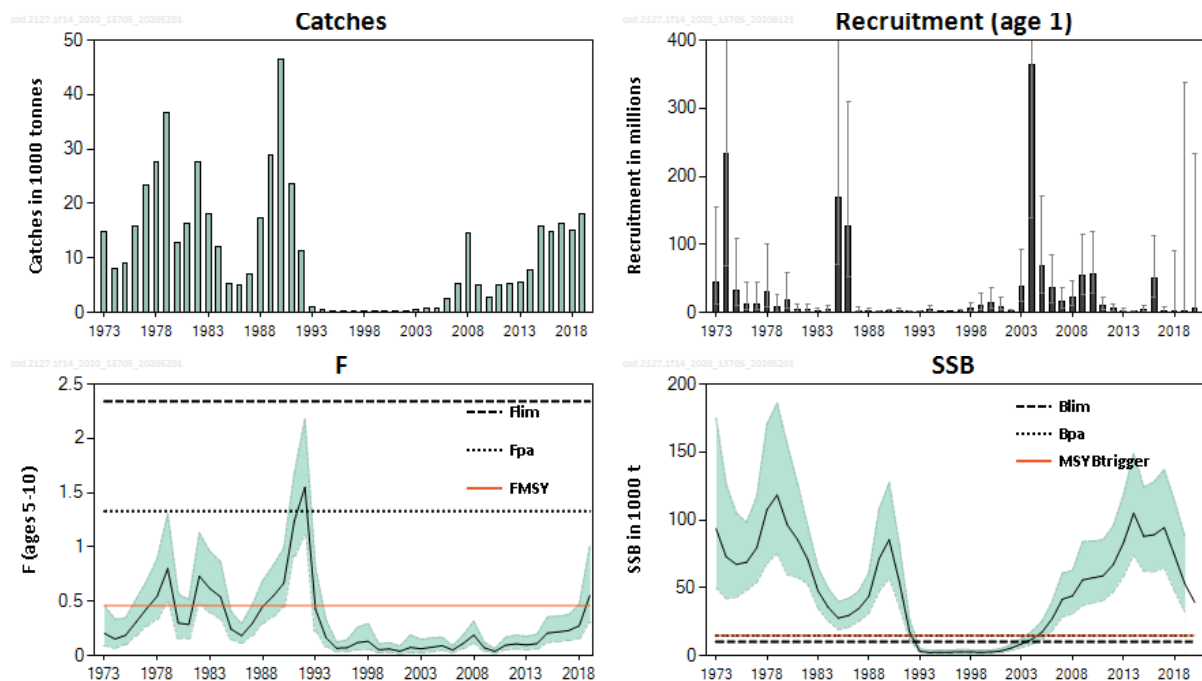
Figure 1   Cod in ICES Subarea 14 and NAFO Division 1F. Summary of the stock assessment with 95% confidence intervals.

Stock and exploitation status

Table 1   Cod in ICES Subarea 14 and NAFO Division 1F. State of the stock and the fishery relative to reference points.

		Fishing pressure				Stock size		
		2017	2018	2019		2018	2019	2020
Maximum sustainable yield	F_{MSY}	✅	✅	❌ Above	$MSY\ B_{trigger}$	✅	✅	✅ Above trigger
Precautionary approach	F_{pa}, F_{lim}	✅	✅	✅ Harvested sustainably	B_{pa}, B_{lim}	✅	✅	✅ Full reproductive capacity
Management plan	F_{MGT}	—	—	— Not applicable	B_{MGT}	—	—	— Not applicable

Catch scenarios

Table 2 Cod in ICES Subarea 14 and NAFO Division 1F. Assumptions made for the interim year and in the forecast. SSB and catch are in tonnes, recruitment in thousands.

Variable	Value	Notes
$F_{ages\ 5-10}$ (2020)	1.33	$F_{ages\ 5-10}$ (2020) assuming Catch$_{2020}$ = TAC
SSB (2021)	28 772	Calculated from the assessment
$R_{age\ 1}$ (2021)	6 165	In thousands. Assuming random walk recruitment drawn from the full time-series (1973–2019)
Catch (2020)	18 824	TAC 2020

Table 3 Cod in ICES Subarea 14 and NAFO Division 1F. Annual catch scenarios. All weights are in tonnes.

| 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}	12767	1.33	20632	−28%	+275%	−32%

* SSB$_{2022}$ relative to SSB$_{2021}$.
** Advice value for 2021 relative to the advice value for 2020, from this updated assessment.
*** Advice value for 2021 relative to the TAC value for 2020, from this updated assessment.

The relatively high increase in the advice is caused by a general upscaling of the stock size this year.

Quality of the assessment
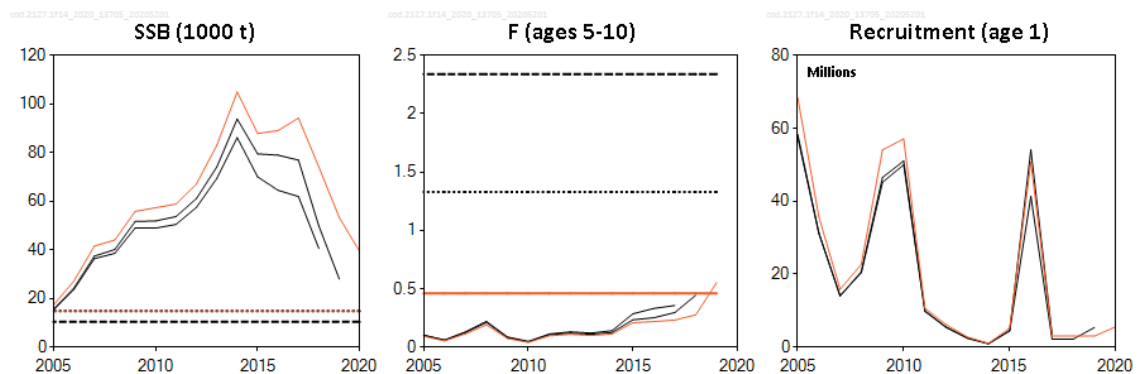
Figure 2 Cod in ICES Subarea 14 and NAFO Division 1F. Historical assessment results. Final-year recruitment values are assumed.

History of the advice, catch, and management

Table 4 Cod in ICES Subarea 14 and NAFO Division 1F. ICES advice, TACs, and catch. All weights are in tonnes.

Year	ICES advice	Catch corresponding to advice	Agreed TAC	ICES catch
2004	Precautionary approach*	0	5000	775
2005	Precautionary approach*	0	5000	890
2006	Precautionary approach*	0	5000	2456
2007	Precautionary approach*	0	5000	5205
2008	Precautionary approach*	0	15000	14628
2009	Precautionary approach*	0	10000	4965
2010	Precautionary approach*	0	5000	2669
2011	Precautionary approach*	0	5000	5113
2012	Precautionary approach**	0	5500	5411
2013	Precautionary approach**	0	6500	5509
2014	Precautionary approach**	0	10000	7893
2015	Precautionary approach**	0	18104	15755

Year	ICES advice	Catch corresponding to advice	Agreed TAC	ICES catch
2016	Precautionary approach	7577	16000	14818
2017	Precautionary approach	≤ 7930	16000	16300
2018	MSY approach	≤ 12151	16500	15068
2019	MSY approach	≤ 5363	20000	18074
2020	MSY approach	≤ 3409	18824	
2021	MSY approach	≤ 6091		

*The advice until 2011 was included in the advice for inshore cod in NAFO Subarea 1 and offshore cod in NAFO divisions 1A–1E.

** The advice for 2012–2015 was combined advice with offshore cod in NAFO divisions 1A–1E.

Summary of the assessment

Table 5 Cod in ICES Subarea 14 and NAFO Division 1F. All weights are in tonnes, recruitment in thousands. The high and low values correspond to 95% confidence intervals.

Year	Recruitment			Spawning-stock biomass			Catches	Fishing mortality		
	Recruitment (age 1)	High	Low	SSB	High	Low		F (ages 5–10)	High	Low
	thousands			tonnes			tonnes			
1973	44195	155710	12544	93530	175062	49970	14725	0.21	0.46	0.091
1974	232950	790475	68650	72741	125843	42046	7950	0.154	0.34	0.071
1975	32390	108021	9712	67234	104923	43083	9091	0.188	0.35	0.102
1976	13062	43638	3910	68838	98167	48271	15922	0.31	0.52	0.185
1977	13071	43597	3919	79478	117165	53912	23455	0.43	0.69	0.27
1978	30198	100689	9057	107540	170420	67861	27561	0.55	0.89	0.34
1979	7524	25602	2211	118282	186019	75211	36775	0.80	1.30	0.49
1980	18792	57977	6091	96195	155230	59612	12724	0.30	0.57	0.160
1981	4640	13008	1655	85439	126794	57573	16255	0.29	0.52	0.159
1982	5092	12781	2029	70955	95336	52810	27720	0.73	1.13	0.48
1983	2573	7044	939	47849	65184	35124	18054	0.62	0.96	0.40
1984	4405	10622	1827	35686	49758	25594	11997	0.54	0.87	0.34
1985	168187	402953	70199	27719	39794	19307	5187	0.25	0.41	0.149
1986	126523	309565	51712	29552	42079	20754	5074	0.185	0.30	0.116
1987	3150	7563	1312	34599	47467	25220	7093	0.30	0.47	0.186
1988	2613	6139	1112	43613	60861	31254	17388	0.45	0.69	0.30
1989	723	1719	304	71389	107683	47327	28917	0.55	0.83	0.36
1990	1470	3655	591	85386	127362	57245	46519	0.67	0.99	0.45
1991	2456	6134	983	54373	81414	36313	23538	1.24	1.68	0.92
1992	918	2198	384	17466	26682	11433	11349	1.55	2.2	1.10
1993	821	2018	334	3317	5097	2158	1135	0.43	0.81	0.23
1994	3752	9547	1475	2355	3988	1391	437	0.166	0.33	0.084
1995	239	646	89	2643	4377	1596	284	0.069	0.125	0.038
1996	313	929	106	2608	4245	1602	192	0.074	0.147	0.038
1997	1617	4697	557	2877	4604	1798	355	0.121	0.26	0.056
1998	5544	13689	2245	2740	4375	1716	345	0.133	0.30	0.059
1999	10944	27561	4345	2589	4196	1598	116	0.055	0.109	0.028
2000	14685	36259	5948	2713	4251	1731	152	0.062	0.120	0.032
2001	8970	22024	3653	3528	5279	2357	125	0.042	0.090	0.0190
2002	1594	4308	590	5741	8426	3912	401	0.076	0.191	0.030
2003	38267	92727	15792	8778	12938	5955	485	0.064	0.151	0.027
2004	362919	944278	139482	12159	17911	8254	775	0.078	0.163	0.037
2005	68473	170466	27504	17300	25316	11822	890	0.093	0.171	0.050
2006	35733	84520	15107	27246	39983	18567	2456	0.053	0.092	0.031
2007	15832	36099	6943	41543	60757	28405	5205	0.113	0.191	0.067
2008	22675	47386	10850	44062	62863	30884	14628	0.190	0.32	0.113
2009	54072	114614	25510	55827	83918	37139	4965	0.073	0.123	0.043
2010	57102	118949	27412	57326	84438	38919	2669	0.040	0.067	0.024
2011	10678	22654	5033	58830	85311	40569	5113	0.096	0.168	0.055
2012	6165	12927	2940	67129	95677	47099	5411	0.109	0.190	0.063
2013	2764	5781	1321	83079	118217	58385	5509	0.099	0.178	0.056
2014	976	2132	447	104961	148779	74048	7893	0.112	0.199	0.063

Year	Recruitment			Spawning-stock biomass			Catches	Fishing mortality		
	Recruitment (age 1)	High	Low	SSB	High	Low		F (ages 5–10)	High	Low
	thousands			tonnes			tonnes			
2015	5230	11145	2454	87870	124126	62204	15755	0.21	0.36	0.122
2016	50753	111790	23042	89086	127996	62004	14818	0.22	0.36	0.131
2017	3009	7507	1206	94280	137043	64860	16300	0.23	0.38	0.142
2018	3009	90111	100	74111	114253	48073	15068	0.28	0.47	0.161
2019	3009	337441	27	53297	88163	32219	18074	0.55	1.01	0.31
2020	5544	232950	313	39282						

Sources and references

ICES. 2020. North-Western Working Group (NWWG). ICES Scientific Reports. 2:51. 431 pp.
http://doi.org/10.17895/ices.pub.6051.

Annex 1

ICES Advice on fishing opportunities, catch, and effort
*Greenland Sea and Icelandic Waters ecoregions*
Published 13 June 2019

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

ICES advice on fishing opportunities

ICES advises that when the MSY approach is applied, catches in 2020 should be no more than 3409 tonnes.

Stock development over time

The spawning-stock biomass (SSB) increased to above MSY $B_{trigger}$ from 2005 and has decreased since 2014, but is still above MSY $B_{trigger}$. Fishing mortality (F) has been below F_{MSY} in the last 25 years, but has increased since 2009 and is approaching F_{MSY}. Recruitment (R) occasionally has large year classes, with the latest being in 2003.
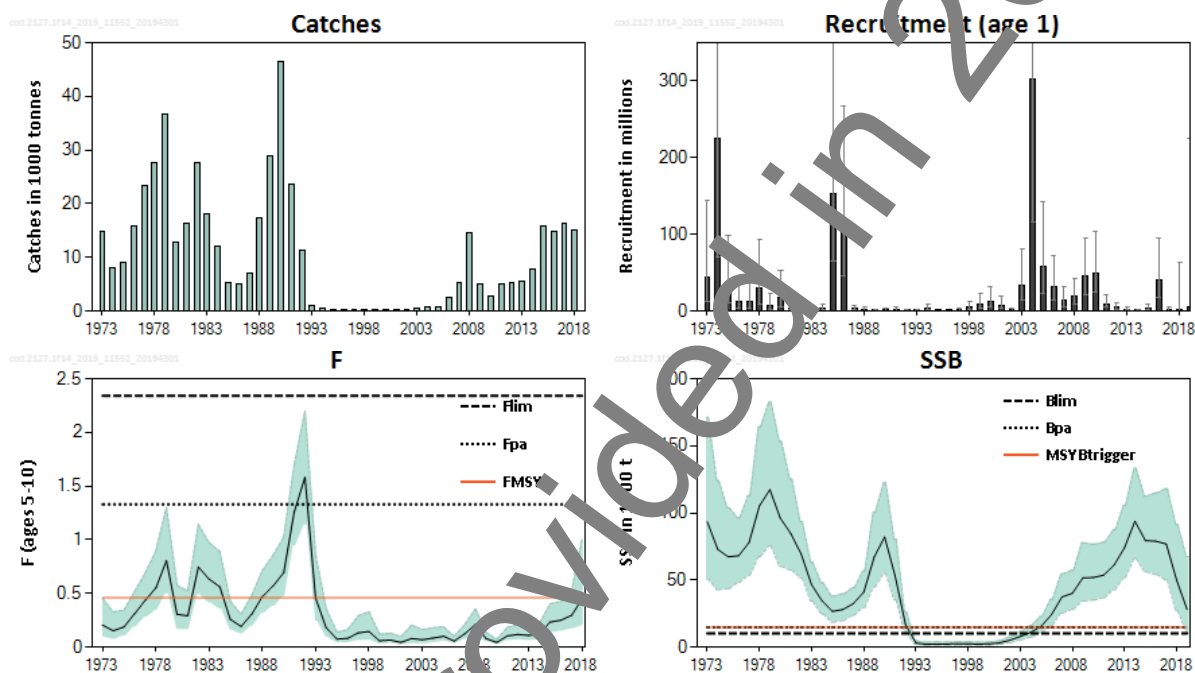
Figure 1   Cod in ICES Subarea 14 and NAFO Division 1F. Summary of the stock assessment with 95% confidence intervals.

Stock and exploitation status

ICES assesses that fishing pressure on the stock is below F_{MSY}, F_{pa}, and F_{lim}. The spawning stock size is above MSY $B_{trigger}$, B_{pa}, and B_{lim}.

Table 1   Cod in ICES Subarea 14 and NAFO Division 1F. State of the stock and fishery relative to reference points.

		Fishing pressure				Stock size		
		2016	2017	2018		2017	2018	2019
Maximum sustainable yield	F_{MSY}	✅	✅	✅ Below	MSY $B_{trigger}$	✅	✅	✅ Above trigger
Precautionary approach	F_{pa}, F_{lim}	✅	✅	✅ Harvested sustainably	B_{pa}, B_{lim}	✅	✅	✅ Full reproductive capacity
Management plan	F_{MGT}	—	—	— Not applicable	B_{MGT}	—	—	— Not applicable

Catch scenarios

Table 2   Cod in ICES Subarea 14 and NAFO Division 1F. Assumptions made for the interim year and in the forecast. SSB and catch are in tonnes, recruitment in thousands.

Variable	Value	Notes
$F_{ages\ 5-10}$ (2019)	1.70	$F_{ages\ 5-10}$ (2019) assuming $Catch_{2019}$ = 15 000 tonnes *
SSB (2020)	18 159	Calculated from assessment
$R_{age\ 1}$ (2020)	7255	Sampled from the full time-series
Total catch (2019)	15 000	Based on catches observed in 2018

* Catches lower than the TAC are expected for 2019.

Table 3   Cod in ICES Subarea 14 and NAFO Division 1F. Annual catch scenarios. All weights are in tonnes.

Rationale	Catch (2020)	F (2020)	SSB (2021)	% SSB change *	% advice change **	% TAC change ***
ICES advice basis						
MSY approach: F_{MSY}	3409	0.46	24 602	35	−36	−83
Other scenarios						
F = 0	0	0	28 757	58	−100	−100
F_{pa}	7723	1.33	19 733	9	45	−64
F = F_{2019} (*status quo*)	9202	1.70	18 334	1	72	−54
F_{lim}	11 252	2.34	15 461	−15	110	−44
SSB_{2021} = B_{lim}	16 339	5.06	10 098	−44	205	−18
SSB_{2021} = B_{pa} = MSY $B_{trigger}$	11 865	2.60	15 342	−16	121	−41

* SSB_{2021} relative to SSB_{2020}.
** Advice value for 2020 relative to the advice value for 2019, from this updated assessment.
*** Advice value for 2020 relative to the TAC value for 2019, from this updated assessment.

The advice change is caused by decreasing SSB and low recruitment.

Basis of the advice

Table 4   Cod in ICES Subarea 14 and NAFO Division 1F. The basis of the advice.

Advice basis	MSY approach
Management plan	ICES is not aware of any agreed precautionary management plan for cod in this area.

Quality of the assessment

Data from tagging experiments show a considerable emigration from East Greenland to Iceland (Hedeholm, 2018). This is accounted for in the assessment. The level is not known exactly, and therefore adds uncertainty to the assessment.

No surveys were conducted in 2018, adding to the uncertainty of the assessment.
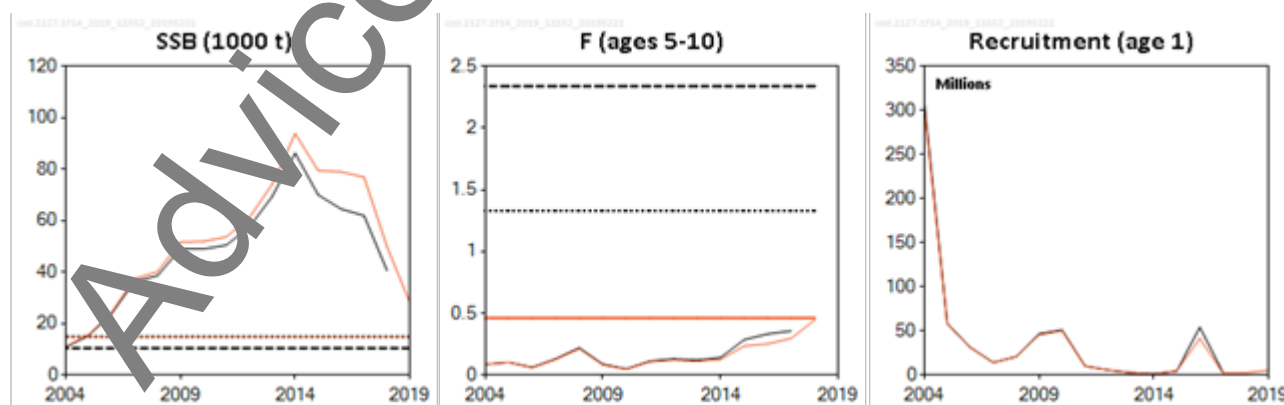
Figure 2   Cod in ICES Subarea 14 and NAFO Division 1F. Historical assessment results.

Issues relevant for the advice

ICES provides advice for cod caught in this area, which may include more than one cod population. There are linkages between this stock and the Icelandic cod stock; some of the spawning stock migrates to Iceland and there is drift of eggs and larvae from Iceland (Therkildsen *et al.,* 2013; Wieland and Hovgård, 2002).

For the forecast calculations, a total catch of 15 000 tonnes in 2019 is assumed. The TAC set for 2019 is 20 000 tonnes, but given the recent history where the TAC was not obtained, a lower estimate is considered likely.

Reference points

Table 5   Cod in ICES Subarea 14 and NAFO Division 1F. Reference points, values, and their technical basis. All weights are in tonnes.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	14 803	Assumed at B_{pa}.	ICES (2018a)
	F_{MSY}	0.46	Stochastic simulations with a Type 1 stock–recruitment relationship.	ICES (2018a)
Precautionary approach	B_{lim}	10 354	Breakpoint in segmented regression.	ICES (2018a)
	B_{pa}	14 803	$B_{lim} \times e^{1.645\sigma}$, σ = 0.217 *	ICES (2018a)
	F_{lim}	2.34	Equilibrium F, which will maintain the stock above B_{lim} with a 50% probability and with stochastic recruitment.	ICES (2018a)
	F_{pa}	1.33	$F_{lim} \times e^{-1.645\sigma}$, σ = 0.343.	ICES (2018a)
Management plan	SSB_{mgt}	-	-	
	F_{mgt}	-	-	

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

Basis of the assessment

Table 6   Cod in ICES Subarea 14 and NAFO Division 1F. Basis of the assessment and advice.

ICES stock data category	1 (ICES, 2018b).
Assessment type	Age-based analytical assessment (SAM; ICES, 2019) that uses catches in the model and in the forecast.
Input data	Catch-at-age and age-disaggregated survey indices: Greenland (GRL-GFS, August, bottom trawl since 2008) and German (GER(GRL)-GFS-Q4, October, bottom trawl since 1982). Age-specific natural mortality incorporating emigration to Iceland (from age 5 onwards).
Discards and bycatch	Discarding is considered negligible.
Indicators	None.
Other information	Benchmarked in 2018 (ICES, 2018a).
Working group	North-Western Working Group (NWWG)

Information from stakeholders

There is no additional available information for this stock.

History of the advice, catch, and management

Table 7 Cod in ICES Subarea 14 and NAFO Division 1F. ICES advice and catch. All weights are in tonnes. Separate advice for this cod stock was provided for the first time in this area for 2016. The advice up to 2011 was included in the advice for inshore cod in NAFO Subarea 1 and offshore cod in NAFO divisions 1A–1E (ICES, 2011). The advice for 2012–2015 was combined advice and TAC with offshore cod in NAFO divisions 1A–1E (ICES, 2014).

Year	ICES advice	Catch corresponding to advice	Agreed TAC	ICES catch
2004	Precautionary approach	0	5 000	775
2005	Precautionary approach	0	5 000	890
2006	Precautionary approach	0	5 000	2 456
2007	Precautionary approach	0	5 000	5 205
2008	Precautionary approach	0	15 000	14 628
2009	Precautionary approach	0	15 000	4 965
2010	Precautionary approach	0	5 000	2 669
2011	Precautionary approach	0	5 000	5 113
2012	Precautionary approach	0	5 500	5 411
2013	Precautionary approach	0	6 500	5 509
2014	Precautionary approach	0	10 000	7 893
2015	Precautionary approach	0	18 104	15 755
2016	Precautionary approach	7 577	16 000	14 818
2017	Precautionary approach	≤ 7 930	16 000	16 300
2018	MSY approach	≤ 12 150	16 500	15 068
2019	MSY approach	≤ 5 360	20 000	
2020	MSY approach	≤ 3 490		

History of the catch and landings

Table 8 Cod in ICES Subarea 14 and NAFO Division 1F. Catch distribution by fleet in 2019 as estimated by ICES. All weights are in tonnes.

Catch (2018)	Landings		Discards
15 068	Trawl 62%	Longline 38%	Discarding is considered negligible
	15 068		

Table 9 Cod in ICES Subarea 14 and NAFO Division 1F. Historical catches, not included in the assessment, in tonnes.

Year	Catch	Year	Catch	Year	Catch	Year	Catch
1954	23759	1973	14725	1992	11349	2011	5113
1955	11567	1974	7950	1993	1135	2012	5411
1956	19189	1975	9091	1994	437	2013	5509
1957	30659	1976	15922	1995	284	2014	7893
1958	46972	1977	23455	1996	192	2015	15755
1959	35500	1978	27561	1997	355	2016	14818
1960	39219	1979	36775	1998	345	2017	16300
1961	40212	1980	12724	1999	116	2018	15068
1962	4184	1981	16255	2000	152		
1963	5626	1982	27720	2001	125		
1964	33751	1983	18054	2002	401		
1965	38063	1984	11997	2003	485		
1966	38956	1985	5187	2004	775		
1967	40738	1986	5074	2005	890		
1968	37844	1987	7093	2006	2456		
1969	31879	1988	17388	2007	5205		
1970	40023	1989	28917	2008	14628		
1971	59789	1990	46519	2009	4965		
1972	32188	1991	23538	2010	2669		

Summary of the assessment

Table 10   Cod in ICES Subarea 14 and NAFO Division 1F. All weights are in tonnes. Recruitment in thousands. The high and low values correspond to 95% confidence intervals.

Year	Recruitment (Age 1)	Recruitment High	Recruitment Low	SSB	SSB High	SSB Low	Catches	F (Ages 5–10)	F High	F Low
1973	43571	144418	13145	93376	171156	50942	14725	0.21		0.093
1974	224531	720330	69988	72934	123998	42899	7950	0.15	0.33	0.072
1975	31348	98959	9931	67381	103882	43705		0.188	0.34	0.103
1976	13120	41509	4147	68116	96267	48198	1 922	31	0.52	0.186
1977	12984	41019	4110	77884	112879	53739		.44	0.69	0.28
1978	29396	92890	9303	105301	164094	67572	2 561	0.55	0.90	0.34
1979	7255	23307	2259	117364	182474	75486	36 77	0.80	1.30	0.50
1980	18155	53341	6179	96146	153299	60301	12 24	0.31	0.57	0.163
1981	4419	11908	1640	84812	125221	5 4	16255	0.29	0.53	0.163
1982	4874	11969	1985	69515	93630	1611	27720	0.75	1.14	0.49
1983	2351	6183	894	46614	63238	343	18054	0.63	0.97	0.41
1984	4144	9762	1759	34599	48037	24 20	11997	0.56	0.89	0.36
1985	152499	356250	65280	26671	379	18735	5187	0.26	0.43	0.157
1986	111518	266875	46600	28097	3 669	19901	5074	0.194	0.31	0.122
1987	2987	7013	1272	32552	44 5	23874	7093	0.31	0.48	0.196
1988	2438	5594	1063	40973	66 4	29616	17388	0.47	0.71	0.31
1989	669	1551	288	671	100 84	44899	28917	0.57	0.86	0.38
1990	1270	3106	519	82 84	122391	55052	46519	0.69	1.02	0.47
1991	2128	5228	866	53 56	80394	35279	23538	1.26	1.70	0.94
1992	824	1930	352	1 212	26183	10924	11349	1.58	2.2	1.14
1993	764	1841	317	3106	4741	2035	1135	0.46	0.86	0.24
1994	3243	8150	1290	170	3640	1294	437	0.180	0.36	0.091
1995	227	602	85	2377	3924	1440	284	0.076	0.140	0.042
1996	299	862	04	2364	3816	1464	192	0.083	0.164	0.042
1997	1512	4241	539	2607	4131	1645	355	0.134	0.29	0.061
1998	4883	11848	2 12	2498	3956	1578	345	0.146	0.33	0.064
1999	9408	23379	3786	2368	3821	1468	116	0.060	0.121	0.030
2000	12933	31376	5331	2494	3895	1597	152	0.067	0.132	0.034
2001	7961	19157	308	3236	4826	2170	125	0.045	0.098	0.021
2002	1568	42 3	585	5226	7650	3570	401	0.081	0.21	0.032
2003	33772	241	14214	7963	11711	5415	485	0.070	0.165	0.030
2004	302197	78 172	115867	11052	16245	7520	775	0.085	0.181	0.040
2005	57 48	14 232	23285	15616	22854	10670	890	0.102	0.191	0.055
2006	312 9	72419	13458	24310	35708	16551	2456	0.058	0.102	0.033
2007	14108	31528	6313	37412	54620	25626	5205	0.125	0.21	0.073
2008	2030	42257	9817	40157	57256	28165	14628	0.21	0.36	0.124
2009	4 90	95449	21395	51681	77793	34335	4965	0.080	0.137	0.047
2010	500 4	103529	24161	51920	76727	35134	2669	0.045	0.075	0.026
2011	9749	20495	4637	53701	78075	36937	5113	0.106	0.186	0.060
2012	5382	11226	2580	61136	87310	42809	5411	0.119	0.21	0.068
2013	2403	5003	1154	74130	105678	52000	5509	0.110	0.199	0.061
2014	895	1938	413	93855	133154	66155	7893	0.125	0.22	0.069
2015	4576	9778	2142	79495	112434	56206	15755	0.23	0.40	0.135
2016	41335	94954	17994	78970	114845	54301	14818	0.25	0.43	0.148

Year	Recruitment (Age 1)	Recruitment High	Recruitment Low	SSB	SSB High	SSB Low	Catches	F (Ages 5–10)	F High	F Low
2017	2178	6267	757	76912	118067	50102	16300	0.30	0.52	0.170
2018	2178	64337	74	49836	91323	27197	15068	0.45	1.01	0.197
2019	5382	224531	299	27985	67592	11619				

Sources and references

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