3.3.2 Cod (*Gadus morhua*) in subareas 1 and 2 (Northeast Arctic)

ICES stock advice

ICES advises that when the Joint Russian–Norwegian Fisheries Commission management plan is applied, catches in 2017 should be no more than 805 000 tonnes. Bycatch of coastal cod and *Sebastes norvegicus* should be kept as low as possible.

Stock development over time

The spawning-stock biomass (SSB) has been above MSY $B_{trigger}$ since 2002. The total stock biomass (TSB) reached a peak in 2013 and has now dropped slightly. Fishing mortality (F) was reduced from well above F_{lim} in 1997 to below F_{MSY} in 2007 and the most recent estimate is just below F_{MSY}. Surveys indicate that year classes 2011–2014 are above or around the long-term average.

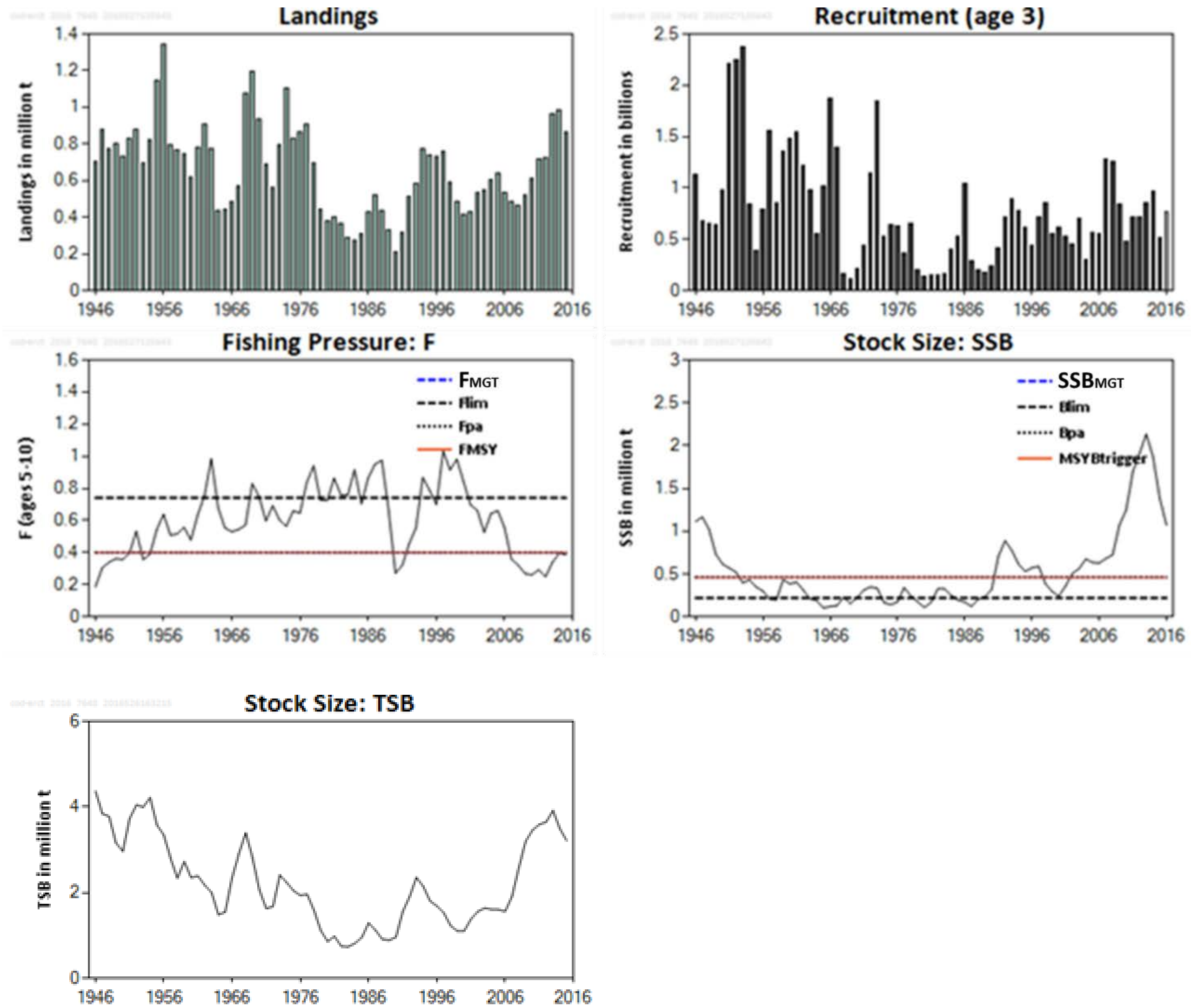

Figure 3.3.2.1 Cod in subareas 1 and 2 (Northeast Arctic). Landings, recruitment, SSB, F, and TSB. Time-series used in the assessment. For this stock, $F_{MGT} = F_{MSY} = F_{pa}$, and SSB_{MGT} = MSY $B_{trigger} = B_{pa}$; therefore, the horizontal lines representing these points in the graph overlap.

https://doi.org/10.17895/ices.advice.18668063

Stock and exploitation status

Table 3.3.2.1 Cod in subareas 1 and 2 (Northeast Arctic). State of the stock and fishery relative to reference points.

	Fishing pressure					Stock size				
		2013	2014	2015			2014	2015	2016	
Maximum sustainable yield	F_{MSY}	✓	✓	✓	Appropriate	MSY $B_{trigger}$	✓	✓	✓	Above trigger
Precautionary approach	F_{pa}, F_{lim}	✓	✓	✓	Harvested sustainably	B_{pa}, B_{lim}	✓	✓	✓	Full reproductive capacity
Management plan	F_{MGT}	✓	✓	✓	Below	SSB_{MGT}	✓	✓	✓	Above

Catch options

Table 3.3.2.2 Cod in subareas 1 and 2 (Northeast Arctic). The basis for the catch options.

Variable	Value	Source	Notes
$F_{ages\ 5–10}$ (2016)	0.39	ICES (2016a)	F *status quo* (2015)
SSB (2017)	1147 kt	ICES (2016a)	
R_{age3} (2016)	766 millions	ICES (2016a)	Recruitment model estimate
R_{age3} (2017)	897 millions	ICES (2016a)	Recruitment model estimate
R_{age3} (2018)	930 millions	ICES (2016a)	Recruitment model estimate
Total catch (2016)	767 kt	ICES (2016a)	Catch corresponding to F *status quo*

Table 3.3.2.3 Cod in subareas 1 and 2 (Northeast Arctic). The catch options. Weights in thousand tonnes.

Rationale	Catches (2017)	Basis	F (2017)	SSB (2018)	%SSB change*	%TAC change**
Management plan ***	805	MP	0.41	1128	−2	−10
MSY approach	795	F_{MSY}	0.40	1135	−1	−11
Precautionary approach	795	F_{Pa}	0.40	1135	−1	−11
Zero catch	0	0	0	1736	51	−100
Status quo	771	F_{sq}	0.39	1153	0	−14
Other options^	805***	HCR 1; F = 0.30, ±10%, 3-year average	0.41	1128	−2	−10
	890	HCR 3; F = 0.50, ±10%, 3-year average	0.46	1068	−7	0
	795	HCR 4; F = 0.40, ±20%, 3-year average	0.40	1135	−1	−11
	795	HCR 5; F=0.40, no constraint, 3-year average	0.40	1135	−1	−11
	890	HCR 6; F = 0.50^^, ±20%,, 3-year average	0.46	1068	−7	0
	890	HCR 7; F = 0.50^^, no constraint, 3-year average	0.46	1068	−7	0
	890	HCR 8; F = 0.50^^, ±20%, 3-year average, if low capelin stock^^^	0.46	1068	−7	0
	890	HCR 9; F = 0.50^^, no constraint, 3-year average, if low capelin stock^^^	0.46	1068	−7	0
	886	HCR 10; F = 0.47^^, no constraint, 2-year average	0.46	1070	−7	−1

* SSB 2018 relative to SSB 2017.
** Catch 2017 relative to TAC 2016.
*** Catch decided by limit of −10% change compared to TAC 2016.
^ Harvest control rules evaluated by ICES (2016b). HCR 2 is the rule in the current management plan.
^^ Rules 6–10 prescribe increases in F at high SSB values. The F value given in the ‘basis’ column corresponds to the value derived from the rule when calculating F based on the 2017 SSB value.
^^^ Rules 8–9 are dependent on the 2016 capelin stock estimate, which is not yet known. As the 2015 capelin stock estimate was low, the values shown here assume that the 2016 capelin stock estimate will also be low.

Basis of the advice

Table 3.3.2.4 Cod in subareas 1 and 2 (Northeast Arctic). The basis of the advice.

Advice basis	Joint Russian–Norwegian Fisheries Commission management plan.
Management plan	At the 38th meeting of the Joint Russian–Norwegian Fisheries Commission (JRNFC) in November 2009, the previously used management plan was amended (marked in bold) and currently states: *"The Parties agreed that the management strategies for cod and haddock should take into account the following:* *conditions for high long-term yield from the stocks* *achievement of year-to-year stability in TACs* *full utilization of all available information on stock development* *On this basis, the Parties determined the following decision rules for setting the annual fishing quota (TAC) for Northeast Arctic cod (NEA cod):* *estimate the average TAC level for the coming 3 years based on F_{pa}. TAC for the next year will be set to this level as a starting value for the 3-year period.* *the year after, the TAC calculation for the next 3 years is repeated based on the updated information about the stock development, however the TAC should not be changed by more than +/- 10% compared with the previous year's TAC.* ***If the TAC, by following such a rule, corresponds to a fishing mortality (F) lower than 0.30 the TAC should be increased to a level corresponding to a fishing mortality of 0.30.*** *if the spawning stock falls below B_{pa}, the procedure for establishing TAC should be based on a fishing mortality that is linearly reduced from F_{pa} at B_{pa}, to F= 0 at SSB equal to zero. At SSB-levels below B_{pa} in any of the operational years (current year, a year before and 3 years of prediction) there should be no limitations on the year-to-year variations in TAC."** At the 39th Session of the Joint Russian–Norwegian Fisheries Commission in October 2010 it was agreed that the current management plan should be used "for five more years" before it is evaluated. At the 45th Session of the Joint Russian–Norwegian Fisheries Commission in 2015 it was decided that a number of alternative harvest control rules (HCRs) for Northeast Arctic cod should be evaluated by ICES. ICES provided advice on these harvest control rules in 2016 (ICES, 2016b).

* This quotation is taken from Annex 14 in the Protocol of the 38th Session of the Joint Russian–Norwegian Fisheries Commission and translated from Norwegian to English. For an accurate interpretation, please consult the text in the official languages of the Commission (Norwegian and Russian).

Quality of the assessment

Sampling of commercial catches is believed to be less precise because of the termination of a Norwegian port sampling programme in mid-2009. Russian sampling of commercial catches has decreased in recent years. Poor sampling of commercial catches is impairing the quality of the assessment and the advice.

Discards are known to have taken place but cannot be quantified (assumed to be below 5% in recent years).

With the recent expansion of the cod distribution, the joint winter trawl and acoustic surveys do not presently cover the whole stock distribution area.

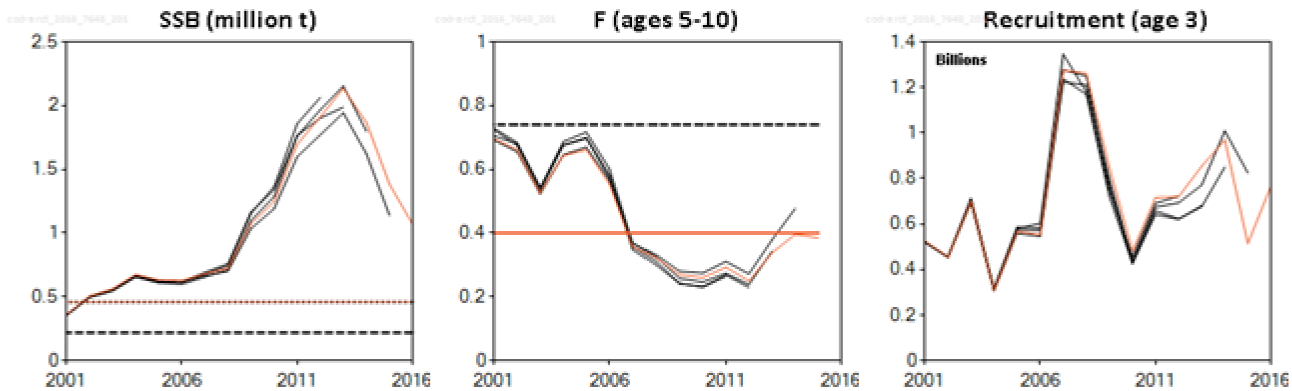

Figure 3.3.2.2 Cod in subareas 1 and 2 (Northeast Arctic). Historical assessment results (final-year recruitment estimates included).

Issues relevant for the advice

The cod stock has a high abundance of old fish and the assessment model is sensitive to this. The estimated fishing mortalities for the strong year classes 2004–2005 are unexpectedly high for 2015 (Figure 3.3.2.3). This may indicate that the abundance of these year classes is underestimated in this year's assessment. ICES will conduct an Inter-benchmark (IBP) process to work through the spring of 2017 to review the assessment for this stock.

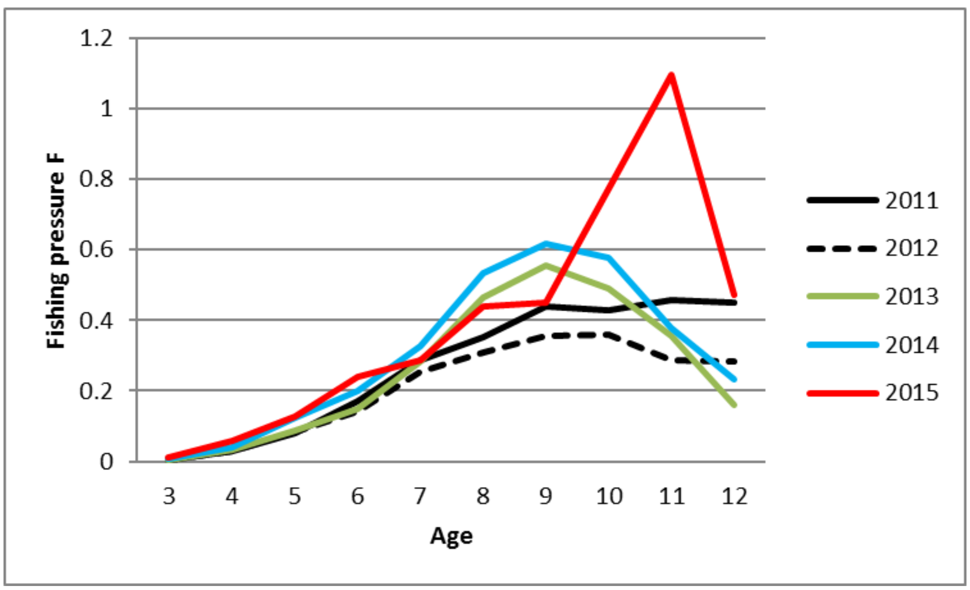

Figure 3.3.2.3 Cod in subareas 1 and 2 (Northeast Arctic). Estimated fishing mortalities by age for the last five years.

Fisheries targeting Northeast Arctic (NEA) cod have as a bycatch a considerable part of the total golden redfish (*Sebastes norvegicus)* catch, and the bycatch of this species is still far above any sustainable catch level. Measures to minimize bycatch levels are essential.

Bycatch of coastal cod should be kept as low as possible in order to obtain the reductions in fishing mortality implied by the coastal cod (*Gadus morhua*) rebuilding plan.

Reference points

Table 3.3.2.5 Cod in subareas 1 and 2 (Northeast Arctic). Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	460 000 t	B_{pa}, and trigger point in HCR.	ICES (2003)
	F_{MSY}	0.40	Long-term simulations.	ICES (2005)
Precautionary approach	B_{lim}	220 000 t	Change point regression.	ICES (2003)
	B_{pa}	460 000 t	The lowest SSB estimate having >90% probability of remaining above B_{lim}.	ICES (2003)
	F_{lim}	0.74	F corresponding to an equilibrium stock = B_{lim}.	ICES (2003)
	F_{pa}	0.40	The highest F estimate having >90% probability of remaining below F_{lim}.	ICES (2003)
Management plan	SSB_{MGT}	460 000 t	B_{pa}, TAC linearly reduced from F_{pa} at SSB = B_{pa} to zero at SSB = 0.	
	F_{MGT}	0.40	$F_{pa,}$ average TAC for the coming three years based on F_{pa}.	

Basis of the assessment

Table 3.3.2.6 Cod in subareas 1 and 2 (Northeast Arctic). The basis of the assessment.

ICES stock data category	1 (ICES, 2016c)
Assessment type	Age-based analytical assessment (XSA) with cannibalism estimated. Catches are used in the model and in the forecast. Following the benchmark from 2015, cannibalism is also estimated for the period 1946–1983; previously it was included only from 1984 to the present. This has had an impact on historical recruitment and total stock biomass estimates.
Input data	Commercial catches (international landings, ages and length frequencies from catch sampling); four survey indices (Joint bottom trawl survey Barents Sea, Feb–Mar (BS-NoRu-Q1 (BTr)); Joint acoustic survey Barents Sea and Lofoten, Feb–Mar (BS-NoRu-Q1 (Aco)); Russian bottom trawl survey, October–December (RU-BTr-Q4)); Joint Ecosystem survey (Eco-NoRu-Q3 (Btr)); annual maturity data from the four surveys; natural mortalities from annual stomach sampling.
Discards and bycatch	Discarding is considered negligible in recent years (below 5%). Bycatch is included.
Indicators	None
Other information	Last benchmarked in January 2015 (WKARCT; ICES, 2015).
Working group	Arctic Fisheries Working Group (AFWG)

Information from stakeholders

There is no available information.

History of the advice, catch, and management

Table 3.3.2.7 Cod in subareas 1 and 2 (Northeast Arctic). History of ICES advice, the agreed TAC, and ICES estimates of landings. Weights in thousand tonnes.

Year	ICES advice	Predicted catch corresp. to advice	Agreed TAC	Official landings	ICES landings	Unreported landings (included in ICES landings)
1987	Gradual reduction in F	595	560	552	523	
1988	F = 0.51; TAC (Advice November 1987, revised advice May 1988)	530 (320–360)	590 (451)	459	435	
1989	Large reduction in F	335	300	348	332	
1990	F at F_{low}; TAC	172	160	210	212	25
1991	F at F_{low}; TAC	215	215	294	319	50
1992	Within safe biological limits	250	356	421	513	130
1993	Healthy stock	256	500	575	582	50
1994	No long-term gains in increased F	649	700	795	771	25
1995	No long-term gains in increased F	681	700	763	740	
1996	No long-term gains in increased F	746	700	759	732	
1997	Well below F_{med}	< 993	850	792	762	
1998	F less than F_{med}	514	654	615	593	
1999	Reduce F to below F_{pa}	360	480	506	485	
2000	Increase B above B_{pa} in 2001	110	390		415	
2001	High prob. of SSB >B_{pa} in 2003	263	395		426	
2002	Reduce F to well below 0.25	181	395		535	90
2003	Reduce F to below F_{pa}	305	395		552	115
2004	Reduce F to below F_{pa}	398	486		606	117
2005	Take into account coastal cod and redfish bycatches. Apply catch rule.	485	485		641	166
2006	Take into account coastal cod and redfish bycatches. Apply amended catch rule.	471	471		538	67
2007	Take into account coastal cod and redfish bycatches. F_{pa}	309	424		487	41
2008	Take into account coastal cod and redfish bycatches. Apply catch rule.	409	430		464	15
2009	Take into account coastal cod and redfish bycatches. Apply catch rule.	473	525		523	0
2010	Take into account coastal cod and redfish bycatches. Apply catch rule.	577.5	607		610	0
2011	Take into account coastal cod and redfish bycatches. Apply catch rule.	703	703		720	0
2012	Take into account coastal cod and redfish bycatches. Apply catch rule.	751	751		728	0
2013	Take into account coastal cod and *S. marinus* bycatches. Apply catch rule.	940	1000		966	0
2014	Take into account coastal cod and *S. marinus* bycatches. Apply catch rule.	993	993		986	0
2015	Take into account coastal cod and *S. norvegicus* bycatches. Apply catch rule.	894	894		864	0
2016	Take into account coastal cod and *S. norvegicus* bycatches. Apply catch rule.	805	894			
2017	Take into account coastal cod and *S. norvegicus* bycatches. Apply management plan.	≤ 805				

History of catch and landings

Table 3.3.2.8 Cod in subareas 1 and 2 (Northeast Arctic). Catch distribution by fleet in 2015 as estimated by ICES.

Total catch (2015)	Landings		Discards
	70% demersal trawls	30% other gear types	
864 kt	864 kt		Considered to be negligible

Table 3.3.2.9 Cod in subareas 1 and 2 (Northeast Arctic). History of commercial landings; both the official and ICES estimated values are presented for each country participating in the fishery. Nominal catch (t) by countries (Subarea 1 and divisions 2.a and 2.b combined, data provided by Working Group members.)

Year	Faroe Islands	France	German Dem.Rep.	Fed.Rep. Germany	Greenland	Iceland	Norway	Poland	United Kingdom	Russia**	Spain	Others	Total all countries
1961	3934	13755	3921	8129			268377	-	158113	325780		1212	783221
1962	3109	20482	1532	6503			225615	-	175020	476760		245	909266
1963	-	18318	129	4223			205056	108	129779	417964		-	775577
1964	-	8634	297	3202			149878	-	94549	180550		585	437695
1965	-	526	91	3670			197085	-	89962	152780		816	444930
1966	-	2967	228	4284			203792	-	103012	169300		121	483704
1967	-	664	45	3632			218910	-	87008	262340		6	572605
1968	-	-	225	1073			255611	-	140387	676758		-	1074084
1969	29374	-	5907	5543			305241	7856	231066	612215		133	1197226
1970	26265	44245	12413	9451			377606	5153	181481	276632		-	933246
1971	5877	34772	4998	9726			407044	1512	80102	144802		215	689048
1972	1393	8915	1300	3405			394181	892	58382	96653		166	565287
1973	1916	17028	4684	16751			285184	843	78808	387196		276	792686
1974	5717	46028	4860	78507			287276	9898	90894	540801		38453	1102434
1975	11309	28734	9981	30037			277099	7435	101843	343580		19368	829377
1976	11511	20941	8946	24369			344502	6986	89061	343057		18090	867463
1977	9167	15414	3463	12763			388982	1084	86781	369876		17771	905301
1978	9092	9394	3029	5434			363088	566	35449	267138		5525	698715
1979	6320	3046	547	2513			294821	15	17991	105846		9439	440538
1980	9981	1705	233	1921			232242	3	10366	115194		8789	380434
1981	12825	3106	298	2228			277818		5262	83000	14500	-	399037
1982	11998	761	302	1717			287525		6601	40311	14515	-	363730
1983	11106	126	473	1243			234000		5840	22975	14229	-	289992
1984	10674	11	686	1010			230743		3663	22256	8608	-	277651
1985	13418	23	1019	4395			211065		3335	62489	7846	4330	307920
1986	18667	591	1543	10092			232096		7581	150541	5497	3505	430113
1987	15036	1	986	7035			268004		10957	202314	16223	2515	523071
1988	15329	2551	605	2803			223412		8107	169365	10905	1862	434939
1989	15625	3231	326	3291			158684		7056	134593	7802	1273	332481
1990	9584	592	169	1437			88737		3412	74609	7950	510	187000
1991	8981	975		2613			126226		3981	119427***	3677	3278	269158
1992	11663	2		3911	3337		168460		6120	182315	6217	1209	383234
1993	17435	3572		5887	5389	9374	221051		11336	244860	8800	3907	531611
1994	22826	1962		8283	6882	36737	318395		15579	291925	14929	28568	746086
1995	22262	4912		7428	7462	34214	319987		16329	296158	15505	15742	739999
1996	17758	5352		8326	6529	23005	319158		16061	305317	15871	14851	732228
1997	20076	5353		6680	6426	4200	357825		18066	313344	17130	13303	762403
1998	14290	1197		3841	6388	1423	284647		14294	244115	14212	8217	592624
1999	13700	2137		3019	4093	1985	223390		11315	210379	8994	5898	484910
2000	13350	2621		3513	5787	7562	192860		9165	166202	8695	5115	414870

Year	Faroe Islands	France	German Dem.Rep.	Fed.Rep. Germany	Greenland	Iceland	Norway	Poland	United Kingdom	Russia**	Spain	Others	Total all countries
2001	12500	2681		4524	5727	5917	188431		8698	183572	9196	5225	426471
2002	15693	2934		4517	6419	5975	202559		8977	184072	8414	5484	445045
2003	19427	2921		4732	7026	5963	191977		8711	182160	7924	6149	436990
2004	19226	3621		6187	8196	7201	212117		14004	201525	11285	6082	489445
2005	16273	3491		5848	8135	5874	207825		10744	200077	9349	7660	475276
2006	16327	4376		3837	8164	5972	201987		10594	203782	9219	6271	470527
2007	14788	3190		4619	5951	7316	199809		9298	186229	9496	5101	445796
2008	15812	3149		4955	5617	7535	196598		8287	190225	9658	7336	449171
2009	16905	3908		8585	4977	7380	224298		8632	229291	12013	7442	523431
2010	15977	4499		8442	6584	11299	264701		9091	267547	12657	9185	609983
2011	13429	1173		4621	7155	12734	331535		8210	310326	13291	17354^	719829
2012	17523	2841		8500	8520	9536	315739		11166	329943	12814	11081	727663
2013	13833	7858		8010	7885	14734	438734		12536	432314	15042	15263	966209
2014	33298	8149		6225	10864	18205	431846		14762	433479	16378	13243	986449
2015*	26568	7480		6427	7055	16120	377983		11778	381778	19905	9880	864384

* Provisional figures.
** USSR prior to 1991.
*** Includes Baltic countries.
^ Includes unspecified EU catches.

Summary of the assessment

Table 3.3.2.10 Cod in subareas 1 and 2 (Northeast Arctic). Assessment summary. Weights are in tonnes and recruitment in thousands.

Year	Recruitment Age 3	Stock size: SSB	Stock size: TSB	Landings	Fishing ressure: F Ages 5–10
1946	1126514	1112945	4367668	706000	0.1856
1947	678224	1165171	3839613	882017	0.3044
1948	649597	1019217	3775604	774295	0.3396
1949	638062	729919	3156987	800122	0.3616
1950	979309	615385	2960071	731982	0.3565
1951	2210700	568882	3722971	827180	0.3957
1952	2250119	520807	4046139	876795	0.5335
1953	2378899	396626	3992058	695546	0.3567
1954	847379	429821	4216295	826021	0.3876
1955	396197	347080	3572939	1147841	0.5433
1956	792842	299937	3342003	1343068	0.639
1957	1558705	207909	2799741	792557	0.5081
1958	850121	195444	2342825	769313	0.516
1959	1354956	432708	2732448	744607	0.5579
1960	1486994	384350	2354866	622042	0.4777
1961	1542917	404333	2395452	783221	0.6335
1962	1224235	311751	2176183	909266	0.7563
1963	977411	209201	2008686	776337	0.984
1964	547510	186570	1487644	437695	0.678
1965	1013702	102315	1550917	444930	0.5528
1966	1871746	120751	2353618	483711	0.53

Year	Recruitment Age 3	Stock size: SSB	Stock size: TSB	Landings	Fishing ressure: F Ages 5–10
1967	1389823	129784	2902009	572605	0.5438
1968	169828	227278	3391704	1074084	0.5704
1969	115958	151870	2808070	1197226	0.8292
1970	220225	224507	2069435	933246	0.749
1971	443681	311666	1631740	689048	0.5955
1972	1146800	347229	1682401	565254	0.6925
1973	1849455	332913	2414550	792685	0.602
1974	533786	164491	2241204	1102433	0.5633
1975	642257	142042	2048293	829377	0.6594
1976	632264	171238	1939090	867463	0.6456
1977	365657	341409	1963956	905301	0.8377
1978	659096	241536	1588144	698715	0.9404
1979	200063	174698	1115016	440538	0.7264
1980	137736	108253	863861	380434	0.7241
1981	150880	166925	983662	399038	0.8632
1982	151830	326133	750875	363730	0.7583
1983	167340	327184	738874	289992	0.756
1984	397854	251086	817605	277651	0.9161
1985	523672	193855	957511	307920	0.7038
1986	1038709	170729	1294412	430113	0.8649
1987	286365	121243	1126279	523071	0.951
1988	204645	202589	915459	434939	0.9743
1989	172785	234716	890362	332481	0.6602
1990	242762	316418	962682	212000	0.271
1991	411745	704748	1561703	319158	0.321
1992	721292	887567	1912313	513234	0.455
1993	894864	775193	2359884	581611	0.5528
1994	783481	614891	2149027	771086	0.8677
1995	615944	528861	1808765	739999	0.7878
1996	440194	571880	1690242	732228	0.6982
1997	718429	589006	1533964	762403	1.0326
1998	848939	386676	1232671	592624	0.9142
1999	552774	294144	1105338	484910	0.9816
2000	615180	242200	1109046	414868	0.8387
2001	525325	359271	1389451	426471	0.6963
2002	453405	504913	1563611	535045	0.6621
2003	698146	561137	1643619	551990	0.5254
2004	308026	674283	1612849	606445	0.6429
2005	566631	632502	1608797	641276	0.6612
2006	552795	627341	1564619	537642	0.5536
2007	1275393	681356	1916395	486883	0.3592
2008	1261051	721967	2592465	464171	0.3206
2009	847471	1072773	3195571	523430	0.2687
2010	481499	1246840	3455083	609983	0.2605
2011	715738	1695243	3587850	719830	0.2927

Year	Recruitment Age 3	Stock size: SSB	Stock size: TSB	Landings	Fishing ressure: F Ages 5–10
2012	719646	1910354	3646148	727663	0.2498
2013	853051	2134044	3913475	966209	0.3382
2014	968368	1866445	3488186	986449	0.3959
2015	514249	1383398	3206335	864384	0.3855
2016	766000*	1069881			
Average	779285	533491	2230562	665055	0.601

* Predicted from external Recruitment model.

Sources and references

ICES. 2003. Report of the Study Group on Biological Reference Points for Northeast Arctic Cod, 13–17 January 2003, Svanhovd, Norway. ICES CM 2003/ACFM:11. 39 pp.

ICES. 2005. Report of the Arctic Fisheries Working Group (AFWG), 19–28 April 2005, Murmansk, Russia. ICES CM 2005/ACFM:20. 564 pp.

ICES. 2015. Report of the Benchmark Workshop on Arctic Stocks (WKARCT), 26–30 January 2015, ICES Headquarters, Denmark. ICES CM 2015/ACOM:31. 126 pp.

ICES. 2016a. Report of the Arctic Fisheries Working Group (AFWG), 19–25 April 2016, ICES HQ, Copenhagen, Denmark. ICES CM 2016/ACOM:06.

ICES. 2016b. Norway/Russia request for evaluation of harvest control rules for Northeast Arctic cod and haddock and for Barents Sea capelin. *In* Report of the ICES Advisory Committee, 2016. ICES Advice 2016, Book 3, Section 3.4.1. ICES Special Request Advice.

ICES. 2016c. General context of ICES advice. *In* Report of the ICES Advisory Committee, 2016. ICES Advice 2016, Book 1, Section 1.2.