

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

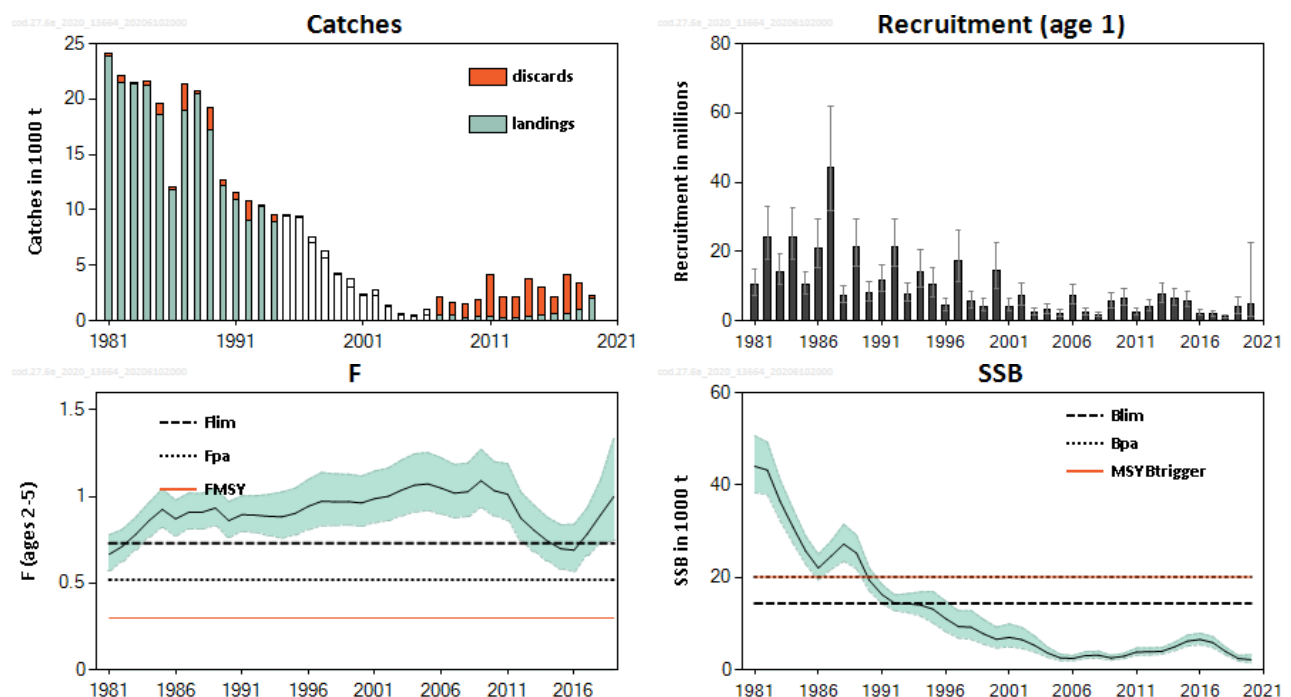
### ICES advice on fishing opportunities

**Please note: The present advice replaces the advice given in June 2019 for catches in 2021.**

ICES advises that when the MSY approach is applied, there should be zero catch in each of the years 2021 and 2022.

### Stock development over time

The current spawning-stock biomass (SSB) is extremely low and has been below  $B_{lim}$  since 1993. Recruitment (R) has also been very low since 2001. Fishing mortality (F) has been estimated above  $F_{lim}$  since 1982, with the exception of the years 2015 and 2016.



**Figure 1** Cod in Division 6.a. Summary of the stock assessment. ICES estimated landings and discards (landings below minimum size [BMS] were negligible) are shown in the upper left panel (catches from 1995–2006 [unshaded] are excluded from the assessment). Shaded areas (F and SSB) and error bars (recruitment) correspond to 95% confidence intervals.

### Stock and exploitation status

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

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

		Fishing pressure				Stock size			
		2017	2018	2019		2018	2019	2020	
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 scenarios

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

Variable	Value	Notes
$F_{\text{ages 2-5}}$ (2020)	1.00	Average $F$ = (2017–2019) scaled to $F_{\text{ages 2-5}}$ in 2019.
SSB (2021)	3025	Short-term forecast; in tonnes.
$R_{\text{age 1}}$ (2020)	5181	Median recruitment estimated in the assessment in 2020; in thousands.
$R_{\text{age 1}}$ (2021 and 2022)	4203	Median recruitment resampled from the years 2010–2019; in thousands.
Total catch (2020)	1395	Short-term forecast; in tonnes.
Projected landings	909	Short-term forecast assuming 2019 discard pattern; in tonnes.
Projected discards (2020)	486	Short-term forecast assuming 2019 discard pattern; in tonnes.

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

Basis	Total catch (2021)	Projected landings (2021)	Projected discards (2021)	$F_{\text{total}}$ (2021)	$F_{\text{projected landings}}$ (2021)	$F_{\text{projected discards}}$ (2021)	SSB (2022)	% SSB change *	% TAC change ^
ICES advice basis									
MSY approach: $F = 0$	0	0	0	0	0	0	6070	101	–100
Other scenarios									
$F_{\text{MSY}} \times \text{SSB (2021)} / \text{MSY } B_{\text{trigger}}$	123	85	37	0.045	0.036	0.0089	5896	95	–90
$F_{\text{MSY lower}}: F_{\text{MSY lower}} \times \text{SSB (2021)} / \text{MSY } B_{\text{trigger}}$	74	52	23	0.027	0.022	0.0054	5963	97	–94
$F_{\text{MSY upper}}: F_{\text{MSY upper}} \times \text{SSB (2021)} / \text{MSY } B_{\text{trigger}}$	198	137	61	0.074	0.059	0.0146	5801	92	–85
$F = F_{\text{MSY lower}}$	465	320	146	0.18	0.144	0.036	5461	81	–64
$F = F_{\text{MSY}}$	738	504	234	0.30	0.24	0.06	5098	69	–42
$F = F_{\text{pa}}$	1182	793	389	0.52	0.42	0.103	4517	49	–7.6
$F = F_{\text{MSY upper}}$	1124	757	367	0.49	0.39	0.097	4591	52	–12.1
$F = F_{2019}$	1914	1258	657	1.00	0.8	0.198	3538	17.0	50
$F = F_{\text{lim}}$	1532	1020	512	0.73	0.59	0.145	4064	34	19.8
Rollover TAC	1279	857	422	0.58	0.46	0.114	4389	45	0.00
SSB (2022) = $B_{\text{lim}}$ **									
SSB(2022) = $B_{\text{pa}} = \text{MSY } B_{\text{trigger}}$ **									

\* SSB 2022 relative to SSB 2021.

\*\* The  $B_{\text{lim}}$ ,  $B_{\text{pa}}$ , and MSY  $B_{\text{trigger}}$  options were left blank because  $B_{\text{lim}}$ ,  $B_{\text{pa}}$ , and MSY  $B_{\text{trigger}}$  cannot be achieved in 2022, even with zero catches.

^ Total catch in 2021 relative to the TAC in 2020 (1279 tonnes).

Because the SSB is estimated to remain below  $B_{\text{lim}}$  (14 376 tonnes) with any catch scenario, the advice for 2021 is the same as for 2020.

## Basis of the advice

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

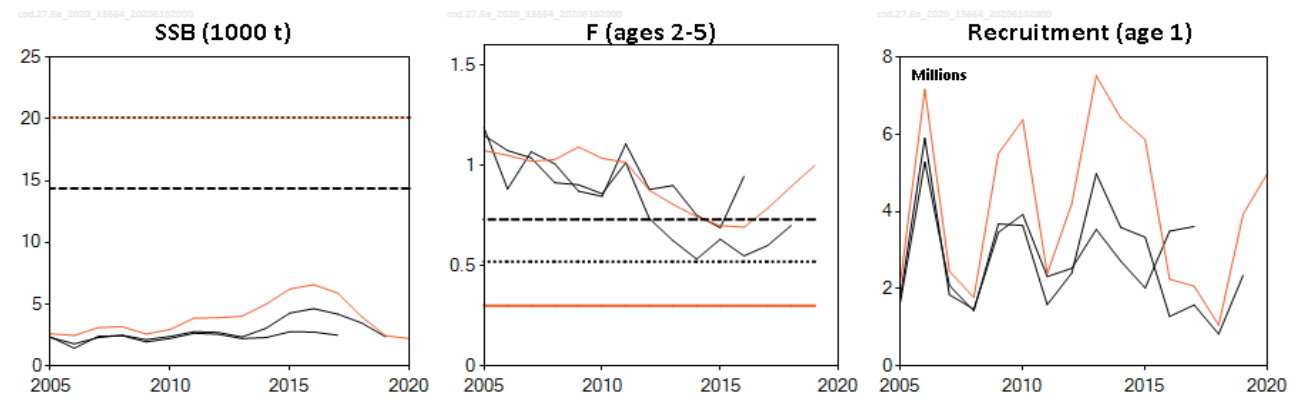
Advice basis	MSY approach.
Management plan	The EU multiannual plan (MAP) for stocks in the Western Waters and adjacent waters (EU, 2019) takes bycatch of this species into account.

## Quality of the assessment

The stock assessment was benchmarked in 2020 (WKDEM; ICES, 2020a). This resulted in a change of the assessment method, the inclusion of revised catch (mostly discards) data from 2003 onwards, and updated biological parameters. The revised estimates of recruitment,  $F$ , and SSB are likely the result of the inclusion of updated historical catch data. However, changes to the input data and assessment model have had only minor impact on the perception of the stock.

The estimates of area-misreported landings (which account for > 40% of the total landings in recent years, average 2017–2019) are uncertain. Although the survey trends are noisy, there was reasonable internal consistency among the surveys used in the assessment.

Stock structure remains an issue for cod in Division 6.a. The issues of multiple stocks in Division 6.a and connectivity with the North Sea stock remain sources of uncertainty.



**Figure 2** Cod in Division 6.a. Historical assessment results. Final-year recruitment estimates are included. The assessment was benchmarked in 2020.

### Issues relevant for the advice

Management measures taken so far have not resulted in a recovery of the stock. Even though fishing mortality declined between 2009 and 2016, it has shown an increase since. It is not known whether, and to what extent this increase is associated with the discontinuation of the days-at-sea regulation in 2017, which was part of the cod recovery plan.

Cod are known to form aggregations; hence, 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 (e.g. real-time closures).

From 2019, cod is fully under the EU landing obligation in Division 6.a. The below minimum size (BMS) landings of cod reported to ICES are currently negligible, and they are much lower than ICES estimates of catches below the minimum conservation reference size (MCRS).

In 2019, there was a significant decrease in the proportion of discards due to an increase in TAC compared to recent years. The partition of catch into projected landings and discards in the forecast is based on the assumption that the discarding pattern according to age seen in 2019 will continue in 2020 and 2021. The increase in discards in the catch prediction relative to 2019 is due to an increased abundance of recruits relative to previous years.

Estimated area-misreported landings (catches taken in Division 6.a, but reported elsewhere) account for over 40% of the total landings in recent years (average percentage 2017–2019). Measures to reduce area misreporting should be introduced.

Grey seal abundance is significant to the west of Scotland, and grey seals 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 $B_{trigger}$	20126	$B_{pa}$ ; in tonnes.	ICES (2020a)
	$F_{MSY}$	0.30	Based on simulation using a segmented regression stock–recruitment relationship (EqSim).	ICES (2020a)
	$F_{MSY\ lower}$	0.18	F at 95% MSY (below $F_{MSY}$ ), based on simulation using a segmented regression stock–recruitment relationship (EqSim).	ICES (2020a)
	$F_{MSY\ upper}$	0.49	F at 95 % MSY (above $F_{MSY}$ ), based on simulation using a segmented regression stock–recruitment relationship (EqSim).	ICES (2020a)
Precautionary approach	$B_{lim}$	14 376	SSB consistent with high probability of above-average recruitment (SSB in 1992 as estimated by WKDEM); in tonnes.	ICES (2020a)
	$B_{pa}$	20 126	$B_{lim} \times 1.4$ ; in tonnes.	ICES (2020a)
	$F_{lim}$	0.73	The F with 50% probability of $SSB < B_{lim}$	ICES (2020a)
	$F_{pa}$	0.52	$F_{lim}/1.4$	ICES (2020a)
	$F_{p.05}$	0.57	The F that leads to $SSB \geq B_{lim}$ with 95% probability.	ICES (2020a)
Management plan	$SSB_{mgt}$	Not applicable		
	$F_{mgt}$	Not applicable		

## Basis of the assessment

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

ICES stock data category	1 ( <a href="#">ICES, 2019</a> ).
Assessment type	Analytical age-based assessment (SAM) that uses catches in the model and in the forecast (ICES, 2020b).
Input data	Commercial catches (international landings, ages and length frequencies from catch sampling); five survey indexes (ScoGFS-WIBTS-Q1 [1985–2010]; UKSGFS-WIBTS-Q1 [2010–2020]; ScoGFS-WIBTS-Q4 [1996–2010]; UKSGFS-WIBTS-Q4 [2011–2019]; IGFS-WIBTS-Q4 [2003–2019]); maturity data from surveys; time-varying natural mortalities (M) based on a 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 89% of the ICES estimated landings in 2019.
Indicators	-
Other information	The stock was last benchmarked in 2020 (WKDEM; ICES, 2020a).
Working group	Working Group for the Celtic Seas Ecoregion ( <a href="#">WGCSE</a> )

## 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		3064	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	1292		60	1353
2004	Zero catch +	0	848		596	573		78	651
2005	Zero catch +	0	721		420	516		54	570
2006	Zero catch +	0	613		484	470	34	461	965
2007	Zero catch +	0	490		487	485	30	1651	2166
2008	Zero catch +	0	402		445	460	102	1037	1598
2009	Zero catch +	0	302	240	234	231	54	1287	1572
2010	Zero catch +	0		240	249	239	119	1575	1933
2011	Zero catch +	0		182	206	211	130	3867	4208
2012	Zero catch +	0		0 **	216	162	65	1914	2141
2013	No directed fisheries, minimize bycatch and discards	0		0 **	172	172	93	1870	2136
2014	No directed fisheries, minimize bycatch and discards	0		0 **	161	161	234	3369	3764
2015	No directed fisheries, minimize bycatch and discards	0		0 **	256	258	270	2498	3026

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
2016	MSY approach (minimize all catches)	0		0 ++	346	336	272	1499	2108
2017	MSY approach (same advised catch value as provided for 2016)	0		0 ++	351	355	320	3519	4195
2018	MSY approach	0		0 ++	360 ***	378	613	2429 ^^^	3419
2019	MSY approach (same advised catch value as provided for 2018)	0		1735 ***	1486 ***	1489	571	204 ^^^	2264
2020	MSY approach	0		1279 ***					
2021	MSY approach	0							
2022	MSY approach (same advised catch value as provided for 2021)	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.

^^^ Including BMS landings from 2018 onwards.

+ 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 this bycatch does not exceed 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 2019 as estimated by ICES.

Catch	Landings				Discards		
	Demersal finfish trawl	<i>Nephrops</i> fleet	Gillnet	Other	Demersal finfish trawl	<i>Nephrops</i> fleet	Other
2264 tonnes	92%	< 1%	2%	6%	51%	45%	4%
2060 tonnes					204 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	Official BMS landings	Total
1985	48	-	-	7411	66	-	2564	-	204	28	260	8032	-		1861
1986	88	-	-	5096	53	-	1704	-	174	-	160	4251	-		1152
1987	33	4	-	5044	12	-	2442	-	77	-	444	1114	-		1919
1988	44	1	11	7669	25	-	2551	-	186	-	230	8465	-		1918
1989	28	3	26	3640	281	-	1642	-	207	85	278	9236	-		1542
1990	-	2	-	2220	586	-	1200	-	150	-	230	7389	-		1177
1991	6	2	-	2503	60	-	761	-	40	-	511	6751	-		1063
1992	-	3	-	1957	5	-	761	-	171	-	577	5543	-		9017
1993	22	2	-	3047	94	-	645	-	72	-	524	6069	-		1047
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	-	13	-	9	121	-		160
2015	-	-	-	11	-	-	17	-	59	-	-	-	168		256
2016	-	11	-	86	-	1	28	-	39	-	-	-	183		348
2017	-	1	-	119	-	-	19	-	14	-	-	-	200		352
2018 *	-	+	+	101	-	-	12	-	37	-	-	-	210		360
2019 *	-	-	-	144	-	-	40	-	47	31	-	-	1225	+	1486

\* Preliminary.

+ Landings < 0.5 tonnes.

## Summary of the assessment

**Table 10** Cod in Division 6.a. Assessment summary. Weights are in tonnes and recruitment in thousands. High and low refer to 95% confidence intervals. Total landings and discards from 1995–2006 are not included as input to the assessment.

Year	Recruitment age 1			SSB			Landings	Discards *	Fishing mortality ages 2–5		
	Value	High	Low	Value	High	Low			Value	High	Low
	thousands			tonnes			tonnes				
1981	10465	14718	7442	44062	50654	38328	23865	303	0.67	0.78	0.57
1982	24111	33013	17610	43237	49257	37953	21511	571	0.71	0.81	0.63
1983	14111	19270	10333	36446	41142	32285	21305	197	0.78	0.88	0.69
1984	23990	32716	17591	30955	34844	27500	21272	329	0.86	0.97	0.77
1985	10500	14281	7720	25764	28978	22908	18607	963	0.93	1.04	0.82
1986	21035	29245	15131	22032	24977	19434	11820	263	0.87	0.98	0.78
1987	44325	62036	31670	24596	27845	21727	18971	2388	0.91	1.02	0.81

Year	Recruitment age 1			SSB			Landings	Discards *	Fishing mortality ages 2–5		
	Value	High	Low	Value	High	Low			Value	High	Low
	thousands			tonnes							
1988	7193	9932	5209	27227	31512	23524	20413	368	0.91	1.02	0.81
1989	21394	29444	15545	25277	29172	21901	17169	2076	0.93	1.05	0.83
1990	8140	11368	5829	19418	22051	17100	12175	571	0.86	0.97	0.77
1991	11833	16199	8644	16295	18467	14378	10927	622	0.90	1.00	0.80
1992	21487	29426	15690	14411	16221	12802	9086	1779	0.89	1.00	0.79
1993	7679	10760	5480	14297	16479	12404	10314	139	0.89	1.01	0.78
1994	14007	20346	9643	14043	16846	11706	8928	661	0.88	1.03	0.76
1995	10292	15269	6938	13142	16965	10180	9439	141	0.90	1.05	0.78
1996	4278	6470	2828	11104	14906	8271	9427	63	0.94	1.10	0.81
1997	17243	26181	11356	9386	12787	6889	7034	499	0.97	1.14	0.83
1998	5511	8426	3604	9224	12839	6627	5714	538	0.97	1.13	0.83
1999	4252	6538	2765	7771	10875	5553	4201	69	0.97	1.13	0.84
2000	14574	22495	9442	6607	9231	4729	2977	821	0.96	1.12	0.83
2001	4219	6539	2722	7025	9925	4973	2347	92	0.99	1.15	0.85
2002	7138	11026	4622	6537	9170	4660	2243	480	1.00	1.16	0.86
2003	2359	3596	1548	5303	7303	3851	1292	60	1.04	1.21	0.89
2004	3230	4812	2168	3686	4947	2747	573	78	1.07	1.25	0.91
2005	2171	3262	1444	2600	3395	1991	516	54	1.07	1.25	0.92
2006	7173	10609	4850	2466	3097	1963	504	461	1.05	1.22	0.90
2007	2452	3709	1621	3101	3930	2446	515	1651	1.02	1.18	0.88
2008	1772	2625	1196	3177	4060	2486	561	1037	1.03	1.19	0.89
2009	5501	7949	3808	2578	3144	2114	284	1287	1.09	1.27	0.94
2010	6381	9098	4475	2953	3581	2435	358	1575	1.03	1.20	0.89
2011	2392	3479	1644	3868	4728	3165	341	3867	1.01	1.19	0.86
2012	4203	5989	2949	3900	4765	3192	227	1914	0.88	1.03	0.75
2013	7525	10797	5245	4022	4800	3369	266	1870	0.81	0.95	0.68
2014	6434	9179	4510	4992	5983	4164	394	3369	0.74	0.88	0.63
2015	5867	8451	4074	6227	7510	5163	528	2498	0.70	0.84	0.58
2016	2248	3229	1565	6581	7935	5458	609	1499	0.69	0.84	0.57
2017	2068	3016	1418	5895	7179	4841	675	3519	0.79	0.94	0.66
2018	1056	1652	675	3980	4901	3233	990	2429	0.89	1.10	0.73
2019	3928	6848	2253	2448	3112	1927	2060	204	1.00	1.34	0.75
2020	5005 **	22353	1121	2213	3304	1482					

\* BMS landings are included with discards from 2018 onwards.

\*\* Recruitment in 2020 is the assessment estimate. The value provided in Table 2 is the median from a normal distribution of the assessment estimate required for stochastic projections.

## 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>.

EU. 2019. Regulation (EU) 2019/472 of the European Parliament and of the Council of 19 March 2019 establishing a multiannual plan for stocks fished in the Western Waters and adjacent waters, and for fisheries exploiting those stocks, amending Regulations (EU) 2016/1139 and (EU) 2018/973, and repealing Council Regulations (EC) No 811/2004, (EC) No 2166/2005, (EC) No 388/2006, (EC) No 509/2007 and (EC) No 1300/2008. *Official Journal of the European Union*, L 83. 17 pp. <http://data.europa.eu/eli/reg/2019/472/oj>.

ICES. 2019. Advice basis. In *Report of the ICES Advisory Committee, 2019. ICES Advice 2019*, section 1.2. <https://doi.org/10.17895/ices.advice.5757>.

ICES. 2020a. Benchmark Workshop for Demersal Species (WKDEM). *ICES Scientific Reports*, 2:31. 136 pp. <http://doi.org/10.17895/ices.pub.5548>.

ICES. 2020. Working Group for the Celtic Seas Ecoregion (WGCSE). Draft report. *ICES Scientific Reports*, 2:40. Xx pp. <http://doi.org/10.17895/ices.pub.5978>. Publication of the full report is expected end of 2020.



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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