

Cod (*Gadus morhua*) in Division 6.a (West of Scotland)

ICES stock advice

ICES advises that when the MSY approach is applied, there should be zero catches in each of the years 2018 and 2019.

Stock development over time

Fishing mortality (F) is high and has been above F_{lim} for most of the time-series. The spawning-stock biomass (SSB) has been below B_{lim} since 1997. Recruitment has been low since 2001.



Figure 1 Cod in Division 6.a. Summary of the stock assessment. The shaded areas in the bottom panels correspond to one standard error for estimates of mortality and SSB.

Stock and exploitation status

Table 1 Cod in Division 6.a. State of the stock and fishery relative to reference points.

		Fishing pressure			Stock size		
		2014	2015	2016	2015	2016	2017
Maximum Sustainable Yield	F_{MSY}	✗	✗	✗ Above	MSY $B_{Trigger}$	✗	✗ Below trigger
Precautionary Approach	F_{pa} F_{lim}	○	○	✗ Harvested unsustainably	B_{pa} , B_{lim}	✗	✗ Reduced reproductive capacity
Management plan	F_{MGT}	—	—	— Not applicable	B_{MGT}	—	— Not applicable

Catch options

Table 2 Cod in Division 6.a. The basis for the catch options.

Variable	Value	Notes	Source
F ages 2–5 (2017)	0.79	$F_{sq} = F_{Average}$ (2014–2016)	ICES (2017)
SSB (2018)	2 835 tonnes	Fishing at $F=0.79$	ICES (2017)
Age1 (2017)	3 614 thousand	Assessment model estimate.	ICES (2017)
Age1 (2018)	2 610 thousand	$GM_{2007-2016}$	ICES (2017)
Catch (2017)	1 627 tonnes	Fishing at $F=0.79$	ICES (2017)
Landings (2017)	535 tonnes	Average discard pattern (2014–2016)	ICES (2017)
Discards (2017)	1 092 tonnes	Average discard pattern (2014–2016)	ICES (2017)

Table 3 Cod in Division 6.a. Annual catch options. All weights are in tonnes. No information on % change in TAC can be shown as the TAC is zero.

Basis	Total catch (2018)	Landings (2018)	Discards (2018)	F_{total} (2018)	$F_{landings}$ (2018)	$F_{discards}$ (2018)	SSB (2019)	% SSB change *
ICES advice basis								
MSY approach: $F=0$	0	0	0	0	0	0	5324	88
Other options								
$F = F_{MSY}$	498	166	332	0.17	0.076	0.094	4654	64
F_{pa}	1464	478	986	0.59	0.27	0.32	3365	18.7
F_{lim}	1866	602	1264	0.82	0.37	0.45	2831	-0.151
$F = F_{2017}$	1826	590	1236	0.79	0.36	0.43	2886	1.77
$SSB(2019)=B_{lim}^{**}$								
$SSB(2019)=B_{pa=MSY} B_{trigger}^{**}$								

* SSB 2019 relative to SSB 2018.

** The B_{lim} , B_{pa} , and $MSY B_{trigger}$ options were left blank because B_{lim} , B_{pa} , and $MSY B_{trigger}$ cannot be achieved in 2019, even with zero advice.

Basis of the advice

Table 4 Cod in Division 6.a. The basis of the advice.

Advice basis	MSY approach
Management plan	The EU cod long-term management plan (EU, 2008), which has not been evaluated by ICES, was modified in 2016 (EU, 2016). The amended plan no longer refers to an F_{mgt} of 0.4.

Quality of the assessment

Recent catch estimates used in the assessment are adjusted to account for area misreporting and include estimates of discards. These two components account for approximately 80 % of the total catch in recent years. No biological sampling is available from the misreported component of the landings. In addition, the total catches of cod from pots and traps are unknown. In the past (between 1991 and 2005), catches were considered unreliable and are estimated within the assessment. Natural mortality is uncertain and seal predation on cod may be significant. In addition, stock structure is complex, and at least two subpopulations occur within this area. Despite these uncertainties it is clear from the assessment and additional information from surveys that the stock remains extremely low.

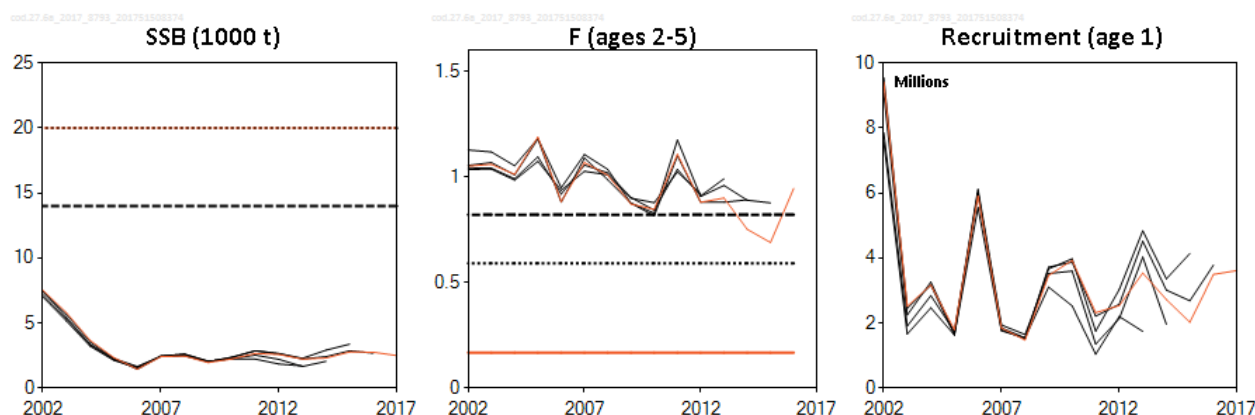


Figure 2 Cod in Division 6.a. Historical assessment results.

Issues relevant for the advice

Management measures taken thus far have not recovered the stock. The zero TAC for this area and 1.5% bycatch by live weight limit implemented since 2012 applies to the retained part of the catches; neither of these measures constrains catches. The proportion of the total catch that is discarded has increased since 2005, and discards now account for over 60% (average 2014–2016) of the total catch. It is necessary to reduce all sources of fishing mortality to recover the stock above B_{pa} as quickly as possible. Measures to reduce area misreporting should also be introduced.

The basis of ICES advice for this stock is the MSY approach. Because of the low SSB and recruitment, it is not possible to identify any non-zero catch that would be compatible with the MSY approach. New reference points were calculated in 2016 (ICES, 2016c). Given the state of the stock this has not affected the advice.

Grey seal abundance is significant west of Scotland, and they are known to feed on cod, among other species. Cook *et al.* (2015) suggests that seal predation may be impairing the recovery of this stock.

Reference points

Table 5 Cod in Division 6.a. Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	20 000 tonnes	B_{pa}	ICES (2016c)
	F_{MSY}	0.17	Based on simulation (EqSim)	ICES (2016c)
Precautionary approach	B_{lim}	14 000 tonnes	B_{loss} from which the stock has increased (SSB in 1992 as estimated in 2015)	ICES (2016c)
	B_{pa}	20 000 tonnes	$B_{lim} \times 1.4$	ICES (2016c)
	F_{lim}	0.82	Based on simulation using segmented regression with B_{lim} as the breakpoint (EqSim)	ICES (2016c)
	F_{pa}	0.59	$F_{lim}/1.4$	ICES (2016c)
Management plan	SSB_{mgt}			
	F_{mgt}			

Basis of the assessment

Table 6 Cod in Division 6.a. Basis of assessment and advice.

ICES stock data category	1 (ICES, 2016a)
Assessment type	Analytical age-based assessment (TSA) that uses catches in the model and in the forecast
Input data	Commercial catches (international landings, ages and length frequencies from catch sampling); two survey indexes (ScoGFS-WIBTS-Q1 and UKSGFS-WIBTS-Q1); maturity data from surveys; natural mortalities (M) at mean weight model (Lorenzen, 1996), using mean weight data from market sampling and discard observations.
Discards and bycatch	Included in the assessment, data series from the main fleets (covering 34% of the ICES estimated landings)
Indicators	Surveys: ScoGFS-WIBTS-Q4, IGFS-WIBTS-Q4, and UKSGFS-WIBTS-Q4
Other information	The stock was benchmarked in 2012 (WKROUND; ICES, 2012) and in 2015 (IBPWSROUND; ICES, 2015).
Working group	Working Group for the Celtic Seas Ecoregion (WGCSE)

Information from stakeholders

Since 2014, there has been increased coverage by the Scottish industry/science observer sampling scheme in subareas 4 and 6. The observer sampling coverage now is more likely to reflect fishing patterns. The Scottish Industry-Science partnership survey was initiated in 2013 and conducted throughout 2014 to provide information on a quarterly basis on the distribution and abundance of cod and other demersal species in Division 6.a.

History of the advice, catch, and management

Table 7 Cod in Division 6.a. ICES advice and official landings. All weights are in tonnes.

Year	ICES advice	Predicted catch corresp. to advice	Agreed TAC*	Agreed TAC**	Official landings	ICES reported landings	Misreporting adjustment	ICES discards	ICES catch
1987	Reduce F towards Fmax	18000	22000		19199	18970		2388	21358
1988	No increase in F; TAC	16000	18430		19182	20413		368	20781
1989	80% of F(87); TAC	16000	18430		15426	17170		2076	19246
1990	80% of F(88); TAC	15000	16000		11777	12175		571	12746
1991	70% of effort (89)	-	16000		10634	10927		622	11549
1992	70% of effort (89)	-	13500		9017	9086 [^]		1779	10865
1993	70% of effort (89)	-	14000		10475	10314 [^]		139	10453
1994	30% reduction in effort	-	13000		9131	8927 [^]		661	9588
1995	Significant reduction in effort	-	13000		9660	9439 [^]		141	9580
1996	Significant reduction in effort	-	13000		9580	9426		63	9489
1997	Significant reduction in effort	-	14000		6992	7034		499	7533
1998	20% reduction in F	9500 ^{^^}	11000		5671	5714		538	6252
1999	F reduced to below Fpa	< 9700 ^{^^}	11800		4289	4201		69	4270
2000	Recovery plan, 60% reduction in F	< 4200	7480		2767 ^{^^^}	2977		821	3798
2001	Lowest possible F, recovery plan	-	3700		2439	2347		92	2439

Year	ICES advice	Predicted catch corresp. to advice	Agreed TAC*	Agreed TAC**	Official landings	ICES reported landings	Misreporting adjustment	ICES discards	ICES catch
2002	Recovery plan or lowest possible F	-	4600		2231	2242		480	2722
2003	Closure	-	1808		1298	1241		34	1275
2004	Zero catch +	0	848		596	540		72	612
2005	Zero catch +	0	721		420	511		41	552
2006	Zero catch +	0	613		484	464	25	465	954
2007	Zero catch +	0	490		487	524	70	1880	2474
2008	Zero catch +	0	402		445	451	231	695	1377
2009	Zero catch +	0	302	240	234	222	186	945	1353
2010	Zero catch +	0		240	249	239	320	785	1344
2011	Zero catch +	0		182	206	206	248	1670	2124
2012	Zero catch +	0		0++	216	160	306	1166	1632
2013	No directed fisheries, minimize bycatch and discards	0		0++	172	176	123	1202	1501
2014	No directed fisheries, minimize bycatch and discards	0		0++	161	152	205	1311	1668
2015	No directed fisheries, minimize bycatch and discards	0		0++	244***	308	461	983	1752
2016	MSY approach (minimize all catches)	0		0++	250***	394	499	852	1745
2017	MSY approach (same advised catch value as provided for 2016)	0		0++					
2018	MSY approach	0							
2019	MSY approach (same advised catch value as provided for 2018)	0							

*TAC is for the whole of Subdivision 5.b₁ and Subareas 6, 12, and 14.

**TAC is for Subdivision 5.b₁ and Division 6.a.

***Preliminary.

^ Including ICES estimates of misreporting.

^^ For Division 6.a only.

^^^ Incomplete data.

+ Single-stock boundaries and the exploitation of this stock should be conducted in the context of mixed fisheries, protecting stocks outside safe biological limits.

++ Bycatch of cod in the area covered by this TAC may be landed, provided that it does not contain more than 1.5% of the live weight of the total catch retained on board per fishing trip.

History of the catch and landings

Table 8 Cod in Division 6.a. Catch distribution by fleet in 2016 as estimated by ICES.

Catch	Landings				Discards		
1 745 tonnes	Demersal finfish trawl	<i>Nephrops</i> fleet	Gillnet	Other	Demersal finfish trawl	<i>Nephrops</i> fleet	Other
	95%	0.95%	3.1%	0.67%	63%	31%	5.9%
893 tonnes					852 tonnes		

Table 9 Cod in Division 6.a. History of commercial landings; official values are presented by country. All weights are in tonnes.

Country	Belgium	Denmark	Faroe Islands	France	Germany	Greenland	Ireland	Netherlands	Norway	Spain	UK (E.W. N.I.)	UK (Scotland)	UK	Total
1985	48	-	-	7411	66		2564	-	204	28	260	8032	-	18613
1986	88	-	-	5096	53		1704	-	174	-	160	4251	-	11526
1987	33	4	-	5044	12		2442	-	77	-	444	11143	-	19199
1988	44	1	11	7669	25		2551	-	186	-	230	8465	-	19182
1989	28	3	26	3640	281		1642	-	207	85	278	9236	-	15426
1990	-	2	-	2220	586		1200	-	150	-	230	7389	-	11777
1991	6	2	-	2503	60		761	-	40	-	511	6751	-	10634
1992	-	3	-	1957	5		761	-	171	-	577	5543	-	9017
1993	22	2	-	3047	94		645	-	72	-	524	6069	-	10475
1994	1	+	-	2488	100		825	-	51	-	419	5247	-	9131
1995	2	4	-	2533	18		1054	-	61	16	450	5522	-	9660
1996	+	2	-	2253	63		1286	-	137	+	457	5382	-	9580
1997	11	-	-	956	5		708	2	36	6	779	4489	-	6992
1998	1	-	-	714	6		478	1	36	42	474	3919	-	5671
1999	+	+	-	842	8		223	-	79	45	381	2711	-	4289
2000	+	-	-	236	6		357	-	114	14	280	2057	-	3064
2001	2	-	-	391	4		319	-	39	3	138	1544	-	2440
2002	+	-	-	208	+		210	-	88	11	195	1519	-	2231
2003	-	-	-	172	+		120	-	45	3	79	879	-	1298
2004	-	-	2	91			34	-	10	-	46	413	-	596
2005	-	-	-	107			28	-	17	-	25	243	-	420
2006	-	-	1	108	2		18	-	30	-	-	-	332	491
2007	-	-	12	92	2		70	-	30	-	21	260	-	487
2008	-	-	1	82	1		58	-	65	-	6	232	-	445
2009	-	-		74	-		24	-	18	-	14	-	104	234
2010	-	-	-	60	-		49	-	21	-	-	-	119	249
2011	-	-	-	49	-		41	-	8	-	-	-	110	208
2012	-	-	-	4	-		18	-	2	-	-	-	137	161
2013	-	-	-	3	-		14	-	24	-	-	-	131	172
2014	-	-	-	5	-		12	-	14	-	-	-	130	161
2015*	-	-	-	-	-		17	-	59	-	-	-	168	244
2016*	-	-	-	-	-	1	28	-	39	-	-	-	182	250

*Preliminary.

Summary of the assessment

Table 10 Cod in Division 6.a. Assessment summary. Weights in tonnes and recruitment in thousands. Obs. = observed; Pred. = predicted (model estimates); High and low refer to 1 x standard error.

Year	Recruit Age 1	High	Low	SSB	High	Low	Land. Obs.	Land. Pred.	High	Low	Disc. Obs..	Disc. Pred..	High	Low	Catch Obs.	Catch Pred.	High	Low	Mean F Ages 2-5	High	Low
1981	10983	11899	10068	40438	42043	38833	23865	24047	25566	22528	303	173	278	68	24168	24220	25737	22704	0.74	0.78	0.69
1982	25925	27306	24545	38122	39749	36496	21511	19667	20944	18389	571	741	921	560	22082	20407	21678	19136	0.66	0.70	0.63
1983	15108	16335	13881	34059	35244	32873	21305	20115	21111	19120	197	279	415	143	21503	20394	21402	19387	0.74	0.79	0.70
1984	25952	27315	24589	31788	32892	30684	21272	20570	21571	19569	329	551	772	330	21601	21121	22121	20121	0.88	0.93	0.83
1985	13472	14683	12261	25146	26031	24260	18607	17760	18611	16909	963	647	802	491	19570	18407	19261	17552	0.99	1.04	0.94
1986	21714	23340	20088	19582	20349	18815	11820	11544	12292	10797	263	523	704	343	12083	12068	12853	11282	0.78	0.83	0.73
1987	59151	65301	53001	20856	21679	20034	18971	17091	18262	15919	2388	1848	2579	1117	21358	18939	20236	17642	0.92	0.97	0.87
1988	6788	7666	5910	26822	28177	25466	20413	19753	21400	18107	368	310	465	155	20781	20063	21729	18398	0.89	0.94	0.84
1989	23900	25920	21880	23007	24453	21562	17169	16031	17316	14746	2076	1393	1858	928	19246	17424	18776	16072	0.95	1.008	0.90
1990	7967	9199	6736	18891	20056	17725	12175	11862	12651	11073	571	201	275	127	12746	12063	12862	11264	0.79	0.85	0.72
1991	12931	14533	11330	15623	17141	14105	10927	10089	11477	8702	622	441	628	255	11549	10531	11972	9089	0.83	0.92	0.74
1992	22630	24618	20641	13206	14574	11838	9086	8675	9946	7403	1779	637	875	398	10865	9311	10643	7980	0.83	0.93	0.74
1993	9076	9943	8208	16511	17945	15077	10314	10630	12004	9256	139	375	507	243	10453	11005	12415	9594	0.83	0.92	0.74
1994	18700	20634	16766	17265	18834	15697	8928	10223	11598	8848	661	662	886	437	9588	10885	12331	9438	0.79	0.88	0.71
1995	15212	16768	13656	17722	19330	16114	9439	11254	12743	9766	141	375	511	240	9580	11630	13157	10103	0.81	0.90	0.73
1996	6776	7720	5832	17742	19427	16057	9427	12120	13733	10507	63	260	353	167	9489	12380	14022	10738	0.94	1.04	0.84
1997	24280	26600	21961	12953	14400	11506	7034	9788	11231	8346	499	938	1295	581	7533	10727	12282	9171	1.01	1.11	0.90
1998	7088	8161	6014	11199	12404	9995	5714	9430	10778	8082	538	327	453	201	6252	9757	11140	8373	0.97	1.08	0.87
1999	5086	5846	4326	10013	11264	8763	4201	7257	8463	6052	69	255	352	159	4270	7513	8755	6270	1.05	1.17	0.94
2000	18662	20682	16643	7007	7953	6061	2977	5299	6199	4398	821	1103	1445	761	3798	6402	7427	5376	0.94	1.05	0.83
2001	4314	4988	3639	7696	8632	6759	2347	5710	6661	4760	92	241	326	156	2439	5951	6934	4969	1.00	1.11	0.89
2002	9421	10776	8065	7521	8530	6513	2243	5717	6706	4729	480	552	754	351	2722	6270	7334	5206	1.05	1.17	0.93
2003	2515	3160	1869	5787	6610	4964	1241	4372	5174	3570	34	167	239	96	1275	4539	5373	3704	1.06	1.18	0.94
2004	3167	3873	2462	3665	4343	2987	540	2557	3155	1958	72	189	270	109	612	2746	3383	2108	1.01	1.13	0.90
2005	1794	2242	1347	2335	2809	1861	511	1827	2316	1338	41	125	180	70	552	1952	2467	1437	1.19	1.34	1.04
2006	5906	6724	5089	1435	1613	1256	488	386	444	328	465	900	1093	708	954	1286	1510	1062	0.88	0.97	0.80
2007	1844	2140	1549	2400	2632	2168	595	538	609	468	1880	1434	1712	1156	2474	1972	2269	1676	1.07	1.15	0.98
2008	1471	1754	1189	2450	2692	2208	682	586	662	509	695	1066	1282	849	1377	1651	1882	1420	1.01	1.10	0.92
2009	3462	3952	2971	1942	2117	1768	408	453	510	396	945	952	1131	774	1353	1405	1587	1223	0.87	0.95	0.79
2010	3927	4371	3483	2219	2416	2022	559	542	593	492	785	1025	1220	831	1344	1567	1783	1352	0.85	0.92	0.77
2011	2317	2631	2002	2648	2864	2431	454	444	489	399	1670	1608	1851	1366	2124	2052	2302	1803	1.11	1.19	1.02
2012	2532	2952	2111	2564	2762	2366	466	453	504	403	1166	1203	1395	1011	1632	1657	1859	1455	0.88	0.95	0.80
2013	3538	4169	2907	2214	2369	2059	299	349	392	305	1202	1123	1292	953	1501	1471	1635	1307	0.90	0.97	0.83
2014	2719	3290	2148	2296	2524	2069	357	416	459	374	1311	991	1191	791	1668	1407	1617	1197	0.75	0.83	0.67
2015	2020	2718	1322	2762	3083	2441	770	575	656	493	983	1000	1207	794	1752	1575	1817	1333	0.69	0.77	0.61
2016	3494	4448	2540	2741	3114	2368	892	826	909	742	852	1069	1308	829	1745	1894	2159	1630	0.94	1.10	0.79
2017	3614	4859	2369	2483	3032	1935															

Sources and references

- Cook, R. M., S. J. Holmes and R. J. Fryer. 2015. Grey seal predation impairs recovery of an over-exploited fish stock. *Journal of Applied Ecology*, 52(4): 969–979. doi: 10.1111/1365-2664.12439.
- EU. 2008. COUNCIL REGULATION (EC) No. 1342/2008 of 18 December 2008 establishing a long-term plan for cod stocks and the fisheries exploiting those stocks and repealing Regulation (EC) No. 423/2004. *Official Journal of the European Union*, L 348/21. <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:348:0020:0033:EN:PDF>.
- EU. 2016. COUNCIL REGULATION (EU) 2016/2094 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 November 2016 amending Council Regulation (EC) No 1342/2008 establishing a long-term plan for cod stocks and the fisheries exploiting those stocks.
- ICES. 2012. Report of the Benchmark Workshop on Western Waters Roundfish (WKROUND), 22–29 February 2012, Aberdeen, UK. ICES CM 2012/ACOM:49. 283 pp.
- ICES. 2015. Report of the Inter-Benchmark Protocol of West of Scotland Roundfish (IBPWSRound), February–April 2015. By correspondence. ICES CM 2015/ACOM:37.
- ICES. 2016a. Advice basis. In Report of the ICES Advisory Committee, 2016. ICES Advice 2016, Book 1, Section 1.2.
- ICES. 2016b. Report of the Working Group for the Celtic Seas Ecoregion (WGCSE), 04–13 May 2016, ICES Headquarters, Copenhagen, Denmark. ICES CM 2016/ACOM:13.
- ICES. 2016c. Report of the Workshop to consider FMSY ranges for stocks in ICES categories 1 and 2 in Western Waters (WKMSYREF4), 13–16 October 2015, Brest, France. ICES CM 2015/ACOM:58. 187 pp.
- ICES. 2017. Report of the Working Group for the Celtic Seas Ecoregion (WGCSE), 9–18 May 2017, ICES Headquarters, Copenhagen, Denmark. ICES CM 2017/ACOM.
- Lorenzen, K. 1996. The relationship between body weight and natural mortality in juvenile and adult fish: a comparison of natural ecosystems and aquaculture. *Journal of Fish Biology*, 49(4): 627–642.