

Sole (*Solea solea*) in Subarea 4 (North Sea)

ICES advice on fishing opportunities

Please note: This advice was updated in May 2021 (ICES, 2021)

ICES advises that when the EU multiannual plan (MAP) for the North Sea is applied, catches in 2021 that correspond to the F ranges in the MAP are between 13 237 tonnes and 32 920 tonnes. According to the MAP, catches higher than those corresponding to F_{MSY} (21 361 tonnes) can only be taken under conditions specified in the MAP, whilst the entire range is considered precautionary when applying the ICES advice rule.

Stock development over time

The spawning-stock biomass (SSB) has fluctuated around B_{lim} since 2003, and has been estimated to be below $MSY B_{trigger}$ since 1999. Fishing mortality (F) has declined since 1999 and was above F_{MSY} in 2019. Recruitment in 2019 is estimated to be the highest since the start of the series in 1957.

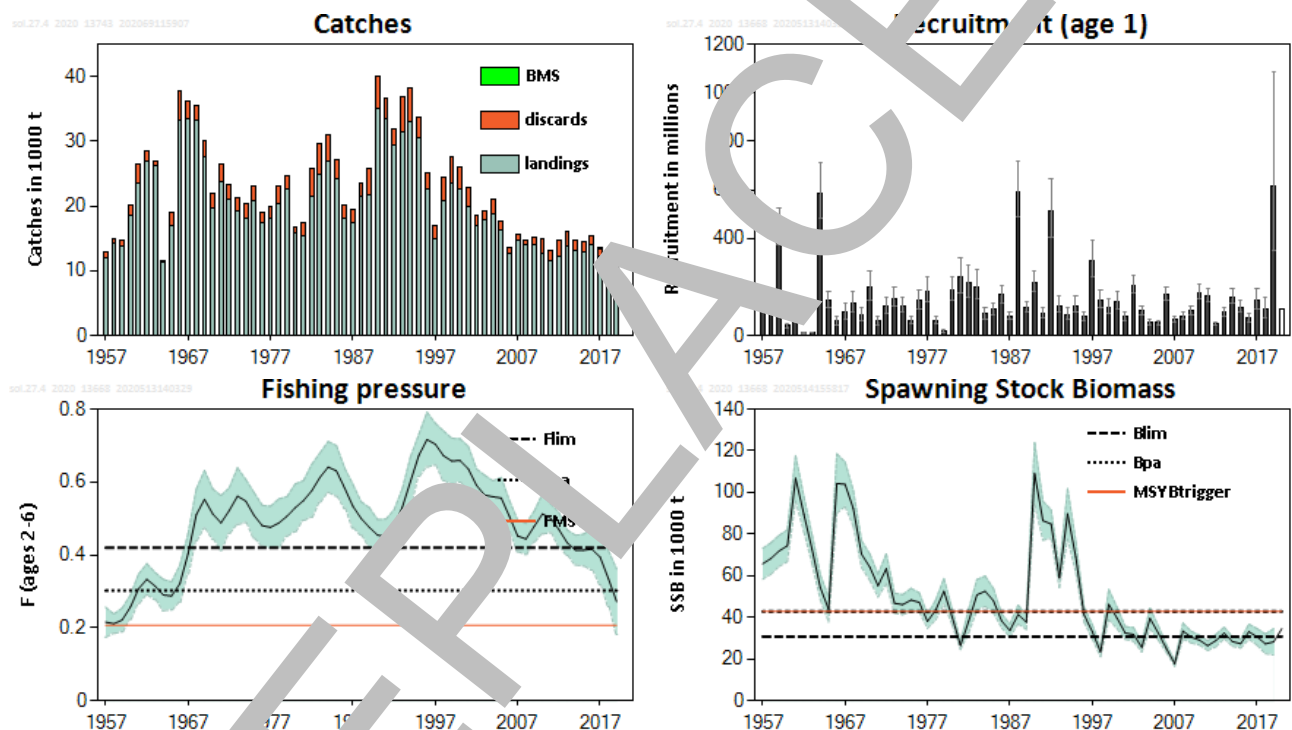


Figure 1 Sole in Subarea 4. Summary of the stock assessment. Estimates of discards are only available from 2002. Shaded areas (green and orange) indicate approximately 95% confidence intervals. Landings below minimum conservation reference size (BMS), are those officially reported.

Stock and exploitation status

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

Table 1 Sole in Subarea 4. 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 sustainably		B_{pa}, B_{lim}	✗	○ Increased risk
Management plan	F_{MGT}	✗	✓	✓ Within range		B_{MGT}	✗	✗ Below

Catch scenarios

Table 2 Sole in Subarea 4. Assumptions made for the interim year and in the forecast. Weights are in tonnes, recruitment is in thousands.

Variable	Value	Notes
$F_{ages\ 2-6}$ (2020)	0.26	The fishing mortality that corresponds to a catch in 2020 equal to 2020 TAC.
SSB (2021)	88012	Short-term forecast (STF).
$R_{age\ 1}$ (2020, 2021)	111481	Geometric mean (1957–2016).
Total catch (2020)	17545	Total allowable catch (TAC).
Projected landings (2020)	14680	STF, assuming average landings ratio by age 2017–2019.
Projected discards (2020)	2865	STF, assuming average discards ratio by age 2017–2019.

Table 3 Sole in Subarea 4. Annual catch scenarios. All weights are in tonnes.

Basis	Total catch * (2021)	Projected landings ** (2021)	Projected discards *** (2021)	F_{total} # (ages 2–6) (2021)	$F_{projected\ landings}$ (ages 2–6) (2021)	$F_{projected\ discards}$ (ages 1–6) (2021)	SSB (2022)	% SSB change ^	% TAC change ^^	% advice change ^^^
ICES advice basis										
EU MAP #: F_{MSY}	21361	19314	2047	0.207	0.174	0.042	86119	–2.2	22	22
$F = MAP\ F_{MSY\ lower}$	13237	11976	1261	0.123	0.103	0.025	93605	6.4	–25	30 ###
$F = MAP\ F_{MSY\ upper}$	32920	29736	3184	0.341	0.29	0.068	75496	–14.2	88	11 ###
Other scenarios										
MSY approach: F_{MSY}	21361	19314	2047	0.207	0.174	0.042	86119	–2.2	22	22
$F = 0$	0	0	0	0	0	0	105832	20	–100	–100
F_{pa}	29715	26849	2867	0.302	0.25	0.061	78438	–10.9	69	69
F_{lim}	39031	35235	3795	0.420	0.35	0.084	69896	–21	122	122
$SSB(2022) = B_{pa}$	68778	61878	6908	0.93	0.78	0.186	42838	–51	290	290
$SSB(2022) = B_{lim}$	85778	73755	8423	1.28	1.07	0.26	30828	–65	370	370
$SSB(2022) = MSY\ B_{trigger}$	58781	51873	5908	0.93	0.78	0.186	42838	–51	290	290
$F = F_{2020}$	25793	23313	2480	0.26	0.22	0.051	82042	–6.8	47	47
Rollover TAC	15868	15868	1677	0.167	0.14	0.033	89634	1.84	0	0

* Differences between the total catch and the sum of projected landings and discards result from rounding.

** Marketable landings.

*** Including MS landings, assuming recent discard rate.

^ SSB 2022 relative to SSB 2020.

^^ Total catch in 2021 relative to the TAC in 2020 (17 545 tonnes).

^^^ Total catch in 2021 relative to the advice value 2020 (17 545 tonnes).

EU multiannual plan (MAP) for the North Sea (EU, 2018).

$F_{projected\ landings}$ and $F_{projected\ discards}$ do not sum up to F_{total} as they are calculated using different ages.

This year's advice value for 2021 relative to last year's advice for 2020; $MAP\ F_{MSY\ lower}$ (10 192 tonnes) and $MAP\ F_{MSY\ upper}$ (29 767 tonnes).

The advice change is mainly due to the large 2018 year class. The stock was benchmarked in 2020, which revised the SSB downward and the biomass reference points upward.

Basis of the advice

Table 4 Sole in Subarea 4. The basis of the advice.

Advice basis	EU multiannual plan (MAP) for the North Sea (EU, 2018).
Management plan	The EU multiannual plan (MAP) for stocks in the North Sea and adjacent waters applies to this stock. The plan specifies conditions for setting fishing opportunities, depending on stock status and making use of the F_{MSY} range for the stock.
	In accordance with the MAP, catches higher than those corresponding to F_{MSY} can only be taken providing SSB is greater than $MSY B_{trigger}$, and one of the following conditions is met: a) if it is necessary for the achievement of mixed fisheries objectives; b) if it is necessary to avoid serious harm to a stock, caused by intra- or interspecies stock dynamics; c) in order to limit variations in fishing opportunities between consecutive years to not more than 20%.
	ICES considers that the F_{MSY} range used in the MAP for this stock is precautionary.

Quality of the assessment

The benchmark conducted in 2020 utilizes additional survey data, covering an important area of the stock distribution. This led to a downward revision of recent SSB estimates and an upward revision of F (ICES 2020a).

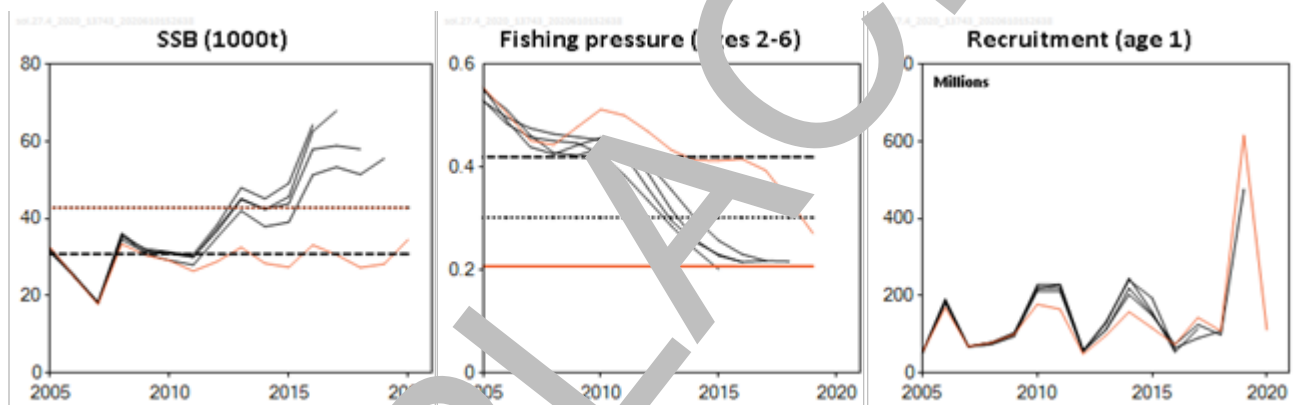


Figure 2 Sole in Subarea 4. Historical assessment results (final-year recruitment included for each line, corresponding to the forecast recruitment in the interim year).

Issues relevant for the advice

Between 2014 and 2019, the use of pulse trawls in the main fishery operating in the North Sea has increased and a fewer number of vessels now operate with traditional beam trawls. Pulse gear allows the fishing of softer grounds and the spatial distribution of the main fisheries has shifted to the southern part of Division 4.c. A larger proportion of the sole catch is now taken in this area (ICES, 2019). Following the EU decision in February 2019 to revise the technical measures regulations, pulse gear will be prohibited from 30 June 2021 and is now being phased out (EU, 2019).

Sole in Subarea 4 has fully been under the landing obligation since 2016, with *de minimis* exemptions in certain fisheries.

Below minimum conservation reference size (BMS) landings of sole reported to ICES are currently much lower than the estimates of discards, which in 2019 amounted to 18.3% of the total catch based on catch monitoring programmes, given the large 2018 year class.

An analysis of beam-trawl survey (BTS) data over the period 2000–2017 (Brunel and Verkempynck, 2018) shows that the stock distribution is expanding north of 56°N, up to the west coast of Denmark, particularly for sole larger than 24 cm.

Reference points

Table 5 Sole in Subarea 4. Reference points, values, and their technical basis. All weights are in tonnes.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	42838	Default to value of B_{pa} .	ICES (2020a)
	F_{MSY}	0.207	EQsim analysis, assuming a hockey-stick stock–recruit relationship, based on the recruitment period 1958–2018.	ICES (2020a)
Precautionary approach	B_{lim}	30828	Breakpoint of the hockey-stick stock–recruit relationship, based on the recruitment period 1958–2018.	ICES (2020a)
	B_{pa}	42838	$B_{lim} \times \exp(1.645 \times 0.2)$.	ICES (2020a)
	F_{lim}	0.420	EQsim analysis, based on the recruitment period 1958–2018.	ICES (2020a)
	F_{pa}	0.302	$F_{lim} \times \exp(-1.645 \times 0.2)$.	ICES (2020a)
EU management plan (MAP)*	MAP MSY $B_{trigger}$	42838	MSY $B_{trigger}$.	ICES (2020a)
	MAP B_{lim}	30828	B_{lim} .	ICES (2020a)
	MAP F_{MSY}	0.207	F_{MSY} .	ICES (2020a)
	MAP target range F_{lower}	0.123–0.207	Consistent with ranges provided by ICES (2020b), resulting in no more than 5% reduction in long-term yield compared with MSY.	ICES (2020a)
	MAP target range F_{upper}	0.207–0.341	Consistent with ranges provided by ICES (2020b), resulting in no more than 5% reduction in long-term yield compared with MSY.	ICES (2020a)

* EU multiannual plan (MAP) for the North Sea (EU, 2018).

Basis of the assessment

Table 6 Sole in Subarea 4. Basis of the assessment and advice.

ICES stock data category	1 (ICES, 2019).
Assessment type	Age-based analytical assessment (Purts and Jørgensen 1999; ICES, 2020a) that uses catches in the model and in the forecast.
Input data	Commercial catches (age frequencies from catch sampling), two survey indices (BTS combined [NL, DE, BE] Q3, SNS Q3). Natural mortality is assumed constant at 0.1 (except for 1963, when it was 0.9). Maturity-at-age is assumed to be knife-edged (at age 3) and constant over time.
Discards, BMS landings, and bycatch	Discard data from 2016 are included in the assessment; discards before 2002 are estimated by the model. In 2019, 99% of the landings had associated discarding information, and 90% of the discards were sampled. BMS landings, when reported, are included with discards in the assessment from 2016.
Indicators	None.
Other information	The stock was last benchmarked in 2020 (ICES, 2020a). The main change was the inclusion of a single index combining various BTS Q3 surveys (NL, DE, and BE; ICES, 2020a).
Working group	Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

Information from stakeholders

There is no additional information.

History of the advice, catch, and management

Table 7 Sole in Subarea 4. ICES advice, and ICES estimates of landings and discards reported to ICES. All weights are in tonnes.

Year	ICES advice	Landings corresponding to advice	Catch corresponding to advice	Agreed TAC	ICES landings	ICES discards	ICES catch
1987	Rebuild SSB to 40 000 t; TAC	11000		14000	17368		
1988	Increase SSB towards 50 000 t; TAC	11000		14000	21590		
1989	Increase SSB towards 50 000 t; TAC	14000		14000	21590		
1990	80% of F (88); TAC	25000		25000	25120		
1991	SSB > 50 000 t; TAC	27000		27000	33513		
1992	TAC	21000		25000	20341		
1993	No long-term gains in increased F	29000		32000	31170		
1994	No long-term gains in increased F	31000		32000	33002		
1995	No long-term gains in increased F	28000		30000	30467		
1996	Mixed fishery, link plaice advice	23000		23000	22651		
1997	< 80% of F (95)	14600		15000	14900		
1998	75% of F (96)	18100		19100	20388		
1999	$F < F_{pa}$ (80% of F (97))	20300		22000	20475		
2000	$F < F_{pa}$	< 19800		22000	22641		
2001	$F < F_{pa}$	< 17700		19000	19944		
2002	$F < 0.37$	< 14300		16000	16945	1712	18657
2003	$F < F_{pa}$	< 14600		15900	17920	1364	19284
2004	$F < F_{pa}$	< 17900		18000	18757	2181	20938
2005	$F < F_{pa}$	< 17300		18600	16355	1341	17696
2006	Keep SSB above B_{pa}	< 11900		17700	12594	994	13588
2007	SSB above B_{pa}	< 10800		15000	14635	871	15506
2008	SSB above B_{pa}	< 9800		12800	14071	545	14616
2009	Apply management plan	< 14000		14000	13952	1261	15213
2010	Apply management plan	< 14100		14100	12603	2246	14849
2011	See scenarios	-		14100	11485	1703	13188
2012	Apply first stage of the management plan	< 11900		16200	11602	2528	14130
2013	Apply first stage of the management plan	< 14000		14000	13137	2119	15256
2014	Apply first stage of the management plan	< 11900		11900	13060	1568	14628
2015	Apply second stage of the management plan	< 11400		11900	12867	1763	14630
2016	Apply second stage of the management plan		≤ 12800	13262	14127	1205 ^	15332 ^

Year	ICES advice	Landings corresponding to advice	Catch corresponding to advice	Agreed TAC	ICES landings	ICES discards	ICES catch
2017	Apply second stage of the management plan		≤ 15300	16123	12370	1246 ^	13616 ^
2018	Apply second stage of the management plan		≤ 15726	15694	11199	1056 ^	12255 ^
2019	MAP* F ranges: F_{lower} to F_{upper} ($F = 0.113 - 0.367$), but F higher than $F_{MSY} = 0.202$ only under conditions specified in the MAP		7451–21644, but catches greater than 12801 only under conditions specified in the MAP	12555	8611	1949 ^	10596 ^
2020	Management Plan		17545 (range 10192–29767)	17545			
2021	Management Plan		21361 (range 13237–32920)				

^ Since 2016, discards include BMS landings.

* EU multiannual plan (MAP) for the North Sea (EU, 2018).

History of the catch and landings

Table 8 Sole in Subarea 4. Catch distribution by fleet in 2019 as estimated by and reported to ICES.

Catch	Landings				Discards
	Beam trawl	Gillnets	Trammelnets	Other	
10596 tonnes	94%	2.0%	1.5%	2.5%	1949 tonnes

Table 9 Sole in Subarea 4. History of landings; the official reported landings are presented by country and total. Official reported BMS landings, ICES estimated landings, and the TAC are presented. All weights are in tonnes.

Year	Belgium	Denmark	France	Germany	Netherlands	UK	Other	Total landings	Official BMS landings	ICES total landings	TAC
1982	1900	524	686	266	7686	73	2	21467		21579	21000
1983	1740	730	332	219	10114	135	0	19957		24927	20000
1984	1771	818	400	1034	14330	586	1	18940		26839	20000
1985	2390	692	875	303	14897	774	3	19934		24248	22000
1986	1833	443	296	155	9558	647	2	12934		18201	20000
1987	1644	342	118	177	10635	676	4	13829		17368	14000
1988	1199	616	487	43	9841	740	28	13363		21590	14000
1989	1596	1020	312	864	9620	1033	50	14495		21805	14000
1990	2389	1421	352	2296	18202	1614	263	26543		35120	25000
1991	2977	1307	422	2107	18758	1723	271	27608		33513	27000
1992	2058	1359	448	1130	18601	1281	277	26004		29341	25000
1993	2783	1111	411	1379	22015	1149	298	29775		31491	32000
1994	2935	1800	499	1744	22874	1137	298	31291		33002	32000
1995	2674	1671	640	1564	20927	1040	312	28780		30467	28000
1996	2157	1118	533	670	15344	848	229	21199		22651	23000
1997	1519	689	99	510	10241	479	204	13741		14901	18000
1998	1844	520	510	782	15198	549	339	19742		20868	19100
1999	1919	811	NA	1458	16283	645	501	21634*		23475	22000
2000	1806	1069	362	1280	15273	600	539	20929		22641	22000
2001	1874	772	411	958	13345	597	394	18351		19944	19000
2002	1437	644	266	759	12120	451	292	15969		16945	16000
2003	1605	703	728	749	12469	521	363	17138		17920	15850
2004	1477	808	655	949	12860	535	544	17828		18757	17000
2005	1374	831	676	756	10917	667	357	15579		16355	18600
2006	980	585	648	475	8299	910	0	11933		12594	17670
2007	955	413	401	458	10365	1203	5	13800		14635	15000

Year	Belgium	Denmark	France	Germany	Netherlands	UK	Other	Total landings	Official BMS landings	ICES total landings	TAC
2008	1379	507	714	513	9456	851	15	13435		14071	12800
2009	1353	476	NA	555	12038	951	1	14898*		13952	14000
2010	1268	406	621	537	8770	526	1.38	12129		12603	14100
2011	857	346	539	327	8133	786	2	10990		11485	14100
2012	593	418	633	416	9089	599	3	11752		11602	16200
2013	697	497	680	561	9987	867	0	13291		13137	14000
2014	920	314	675	642	9569	840	0	12547		13060	11900
2015	933	271	532	765	8899	804	0	12203		12867	11900
2016	767	355	362	861	9600	705	0	12651	NA	14127	13262
2017	556	432	393	731	9155	513	0	11781	30	12370	16123
2018	408**	368**	432**	717**	8412**	431**	2**	10771**	57**	11199	15694
2019	253**	109**	107**	619**	6914**	332**	1**	8300**	100**	8647	12555

* These totals do not include reported official landings of all countries.

** Preliminary reported official landings.

NA = not available.

Summary of the assessment

Table 10 Sole in Subarea 4. Assessment summary. Recruitment in thousands, weights are in tonnes. High and low are 2 standard errors (approximately 95% confidence intervals).

Year	Recruitment			Spawning-stock biomass			Landings [§]	Discards [§] ^	Official BMS landings	Catch [§] ^	Fishing mortality		
	(Age 1)	High	Low	SSB	High	Low					F (ages 2–6)	High	Low
	thousands			tonnes									
1957	137861	161700	117536	65708	73097	58319	12067	742		12809	0.22	0.26	0.175
1958	121783	143354	103459	68255	75807	60703	14287	737		15024	0.21	0.24	0.185
1959	442856	525435	373255	71937	79398	64476	13832	965			0.22	0.25	0.189
1960	40095	47724	33685	74376	81994	66758	18620	1495		20115	0.26	0.29	0.22
1961	67037	79425	56581	106790	117686	95894	23566	2801		26367	0.31	0.35	0.27
1962	10553	12542	8880	89594	98061	81127	26877	1526		28403	0.31	0.38	0.29
1963	12372	14657	10443	72662	79595	65729	26164	753		26917	0.31	0.35	0.28
1964	583617	708784	480554	54407	60461	48353	11342	303		11645	0.29	0.33	0.25
1965	146825	184344	116943	43843	49859	37827	17043	185		17155	0.29	0.33	0.25
1966	59219	77530	45233	104300	118529	90071	33340	1653		37695	0.32	0.37	0.27
1967	96568	133907	69640	103920	114599	93241	33439	2632		36071	0.40	0.46	0.35
1968	131663	183843	94293	92302	100915	83689	33179	2332		3111	0.51	0.58	0.44
1969	85905	117844	62623	70390	76841	63939	27559	260		10179	0.55	0.63	0.47
1970	197996	268166	146187	64146	70484	57808	19660	2295		21979	0.51	0.58	0.44
1971	57989	77934	43148	55203	60645	49761	10552	2754		26406	0.49	0.56	0.41
1972	118302	158809	88128	63402	70549	56255	21087	2285		23372	0.52	0.58	0.46
1973	153584	198924	118577	46796	51593	41999	19308	1982		21290	0.56	0.64	0.48
1974	120934	154591	94604	46126	50905	41347	17990	2380		20370	0.55	0.61	0.49
1975	61023	77397	48113	48319	53931	42707	17773	2219		22991	0.51	0.57	0.45
1976	145365	189332	111607	47220	51810	42630	17511	1457		19052	0.48	0.54	0.42
1977	182225	239613	138582	38075	41407	34743	18003	1974		19977	0.48	0.53	0.42
1978	62380	80881	48111	43552	48318	37800	20280	2851		23131	0.49	0.55	0.42
1979	17166	22053	13362	52569	58660	44778	22390	2139		24737	0.51	0.56	0.45
1980	187025	244053	143324	40157	43892	36300	15806	1024		16830	0.53	0.59	0.46
1981	239187	322707	177283	26510	28485	24550	15403	1933		17336	0.55	0.60	0.49
1982	215561	289879	160296	38237	43923	32551	21578	4096		25674	0.58	0.65	0.50
1983	200787	269531	149576	50830	58152	43508	24927	4655		29582	0.61	0.68	0.55
1984	90219	116534	69847	52550	59836	45276	26839	4180		31019	0.64	0.71	0.57
1985	106404	134699	84053	48079	52904	42250	24248	2854		27102	0.63	0.70	0.56
1986	166542	208247	133188	41111	44977	34000	18201	1909		20110	0.58	0.64	0.53
1987	79858	98985	64426	33660	36785	27443	17368	2156		19524	0.53	0.59	0.47
1988	590072	715907	486350	41407	45923	36891	21590	2027		23617	0.50	0.55	0.45
1989	114234	137626	94604	37700	41217	34213	21804	3891		25695	0.48	0.53	0.42
1990	219916	265659	182049	106600	123801	94319	35121	4869		39990	0.45	0.50	0.41
1991	92503	113065	65681	42300	95778	77068	33514	3182		36696	0.45	0.50	0.40
1992	511959	648204	404352	84000	91690	77982	29341	2554		31895	0.48	0.52	0.43
1993	123624	161200	94767	58907	63579	54235	31491	5248		36739	0.53	0.58	0.48
1994	86769	111009	66700	89759	101749	77769	33002	5226		38228	0.60	0.67	0.54
1995	123871	160000	94032	61014	76506	61322	30468	3165		33633	0.67	0.73	0.62
1996	78042	99854	60995	41323	44929	37717	22650	2368		25018	0.72	0.79	0.64
1997	307122	377777	237036	33050	36507	29593	14902	2052		16954	0.70	0.76	0.65
1998	146500	180002	113900	23418	25734	21102	20867	3467		24334	0.67	0.74	0.60
1999	111095	140068	92210	46230	53439	39021	23475	4001		27476	0.66	0.72	0.60
2000	100775	126006	76006	39662	44800	34524	22641	3299		25940	0.66	0.72	0.60
2001	70001	87390	63292	32500	35564	29436	19944	2917		22861	0.64	0.70	0.57
2002	207100	248188	172829	31836	35092	28580	16946	1712		18658	0.59	0.64	0.55
2003	101722	123239	83962	25627	27911	23343	17921	1364		19285	0.56	0.62	0.51
2004	53263	60002	43874	39527	44395	34659	18757	2181		20938	0.56	0.60	0.52
2005	52945	62827	44616	32541	35976	29106	16355	1341		17696	0.56	0.61	0.50
2006	168721	199634	142594	24973	26813	23133	12594	994		13588	0.51	0.55	0.46
2007	68460	80930	57911	17824	19184	16464	14635	871		15506	0.45	0.50	0.41
2008	78276	94182	65057	33437	37264	29610	14071	545		14616	0.44	0.49	0.40
2009	100208	121311	82776	30520	33331	27709	13952	1261		15213	0.48	0.52	0.44
2010	177726	209731	150606	29091	31441	26741	12603	2246		14849	0.51	0.57	0.46
2011	165049	191842	141999	26402	28693	24111	11485	1703		13188	0.50	0.54	0.46
2012	48825	57044	41790	28880	31875	25885	12168	2528		14696	0.47	0.52	0.42

Year	Recruitment			Spawning–stock biomass			Landings\$	Discards \$ ^	Official BMS landings	Catch \$ ^	Fishing mortality		
	(Age 1)	High	Low	SSB	High	Low					F (ages 2–6)	High	Low
	thousands			tonnes			tonnes						
2013	97246	115305	82015	32536	35299	29773	13839	2119		15958	0.43	0.47	0.40
2014	158261	190536	131453	28413	30722	26104	13072	1568		14640	0.41	0.45	0.37
2015	116658	142963	95193	27390	29525	25255	12827	1763		14590	0.41	0.46	0.37
2016	73350	93157	57755	33144	36753	29535	14118	1205		15323	0.42	0.47	0.36
2017	143487	193242	106543	30612	34576	26648	12327	1216*	30	13573	0.39	0.47	0.32
2018	108662	156073	75654	27298	32018	22578	11209	999*	57	12265	0.33	0.41	0.26
2019	615999	1082734	350459	28244	34549	21939	8658	1901*	48	10607	0.27	0.36	0.182
2020	111481**			34569***									

* Since 2017, discards minus BMS landings from EU fleets officially reported in logbooks.

** Geometric mean (1957–2016).

*** From the short-term forecast.

$\S$ Catches presented are the sum of product (SOP) values from catch and weight-at-age used in the assessment model.

^ Since 2002, discard estimates are raised from the observer programme. Discards prior to 2002 are reconstructed by the model.

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