

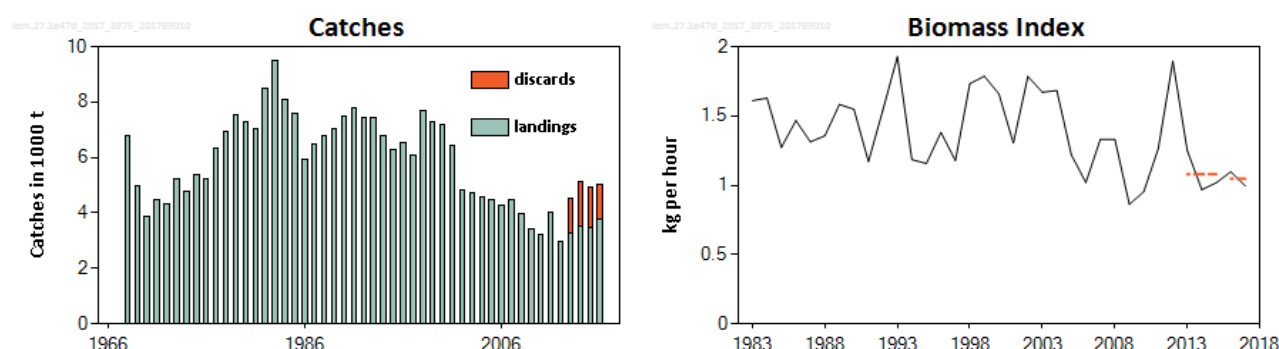
## Lemon sole (*Microstomus kitt*) in Subarea 4 and divisions 3.a and 7.d (North Sea, Skagerrak and Kattegat, eastern English Channel)

### ICES stock advice

ICES advises that when the precautionary approach is applied, catches should be no more than 5484 tonnes in each of the years 2018 and 2019. If discard rates do not change from the average of the last three years (2014–2016), this implies landings of no more than 3924 t in each of the years 2018 and 2019.

### Stock development over time

The biomass index (IBTS Q1 SSB per hour) has fluctuated without significant trend since the mid-1980s. Landings have mostly decreased since the early 1980s, with a small increase in recent years. The discard rate is similar over the four years for which estimates are available.

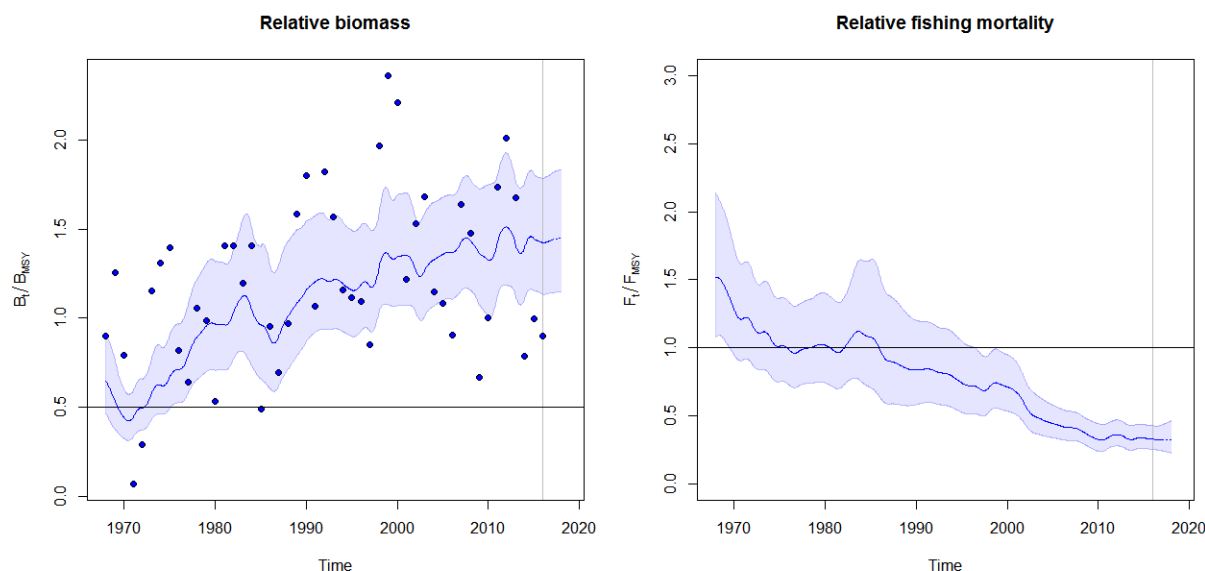


**Figure 1** Lemon sole in Subarea 4 and divisions 3.a and 7.d. Summary of the stock assessment. Left: Official landings (1983–2012), and ICES estimated landings and discards (2013–2016; tonnes). The discard estimate for 2012 was based on very low sample rates from few countries, and is not thought to be reliable. Official landings for 2012 are low because some data were not submitted. Right: Abundance indices (trend in catch per unit effort since 1966 ( $\text{kg h}^{-1}$ ) from IBTS Q1), including horizontal lines showing the DLS 3.2 decision rule.

### Stock and exploitation status

**Table 1** Lemon sole in Subarea 4 and divisions 3.a and 7.d. State of the stock and fishery relative to reference points. The fishing pressure and stock size status indicators are based on the SPiCT analyses shown in Figure 2.

		Fishing pressure				Stock size		
		2014	2015	2016		2015	2016	2017
Maximum sustainable yield	$F_{\text{MSY}}$ proxy	✓	✓	✓ Below		$\text{MSY } B_{\text{trigger}}$ proxy	✓	✓ Above trigger
Precautionary approach	$F_{\text{pa}}, F_{\text{lim}}$	✓	✓	✓ Below possible reference points		$B_{\text{pa}}, B_{\text{lim}}$	✓	✓ Above possible reference points
Management plan	$F_{\text{MGT}}$	—	—	— Not applicable		$B_{\text{MGT}}$	—	— Not applicable



**Figure 2** Lemon sole in Subarea 4 and divisions 3.a and 7.d. SPiCT analysis showing exploitable biomass relative to  $B_{MSY}$  and fishing mortality relative to  $F_{MSY}$ . The symbols in the relative biomass plot indicate observed biomass indices (blue dots = IBTS Q1) while the shaded areas in both plots indicate 95% confidence intervals. The horizontal lines indicate levels relative to the  $F_{MSY}$  and  $MSY B_{trigger}$  proxies. A subset of the IBTS Q1 index (Dutch and Scottish surveys only) is used for the SPiCT analysis, which differs from the full IBTS used for the index ratio in Table 2.

### Catch options

The ICES framework for category 3 stocks was applied (ICES, 2012). The IBTS Q1 survey (SSB per hour,  $kg h^{-1}$ ) was used as the index of stock development. The advice is based on a comparison of the two latest index values (index A) with the three preceding values (index B), multiplied by the recent (advised catch). The index is estimated to have decreased by less than 20% and thus the uncertainty cap was not applied.

The Surplus Production in Continuous Time (SPiCT; Pedersen and Berg, 2017) analysis suggests that fishing mortality is below and stock size above proxies of the MSY reference points (Figure 2); therefore, no additional precautionary buffer was applied.

**Table 2** Lemon sole in Subarea 4 and divisions 3.a and 7.d. The basis for the catch options.\*

Index A (2016–2017)	1.05 $kg h^{-1}$	
Index B (2013–2015)	1.08 $kg h^{-1}$	
Index ratio (A/B)	0.97	
Uncertainty cap	Not applied	-
Advised catch for 2016–2017	5655 tonnes	
Discard rate (2014–2016)	28.44%	
Precautionary buffer	Not applied	-
Catch advice**	5484 tonnes	
Landings corresponding to the catch advice***	3924 tonnes	

\*The figures in the table are rounded. Calculations were done with unrounded inputs and computed values may not match exactly when calculated using the rounded figures in the table.

\*\* [Advised catch for 2016–2017]  $\times$  [index ratio].

\*\*\* [Advised catch for 2016–2017]  $\times$  [index ratio]  $\times$  [1 – discard rate].

### Basis of the advice

**Table 3** Lemon sole in Subarea 4 and divisions 3.a and 7.d. The basis of the advice.

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

## Quality of the assessment

Official landings data are presented from 1950 onwards, while ICES landings and discard estimates are provided for the years 2013–2016. However, length data from commercial fleets have not been consistently provided, and age data are very sparse indeed. Improved information on age and length distributions in landings and discards, from most countries participating in the fishery, would be required in order to conduct a fully analytical, catch-based assessment.

IBTS survey data are available from 1966 to 2017, although only the Scottish and Dutch sections of the survey recorded lemon sole catches for the full time period, while BTS survey data are provided from 1987 to 2017. Catchability of lemon sole at younger ages appears to be reduced in the IBTS survey, while the BTS survey does not cover the full extent of stock distribution. A fishery-independent index covering the entire distribution area of the stock and targeting lemon sole could improve the assessment.

## Issues relevant for the advice

Lemon sole is mainly a bycatch species in mixed fisheries. Management of lemon sole and witch under a combined species TAC prevents effective control of the single-species exploitation rates and could potentially lead to overexploitation of either species. A single-species TAC could be more appropriate.

In 2017, for the first time, the fishing pressure and stock size status indicators are based on a SPiCT analysis. This model uses a longer IBTS Q1 index, which only includes data from the Dutch and Scottish surveys that have been reporting lemon sole consistently since 1968.

## Reference points

**Table 4** Lemon sole in Subarea 4 and divisions 3.a and 7.d. Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{\text{trigger proxy}}$	$\frac{B}{B_{\text{MSY}}} = 0.5$	$0.5 \times B_{\text{MSY}}$ (estimated by SPiCT from model parameters, using data from 1968–2017).	ICES (2017)
	$F_{\text{MSY proxy}}$	$\frac{F}{F_{\text{MSY}}} = 1^*$	$F_{\text{MSY}}$ (estimated by SPiCT from model parameters, using data from 1968–2017).	ICES (2017)
Precautionary approach	$B_{\text{lim}}$	Not defined		
	$B_{\text{pa}}$	Not defined		
	$F_{\text{lim}}$	Not defined		
	$F_{\text{pa}}$	Not defined		
Management plan	$\text{SSB}_{\text{mgt}}$	Not defined		
	$F_{\text{mgt}}$	Not defined		

\* No reference points are defined for this stock in terms of absolute values. The SPiCT-estimated values of the ratios  $F/F_{\text{MSY}}$  and  $B/B_{\text{MSY}}$  are used to estimate stock status relative to the proxy MSY reference points.

## Basis of the assessment

**Table 5** Lemon sole in Subarea 4 and divisions 3.a and 7.d. Basis of the assessment and advice.

ICES stock data category	3 ( <a href="#">ICES, 2016</a> ).
Assessment type	Survey trends-based assessment (ICES, 2017).
Input data	Commercial catches (international landings and discards), one survey index (IBTS Q1), annual maturity and weight-at-age data from surveys.
Discards and bycatch	Discarding is known to take place and discards have been quantified for 2013–2016 (average rate 28%). Discard estimates were provided for 60% of the landings in 2016.
Indicators	SPiCT assessment based on IBTS Q1 (Scottish and Dutch surveys).
Other information	None.
Working group	Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

## Information from stakeholders

There is no additional available information for this stock.

## History of the advice, catch, and management

**Table 6** Lemon sole in Subarea 4 and divisions 3.a and 7.d. ICES advice and official landings. All weights are in tonnes.

Year	ICES advice	Predicted landings corresp. to advice	Predicted catch corresp. to advice	Agreed TAC * 4 and 2.a Lemon sole and witch	ICES est. total catch 3.a, 4 and 7.d Lemon sole	ICES est. landings 3.a, 4 and 7.d Lemon sole	ICES est. discards 3.a, 4 and 7.d Lemon sole	Official landings 3.a, 4 and 7.d Lemon sole and witch	Official landings 3.a, 4 and 7.d Lemon sole
2006		-		6175				6593	4290
2007		-		6175				6725	4488
2008		-		6793				5929	3975
2009		-		6793				5212	3394
2010		-		6521				4691	3201
2011		-		6391				5552	4022
2012	No increase in catch	-		6391				5922	4026
2013	No new advice, same as for 2012	-		6391	4546	3265	1281	5754 **	3761
2014	No more than 16% increase in landings (last 3 years average)	< 4350		6391	5120	3508	1612	6335	3689
2015	No new advice, same as for 2014	< 4350		6391	4926	3481	1445	5752	3394
2016	Precautionary approach (decrease catches by 9%)		< 5655		5012	3784	1228	6463	3803
2017	Precautionary approach (same advised catch value as given for 2016)		< 5655						
2018	Precautionary approach (decrease catches by 3%)		< 5484						
2019	Precautionary approach (same advised catch value as given for 2016)		< 5484						

\* EU combined TAC for lemon sole and witch in EU waters of Division 2.a and Subarea 4.

\*\* Preliminary.

## History of the catch and landings

**Table 7** Lemon sole in Subarea 4 and divisions 3.a and 7.d. Catch distribution by fleet in 2016 as estimated by ICES.

Table 7. Lemon sole in Subarea 4 and divisions 5.0 and 7.0: Catch distribution by fleet in 2016 as estimated by ICES.						
Catch (2016)	Landings					Discards
5012 tonnes	Otter trawl 61%	Beam trawl 31%	Seine 3%	Gillnet 2%	Other 3%	1228 tonnes
	3784 tonnes					

**Table 8** Lemon sole in Subarea 4 and divisions 3.a and 7.d. History of commercial catch and landings; the official landings (1950–2016) and ICES estimates (2013–2016) are presented by area for each country participating in the fishery. All weights are in tonnes.

**Area 7d: official landings**

Year	Official landings						
	Belgium	Denmark	France	Netherlands	UK	Other	Total
1950	10	0	174	0	24	0	208
1951	5	0	262	0	47	0	314
1952	10	0	188	0	100	0	298
1953	7	0	196	0	183	0	386
1954	9	0	361	0	164	0	534
1955	9	0	0	0	132	0	141
1956	4	0	0	0	99	0	103
1957	7	0	0	0	95	0	102
1958	1	0	0	0	81	0	82
1959	2	0	0	0	80	0	82
1960	4	0	0	0	62	0	66
1961	1	0	0	0	106	1	108
1962	2	0	0	0	99	0	101
1963	3	0	0	0	63	0	66
1964	5	0	0	0	72	0	77
1965	16	0	0	0	89	0	105
1966	7	0	0	0	194	0	201
1967	6	0	0	0	325	0	331
1968	8	0	0	0	329	0	337
1969	12	0	0	0	303	0	315
1970	16	0	0	0	240	0	256
1971	22	0	0	0	335	0	357
1972	18	0	0	0	457	0	475
1973	25	0	0	0	426	0	451
1974	16	0	0	1	334	0	351
1975	19	0	0	0	14	0	33
1976	24	0	0	0	18	0	42
1977	21	1	0	0	15	0	37
1978	45	2	63	0	31	0	141
1979	60	0	165	0	35	0	260
1980	33	0	109	0	10	0	152
1981	66	0	212	0	12	0	290
1982	96	0	406	1	81	0	584
1983	108	0	298	0	85	0	491
1984	110	0	367	0	109	0	586
1985	117	0	164	0	66	0	347
1986	77	0	133	0	41	0	251
1987	81	0	185	0	44	0	310
1988	74	0	155	0	29	0	258
1989	68	0	252	0	44	0	364
1990	68	0	272	0	83	0	423
1991	83	0	272	0	73	0	428
1992	66	0	176	0	122	0	364
1993	36	0	311	0	75	0	422
1994	97	0	505	0	93	0	695
1995	138	0	584	0	155	0	877
1996	213	0	720	0	218	0	1151
1997	143	0	305	0	115	0	563
1998	53	0	198	0	95	0	346
1999	50	0	0	0	90	0	140
2000	62	0	200	0	126	0	388
2001	104	0	191	0	188	0	483
2002	101	0	256	0	117	0	474

Year	Official landings						
	Belgium	Denmark	France	Netherlands	UK	Other	Total
2003	128	0	251	0	112	0	491
2004	120	0	198	1	105	0	424
2005	90	0	187	2	71	0	350
2006	98	0	100	0	48	0	246
2007	70	0	72	1	21	0	164
2008	140	0	46	3	45	0	234
2009	149	0	176	9	108	0	442
2010	101	0	85	5	32	0	223
2011	153	0	178	15	57	0	403
2012	171	0	167	20	0	0	358
2013	176	0	179	26	110	0	491
2014	162	0	108	14	72	0	357
2015	123	0	84	5	41	0	253
2016	115	0	69	9	47	0	240

**Area 7.d: ICES estimates of landings and discards**

Year	ICES estimates of landings							ICES estimates of discards
	Belgium	Denmark	France	Netherlands	UK	Other	Total	Total
2013	174	0	178	0	110	0	463	113
2014	163	0	0	0	72	0	234	99
2015	123	0	85	10	42	0	260	113
2016	158	0	69	8	47	0	281	64

**Area 4: official landings**

Year	Official landings								
	Belgium	Denmark	France	Germany	Netherlands	Norway	UK	Other	Total
1950	112	435	139	31	156	0	2855	26	3754
1951	115	845	90	21	167	0	3430	42	4710
1952	98	391	227	26	168	0	3953	59	4922
1953	73	409	189	18	132	0	4590	29	5440
1954	2	272	177	24	112	0	3368	17	3972
1955	49	311	0	15	78	0	3374	9	3836
1956	48	222	0	19	58	0	3034	14	3395
1957	39	249	0	24	64	0	3032	11	3419
1958	30	171	0	13	43	0	2835	12	3104
1959	85	242	0	40	43	0	3226	11	3647
1960	155	577	0	46	67	0	3178	12	4035
1961	286	488	0	79	102	0	3934	11	4900
1962	175	501	0	54	106	0	3794	0	4630
1963	365	222	0	36	71	0	3097	0	3791
1964	484	358	0	62	75	0	3142	0	4121
1965	562	385	0	91	93	0	3818	0	4949
1966	594	548	0	98	65	0	4110	0	5415
1967	601	791	0	136	61	0	4599	0	6188
1968	422	775	0	96	34	0	4943	0	6270
1969	292	639	0	80	36	0	3423	0	4470
1970	241	307	0	52	58	0	2776	0	3434
1971	348	514	0	54	122	0	2929	0	3967
1972	423	530	0	59	130	0	2530	0	3672
1973	566	478	0	73	217	16	3218	0	4568
1974	486	447	0	59	269	0	2966	0	4227
1975	748	521	0	83	299	0	3367	11	5029
1976	493	506	0	68	308	0	3443	12	4830
1977	618	321	0	71	262	0	4387	2	5661
1978	760	517	28	54	231	0	4518	0	6108
1979	674	876	136	41	390	0	4308	3	6428
1980	484	599	102	49	303	0	4885	2	6424

Year	Official landings								
	Belgium	Denmark	France	Germany	Netherlands	Norway	UK	Other	Total
1981	555	605	237	39	412	0	4084	1	5933
1982	879	670	419	52	759	0	4386	3	7168
1983	1122	735	402	28	1009	0	4957	4	8257
1984	1144	567	344	22	0	0	4850	3	6930
1985	989	555	157	26	0	0	4703	5	6435
1986	511	577	103	16	0	0	3839	1	5047
1987	448	742	174	14	0	0	4137	1	5516
1988	539	639	184	14	301	0	4220	1	5898
1989	441	828	176	40	397	0	4083	2	5967
1990	491	1007	208	49	0	0	4431	4	6190
1991	544	1099	250	41	0	12	4666	6	6618
1992	577	1149	177	30	0	13	4175	5	6126
1993	525	966	240	37	0	9	4059	3	5839
1994	436	597	436	27	0	11	3754	1	5262
1995	588	585	412	70	0	9	3046	2	4712
1996	592	547	534	67	0	18	2976	3	4737
1997	504	499	224	76	0	29	3391	4	4727
1998	815	796	197	149	838	23	3643	5	6466
1999	662	1015	0	62	681	24	3866	6	6316
2000	711	1277	184	72	492	17	3222	5	5980
2001	694	1281	191	77	451	22	2666	7	5389
2002	604	971	190	116	402	17	1521	6	3827
2003	517	1008	239	136	369	16	1399	4	3688
2004	667	1113	120	81	355	12	1192	3	3543
2005	595	1057	102	85	402	13	1188	2	3444
2006	552	968	57	183	412	13	1440	2	3627
2007	542	1136	65	143	367	23	1610	6	3892
2008	527	925	47	120	434	26	1383	4	3466
2009	389	898	88	64	294	31	927	2	2693
2010	375	821	32	102	323	35	935	2	2625
2011	387	999	56	96	641	27	1157	2	3365
2012	406	999	34	61	587	30	NA*	2	2119
2013	527	649	27	67	479	16	1214	2	2981
2014	648	626	27	63	425	23	1202	3	3017
2015	425	794	16	82	423	12	1116	3	2871
2016	448	1054	15	82	443	23	1196	5	3266

\* NA = not available.



**Area 4: ICES estimates of landings and discards**

Year	ICES estimates of landings									ICES estimates of discards
	Belgium	Denmark	France	Germany	Netherlands	Norway	UK	Other	Total	Total
2013	523	662	26	66	0	17	1213	2	2509	1102
2014	649	637	27	63	361	23	1202	3	2964	1426
2015	444	815	17	82	426	12	1120	3	2919	1248
2016	405	1055	15	82	420	23	1195	5	3200	1097

**Area 3.a: Official landings**

Year	Official landings						
	Belgium	Denmark	Germany	Netherlands	Sweden	Other	Total
1950	0	100	1	0	206	0	307
1951	0	74	1	0	173	0	248
1952	0	64	0	0	179	0	243
1953	0	35	0	0	97	0	132
1954	0	33	0	0	95	0	128
1955	0	29	0	0	73	0	102
1956	0	33	0	0	63	0	96
1957	0	27	0	0	51	0	78
1958	0	38	0	0	56	0	94
1959	0	71	0	0	59	0	130
1960	0	95	1	0	57	0	153
1961	0	90	0	0	71	0	161
1962	0	92	1	0	0	0	93
1963	0	99	0	0	0	0	99
1964	0	133	1	0	0	0	134
1965	0	163	1	0	0	0	164
1966	0	159	0	0	0	0	159
1967	0	189	1	0	0	1	191
1968	0	184	0	0	0	1	185
1969	0	215	0	0	0	0	215
1970	0	169	0	0	0	0	169
1971	0	173	0	0	0	0	173
1972	0	168	0	0	0	0	168
1973	0	214	0	0	0	0	214
1974	0	183	0	0	0	0	183
1975	0	263	1	1	52	0	317
1976	10	294	1	19	37	0	361
1977	9	528	2	37	51	0	627
1978	4	628	2	12	59	0	705
1979	7	704	1	10	111	0	833
1980	12	622	0	0	87	1	722
1981	1	710	0	3	75	4	793
1982	2	647	0	9	77	0	735
1983	3	636	0	10	110	0	759
1984	6	525	0	0	64	0	595
1985	0	729	0	0	64	0	793
1986	7	576	0	0	56	0	639
1987	24	577	0	0	68	0	669
1988	11	569	0	6	56	0	642
1989	8	610	0	0	75	0	693
1990	16	782	0	0	74	0	872
1991	11	640	0	0	83	0	734
1992	22	793	0	0	120	17	952
1993	14	980	4	0	141	17	1156
1994	10	648	2	0	127	16	803
1995	27	576	2	0	91	18	714
1996	0	513	1	0	97	24	635

Year	Official landings						
	Belgium	Denmark	Germany	Netherlands	Sweden	Other	Total
1997	0	628	2	0	115	23	768
1998	0	743	3	0	100	22	868
1999	0	731	3	0	88	22	844
2000	0	722	1	0	65	15	803
2001	0	511	1	0	53	19	584
2002	0	457	4	0	41	20	522
2003	0	451	6	30	35	21	543
2004	0	472	5	82	29	19	607
2005	0	468	5	147	38	16	674
2006	0	321	8	40	32	16	417
2007	0	374	5	16	18	19	432
2008	0	239	7	3	15	12	276
2009	0	233	4	1	15	9	262
2010	0	286	3	35	19	7	350
2011	0	223	0	0	12	16	254
2012	0	446	3	0	15	18	482
2013	0	259	3	5	10	12	289
2014	0	276	7	12	14	6	315
2015	0	250	4	0	9	6	269
2016	0	265	5	16	7	6	299

**Area 3.a: ICES estimates of landings and discards**

Year	ICES estimates of landings							ICES estimates of discards
	Belgium	Denmark	Germany	Netherlands	Sweden	Other	Total	Total
2013	0	267	4	0	10	12	293	67
2014	0	283	7	0	14	6	310	87
2015	0	257	5	25	9	6	302	84
2016	0	265	5	20	7	6	302	67

## Summary of the assessment

**Table 9** Lemon sole in Subarea 4 and divisions 3.a and 7.d. Assessment summary. Weights are in tonnes.

Year	Biomass index (all countries) kg h <sup>-1</sup>	Biomass index (Scotland and Netherlands only) kg h <sup>-1</sup>	Official landings tonnes	ICES estimates	
				Landings tonnes	Discards tonnes
1968		1.068	6792		
1969		1.487	5000		
1970		0.935	3859		
1971		0.083	4497		
1972		0.341	4315		
1973		1.367	5233		
1974		1.552	4761		
1975		1.653	5379		
1976		0.971	5233		
1977		0.759	6325		
1978		1.25	6954		
1979		1.166	7521		
1980		0.629	7298		
1981		1.668	7016		
1982		1.666	8487		
1983	1.61	1.418	9507		
1984	1.629	1.667	8111		
1985	1.273	0.581	7575		
1986	1.467	1.128	5937		
1987	1.313	0.825	6495		
1988	1.357	1.15	6798		
1989	1.583	1.88	7024		
1990	1.548	2.133	7485		
1991	1.171	1.263	7780		
1992	1.542	2.162	7442		
1993	1.927	1.856	7417		
1994	1.185	1.37	6760		
1995	1.157	1.32	6303		
1996	1.381	1.293	6523		
1997	1.179	1.005	6058		
1998	1.733	2.33	7680		
1999	1.787	2.798	7300		
2000	1.659	2.618	7171		
2001	1.305	1.441	6456		
2002	1.785	1.817	4823		
2003	1.671	1.996	4722		
2004	1.683	1.363	4574		
2005	1.22	1.283	4468		
2006	1.02	1.074	4290		
2007	1.331	1.943	4488		
2008	1.331	1.747	3976		
2009	0.862	0.79	3397		
2010	0.954	1.19	3198		
2011	1.265	2.057	4019		
2012	1.895	2.383	2959		
2013	1.249	1.988	3761	3265	1281
2014	0.968	0.934	3688	3508	1612
2015	1.019	1.179	3393	3481	1445
2016	1.097	1.068	3805	3784	1228
2017	0.995	0.725			

## Sources and references

- ICES 2012. ICES Implementation of Advice for Data-limited Stocks in 2012 in its 2012 Advice. ICES CM 2012/ACOM:68. 42 pp.
- ICES. 2016. Advice basis. *In* Report of the ICES Advisory Committee, 2016. ICES Advice 2016, Book 1, Section 1.2.
- ICES. 2017. Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK), 26 April–5 May 2017, ICES Headquarters, Copenhagen, Denmark. ICES CM 2017/ACOM:21.
- Pedersen, M. W., and Berg, C. W. 2017. A stochastic surplus production model in continuous time. *Fish and Fisheries*, 18: 226–243. doi: 10.1111/faf.12174.