Published 23 February 2017
DOI: 10.17895/ices.pub.3226

Sandeel (*Ammodytes* spp.) in divisions 4.a–b and Subdivision 20, Sandeel Area 3r (northern and central North Sea, Skagerrak)

ICES stock advice

ICES advises that when the MSY approach is applied, catches in 2017 should be no more than 74 176 tonnes.

Stock development over time

The spawning-stock biomass (SSB) was below B_{lim} in 2013 and has increased to above B_{pa} = MSY $B_{escapement}$ in 2015, 2016, and 2017. Recruitment (R) was above average in 2014 and low in 2015; R in 2016 is highly uncertain.

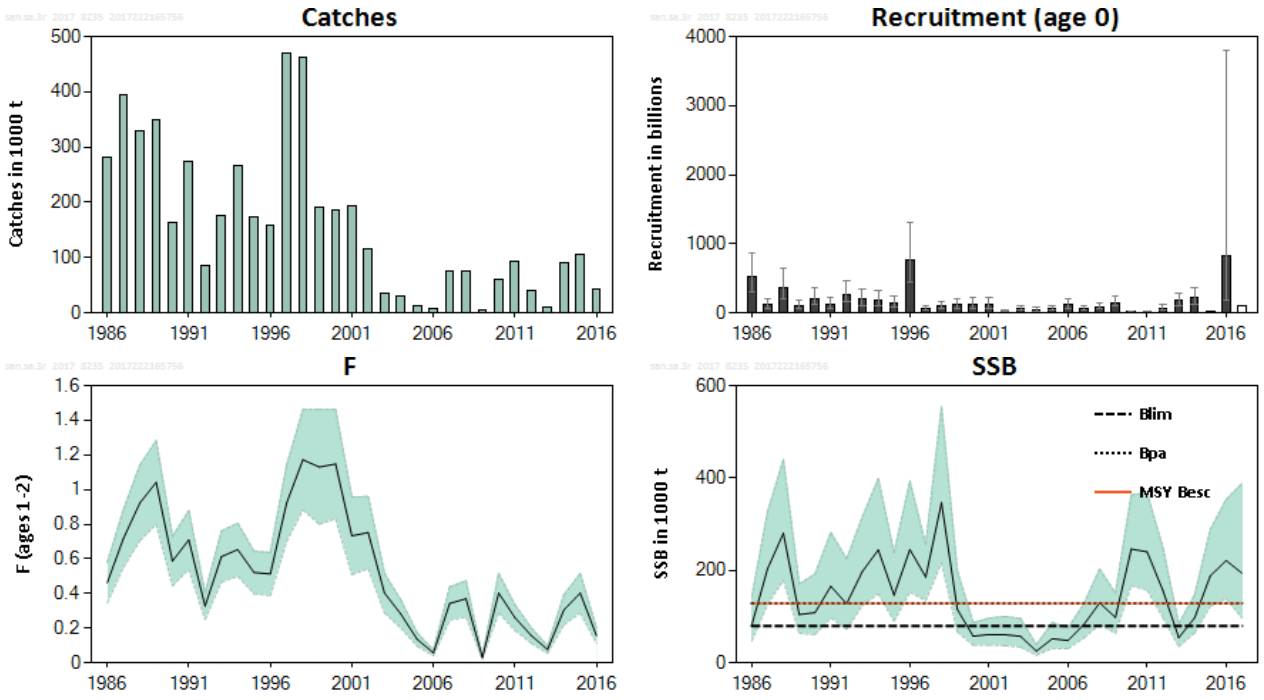

Figure 1 **Sandeel in divisions 4.a–b and Subdivision 20, Sandeel Area 3r. Historical development of the stock from the summary of the stock assessment, with 90% confidence intervals. Predicted values are not shaded. The 2016 recruitment value was replaced by the geometric mean in the basis for the forecast (see Table 2).**

Stock and exploitation status

Table 1 Sandeel in divisions 4.a–b and Subdivision 20, Sandeel Area 3r. 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}	?	?	?	Unknown	MSY $B_{escapement}$	✓	✓	✓	Above trigger
Precautionary approach	F_{pa}, F_{lim}	?	?	?	Unknown	B_{pa}, B_{lim}	✓	✓	✓	Full reproductive capacity
Management plan	F_{MGT}	-	-	-	Not applicable	SSB_{MGT}	-	-	-	Not applicable

Catch options

Table 2 Sandeel in divisions 4.a–b and Subdivision 20, Sandeel Area 3r. The basis for the catch options.

Variable	Value	Source	Notes
F (2016)	0.128	ICES (2017a)	Sum of half-yearly Fs
Recruitment (2016)	98273292	ICES (2017a)	Geometric mean 1986–2015 (in thousands)
Recruitment (2017)	98273292	ICES (2017a)	Geometric mean 1986–2015 (in thousands)
SSB (2017)	131621	ICES (2017a)	In tonnes (using geometric mean recruitment in 2016)

Table 3 Sandeel in divisions and 4.a–b and Subdivision 20, Sandeel Area 3r. Annual catch options. All weights are in tonnes.

Basis	Total catch (2017)	F_{total} (2017)	SSB (2018)	% SSB change *	% TAC change **
ICES advice basis					
$SSB_{2018} \geq$ MSY $B_{escapement}$	74176	0.29	133087	1.11	-28
Other options					
F = 0	0	0	356303	171	−100
F_{pa}	Not applicable				
F_{lim}	Not applicable				
B_{pa}	81367	0.32	129000	−1.99	-21
B_{lim}	173725	0.85	80000	−39	69
F_{2016}	35189	0.128	173725	32	-66

* SSB_{2018} relative to SSB_{2017}.
** Catch option for 2017 relative to TAC in 2016 (103 000 t = 63 000 t EU + 40 000 t Norway).

Basis of the advice

Table 4 Sandeel in divisions 4.a–b and Subdivision 20, Sandeel Area 3r. The basis of the advice.

Advice basis	MSY approach (Escapement strategy with F_{cap})
Management plan	ICES is not aware of any agreed precautionary management plan that applies to all of Sandeel Area 3; therefore, ICES bases the advice on the MSY approach.

Quality of the assessment

This stock was benchmarked in the period between the 2016 and 2017 assessments (ICES, 2017a). ICES statistical rectangles included in this sandeel area were changed.

The large retrospective pattern in the recruitment leads to overestimation of the recruitment; this has not been accounted for in the estimation of F_{cap}. The age 0 dredge survey index for the 2016 year class is high, but the dredge survey also has a large survey CV as estimated by the assessment. Therefore, the 2016 recruitment used in the forecast is calculated as the geometric mean for the years 1986–2015.

Figure 2 Sandeel in divisions 4.a–b and Subdivision 20, Sandeel Area 3r. Historical assessment results (final-year recruitment estimates included).

Issues relevant for the advice

In 2017 the name of this sandeel area was changed from Sandeel Area 3 to Sandeel Area 3r because of a change in the statistical rectangles included in the stock area (ICES, 2017a).

The reported catches in 2014 and 2015 were revised based on information from VMS and previous catch distributions to account for substantial area misreporting of catches. Based on the misreporting of catches observed in 2014, management measures to avoid area misreporting (only one fishing area per trip) have been mandatory for the Danish fishery since 2015. This eliminated the misreporting issue for Danish catches; however, there are strong indications of area misreporting for other nations in 2015. Management measures for all nations, similar to those in the Danish fishery, should reduce area misreporting. The acoustic survey index is now used in the assessment for sandeel in this area.

ICES provides advice for this stock according to the MSY approach; however, most of this area is within the Norwegian EEZ and fisheries are managed by alternately opening and closing areas (ICES, 2017a). ICES has not evaluated this management plan.

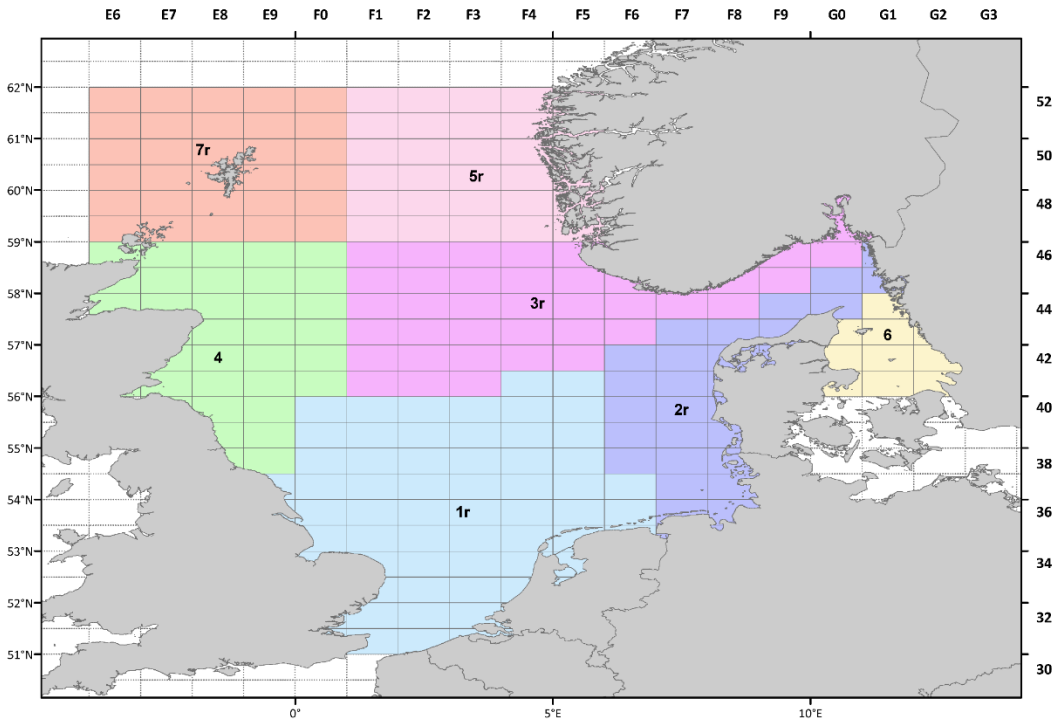

Figure 3 Sandeel in divisions 4.a–b and Subdivision 20, Sandeel Area 3r. Sandeel are largely sedentary after settlement and form a complex of local (sub-)stocks in the North Sea. To avoid local depletion, ICES advice for sandeel is provided separately for seven areas in Division 3.a and Subarea 4. Advice for sandeel in divisions 4.a–b and Subdivision 20, Sandeel Area 3r is defined as ICES statistical rectangles 41–46 F1–F3; 42–46 F4–F5; 43–46 F6; 44–46 F7–F8; 45–46 F9; 46–47 G0; 47 G1 and 48 G0. ICES revised this sandeel area by ICES statistical rectangle at the 2016 benchmark (ICES, 2017a).

Reference points

Table 5 Sandeel in divisions 4.a–b and Subdivision 20, Sandeel Area 3r. Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{escapement}$	129000 t	= B_{pa}	ICES (2017a)
	F_{MSY}	Not defined		
	F_{cap}	0.29	Maximum F estimated from MSE that results in less than 5% probability of SSB < B_{lim}.	ICES (2017a)
Precautionary approach	B_{lim}	80000 t	The lowest SSB at which a high recruitment is observed	ICES (2017a)
	B_{pa}	129000 t	$B_{pa} = B_{lim} \times \exp(\sigma \times 1.645)$, with $\sigma = 0.29$ estimated from the assessment uncertainty in the terminal year.	ICES (2017a)
	F_{lim}	Not defined		
Management plan	SSB_{MGT}	Not defined		
	F_{MGT}	Not defined		

Basis of the assessment

Table 6 Sandeel in divisions 4.a–b and Subdivision 20, Sandeel Area 3r**.**The basis of the assessment and advice.

ICES stock data category	1 (see ICES, 2016)
Assessment type	Analytical seasonal age-based (SMS-effort) (ICES, 2017b)
Input data	Acoustic survey index (2009–2016) and dredge survey index (dredge survey 2005–2016). Total international catch and fishing effort. Constant maturity-at-age estimated from the dredge survey. Natural mortality estimated from multispecies assessment. From 2012 and onwards the mortality has been constant. Age and length frequencies from catch sampling.
Discards and bycatch	Discarding is considered to be negligible.
Indicators	None
Other information	Last benchmarked in 2016 (ICES, 2017a).
Working group	Herring Assessment Working Group (HAWG)

Information from stakeholders

There is no available information.

History of advice, catch, and management

Table 7 Sandeel in divisions and 4.a–b and Subdivision 20, Sandeel Area 3r. History of ICES advice, the agreed TAC, and ICES estimates of catch. All weights are in tonnes. Values of catch for the period 2005 to 2015 are presented to the nearest thousand tonnes.

Year	ICES advice	Catch corresponding to advice	EU zone TAC	Norwegian zone TAC	ICES catch SA 3	ICES catch SA 3r	Total ICES catch (SAs 1r–7r)
2005*	Exploitation to be kept below the level of 2003. Adjustment to be made conditional on the abundance of the 2004 year class.	-	661000**	10000***	30000		177000
2006*	The fishery should remain closed until information is available which assures that the stock can be rebuilt to B_{pa} by 2007.	-	300000**	0	19000		293000
2007*	The fishery should remain closed until information is available which assures that the stock can be rebuilt to B_{pa} by 2008.	-	173000**	51000	114000		230000
2008*	The fishery should only be allowed if monitoring information is available and shows that the stock can be rebuilt to B_{pa} by 2009.	-	375000**	128000	95000		348000
2009*	The fishery should only be allowed if monitoring information is available and shows that the stock can be rebuilt to B_{pa} by 2010.	-	377000**	0	34000		353000
2010*	The fishery should only be allowed if monitoring information is available and shows that the stock can be rebuilt to B_{pa} by 2011.	-	377000**	50000	81000		414000
2011	No fishery	0	10000	90000	95000		438000
2012	Catches for monitoring purposes should not exceed 5 000 t.	< 5000	5000	42000	46000		102000
2013	MSY approach: allow for sufficient stock (MSY $B_{escapement}$) to remain for successful	< 78331	40000	20000	39000		278000

Year	ICES advice	Catch corresponding to advice	EU zone TAC	Norwegian zone TAC	ICES catch SA 3	ICES catch SA 3r	Total ICES catch (SAs 1r–7r)
	recruitment.						
2014	MSY approach: allow for sufficient stock (MSY $B_{escapement}$) to remain for successful recruitment.	< 270000	140000	90000	143000		264000
2015	MSY approach: allow for sufficient stock (MSY $B_{escapement}$) to remain for successful recruitment, with additional F_{cap}.	< 370000	190000	100000	122000		312000
2016	MSY approach: allow for sufficient stock (MSY $B_{escapement}$) to remain for successful recruitment.	≤ 123135	63000	40000	50737****	43973****	73420****
2017^	MSY approach: allow for sufficient stock (MSY $B_{escapement}$) to remain for successful recruitment.	≤ 74176					

* Advice for Subarea 4, excluding the Shetland area.
** Set for EU waters of divisions 2.a and 3.a and Subarea 4.
*** TAC set for EU fisheries 10 kt; seasonal effort limitations set for Norwegian fisheries.
**** Preliminary.
^ ICES statistical rectangles included in this sandeel area have changed in the 2017 assessment and advice.

History of catch and landings

Table 8 Sandeel in divisions 4.a–b and Subdivision 20, Sandeel Area 3r**.** Catch distribution by fleet in 2016 as estimated by ICES (in tonnes).

Total catch (2016)	Landings	Discards
43973	100% industrial trawl fisheries	Negligible
	43973	

Table 9 Sandeel in divisions 4.a–b and Subdivsion 20, Sandeel Area 3r**.** History of total catch (in tonnes) as estimated by ICES.

Year	Catch
1982	45648
1983	24828
1984	49111
1985	20859
1986	282334
1987	395298
1988	336919
1989	374252
1990	163224
1991	274839
1992	87022
1993	200123
1994	267281
1995	213168
1996	159304
1997	474093
1998	469183
1999	145159
2000	196177
2001	150534
2002	116007
2003	33788
2004	30496
2005	13994
2006	7008
2007	75391
2008	74992
2009	6362
2010	61243
2011	92452
2012	40134
2013	9844
2014	95464
2015	104631
2016	43973

Summary of the assessment

Table 10 Sandeel in divisions 4.a–b and Subdivision 20, Sandeel Area 3r**.** Assessment summary with weights (in tonnes) and recruits (at age 0, in thousands). The SSB is estimated for 1 January. Yield values used for the assessment do not include catches of age 0 in the first half of the year and, hence, may differ slightly from the ICES catch estimates presented in other tables.

Year	Recruitment Age 0 thousands	High	Low	Stock size (SSB) tonnes	High	Low	Total catch tonnes	F per year Ages 1–2	High	Low
1986	515734366	873911261	304358060	82034	127531	36537	282315	0.46	0.58	0.35
1987	116728831	206572639	65960430	203410	299753	107067	395296	0.72	0.89	0.55
1988	365462657	635248146	210253197	280570	406745	154395	330358	0.92	1.14	0.71
1989	105956543	186887099	60072573	104680	155897	53463	350409	1.04	1.28	0.80
1990	209707848	370286382	118765862	108780	170925	46635	163224	0.59	0.73	0.45
1991	120544275	217796058	66718022	165760	253953	77567	274839	0.71	0.88	0.54
1992	266501289	459529473	154555782	127920	200295	55545	86788	0.33	0.41	0.25
1993	195469284	339530558	112532554	198130	290791	105469	175786	0.61	0.76	0.47
1994	186731619	329743801	105744816	244430	364156	124704	267281	0.65	0.81	0.50
1995	141498581	249835247	80140207	146730	217898	75562	173607	0.52	0.64	0.40
1996	770286470	1309981750	452938559	245420	361156	129684	159024	0.51	0.64	0.39
1997	60909061	106806400	34734938	185650	245367	125933	470670	0.92	1.14	0.70
1998	95156529	166482302	54388754	346500	509228	183772	462081	1.17	1.46	0.88
1999	122041827	211586263	70393074	115800	178651	52949	191253	1.13	1.46	0.80
2000	125897863	223492659	70920772	57713	81534	33892	186837	1.15	1.46	0.83
2001	121662402	215013252	68841060	61360	89317	33403	193684	0.73	0.96	0.51
2002	28195125	51725800	15368831	61161	91567	30755	116298	0.75	0.96	0.54
2003	62361521	112799176	34476841	57515	86969	28061	34673	0.40	0.52	0.29
2004	40453146	75621294	21640161	25558	36608	14508	31285	0.28	0.36	0.20
2005	60909471	109695295	33820627	52488	79295	25681	13991	0.136	0.175	0.097
2006	117906379	199864535	69556684	48487	70092	26882	7094	0.058	0.074	0.041
2007	65037866	107688673	39279192	82889	118827	46951	74972	0.34	0.44	0.25
2008	91242621	146212548	56939134	130030	188210	71850	74933	0.37	0.47	0.27
2009	149361338	235793084	94611805	98260	150710	64064	6261	0.031	0.040	0.022
2010	15222288	26242253	8829960	246360	363831	166817	61241	0.40	0.52	0.29
2011	11436471	19155640	6827904	240330	367414	157203	92452	0.26	0.34	0.19
2012	71224694	119616912	42410032	156620	249212	98430	40116	0.158	0.20	0.113
2013	179774244	292478618	110499629	54529	84506	35186	9844	0.077	0.099	0.055
2014	219852637	366902205	131738598	97364	146715	64613	90876	0.31	0.39	0.22
2015	3948164	8443292	1846199	188540	289291	122877	104631	0.40	0.52	0.29
2016	829176958	3806605751	180616138	221550	353858	138712	42809	0.157	0.20	0.113
2017	98273292**			194120*	388505	96994				
Avg	173895793	380049947	92896142	144131	216671	80966	160159	0.53	0.66	0.39

* Using mean weight-at-age from 2012 to 2016 and proportion mature from December 2016.

** Geometric mean (1986–2015). The 2016 recruitment value from the summary of the assessment was replaced by the geometric mean in the basis for the forecast (see Table 2).

Sources and references

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