

Sole (*Solea solea*) in subdivisions 20–24 (Skagerrak and Kattegat, western Baltic Sea)

ICES stock advice

ICES advises that when the MSY approach is applied, catches in 2018 should be no more than 453 tonnes.

Stock development over time

Spawning-stock biomass (SSB) has been fluctuating between MSY $B_{trigger}$ and B_{lim} since 2008 and is estimated to be below MSY $B_{trigger}$ in 2017. Fishing mortality (F) has decreased since 2005 and has been below F_{MSY} since 2010. After a series of low recruitment years the 2013 and 2014 year classes are estimated to remain below the average of the time-series.

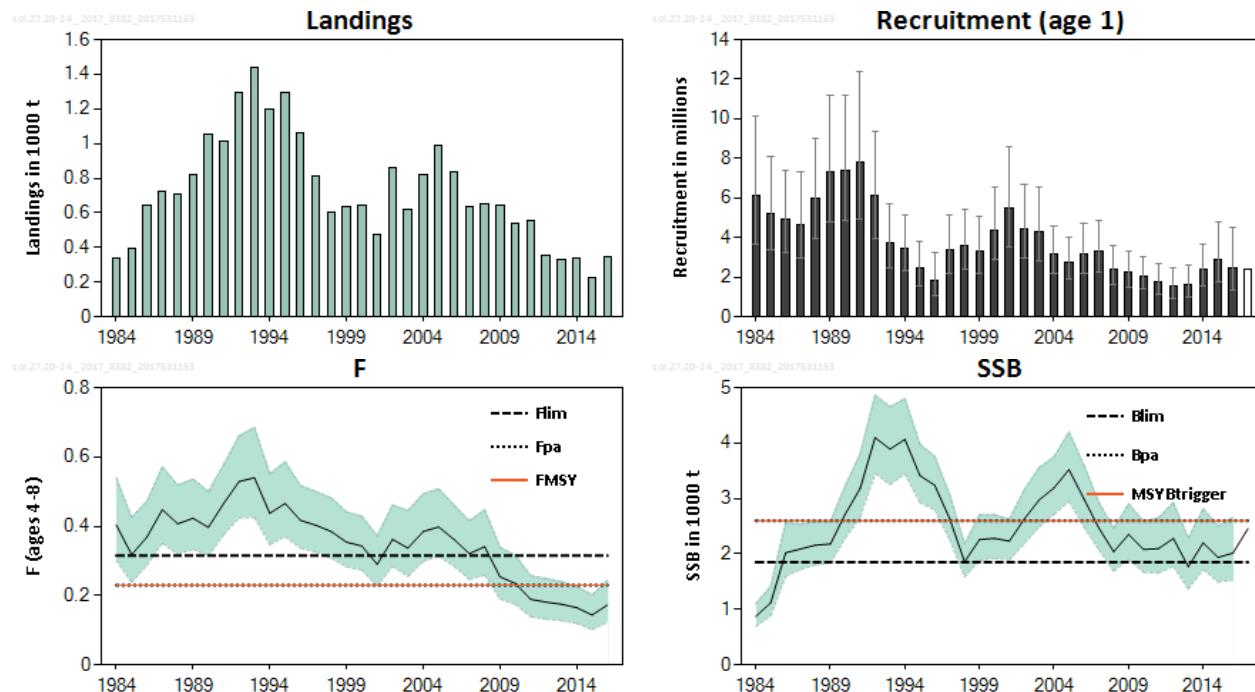


Figure 1 Sole in subdivisions 20–24. Summary of the stock assessment (weights in thousand tonnes). 95% confidence limits indicated for recruitment, fishing mortality, and spawning-stock biomass. Predicted values are unshaded.

Stock and exploitation status

Table 1 Sole in subdivisions 22–24. 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}	✓	✓	✓	Below	MSY
Precautionary approach	F_{pa} , F_{lim}	✓	✓	✓	Harvested sustainably	$B_{trigger}$
Management plan	F_{MGT}	-	-	-	Not applicable	B_{pa}, B_{lim}
						SSB_{MGT}

Catch options

Table 2 Sole in subdivisions 20–24. The basis for the catch options.

Variable	Value	Source	Notes
$F_{ages\ 4-8}$ (2017)	0.17	ICES (2017)	F_{sq} (F2016).
SSB (2018)	2741	ICES (2017)	When fishing at F_{sq} (0.17) in 2017. In tonnes.
R_{age1} (2017–2018)	2392	ICES (2017)	Sampling from recruitment (2012–2016). In thousands.
Landings (2017)	291	ICES (2017)	In tonnes.
Discards (2017)	4.0%	ICES (2017)	Mean (2012–2016) discard rate in weight.
Total catch (2017)	303	ICES (2017)	Landings corresponding to F_{sq} incl. discards. In tonnes.

Table 3 Sole in subdivisions 20–24. Annual catch options. All weights are in tonnes.

Basis	Total catch (2018)*	Wanted catch** (2018)	Unwanted catch** (2018)	F_{wanted} (2018)	SSB (2019)	% SSB change ***	% TAC change^
ICES advice basis							
MSY approach: F_{MSY}	453	436	17	0.23	2811	2.6	-21
Other options							
$F = 0$	0	0	0	0	3273	19	-100
F_{pa}	453	436	17	0.23	2811	2.6	-21
F_{lim}	598	575	23	0.32	2668	-2.7	3.6
SSB (2019) = B_{lim}	1452	1367	56	0.99	1850	-33	146
SSB (2019) = B_{pa}	680	640	26	0.36	2600	-5.1	15.3
SSB (2019) = MSY $B_{trigger}$	680	640	26	0.36	2600	-5.1	15.3
$F = F_{2017}$	382	336	15	0.17	2919	6.5	-39

* Total catch is calculated based on wanted catch (fish that would be landed in the absence of the EU landing obligation) and 4% discard rate (in weight).

** "Wanted" and "unwanted" catch are used to describe fish that would be landed and discarded in the absence of the EU landing obligation, based on discard rate estimates for 2012–2016.

*** SSB 2019 relative to SSB 2018.

^ Wanted catch in 2018 relative to TAC in 2017 (555 t).

Basis of the advice

Table 4 Sole in subdivisions 20–24. The basis of the advice.

Advice basis	MSY approach.
Management plan	ICES is not aware of any agreed precautionary management plan for sole in this area.

Quality of the assessment

Sufficient biological sampling of landings is difficult to obtain from the mixed fisheries, where sole is caught as a valuable by-catch. This is due to the low total sole landings that are spatially dispersed. In recent years the mixed trawl fisheries has mainly targeted *Nephrops* due to high market prices, resulting in less effort on the traditional sole fishing grounds. With continued low landings of sole in 2016, this affects the quality of the input data, including the weight-at-age.

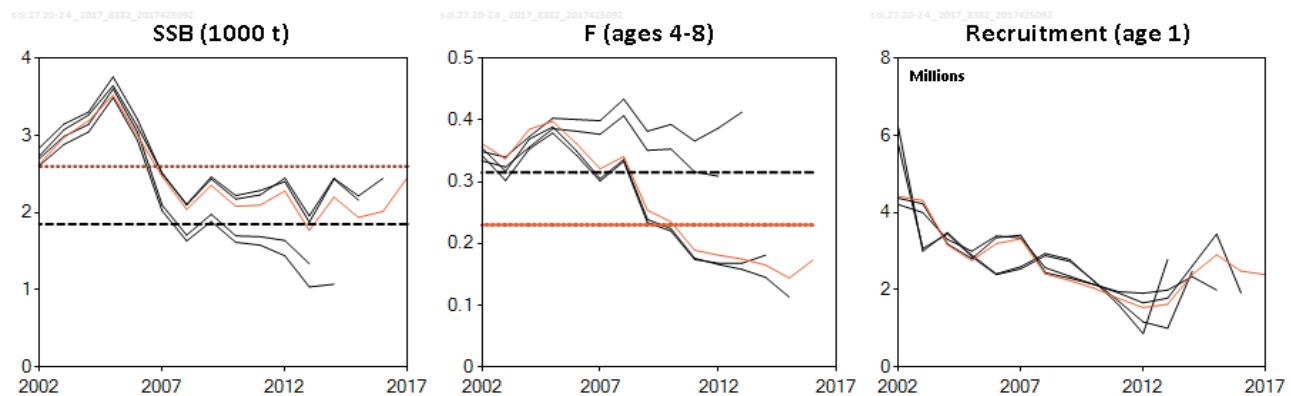


Figure 2 Sole in subdivisions 20–24. Historical assessment results (final-year recruitment estimates included). Recruitment age in the assessment has changed from two to one following the inter-benchmark in 2015 (ICES, 2015).

Issues relevant for the advice

There are no issues.

Reference points

Table 5 Sole in subdivisions 20–24. Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	2600 t	B_{pa}	ICES (2015)
	F_{MSY}	0.23	Equilibrium scenarios stochastic recruitment, short time-series 1992–2014, constrained by F_{pa} .	ICES (2015)
Precautionary approach	B_{lim}	1850 t	B_{loss} from 1992 (low productivity regime).	ICES (2015)
	B_{pa}	2600 t	$B_{lim} \times e^{1.645\sigma}, \sigma = 0.20$	ICES (2015)
	F_{lim}	0.315	Equilibrium scenarios prob(SSB < B_{lim}) < 50% with stochastic recruitment.	ICES (2015)
	F_{pa}	0.23	$F_{lim} \times e^{-1.645\sigma}, \sigma = 0.18$	ICES (2015)
Management plan	SSB_{MGT}	Not defined.		
	F_{MGT}	Not defined.		

Basis of the assessment

Table 6 Sole in subdivisions 20–24. Basis of the assessment and advice.

ICES stock data category	1 (ICES, 2016).
Assessment type	Age-based analytical stochastic assessment (SAM) that uses landings only in the model. Discards are included afterwards in the forecast (ICES, 2017).
Input data	Commercial catches (international landings, ages and length frequencies from catch sampling), one survey index (Fishermen–DTU Aqua 2004–2016), two commercial indices: (private logbook gillnetters (1994–2007), private logbook trawlers (1987–2008)); fixed maturity and fixed natural mortality (0.1) for all age groups.
Discards and bycatch	Used to provide advice, but not included in the assessment. Discard information available since 2000, average discard rates 2012–2016 are 4%.
Indicators	None.
Other information	Stock inter-benchmarked in 2015 (ICES, 2015).
Working group	Baltic Fisheries Assessment Working Group (WGBFAS)

Information from stakeholders

There is no additional available information for this stock.

History of the advice, catch, and management

Table 7 Sole in subdivisions 20–24. History of ICES advice, the agreed TAC, and ICES estimates of landings/discard. Weights are in tonnes.

Year	ICES advice	Predicted catch corresp. to advice	Predicted landings corresp. to advice	Agreed TAC*	ICES landings**	ICES discards***
1987	-	-	-	850	722	-
1988	-	-	-	950	706	-
1989	TAC	-	< 800	800	824	-
1990	Precautionary TAC	-	600	500	1050	-
1991	TAC	-	1000	1000	-^	-
1992	TAC	-	1000	1400	-^	-
1993	TAC at recent catch levels	-	1000	1600	-^	-
1994	No advice due to uncertain catches	-	-	2100	1198	-
1995	No advice	-	-	2250	1297	-
1996	No advice	-	-	2250	1059	-
1997	No advice	-	-	2250	814	-
1998	No advice	-	-	1800	605	-
1999	No increase in F	-	800	1350	637	-
2000	No increase in F	-	650	950	645	169
2001	No increase in F	-	700	700	478	-
2002	F below F_{pa}	-	500	500	862	10
2003	F below F_{pa}	-	300	350	618	43
2004	F below F_{pa}	-	500	520	824	-
2005	No increase in F	-	850	900	990	-
2006	F below F_{pa}	-	820	900	836	-
2007	Limit catches to 2002–2005 average	-	740	900	633	-
2008	F below F_{pa}	-	970	940	655	-
2009	F below F_{pa}	-	800	800	641	-
2010	F below F_{pa}	-	620	700	538	14
2011	See scenarios	-	-	840	552	8
2012	MSY framework	-	610	0.61^^	358	11
2013	MSY framework	-	560	590	332	10
2014	MSY approach	353	353^^^	350	335	32
2015	MSY approach	211	205	205	224	6
2016	MSY approach	≤ 394	379	391	348	17
2017	MSY approach	≤ 555	-	555		
2018	MSY approach	≤ 453	-			

*TAC applies to subdivisions 20–21 and the EC waters of subdivisions 22–32.

**Landings include subdivisions 20–21 and subdivisions 22–24.

***Discard estimates are not available for all years.

^ Uncertain.

^^ No more than 461 t in subdivisions 20–21.

^^^ Discarding assumed to be negligible.

History of the catch and landings

Table 8 Sole in subdivisions 20–24. Catch distribution by fleet in 2016 as estimated by ICES.

Catch (2016)		Official landings					Discards	
365 tonnes		Active gears 61%			Passive gears 39%			17 tonnes
		348 tonnes						

Table 9 Sole in subdivisions 20–24. History of commercial landings by country and area. Weights are in tonnes.

Year	Denmark			Sweden	Germany	Belgium	Netherlands	Norway	Total official landings	ICES estimated landings
	Kattegat	Skagerrak	Belts							
1952	156			51	59				266	266
1953	159			48	42				249	249
1954	177			43	34				254	254
1955	152			36	35				223	223
1956	168			30	57				255	255
1957	265			29	53				347	347
1958	226			35	56				317	317
1959	222			30	44				296	296
1960	294			24	83				401	401
1961	339			30	61				430	430
1962	356				58				414	414
1963	338				27				365	365
1964	376				45				421	421
1965	324				50				374	374
1966	312				20				332	332
1967	429				26				455	455
1968	290				16				306	306
1969	261				7				268	268
1970	158	25							183	183
1971	242	32			9				283	283
1972	327	31			12				370	370
1973	260	52			13				325	325
1974	388	39			9				436	436
1975	381	55		16	16	9			477	468
1976	367	34		11	21	2	155		590	435
1977	400	91		13	8	1	276		789	513
1978	336	141		9	9	141			636	495
1979	301	57		8	6	1	84		457	373
1980	228	73		9	12	2	5		329	324
1981	199	59		7	16	1			282	282
1982	147	52		4	8	1	1		213	212
1983	180	70		11	15		31		307	276
1984	235	76		13	13		54		391	337
1985	275	102		19	1	+	132		529	397
1986	456	158		26	1	2	109		752	643
1987	564	137		19		2	70		792	722
1988	540	138		24		4			706	706
1989	578	217		21	7	1			824	824
1990	464	128		29		2			623	1050
1991*	746	216		38	+				1000	1011
1992	856	372		54					1282	1294

Year	Denmark			Sweden	Germany	Belgium	Netherlands	Norway	Total official landings	ICES estimated landings
	Kattegat	Skagerrak	Belts							
1993	1016	355		68	9				1448	1439
1994	890	296		12	4				1202	1198
1995	850	382		65	6				1303	1297
1996	784	203		57	612				1656	1059
1997	560	200		52	2				814	814
1998	367	145		90	3				605	605
1999	431	158		45	3				637	637
2000	399	320	13	34	11				777	645
2001	249	286	21	25					581	478
2002**	360	177	18	15	11				581	862
2003**	195	77	17	11	17				317	618
2004**	249	109	40	16	18				432	824
2005**	531	132	118	30	34				845	990
2006	521	114	107	38	43		4	9	836	836
2007	366	81	93	45	39		0	9	633	633
2008	361	102	113	34	35		3	7	655	655
2009	325	103	145	37	27			4	641	641
2010	273	61	125	46	26		3	3	537	538
2011	271	127	65	53	33			3	552	552
2012	154	140	28	30				6	358	358
2013	153	78		54	9			6	300	332
2014	141	104	48	36	2		0.3	3	335	335
2015	95	66	36	9	7		6	5	224	224
2016	164	78	56	14	17		16	2	348	348

*Considerable non-reporting assumed for the period 1991–1993.

**Assuming misreporting rates at 50%, 100%, 100%, and 20% in 2002–2005, respectively.

Summary of the assessment

Table 10 Sole in subdivisions 20–24. Assessment summary. Weights are in tonnes. Recruitment in thousands. High and low refers to 95% confidence intervals.

Year	Recruitment (Age 1)	High	Low	SSB	High	Low	Landings	F (Ages 4–8)	High	Low
1984	6103	10155	3667	873	1100	692	337	0.40	0.54	0.30
1985	5236	8074	3395	1122	1424	885	397	0.32	0.43	0.24
1986	4893	7409	3231	2021	2559	1596	643	0.37	0.47	0.29
1987	4679	7327	2988	2090	2535	1723	722	0.45	0.57	0.35
1988	5949	8982	3940	2160	2587	1803	706	0.41	0.52	0.32
1989	7328	11155	4814	2179	2584	1837	824	0.42	0.54	0.33
1990	7378	11179	4870	2719	3230	2288	1050	0.40	0.50	0.32
1991	7810	12375	4928	3186	3806	2667	1011	0.47	0.58	0.38
1992	6099	9386	3963	4099	4866	3453	1294	0.53	0.66	0.42
1993	3756	5679	2485	3889	4651	3252	1439	0.54	0.69	0.43
1994	3454	5165	2310	4067	4802	3444	1198	0.44	0.55	0.35
1995	2435	3819	1552	3415	3980	2930	1297	0.47	0.59	0.37
1996	1839	3248	1041	3239	3758	2792	1059	0.42	0.52	0.34
1997	3349	5104	2197	2636	3068	2264	814	0.40	0.50	0.33
1998	3596	5396	2397	1859	2182	1583	605	0.39	0.48	0.31
1999	3318	5078	2168	2260	2706	1887	637	0.35	0.44	0.28

Year	Recruitment (Age 1)	High	Low	SSB	High	Low	Landings	F (Ages 4–8)	High	Low
2000	4375	6561	2917	2282	2706	1924	645	0.34	0.43	0.27
2001	5499	8549	3538	2231	2629	1892	478	0.29	0.37	0.23
2002	4422	6652	2939	2629	3155	2190	862	0.36	0.46	0.29
2003	4317	6569	2837	2975	3560	2485	618	0.34	0.45	0.26
2004	3164	4585	2183	3191	3751	2715	824	0.39	0.49	0.30
2005	2753	4046	1873	3522	4200	2954	990	0.40	0.51	0.31
2006	3199	4697	2179	2996	3601	2492	836	0.36	0.46	0.29
2007	3318	4885	2254	2469	2933	2078	633	0.32	0.42	0.25
2008	2409	3590	1617	2041	2462	1692	655	0.34	0.45	0.26
2009	2237	3296	1519	2354	2905	1908	641	0.25	0.34	0.190
2010	2039	3010	1381	2082	2590	1673	538	0.24	0.32	0.175
2011	1774	2697	1167	2097	2653	1657	552	0.189	0.26	0.139
2012	1537	2485	950	2280	2927	1777	358	0.181	0.25	0.132
2013	1624	2615	1009	1770	2287	1370	332	0.175	0.24	0.128
2014	2392	3670	1559	2200	2816	1719	335	0.165	0.23	0.120
2015	2906	4770	1770	1938	2508	1498	224	0.144	0.20	0.102
2016	2484	4540	1359	2016	2662	1527	348	0.173	0.24	0.123
2017	2392*			2457						
Average	3825	5962	2515	2510	3036	2080	724	0.35	0.45	0.27

* Estimated from the period 2012–2016.

Sources and references

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