Cod (*Gadus morhua*) in NAFO Subarea 1, inshore (West Greenland cod)

ICES advice on fishing opportunities

ICES advises that when the MSY approach is applied, catches in 2020 should be no more than 5537 tonnes.

Stock development over time

The spawning-stock biomass (SSB) of West Greenland inshore cod is above MSY $B_{trigger}$ and has steeply declined since 2015. Fishing mortality (F) has been stable in recent years, well above F_{MSY}. Recent recruitment has gradually decreased from a decade of high values, and is currently close to historically low levels.

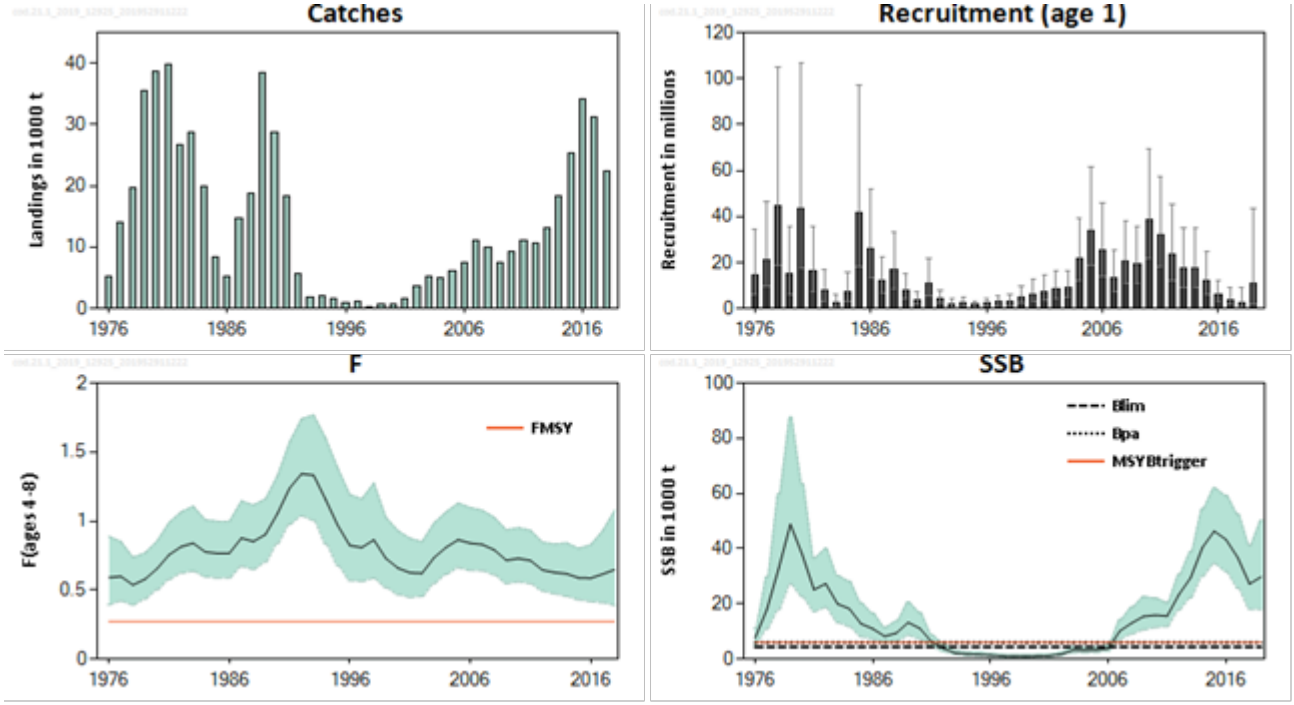

Figure 1 Cod in NAFO Subarea 1, inshore. Summary of the stock assessment with 95% confidence intervals.

Stock and exploitation status

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

Table 1 Cod in NAFO Subarea 1, inshore. 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}	✗	✗	✗	Above	MSY $B_{trigger}$	✓	✓	✓ Above trigger
Precautionary approach	F_{pa},F_{lim}	?	?	?	Undefined	B_{pa},B_{lim}	✓	✓	✓ Full reproductive capacity
Management plan	F_{MGT}	–	–	–	Not applicable	B_{MGT}	–	–	– Not applicable

Catch scenarios

Table 2 Cod in NAFO Subarea 1, inshore. Assumptions made for the interim year and in the 2020 forecast. All weights are in tonnes, recruitment in thousands.

Variable	Value	Notes
$F_{ages\ 4–8}$ (2019)	0.648	$F_{ages\ 4–8}$ (2019) = $F_{ages\ 4–8}$ (2018).
SSB (2020)	21 487	Fishing at F_{sq}
$R_{age\ 1}$ (2020)	12 217	Sampled from the full time-series.
Total catch (2019)	15 039	Based on $F_{ages\ 4–8}$ (2019) = 0.648

Table 3 Cod in NAFO Subarea 1, inshore. Annual catch scenarios. All weights are in tonnes.

Rationale	Catch (2020)	F (2020)	SSB (2021)	% SSB change *	% advice change **
ICES advice basis					
MSY approach: F_{MSY}	5537	0.27	21 462	−0.01	−19
Other scenarios					
F = 0	0	0	28 749	34	−100
F = F_{2019} (*status quo*)	10 560	0.648	15 561	−28	55
SSB_{2021} = B_{lim}	21 731	4.15	4 379	−80	219
SSB_{2021} = B_{pa} = MSY $B_{trigger}$	19 904	2.73	6 016	−72	192

* SSB_{2021} relative to SSB_{2020}.
** Advice value for 2020 relative to the advice value for 2019.

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

Basis of the advice

Table 4 Cod in NAFO Subarea 1, inshore. 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

The assesment is considered uncertain because of known stock mixing that affects both surveys and commercial catches. However, survey catches are less influenced by cod from other areas than the commercial catches. The assessment fits the survey observations better than the catches.

The chosen stock assessment model estimates catches and these differ from observed catches, especially when the reported landings are high (Figure 2). The input landings include some catches of other cod stocks in addition to the West Greenland inshore stocks, and this is likely to contribute to the discrepancy above. This is also a violation of basic assumptions made and may cause a considerable overestimation of stock size.

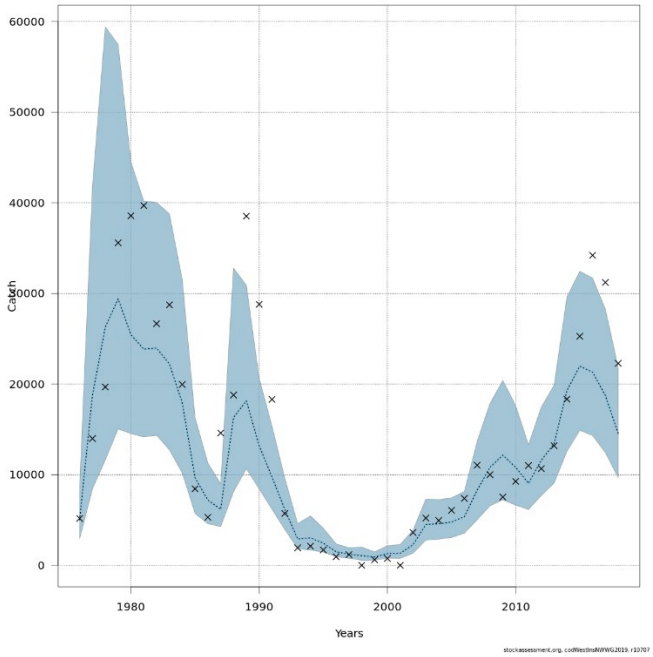

Figure 2 Cod in NAFO Subarea 1, inshore. Observed catches (tonnes) from the inshore area (crosses) and the model estimate of catches (dotted line). The model estimates are shown with 95% confidence intervals.

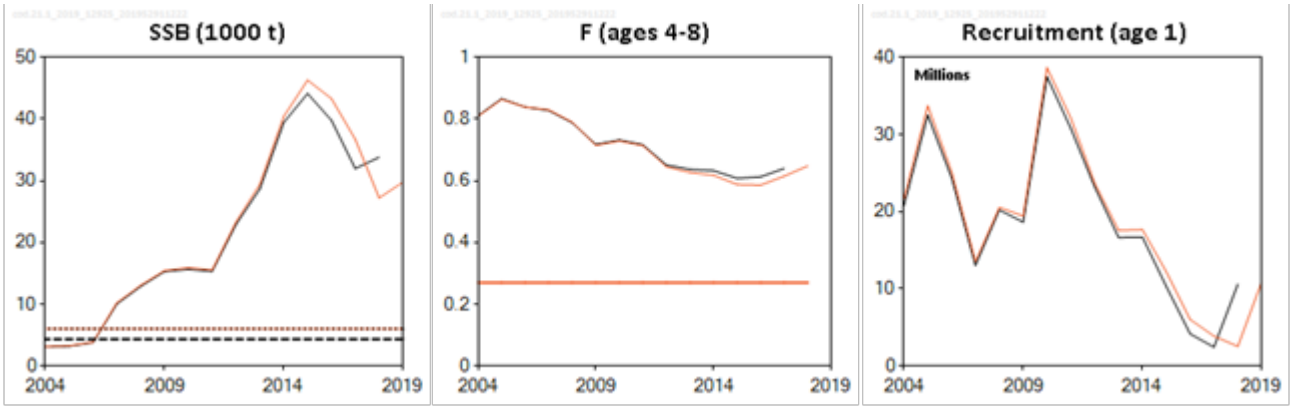

Figure 3 Cod in NAFO Subarea 1. Historical assessment results.

Issues relevant for the advice

The TAC area covers NAFO Subarea 1 inshore. Several cod stocks mix in this inshore area, including West Greenland inshore and offshore cod, East Greenland cod, and Icelandic cod (Storr-Paulsen *et al.*, 2004). The proportional contribution of each stock is highly uncertain and is still being investigated.

When setting species TAC there is an increased risk of overexploitation of the weakest stock. The West Greenland offshore stock is in a depleted condition and the current ICES advice is zero catch. Bycatch of offshore cod should be kept as low as possible in order to promote rebuilding of the offshore cod stock.

TACs have not been caught in the last two years, and it is unlikely that the species TAC of 30 000 tonnes in 2019 will be caught. ICES has assumed that F_{2019} will equal F_{2018}, corresponding to estimated catches of inshore cod in 2019 of 15 039 tonnes.

Reference points

Table 5 Cod in NAFO Subarea 1, inshore. Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	5983 tonnes	Assumed at B_{pa}	ICES (2018a)
	F_{MSY}	0.27	Stochastic simulations with segmented regression and a Beverton–Holt stock–recruitment curve from 1973 to 2017.	ICES (2018a)
Precautionary approach	B_{lim}	4346 tonnes	Breakpoint in segmented regression	ICES (2018a)
	B_{pa}	5983 tonnes	$B_{lim} \times e^{1.645\sigma}$, $\sigma = 0.194$	ICES (2018a)
	F_{lim}	-	Not defined	
	F_{pa}	-	Not defined	
Management plan	SSB_{mgt}	-	-	
	F_{mgt}	-	-	

Basis of the assessment

Table 6 Cod in NAFO Subarea 1, insho.re. 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 (WGRL-Gill, July, gillnet since 1985).
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.

History of the advice, catch, and management

Table 7 Cod in NAFO Subarea 1, inshore. ICES advice, TACs, and catch. All weights are in tonnes.

Year	ICES advice	Catch corresponding to advice	Agreed TAC *	ICES catch *
2012			15000	10672
2013	Mean catch in recent 10 years	8000	13500	13202
2014	20% increase in catch (relative to 3-year average)	< 12379	18500	18331
2015	Same basis as 2014	< 12379	27500	25272
2016	Same advice as in 2014	< 12379	35400	34204
2017	Precautionary approach (same advice value as for 2014–2016)	< 12379	36500	31220
2018	MSY approach	< 8858	36500	22290
2019	MSY approach	≤ 6806	30000	
2020	MSY approach	≤ 5537		

* Includes all cod taken in NAFO Subarea 1 inshore.

History of the catch and landings

Table 8 Cod in NAFO Subarea 1, inshore. Catch distribution by fleet in 2018 as estimated by ICES. All weights are in tonnes.

Catch (2018)	Catches				Discards
22 290	Poundnet 73%	Longline 14%	Gillnet 5%	Hooks 8%	Discarding is considered negligible
	22 290				

Table 9 Historical catches of cod in NAFO Subarea 1, inshore. All weights are in tonnes.

Year	NAFO divisions							Total West Greenland	ICES Division 14.b
	1A	1B	1C	1D	1E	1F	Unknown NAFO division		
1911				19				19	
1912				5				5	
1913				66				66	
1914				60				60	
1915		47	6	45				98	
1916		66	24	103				193	
1917		67	28	59				154	
1918		106	26	140		169		441	
1919		39	37	140	148	137		501	
1920		117	32	187	23	95		454	
1921		116	92	97	7	196		508	
1922		82	178	144	40	158		602	
1923		120	116	147	0	307		690	
1924		131	223	221	1	267		843	
1925		122	371	318	45	168		1024	
1926		97	785	673	170	499		2224	
1927		282	974	982	305	1027		3570	
1928		426	888	1153	497	1199		4163	
1929		1479	1572	1335	642	2052		7080	
1930	137	2208	2326	1681	994	2312		9658	
1931	315	1905	2026	1520	835	2453		9054	
1932	358	1713	2130	1042	731	3258		9232	
1933	304	1799	1743	1148	948	2296		8238	
1934	451	2080	1473	652	921	3591		9168	
1935	524	1870	1277	769	670	2466		7576	
1936	329	2039	1199	705	717	2185		7174	
1937	135	1982	1433	854	496	2061		6961	
1938	258	1743	1406	703	347	1035		5492	
1939	416	2256	1732	896	431	1430		7161	
1940	482	2478	1600	1061	646	1759		8026	
1941	636	3229	1473	823	593	1868		8622	
1942	879	3831	2249	1332	1003	2733		12027	
1943	1507	5056	2016	1240	1134	2073		13026	
1944	1795	4322	2355	1547	1198	2168		13385	
1945	1585	4987	2844	1207	1474	2192		14289	
1946	1889	5210	2871	1438	1139	2715		15262	
1947	1573	5261	3323	2096	1658	4118		18029	
1948	1130	5660	3756	1657	1652	4820		18675	
1949	1403	4580	3666	2110	2151	3140		17050	
1950	1657	6358	4140	2357	2278	4383		21173	
1951	1277	5322	3324	2571	2101	3605		18200	
1952	646	4443	2906	2437	2216	4078		16726	
1953	1092	5030	3662	5513	3093	4261		22651	
1954	950	6164	3118	3275	1773	3418		18698	
1955	591	5523	3225	4061	2773	3614		19787	
1956	475	5373	3175	5127	3292	3586		21028	
1957	277	6146	3282	5257	4380	5251		24593	
1958	19	6178	3724	5456	3975	6450		25802	
1959	237	6404	5590	5009	3767	6570		27577	
1960	188	6741	6230	3614	3626	6610		27009	

Year	NAFO divisions							Total West Greenland	ICES Division 14.b
	1A	1B	1C	1D	1E	1F	Unknown NAFO division		
1961	601	6569	6726	4178	6182	9709		33965	
1962	315	7809	6269	3824	5638	11525		35380	
1963	295	4877	3178	2804	3078	9037		23269	
1964	275	3311	2447	8766	2206	4981		21986	
1965	325	5209	4818	6046	2477	5447		24322	
1966	483	8738	5669	7022	2335	4799		29046	
1967	310	5658	6248	6747	2429	6132		27524	
1968	142	1669	2738	6123	2837	7207		20716	
1969	57	1767	4287	7540	2017	5568		21236	
1970	136	1469	2219	3661	2424	5654		15563	
1971	255	1807	2011	3802	1698	3933		13506	
1972	263	1855	3328	3973	1533	3696		14648	
1973	158	1362	1225	3682	1614	1581		9622	
1974	454	926	1449	2588	1628	1593		8638	
1975	216	1038	1930	1269	964	1140		6557	
1976	204	644	1224	904	1367	831		5174	
1977	216	580	2505	2946	3521	4231		13999	
1978	348	1587	3244	2614	4642	7244		19679	
1979	433	1768	2201	6378	9609	15201		35590	
1980	719	2303	2269	7781	10647	14852		38571	
1981	281	2810	3599	6119	7711	11505	7678	39703	
1982	206	2448	3176	7186	4536	3621	5491	26664	
1983	148	2803	3640	7430	5016	2500	7205	28742	
1984	175	3908	1889	5414	1149	1333	6090	19958	
1985	149	2936	957	1976	1178	1245		8441	
1986	76	1038	255	1209	1456	1268		5302	
1987	77	2366	423	6407	3602	1326	403	14604	
1988	333	6294	1342	2992	3346	4484		18791	
1989	634	8491	5671	8212	10845	4676		38529	
1990	476	9857	1482	9826	1917	5241		28799	
1991	876	8641	917	2782	1089	4007		18312	
1992	695	2710	563	1070	239	450		5727	
1993	333	327	168	970	19	109		1926	
1994	209	332	589	914	11	62		2117	
1995	53	521	710	332	4	81		1701	
1996	41	211	471	164	11	46		944	
1997	18	446	198	99	13	130	282	1186	
1998	9	118	79	78	0	38		322	
1999	68	142	55	336	8	4		613	
2000	154	266	0	332	0	12		764	
2001	117	1183	245	54	0	81		1680	
2002	263	1803	505	214	24	813		3622	
2003	1109	1522	334	274	3	479	1494	5215	
2004	535	1316	242	116	47	84	2608	4948	
2005	650	2351	1137	1162	278	382	83	6043	
2006	922	1682	577	943	630	1461	1173	7388	
2007	416	2547	1195	1842	659	4391		11050	42
2008	870	3066	1539	3172	225	1133		10005	6
2009	325	1288	1189	2009	1142	1581		7534	2
2010	559	2990	1607	1795	1458	859		9268	2
2011	567	2364	2850	2905	1274	1047		11007	0

Year	NAFO divisions							Total West Greenland	ICES Division 14.b
	1A	1B	1C	1D	1E	1F	Unknown NAFO division		
2012	546	1376	2061	4375	1989	325		10672	0.02
2013	1506	2552	2784	4711	1450	198		13202	35
2014	3084	6142	3710	4629	684	82		18331	38
2015	4088	7912	6426	6613	117	115		25272	50
2016	5929	11466	11270	5279	87	173		34204	39
2017	5797	11110	10060	4066	56	131		31220	82
2018	2213	6422	6190	7043	31	390		22290	51

Summary of the assessment

Table 10 Cod in NAFO Subarea 1, inshore. Assessment summary. Weights are in tonnes. Recruitment in thousands.

Year	Recruitment Age 1	Recruitment High	Recruitment Low	SSB	SSB High	SSB Low	Landings	F Ages 4–8	F High	F Low
	thousands			tonnes			tonnes			
1976	14515	34209	6159	7598	11151	5177	5174	0.59	0.89	0.39
1977	20885	46241	9433	17996	29702	10904	13999	0.60	0.85	0.42
1978	44659	104978	18999	32800	59868	17970	19679	0.54	0.74	0.39
1979	15111	35785	6381	48796	87587	27186	35590	0.58	0.77	0.44
1980	43223	106786	17495	37858	63502	22570	38571	0.66	0.86	0.50
1981	16230	35795	7359	25104	36639	17200	39703	0.76	0.99	0.58
1982	7604	17148	3372	27311	39979	18658	26664	0.81	1.07	0.62
1983	2435	6235	951	19954	30203	13183	28742	0.84	1.11	0.64
1984	7198	15786	3282	18227	28170	11794	19958	0.78	1.01	0.60
1985	41886	97285	18034	12775	20269	8052	8441	0.77	1.00	0.59
1986	26156	52041	13146	10950	16573	7234	5302	0.77	1.00	0.59
1987	12073	22530	6470	8225	11495	5885	14604	0.88	1.15	0.67
1988	16985	33427	8630	9407	13751	6435	18791	0.85	1.12	0.65
1989	7942	14993	4207	13259	20636	8519	38529	0.90	1.16	0.70
1990	3565	7188	1768	11082	16836	7294	28799	1.05	1.33	0.84
1991	10867	21923	5387	6224	8749	4427	18312	1.24	1.57	0.98
1992	4201	8040	2195	3833	5550	2647	5727	1.34	1.74	1.04
1993	1963	4008	962	2165	3173	1478	1926	1.33	1.77	1.00
1994	2611	5176	1317	1778	2691	1174	2117	1.16	1.60	0.83
1995	1615	3184	819	1612	2556	1016	1701	0.97	1.38	0.68
1996	2272	4449	1160	1364	2098	887	944	0.82	1.19	0.57
1997	2841	5521	1462	1099	1691	714	1186	0.81	1.16	0.56
1998	2963	6087	1442	939	1578	559	322	0.86	1.27	0.59
1999	4644	9800	2200	968	1593	588	613	0.73	1.03	0.52
2000	6365	12909	3138	1106	1702	719	764	0.66	0.93	0.47
2001	7394	14469	3779	1196	1787	800	1680	0.63	0.87	0.45
2002	8710	16636	4560	1718	2469	1196	3622	0.62	0.85	0.45
2003	8885	16611	4752	3237	4612	2272	5215	0.74	0.99	0.55
2004	21649	39051	12001	3139	4326	2277	4948	0.81	1.07	0.61
2005	33725	61381	18529	3247	4441	2374	6043	0.86	1.13	0.66
2006	25166	46130	13729	3840	5116	2882	7388	0.84	1.10	0.64
2007	13557	25534	7197	10227	14304	7312	11050	0.83	1.08	0.64
2008	20556	38236	11050	13068	18825	9071	10005	0.79	1.03	0.61
2009	19424	35437	10647	15458	22557	10593	7534	0.72	0.94	0.55
2010	38657	69416	21528	15885	22089	11424	9268	0.73	0.95	0.56
2011	32111	57210	18024	15567	20465	11841	11007	0.71	0.93	0.55
2012	23698	45341	12387	23356	30599	17828	10672	0.65	0.85	0.49
2013	17573	34854	8860	29438	38916	22268	13202	0.63	0.83	0.47

Year	Recruitment Age 1	Recruitment High	Recruitment Low	SSB	SSB High	SSB Low	Landings	F Ages 4–8	F High	F Low
	thousands			tonnes			tonnes			
2014	17668	34889	8948	40417	54471	29990	18331	0.62	0.84	0.45
2015	12217	24512	6089	46312	61977	34607	25272	0.59	0.80	0.43
2016	6019	11921	3039	43312	59212	31681	34204	0.59	0.83	0.42
2017	3860	9166	1626	36722	52505	25683	31220	0.62	0.93	0.41
2018	2525	8963	711	27224	41141	18015	22290	0.65	1.08	0.39
2019	10867	43223	1615	29776	50244	17976				

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