

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

ICES advice on fishing opportunities

ICES advises that when the MSY approach is applied, there should be zero catches in each of the years 2020 and 2021.

Stock development over time

The current spawning-stock biomass (SSB) is extremely low and has been below B_{lim} since 1997. Recruitment has also been very low since 2001, and below the time-series average. Fishing mortality (F) declined between 2005 and 2014 but has remained between F_{pa} and F_{lim} since 2014.

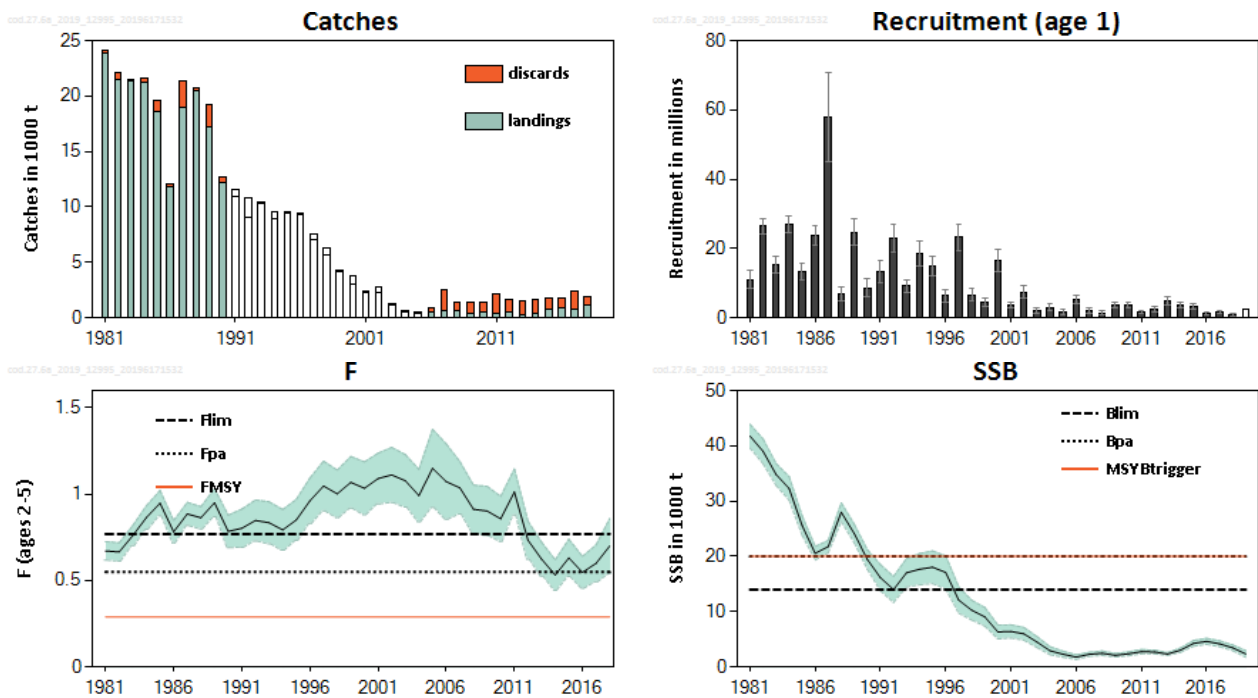


Figure 1 Cod in Division 6.a. Summary of the stock assessment. Reported landings and estimated discards shown in the upper left panel (catches from 1991–2005 (unshaded) are excluded from the assessment). Shaded areas (F and SSB) and error bars (recruitment) correspond to 95% confidence intervals. Assumed recruitment is unshaded.

Stock and exploitation status

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

Table 1 Cod in Division 6.a. 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}	✘	✘	✘	MSY $B_{trigger}$	✘	✘	✘	Below trigger
Precautionary approach	F_{pa} , F_{lim}	✔	○	○	B_{pa} , B_{lim}	✘	✘	✘	Reduced reproductive capacity
Management plan	F_{MGT}	—	—	—	B_{MGT}	—	—	—	Not applicable

Catch scenarios

Table 2 Cod in Division 6.a. Assumptions made for the interim year and forecast.

Variable	Value	Notes
$F_{\text{ages 2-5}}$ (2019)	0.70	Average $F = (2016-2018)$ scaled to $F_{\text{ages 2-5}}$ in 2018
SSB_{2020}	2013	Tonnes; short-term forecast.
$R_{\text{age 1}}$ (2019 & 2020)	2349	Thousands; GM recruitment (2009-2018)
Catch (2019)	1421	Tonnes; short-term forecast.

Table 3 Cod in Division 6.a. Annual catch scenarios. All weights are in tonnes.

Basis	Total catch (2020)	F_{total} (2020)	SSB (2021)	% SSB change *	% TAC change ***
ICES advice basis					
MSY approach: $F = 0$	0	0	3765	87	-100
Other scenarios					
$F_{\text{MSY}} \times SSB(2020) / \text{MSY } B_{\text{trigger}}$	70	0.029	3679	83	-96
$F_{\text{MSY lower}}: F_{\text{MSY lower}} \times SSB(2020) / \text{MSY } B_{\text{trigger}}$	48	0.020	3705	84	-97
$F_{\text{MSY upper}}: F_{\text{MSY upper}} \times SSB(2020) / \text{MSY } B_{\text{trigger}}$	98	0.041	3644	81	-95
$F = F_{\text{MSY lower}}$	446	0.20	3218	60	-75
$F = F_{\text{MSY}}$	623	0.29	3002	49	-66
F_{pa}	1064	0.55	2469	23	-42
$F = F_{\text{MSY upper}}$	839	0.41	2741	36	-54
$F = F_{2019}$	1279	0.70	2212	9.9	-30
F_{lim}	1371	0.77	2103	4.5	-25
$SSB(2021) = B_{\text{lim}}$ **					
$SSB(2021) = B_{\text{pa}} = \text{MSY } B_{\text{trigger}}$ **					

* SSB 2021 relative to SSB 2020.

** The B_{lim} , B_{pa} , and $\text{MSY } B_{\text{trigger}}$ options were left blank because B_{lim} , B_{pa} , and $\text{MSY } B_{\text{trigger}}$ cannot be achieved in 2021, even with zero advice.

*** Total catch in 2020 relative to TAC in 2019 (1735 tonnes).

Because the SSB is estimated to remain below B_{lim} , the advice is the same as for 2019.

Basis of the advice

Table 4 Cod in Division 6.a. 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 assessment was interbenchmarked in 2019 (IBPCod6.a, ICES, 2019a). The new assessment includes additional survey indices and modified assumptions about the uncertainty in the commercial catch-at-age data; it allows greater flexibility in the estimation of fishery selectivity parameters. Estimates of F and SSB from the new assessment are robust to assumptions about fishery selectivity, survey catchability, the time-series of data included, and the relative uncertainty of survey and landings data. The downward revision of fishing mortality in the new assessment is largely the result of the changes in the assessment assumptions.

The uncertainty of the estimates of area-misreported landings (which account for > 60% of total landings) is unknown and not included in the assessment. The uncertainty estimates from the final assessment are therefore unlikely to adequately reflect the true uncertainty in the estimates of stock biomass and fishing mortality for this stock.

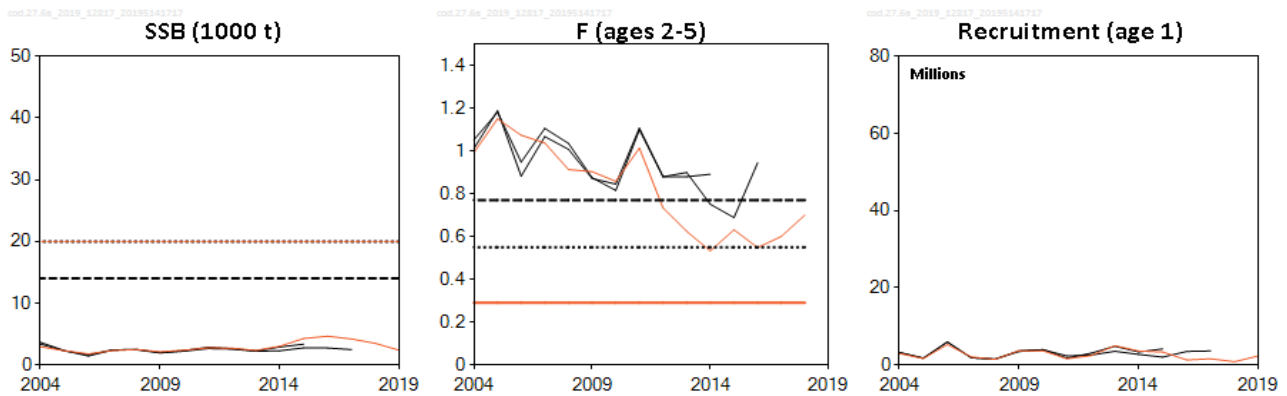


Figure 2 Cod in Division 6.a. Historical assessment results. Final-year recruitment estimates are included; these are model estimates for historical assessments and GM 2009–2018 for the 2019 assessment.

Issues relevant for the advice

Management measures taken so far have not resulted in a recovery of the stock. Although fishing mortality on this stock has been reduced since 2005 (showing a proportionately similar reduction to the decline in reported effort since 2003), it remains well above F_{MSY} and showed an increase in 2018.

Cod are known to form aggregations, so it is still possible to find areas of high cod density at low stock abundance. This can lead to high catches in localized areas, generating high fishing mortality even with low fishing effort. The impact of this could be reduced by temporary spatial measures.

Discards in recent years have been largely the result of high grading, because of restrictive TACs. It is not known how the fishery will respond to the increase in TAC for 2019. ICES is not able, therefore, to provide estimates of wanted and unwanted catch proportions.

Estimated area-misreported landings (catches taken in 6.a, but reported elsewhere) account for over 60% of the total landings in 2018. Measures to reduce area misreporting should 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 fishing mortality reference points were calculated in 2019 (ICES, 2019a). 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 (2017, 2019a)
	F_{MSY}	0.29	Based on simulation (EqSim)	ICES (2019a)
Precautionary approach	B_{lim}	14 000 tonnes	B_{loss} from which the stock has increased (SSB in 1992 as estimated in 2015)	ICES (2017, 2019a)
	B_{pa}	20 000 tonnes	$B_{lim} \times 1.4$	ICES (2017, 2019a)
	F_{lim}	0.77	Based on simulation using segmented regression with B_{lim} as the breakpoint (EqSim)	ICES (2019a)
	F_{pa}	0.55	$F_{lim} / 1.4$	ICES (2019a)
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, 2018)
Assessment type	Analytical age-based assessment (TSA) that uses catches in the model and in the forecast (ICES, 2019b)
Input data	Commercial catches (international landings, ages and length frequencies from catch sampling); five survey indexes (ScoGFS-WIBTS-Q1;UKSGFS-WIBTS-Q1; ScoGFS-WIBTS-Q4; UKSGFS-WIBTS-Q4; IGFS-WIBTS-Q4); 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 for the full time-series and covering 85 % of the ICES reported landings. No estimates of discards are available from the area misreported landings.
Indicators	None
Other information	The stock was benchmarked in 2012 (WKROUND; ICES, 2012), in 2015 (IBPWSROUND; ICES, 2015) and in 2019 (IBPCOD6.a; ICES, 2019a).
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 is changing, and is more likely to be representative of fishing patterns.

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 estimates of reported landings	Misreporting adjustment	ICES discards	ICES catch
1987	Reduce F towards F_{max}	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 F_{pa}	< 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
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

Year	ICES advice	Predicted catch corresp. to advice	Agreed TAC *	Agreed TAC **	Official landings	ICES estimates of reported landings	Misreporting adjustment	ICES discards	ICES catch
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 ++	256	308	461	983	1752
2016	MSY approach (minimize all catches)	0		0 ++	346	394	499	852	1745
2017	MSY approach (same advised catch value as provided for 2016)	0		0 ++	351	365	429	1569	2363
2018	MSY approach	0		0 ++	360 ***	388	741	760	1890
2019	MSY approach (same advised catch value as provided for 2018)	0		1735 ***					
2020	MSY approach	0							
2021	MSY approach (same advised catch value as provided for 2020)	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.

+++ Bycatch TAC.

History of the catch and landings

Table 8 Cod in Division 6.a. Catch distribution by fleet in 2018 as estimated by ICES.

Catch	Landings				Discards		
	Demersal finfish trawl	<i>Nephrops</i> fleet	Gillnet	Other	Demersal finfish trawl	<i>Nephrops</i> fleet	Other
1890 tonnes	96%	< 1%	< 1%	3%	89%	10%	1%
	1129 tonnes				760 tonnes		

Table 9 Cod in Division 6.a. History of commercial landings; official values are presented by country. All weights are in tonnes. + represents landings < 0.5 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	-	14	318	-	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	-	4	115	-	249
2011	-	-	-	49	-	-	41	-	8	-	3	107	-	208
2012	-	-	-	4	-	-	18	-	2	-	2	135	-	161
2013	-	-	-	3	-	-	14	-	24	-	1	130	-	172
2014	-	-	-	5	-	-	12	-	14	-	9	121	-	161
2015	-	-	-	11	-	-	17	-	59	-	-	-	168	256
2016	-	11	-	86	-	1	28	-	39	-	-	-	182	346
2017	-	1	-	119	-	-	19	-	14	-	-	-	199	351
2018 *	-	+	+	101	-	-	12	-	37	-	-	-	210	360

*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 95.% CI

Year	Recruitment Age 1			SSB			Landings	Discards	F Ages 2–5			Catch estimate			Landings estimate			Discards estimate		
	Low	Value	High	Low	Value	High			Low	Value	High	Low	Value	High	Low	Value	High	Low	Value	High
1981	8553	11028	13504	39610	41750	43890	23865	303	0.62	0.67	0.73	22350	24219	26089	22179	24052	25925	-20	167	354
1982	24219	26437	28654	36780	39023	41267	21511	571	0.61	0.67	0.72	19361	20933	22505	18553	20140	21728	436	793	1150
1983	12968	15317	17666	32849	34821	36793	21305	197	0.7	0.76	0.82	19803	21171	22540	19497	20843	22188	23	329	634
1984	24674	27103	29531	30167	32299	34430	21272	329	0.8	0.87	0.93	19923	21479	23035	19285	20866	22446	133	613	1094
1985	10902	13406	15910	23805	25558	27312	18607	963	0.87	0.95	1.02	17030	18413	19796	16403	17800	19197	291	613	936
1986	20911	23663	26415	19331	20564	21797	11820	263	0.72	0.78	0.85	11766	12752	13739	11246	12177	13109	177	575	974
1987	45160	57984	70807	20672	21786	22899	18971	2388	0.82	0.89	0.95	17066	19324	21581	15745	17550	19355	251	1774	3296
1988	4857	6830	8802	26302	27998	29694	20413	368	0.8	0.86	0.93	18655	20633	22611	18357	20295	22233	-16	338	692
1989	20773	24723	28672	22413	24102	25790	17169	2076	0.87	0.95	1.03	16566	18257	19948	15354	16851	18348	414	1406	2399
1990	5927	8515	11103	17662	19431	21199	12175	571	0.69	0.78	0.88	11491	12470	13450	11280	12242	13205	52	228	404
1991	10243	13386	16529	13776	16143	18511	10927	622	0.69	0.8	0.91	8707	10651	12595	8332	10173	12014	67	478	889
1992	18986	22922	26859	11664	14020	16376	9086	1779	0.73	0.85	0.97	7865	9851	11836	7316	9211	11106	129	640	1150
1993	7370	9087	10804	14469	17042	19616	10314	139	0.71	0.83	0.96	9233	11319	13404	8898	10934	12971	119	385	650
1994	15012	18653	22294	14856	17693	20530	8928	661	0.68	0.79	0.91	8886	11114	13343	8327	10437	12548	203	677	1151
1995	12051	14871	17690	15091	18040	20988	9439	141	0.73	0.85	0.97	9754	12241	14729	9439	11861	14284	96	380	664
1996	4632	6364	8096	14116	17111	20107	9427	63	0.83	0.96	1.09	9523	12150	14777	9329	11911	14493	65	239	413
1997	19278	23205	27133	9727	12106	14486	7034	499	0.9	1.05	1.19	7988	10329	12670	7302	9457	11612	181	872	1564
1998	4774	6608	8441	8494	10273	12051	5714	538	0.86	1	1.14	7463	9253	11043	7187	8928	10670	73	324	576
1999	3328	4501	5674	7393	9078	10763	4201	69	0.92	1.07	1.22	5353	6911	8470	5179	6686	8193	50	225	401
2000	13267	16469	19670	5070	6338	7606	2977	821	0.88	1.03	1.19	4751	6056	7362	3823	4978	6132	455	1078	1702
2001	2659	3566	4474	5251	6441	7632	2347	92	0.94	1.09	1.24	4078	5265	6453	3906	5055	6204	69	211	353
2002	5506	7436	9367	4843	5995	7148	2243	480	0.95	1.11	1.27	3971	5103	6234	3596	4627	5658	144	476	808
2003	1218	1978	2739	3516	4510	5504	1241	34	0.93	1.08	1.23	2707	3661	4616	2605	3519	4432	28	142	257
2004	1916	2947	3979	2221	2945	3670	540	72	0.84	0.99	1.14	1558	2204	2850	1428	2017	2606	49	187	325
2005	764	1660	2556	1757	2309	2860	511	41	0.92	1.15	1.38	1274	1828	2382	1190	1707	2224	22	121	219
2006	3909	5291	6673	1360	1790	2220	488	465	0.85	1.07	1.29	1048	1579	2109	269	493	716	630	1086	1542
2007	1318	2088	2857	1937	2299	2661	595	1880	0.88	1.04	1.19	1384	1815	2245	362	487	612	920	1328	1736
2008	942	1424	1906	2076	2488	2899	682	695	0.77	0.91	1.05	1211	1587	1963	407	583	759	645	1004	1363
2009	2731	3681	4630	1794	2124	2454	408	945	0.76	0.9	1.05	1189	1506	1822	381	475	568	711	1031	1351
2010	2881	3642	4403	2029	2385	2741	559	785	0.73	0.86	0.99	1231	1612	1993	450	555	660	702	1057	1411
2011	1224	1586	1948	2383	2769	3156	454	1670	0.88	1.01	1.15	1486	1883	2281	357	474	592	1022	1409	1796
2012	1644	2407	3170	2369	2715	3061	466	1166	0.62	0.73	0.84	1224	1528	1833	392	488	583	743	1041	1338
2013	3793	4986	6180	2084	2347	2610	299	1202	0.53	0.62	0.72	1036	1268	1499	322	392	461	638	876	1114
2014	2783	3592	4401	2641	3042	3443	357	1311	0.44	0.53	0.62	1126	1480	1834	332	416	500	731	1064	1397
2015	2584	3337	4091	3754	4279	4804	770	983	0.52	0.63	0.74	1633	2091	2548	543	718	894	964	1372	1780
2016	870	1282	1694	4091	4642	5192	892	852	0.46	0.55	0.64	1613	2037	2461	651	805	959	840	1232	1623
2017	1085	1579	2073	3658	4196	4734	795	1569	0.49	0.6	0.71	1593	1969	2345	736	873	1010	741	1096	1450
2018	460	826	1192	2958	3478	3998	1129	760	0.54	0.7	0.86	1501	1791	2081	980	1128	1275	421	663	906
2019		2349*		1744	2357	2970														

*Geometric mean 2009–2018.

Sources and references

- Cook, R. M., Holmes, S. J., and Fryer, R. J. 2015. Grey seal predation impairs recovery of an over-exploited fish stock. *Journal of Applied Ecology*, 52(4): 969–979. <https://doi.org/10.1111/1365-2664.12439>
- 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. <https://doi.org/10.17895/ices.pub.5424>
- ICES. 2015. Report of the Inter-Benchmark Protocol of West of Scotland Roundfish (IBPWSRound), February–April 2015. By correspondence. ICES CM 2015/ACOM:37. <https://doi.org/10.17895/ices.pub.5425>
- ICES. 2017. 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. <https://doi.org/10.17895/ices.pub.5348>
- ICES. 2018. Advice basis. In Report of the ICES Advisory Committee, 2018. ICES Advice 2018, Book 1, Section 1.2. <https://doi.org/10.17895/ices.pub.4503>
- ICES. 2019a. Inter-benchmark Workshop on West of Scotland Cod (6.a) (IBPCod6.a). ICES Scientific Reports. 1:13. 171 pp. <http://doi.org/10.17895/ices.pub.4976>
- ICES. 2019b. Report of the Working Group for the Celtic Seas Ecoregion. ICES Scientific Reports. 1:29. XXXX pp. <http://doi.org/10.17895/ices.pub.4982>.
- 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. <https://doi.org/10.1111/j.1095-8649.1996.tb00060.x>

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