

ECOREGION Barents Sea and Norwegian Sea
STOCK Cod in Subareas I and II (Northeast Arctic cod)

Advice summary for 2011

Cautiously avoid impaired recruitment and achieve other objective(s) of the existing **management plan** (e.g., catch stability) suggest that catches in 2011 should be less than 703 kt.

Stock status

Spawning Stock Biomass (SSB)	2008	2009	2010
$MSY B_{trigger}$	Not defined	Not defined	Not defined
B_{PA}/B_{lim}	Above	Above	Above
Fishing mortality	2007	2008	2009
F_{MSY}	Not defined	Not defined	Not defined
F_{PA}/F_{lim}	Below	Below	Below

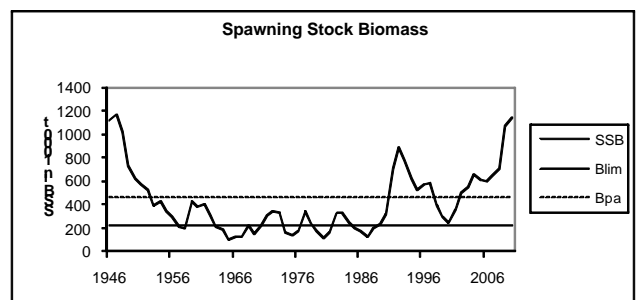
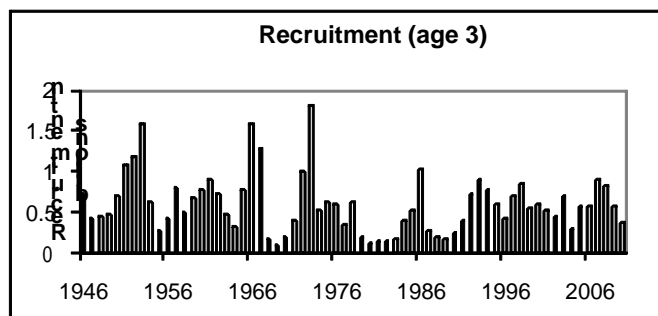
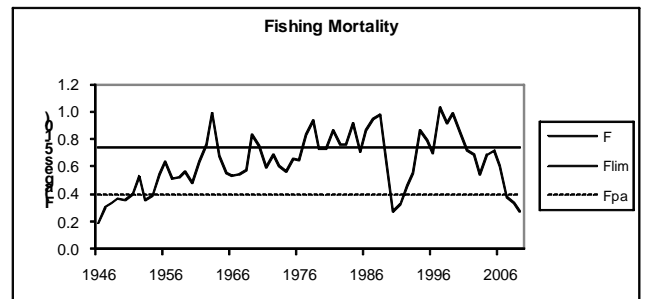
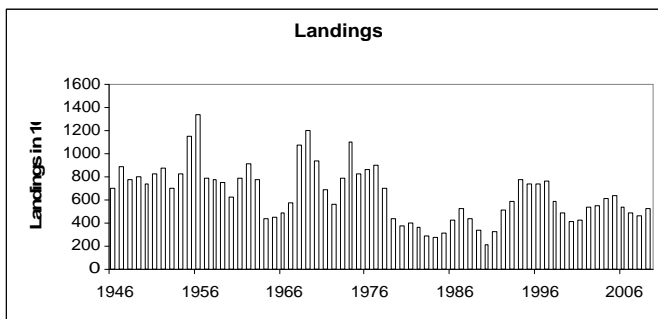
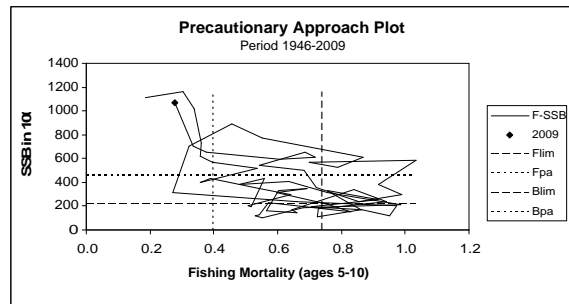


Figure 3.4.1.2 Cod in Subareas I and II. Summary of stock assessment (weights in '000 tonnes). Top right: SSB and F over the years.

The SSB has been above B_{pa} since 2002 and is now near its record high. Fishing mortality was reduced from well above F_{lim} in 1999 to below F_{pa} in 2007 and is now close to its lowest value. Surveys indicate that cod recruitment will be below the average in 2010-2012.

Management plans

A management plan has been implemented since 2004 (Annex 3.4.1) with the objectives of maintaining high long-term yield, year-to-year stability, and full utilization of all available information on stock dynamics. The plan aims to maintain F at $F_{pa} = 0.40$ and restrict between-year TAC change to $\pm 10\%$ unless SSB falls below B_{pa} , in which case the target F should be reduced.

The management plan was amended in 2009 by adding a new condition “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” in case if $SSB > B_{pa}$.

The amended plan was evaluated in 2010 and ICES considers it to be in accordance with the precautionary approach. If conditions change to outside the range assumed in management plan evaluation (with respect to biological conditions, assessment quality, and implementation error), then the management plan may have to be revised.

Environmental influence on the stock

The Northeast Arctic cod is characterized by significant year-to-year variations in the growth rate. In some years the mean weight of fish at the same age may differ by a factor of 2 or 3. Among the factors influencing cod growth are water temperature, food supply, and cod population abundance. Environmental drivers were used in estimating recruitment and temperature used for estimating cod consumption.

Northeast Arctic cod is an important predator on other species in the ecosystem, notably capelin. The management of Northeast Arctic cod will therefore have implications on the dynamics of these stocks. Changes in growth, maturity, and cannibalism are linked to the abundance of capelin. This linkage appears to be less pronounced in the recent period compared to the 1980s and 1990s. Capelin abundance is at present at an intermediate level. In recent years, a slight decrease in maturation and growth rates, and an increase in cannibalism have been observed. These are most likely due to increasing cod stock size.

The fisheries

TAC regulations are in place but there was non-compliance, resulting in a significant amount of unreported landings in the past. However, IUU (Illegal, Unreported and Unregulated) catches have decreased in the recent years and were close to zero in 2009.

Discarding is illegal in Norway and Russia. Data on discarding are scarce, but attempts to obtain better quantification continue. The fisheries are controlled by inspections of the trawler fleet at sea, i.e. by a requirement to report to catch control points when entering and leaving the EEZs, VMS satellite tracking for some fleets, and by random inspections of fishing vessels when landing the fish. Keeping a detailed fishing logbook on-board is mandatory for most vessels, and large parts of the fleet report to the authorities on a daily basis.

Catch by fleet Total catch (2009) 523 kt (72 % trawls, 28 % other gear-types)

Effects of the fisheries on the ecosystem

Fisheries of cod in the Barents Sea do not only influence the targeted stock. Due to strong species interactions fisheries removal of cod influences the abundance of prey stocks.

Quality considerations

The uncertainties in this assessment relate both to catch and survey data. Unreported catches (IUU) and incomplete spatial coverage in surveys has been a problem in recent years, but do not affect the data collected in 2009-2010.

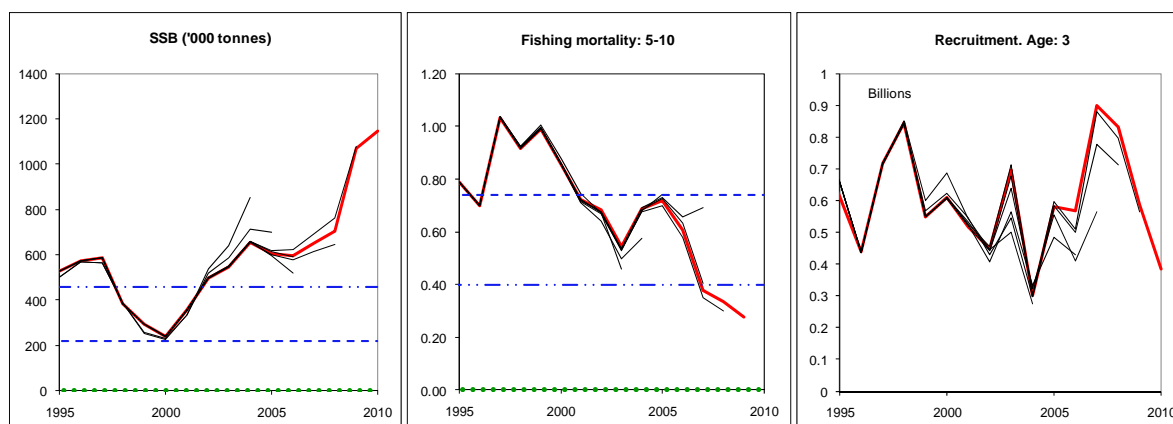


Figure 3.4.1.2 Northeast Arctic cod (Subareas I and II). Historical performance of the assessment.

Scientific basis

Assessment type	Age based analytical assessment (XSA)
Input data	Three survey indices Joint bottom trawl survey Barents Sea Feb-Mar Joint acoustic survey Barents Sea+Lofoten Feb-Mar Russian bottom trawl survey Oct-Dec one commercial CPUE index data from the Russian trawl fisheries
Discards and by-catch	Discards are not accounted for By-catch of juvenile cod unknown
Indicators	None
Other information	None
Working group report	<u>AFWG</u>

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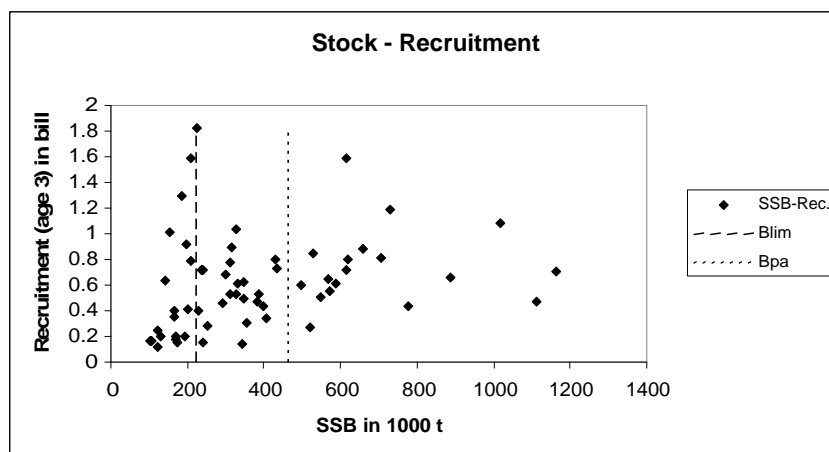
Reference points

	<i>Type</i>	<i>Value</i>	<i>Technical basis</i>
MSY Approach	MSY $B_{trigger}$	Not defined	
	F_{MSY}	Not defined	
Precautionary Approach	B_{lim}	220 kt	change point regression
	B_{pa}	460 kt	the lowest SSB estimate having >90% probability of remaining above B_{lim}
	F_{lim}	0.74	F corresponding to an equilibrium stock = B_{lim}
	F_{pa}	0.40	the highest F estimate having >90% probability of remaining below F_{lim}

(unchanged since: 2003)

Yield and spawning biomass per Recruit F-reference points (2010):

	Fish Mort Ages 5-10	Yield/R	SSB/R
Average last 3 years			
Fmax	0.33	1.22	2.73
F0.1	0.25	1.23	3.87
Fmed	0.12	1.12	7.60
	0.83	1.06	0.66

**Outlook for 2011**

Basis: $F_{2010} = F_{2009} = 0.28$; SSB (2011) = 1 488; R (2010) = 384; Landings (2010) = 593;

Rationale	Landings (2011)	Basis	F (2011)	SSB (2012)	%SSB change ¹⁾	%TAC change ²⁾
Management plan ³⁾	703	F _{mg}	0.30	1689	+14	+16
Precautionary approach	896	F_{pa}	0.40	1527	+3	+48
Zero catch	0	$0 * F_{sq}$	0	2192	+47	-100
Status quo	654	$1.00 * F_{sq}$	0.28	1731	+16	+8

Units: '000 tonnes.

¹⁾ SSB 2012 relative to SSB 2011.

²⁾ Catch 2011 relative to TAC 2010.

³⁾ Forecast based on $F=0.30$.

MSY approach

For NEA cod stochastic simulations show that F_{MSY} is in the range 0.25-0.60, where the yield curve is fairly flat, the exact shape is dependent on the biological model used. This range is higher than the range obtained from the yield per recruit analysis. Work is in progress to evaluate the current management plan in relation to the MSY framework.

PA approach

The fishing mortality in 2011 should be no more than F_{pa} corresponding to landings of 896 kt. This is expected to keep SSB above B_{pa} in 2012.

Management plan

In accordance with the adopted management plan fishing mortality in 2011 should be no more than $F=0.30$ corresponding to landings of 703 kt. This is expected to keep SSB above B_{pa} in 2012.

Additional considerations

Management considerations

ICES considers that application of the agreed management plan in 2011 has long-term benefits above the application of F_{pa} .

The estimates of unreported landings have been reduced considerably from 2006 to 2008. For 2009, the estimate of unreported landings is close to zero.

Unreported landings will reduce the effect of management measures and will undermine the intended objectives of the harvest control rule. It is therefore important that management agencies ensure that all catches are counted against the TAC.

Regulations and their effects

In addition to quotas, the fisheries are regulated by mesh size limitations, a minimum catching size, a maximum bycatch of undersized fish, maximum bycatch of non-target species, closure of areas with high densities of juveniles, and other seasonal and area restrictions. The total effects of these regulations have not been evaluated.

Since January 1997, sorting grids have been mandatory for the trawl fisheries in most of the Barents Sea and Svalbard area. From 2011 onwards, the minimum mesh size for bottom trawl fisheries for cod and haddock will be 130 mm for the entire Barents Sea (at present the minimum mesh size is 135 mm in the Norwegian EEZ and 125 mm in the Russian EEZ). This change is not expected to have a significant impact on the total exploitation pattern for this stock, thus a recent average exploitation pattern is used in the predictions.

A real-time closure system has been in force along the Norwegian Coast and in the Barents Sea since 1984, aimed at protecting juvenile fish. Based on scientific research data and mapping of areas by hired fishing vessels, fishing is prohibited in areas where the proportion by number of undersized cod, haddock and saithe combined has been observed by inspectors to exceed 15% (the size limits vary by species). The time of notice before a closure of an area comes into force is 2-4 hours for national vessels and 7 days for foreign vessels. Before or parallel to a closure, the Coast Guard requests vessels not to fish in an area with too much small fish observed during their inspections. A closed area is not opened until it is documented to have less than 15% undersized by trial fishing by the Surveillance Service.

A preliminary evaluation of the effectiveness of the system up to 1998 shows a clear decrease in the discarding of small cod and haddock.

Information from fishing industry

Several Norwegian fishing vessels (13 oceanic and 21 coastal) provide regular sampling data for length and age. These data are used for estimating catch at age for the corresponding fleets. Russian fishing vessels with observers onboard provide similar information on catch length distribution and sample fish to receive data on length-age matrices.

Data issues

Analytical assessment is based on catch-at-age data, using one commercial cpue series and three survey series. The total effect of discarding is still unclear and requires more work before it can be included in the assessments. Estimates of cannibalism are included in the natural mortality. Two series of IUU catch were made available to ICES for the years 2002-2008, but the advice is based on the use of one of the series that is considered the most reliable. Since 2008, the recruitment predictions have included information on environmental drivers (ice coverage, temperature and oxygen saturation at the Kola section, air temperature at Murman coast, and capelin biomass).

Comparison with previous assessment and advice

Compared to last year's assessment, the current assessment estimates the SSB in 2009 is the same as previous year and the reference F in 2008 is 12 % higher. The basis of the advice is the same as last year.

Sources

ICES. 2010. Report of the Arctic Fisheries Working Group, 22-28 April 2010. ICES CM 2010/ACOM:05.

Table 3.4.1.1 Cod in Subareas I and II. ICES advice, management and landings

Year	ICES Advice	Single-stock exploitation boundaries	Predicted catch corresp. to advice	Predicted catch corresp. to single-stock exploitation boundaries	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 87, revised advice May 88)		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 by-catches	Apply catch rule	485		485		641	166
2006	Take into account coastal cod and redfish by-catches	Apply amended catch rule	471		471		538	67
2007	Take into account coastal cod and redfish by-catches	F_{pa}	309		424		487	41
2008	Take into account coastal cod and redfish by-catches	Apply catch rule	409		430		464	15
2009	Take into account coastal cod and redfish by-catches	Apply catch rule	473		525		523	0
2010	Take into account coastal cod and redfish by-catches	Apply catch rule	577.5		607			
2011	Take into account coastal cod and redfish bycatches	Apply catch rule	703					

Weights in '000 tonnes.

Unreported landings 2002–2008 corrected according to Table 3.4.1.1.

Table 3.4.1.2 Northeast Arctic COD. Total landings (t) by fishing areas and unreported landings.

Year	Subarea I	Division IIa	Division IIb	Unreported catches	Total catch
1961	409 694	153 019	220 508		783 221
1962	548 621	139 848	220 797		909 266
1963	547 469	117 100	111 768		776 337
1964	206 883	104 698	126 114		437 695
1965	241 489	100 011	103 430		444 983
1966	292 253	134 805	56 653		483 711
1967	322 798	128 747	121 060		572 605
1968	642 452	162 472	269 254		1 074 084
1969	679 373	255 599	262 254		1 197 226
1970	603 855	243 835	85 556		933 246
1971	312 505	319 623	56 920		689 048
1972	197 015	335 257	32 982		565 254
1973	492 716	211 762	88 207		792 685
1974	723 489	124 214	254 730		1 102 433
1975	561 701	120 276	147 400		829 377
1976	526 685	237 245	103 533		867 463
1977	538 231	257 073	109 997		905 301
1978	418 265	263 157	17 293		698 715
1979	195 166	235 449	9 923		440 538
1980	168 671	199 313	12 450		380 434
1981	137 033	245 167	16 837		399 037
1982	96 576	236 125	31 029		363 730
1983	64 803	200 279	24 910		289 992
1984	54 317	197 573	25 761		277 651
1985	112 605	173 559	21 756		307 920
1986	157 631	202 688	69 794		430 113
1987	146 106	245 387	131 578		523 071
1988	166 649	209 930	58 360		434 939
1989	164 512	149 360	18 609		332 481
1990	62 272	99 465	25 263	25 000	212 000
1991	70 970	156 966	41 222	50 000	319 158
1992	124 219	172 532	86 483	130 000	513 234
1993	195 771	269 383	66 457	50 000	581 611
1994	353 425	306 417	86 244	25 000	771 086
1995	251 448	317 585	170 966		739 999
1996	278 364	297 237	156 627		732 228
1997	273 376	326 689	162 338		762 403
1998	250 815	257 398	84 411		592 624
1999	159 021	216 898	108 991		484 910
2000	137 197	204 167	73 506		414 870
2001	142 628	185 890	97 953		426 471
2002 ²	184 789	189 013	71 242	90000/21716	535045/466760
2003 ²	163 109	222 052	51 829	115000/27748	551990/464738
2004 ²	177 888	219 261	92 296	117000/30000	606445/519445
2005 ²	159 573	194 644	121 059	166000/41000	641276/516276
2006 ²	159 851	204 603	104 743	127000/28000	596197/497197
2007 ²	152 522	195 383	97 891	41087/8757	486883/454553
2008 ²	144 905	203 244	101 022	15000/0	464171/449171
2009 ¹	161 602	207 205	154 623	0	523 431

¹ Provisional figures.² two alternative estimates (see Chapter 3.1.3 of the 2008 AFWG Report for further details)

Table 3.4.1.3 Northeast Arctic cod (Subareas I and II). Weights in t.

Year	Recruitment Age 3 thousands	SSB tonnes	Landings tonnes	Mean F Ages 5-10
1946	728139	1112776	706000	0.1857
1947	425311	1165059	882017	0.3047
1948	442592	1019114	774295	0.3398
1949	468348	729879	800122	0.3619
1950	704908	615339	731982	0.3566
1951	1083753	568705	827180	0.3966
1952	1193111	520599	876795	0.5348
1953	1590377	396417	695546	0.3572
1954	641584	429694	826021	0.3879
1955	272778	346919	1147841	0.5437
1956	439602	299823	1343068	0.6401
1957	804781	207840	792557	0.5089
1958	496824	195377	769313	0.5169
1959	683690	432489	744607	0.5596
1960	789653	383479	622042	0.4789
1961	916842	404228	783221	0.6348
1962	728338	311678	909266	0.7576
1963	472064	208207	776337	0.9866
1964	338678	186570	437695	0.6789
1965	776941	102315	444930	0.5533
1966	1582560	120722	483711	0.5302
1967	1295416	129784	572605	0.5439
1968	164955	227215	1074084	0.5704
1969	112039	151870	1197226	0.8292
1970	197105	224482	933246	0.7493
1971	404774	311662	689048	0.5956
1972	1015319	346511	565254	0.6928
1973	1818949	332913	792685	0.6020
1974	523916	164491	1102433	0.5633
1975	621616	142028	829377	0.6595
1976	613942	171238	867463	0.6457
1977	348054	341385	905301	0.8379
1978	638490	241536	698715	0.9406
1979	198490	174699	440538	0.7264
1980	137735	108253	380434	0.7241
1981	150868	166926	399038	0.8632
1982	151830	326133	363730	0.7583
1983	166831	327181	289992	0.7560
1984	397831	251087	277651	0.9161
1985	523674	193856	307920	0.7038
1986	1038825	170729	430113	0.8649
1987	285293	121243	523071	0.9510
1988	204644	202582	434939	0.9743
1989	172782	234698	332481	0.6604
1990	242750	316206	212000	0.2711
1991	411766	704745	319158	0.3210
1992	721185	887563	513234	0.4550
1993	894434	775183	581611	0.5528
1994	781468	614866	771086	0.8678
1995	613875	528781	739999	0.7880
1996	438206	571620	732228	0.6987
1997	715163	588621	762403	1.0338
1998	844814	385946	592624	0.9170
1999	547772	292807	484910	0.9892
2000	610255	240096	414868	0.8546
2001	516555	354492	426471	0.7213
2002	449404	496423	535045	0.6840
2003	697062	547175	551990	0.5441
2004	300161	654572	606445	0.6866
2005	581337	606902	641276	0.7172
2006	566885	595285	537642	0.6063
2007	899016	649186	486883	0.3774
2008	830932	703780	464171	0.3337
2009	588966	1069646	523430	0.2762
2010	384000	1145460		
Average	606158	423832	651240	0.6319

Annex 3.4.1 Northeast Arctic Cod Management Agreement

At the 38th meeting of the Joint Russian–Norwegian Fisheries Commission (JRNC) in November 2009, the previously used management plan was amended (marked in bold) and currently stated as follows:

“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.¹

¹ This quotation is taken from Annex 14 in the Protocol of the 38th session of The Joint Norwegian–Russian Fishery 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).