Sandeel (*Ammodytes* spp.) in divisions 4.b–c, Sandeel Area 1r (central and southern North Sea, Dogger Bank)

ICES advice on fishing opportunities

ICES advises that when the MSY approach is applied, catches in 2020 should be no more than 113 987 tonnes.

Stock development over time

The spawning-stock biomass (SSB) was below B_{lim} and B_{pa} = MSY $B_{escapement}$ in 2019 and at the beginning of 2020. Recruitment (R) in 2019 was above the geometric mean of the time-series, and higher than in 2018. Fishing mortality (F) has fluctuated, showing a decrease since the mid-2000s followed by an increase in 2017 to approximately the long-term average, where it has remained for the last two years.

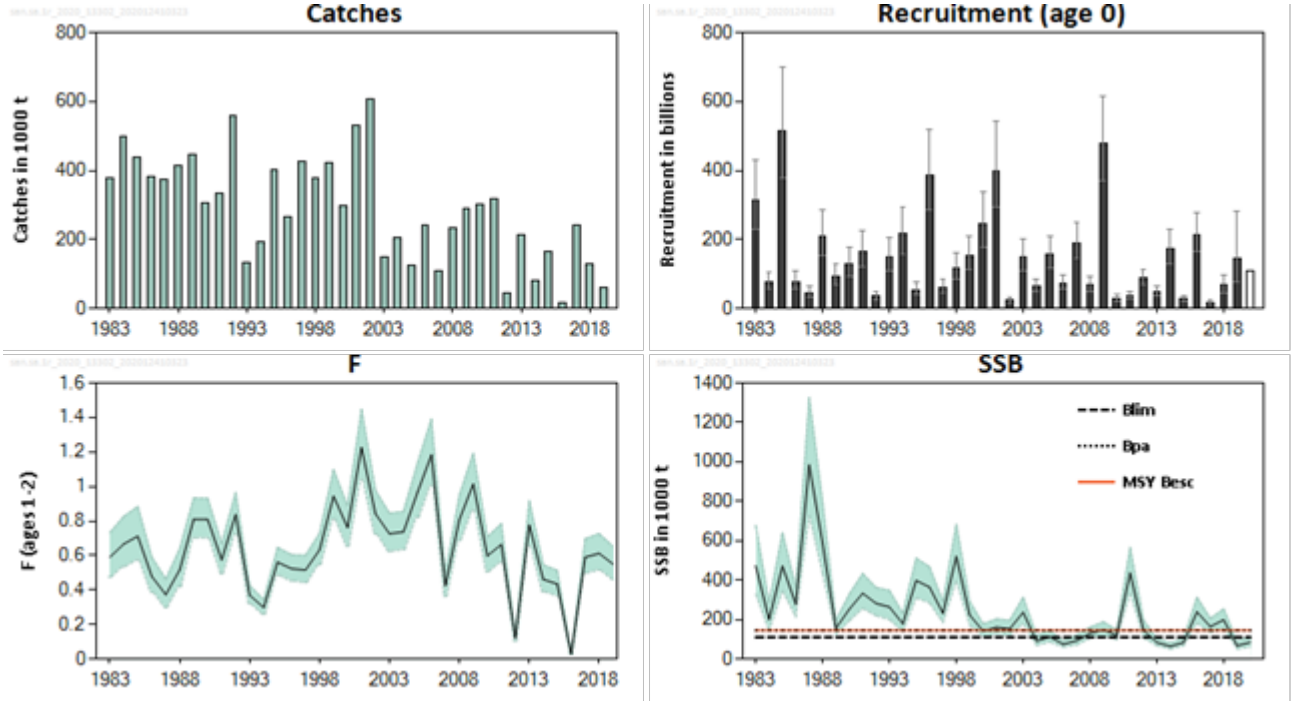

Figure 1 Sandeel in divisions 4.b–c, Sandeel Area 1r. Historical development of the stock from the summary of the stock assessment, with 90% confidence intervals. Assumed recruitment values are not shaded.

Stock and exploitation status

ICES assesses that the spawning-stock size is below MSY $B_{escapement}$, B_{pa}, and B_{lim}. No reference points for fishing pressure have been defined for this stock.

Table 1 Sandeel in divisions 4.b–c, Sandeel Area 1r. State of the stock and fishery relative to reference points.

	Fishing pressure					Stock size				
		2017	2018	2019			2018	2019	2020	
Maximum sustainable yield	F_{MSY}	?	?	?	Undefined	MSY $B_{escapement}$	✓	✗	✗	Below escapement
Precautionary approach	F_{pa},F_{lim}	?	?	?	Undefined	B_{pa},B_{lim}	✓	✗	✗	Reduced reproductive capacity
Management plan	F_{MGT}	–	–	–	Not applicable	B_{MGT}	–	–	–	Not applicable

Catch scenarios

Table 2 Sandeel in divisions 4.b–c, Sandeel Area 1r. The basis for the catch scenarios.

Variable	Value	Notes
F (2019)	0.55	From the assessment
Recruitment (2019)	145 982 893	From the assessment; in thousands
Recruitment (2020)	104 153 964	Geometric mean 1983–2018; in thousands
SSB (2020)	84 881	In tonnes

Table 3 Sandeel in divisions 4.b–c, Sandeel Area 1r. Annual catch scenarios. All weights are in tonnes.

Basis	Total catch (2020)	F_{total} (2020)	SSB (2021)	% SSB change *	% TAC change **	% advice change ***
ICES advice basis						
$SSB_{2021} \geq MSY\ B_{escapement}$ with F_{cap}	113987	0.49	169415	+100	+24	+24
Other scenarios						
F = 0	0	0	242708	+186	−100	−100
$SSB_{2021} = MSY\ B_{escapement} = B_{pa}$	153990	0.72	145000	+71	+68	+68
B_{lim}	213893	1.16	110000	+30	+133	+133
$F = F_{2019}$	124970	0.55	162636	+92	+36	+36

* SSB_{2021} relative to SSB_{2020}.
** Catch scenario for 2020 relative to TAC in 2019 (91 916 t).
*** Advice value 2020 relative to advice value 2019 (91 916 t).

Stock size at the beginning of 2020 is estimated to be below B_{lim}; however, the 2019 year class is large enough to contribute both to an increase in SSB and to the advised catch for 2020.

Basis of the advice

Table 4 Sandeel in divisions 4.b–c, Sandeel Area 1r. 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 for sandeel in this area.

Quality of the assessment

The confidence intervals of SSB, F, and recruitment are estimated to be small; however, the tendency of the assessment to downscale SSB cannot presently be explained or resolved.

The 2018 recruitment has been revised downward by this year's assessment.

Figure 2 Sandeel in divisions 4.b–c, Sandeel Area 1r. Historical assessment results (final-year recruitment is the geometric mean).

Issues relevant for the advice

The large change in the advice from year to year can be explained by the marked interannual variability of biomass and recruitment as well as the early maturation, both of which are typical for a short-living species.

The mean weight-at-age has decreased in the last three decades, with the lowest on record being observed for ages 3 and 4, and the second lowest for age 1, in 2019. Reasons remain unknown.

SSB was estimated to be below B_{lim} at the beginning of 2020 as a result of the downward revision of the 2018 recruitment and a lower than expected weight-at-age.

Catches in the past have be corrected for area misreporting. Management measures to avoid area misreporting (only one fishing area per trip) have been mandatory for the Danish fishery since 2015. This is not the case for other countries.

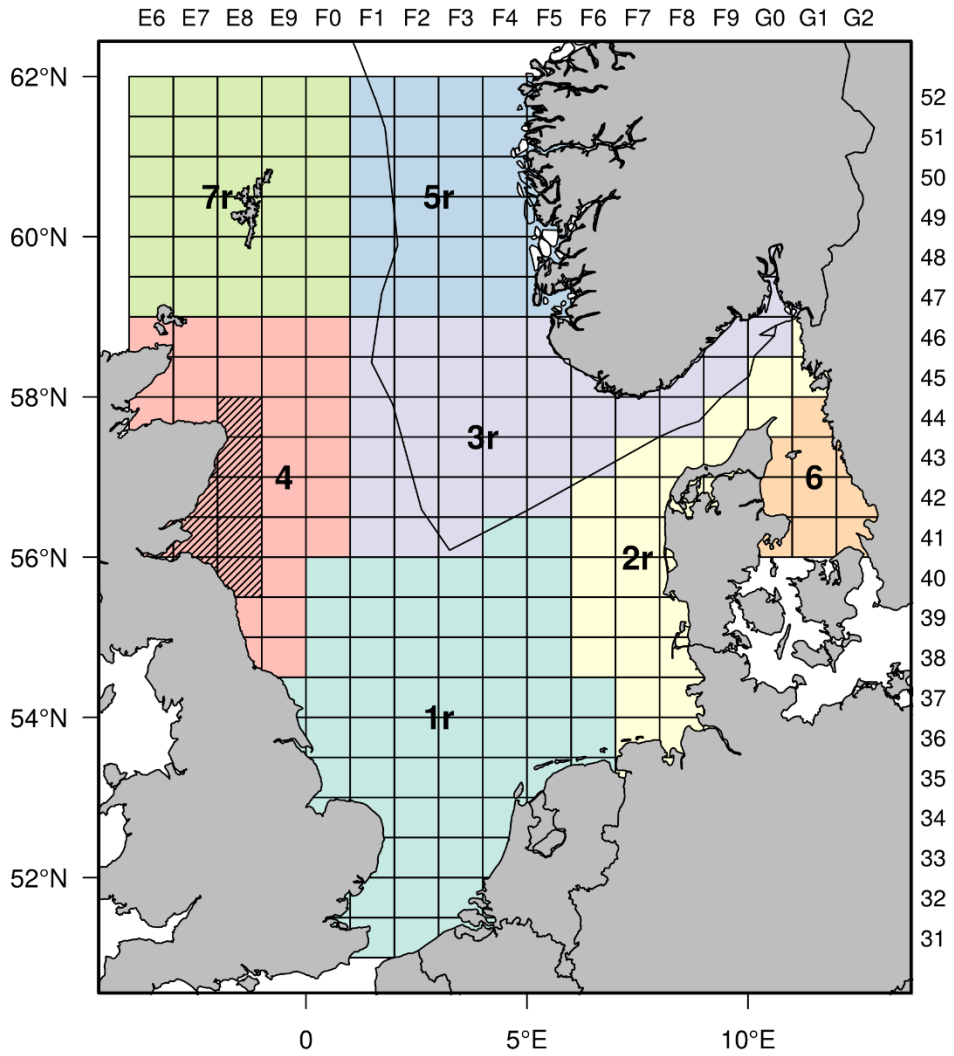

Figure 3 Sandeel in divisions 4.b–c, Sandeel Area 1r. Stock areas for the seven sandeel stocks. The border of the Norwegian Exclusive Economic Zone (EEZ) is also shown. The closed part of Sandeel Area 4 is shown with hatched markings.

Reference points

Table 5 Sandeel in divisions 4.b–c, Sandeel Area 1r. Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{escapement}$	145 000 t	= B_{pa}	ICES (2017)
	F_{MSY}	Not defined		
	F_{cap}*	0.49	Maximum F, estimated from the management strategy evaluation (MSE), resulting in less than 5% probability of SSB < B_{lim}.	ICES (2017)
Precautionary approach	B_{lim}	110 000 t	The lowest SSB at which a high recruitment is observed.	ICES (2017)
	B_{pa}	145 000 t	$B_{pa} = B_{lim} \times \exp(\sigma \times 1.645)$, with $\sigma = 0.17$ estimated from the assessment uncertainty in the terminal year.	ICES (2017)
	F_{lim}	Not defined		
Management plan	SSB_{MGT}	Not defined		
	F_{MGT}	Not defined		

* Not used as a biological reference point, but used in the ICES MSY approach for stocks of short-lived species.

Basis of the assessment

Table 6 Sandeel in divisions 4.b–c, Sandeel Area 1r. The basis of the assessment and advice.

ICES stock data category	1 (see ICES, 2019).
Assessment type	Age-structured model (SMS-effort), half-yearly time-steps (ICES, 2020).
Input data	One survey index in December (dredge survey since 2004) and commercial catch rates in April. Total international catch and fishing effort. Annual natural mortality estimated from multispecies assessment (ICES, 2018). Constant maturity-at-age from surveys. Age frequencies from catch sampling.
Discards and bycatch	Discarding is considered to be negligible.
Indicators	None.
Other information	Last benchmarked in 2016 (ICES, 2017).
Working group	Herring Assessment Working Group (HAWG)

Information from stakeholders

There is no additional available information.

History of the advice, catch, and management

Table 7 Sandeel in divisions 4.b–c, Sandeel Area 1r. History of ICES advice, the agreed TAC, and ICES estimates of catch. All weights are in tonnes. Values of catches for the period 2005 to 2015 are presented to the nearest thousand tonnes.

Year	ICES advice	Catch corresponding to advice	TAC	ICES catch SA 1	ICES catch SA 1r	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**	104000		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**	238000		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**	109000		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**	239000		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**	309000		353000

Year	ICES advice	Catch corresponding to advice	TAC	ICES catch SA 1	ICES catch SA 1r	Total ICES catch (SAs 1r–7r)
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**	301000		414000
2011	MSY approach: allow for sufficient stock (MSY $B_{escapement}$) to remain for successful recruitment.	< 320000	320000	312000		438000
2012	MSY approach: allow for sufficient stock (MSY $B_{escapement}$) to remain for successful recruitment.	< 23000	23000	46000		102000
2013	MSY approach: allow for sufficient stock (MSY $B_{escapement}$) to remain for successful recruitment.	< 224544	225000	210000		278000
2014	MSY approach: allow for sufficient stock (MSY $B_{escapement}$) to remain for successful recruitment.	< 57000	57000	99000		264000
2015	MSY approach: allow for sufficient stock (MSY $B_{escapement}$) to remain for successful recruitment.	< 133000	133000	163000		312000
2016	Catches for monitoring purposes should not exceed 5 000 t.	≤ 5000	13000	12751	15264	75405
2017^	MSY approach: allow for sufficient stock (MSY $B_{escapement}$) to remain for successful recruitment.	≤ 255956	255956		242069	517499
2018^	MSY approach: allow for sufficient stock (MSY $B_{escapement}$) to remain for successful recruitment.	≤ 134461	134461		131898	269579
2019^	MSY approach: allow for sufficient stock (MSY $B_{escapement}$) to remain for successful recruitment.	≤ 91916	91916		86066***	234778***
2020^	MSY approach: allow for sufficient stock (MSY $B_{escapement}$) to remain for successful recruitment.	≤ 113987				

* Advice for Subarea 4, excluding the Shetland area.
** Set for EU waters of divisions 2.a and 3.a and Subarea 4.
*** Preliminary.
^ ICES statistical rectangles included in this sandeel area have changed with the 2017 assessment and advice.

History of catch and landings

Table 8 Sandeel in divisions 4.b–c, Sandeel Area 1r. Catch distribution by fleet in 2019 as estimated by ICES (in tonnes).

Total catch (2019)	Landings	Discards
86066	100% industrial trawl fisheries	Discarding is considered negligible
	86066	

Table 9 Sandeel in divisions 4.b–c, Sandeel Area 1r. History of the total catch (in tonnes) as estimated by ICES.

Year	Catch
1983	382629
1984	498671
1985	460057
1986	382844
1987	373021
1988	422805
1989	446129
1990	306302
1991	332204
1992	558602
1993	144389
1994	193241
1995	400759
1996	291709
1997	426414
1998	377473
1999	424279
2000	374703
2001	508016
2002	610123
2003	178488
2004	215351
2005	126261
2006	247504
2007	110389
2008	236066
2009	309591
2010	300892
2011	319656
2012	46116
2013	214981
2014	98732
2015	164770
2016	15264
2017	242069
2018	131898
2019	86066

Summary of the assessment

Table 10 Sandeel in divisions 4.b-4.c, Sandeel Area 1r. Assessment summary. Weights are in tonnes, recruitment is in thousands. The SSB is estimated for 1 January. Catch 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. High and Low refer to 90% confidence intervals.

Year	Recruitment (age 0)	High	Low	SSB	High	Low	Total catch	F ages 1–2	High	Low
	thousands			tonnes			tonnes			
1983	314973794	431980284	229659766	473071	678776	329705	378795	0.59	0.73	0.48
1984	76668386	105942620	55483255	201390	284419	142600	498626	0.67	0.83	0.54
1985	514651227	700489951	378115182	471182	641958	345837	437114	0.71	0.88	0.57
1986	78609255	108892933	56747622	278452	363251	213448	382844	0.48	0.59	0.39
1987	45993011	64681986	32703959	983625	1326292	729491	373021	0.37	0.46	0.30
1988	208823509	285339210	152826028	587129	795205	433499	413646	0.52	0.64	0.42
1989	93455879	128546616	67944234	156686	198016	123983	446028	0.81	0.93	0.70
1990	128829451	175742038	94439711	252963	329339	194300	306240	0.81	0.93	0.70
1991	163774330	223459699	120030731	333701	433917	256630	332204	0.57	0.67	0.50
1992	35712096	49431703	25800320	282377	362583	219914	558599	0.84	0.97	0.73
1993	149080949	203538705	109193627	264078	348387	200172	132024	0.37	0.43	0.32
1994	215829651	293735975	158586084	179512	232251	138749	193241	0.30	0.35	0.26
1995	54352436	74924390	39428915	398316	511914	309926	400588	0.56	0.65	0.49
1996	385480051	520309272	285589508	364762	467728	284463	265869	0.52	0.61	0.45
1997	60733136	83533041	44156345	232118	291415	184886	426089	0.52	0.60	0.44
1998	116686336	160454748	84856952	520216	683786	395775	377073	0.63	0.73	0.55
1999	152549547	208432007	111649667	223910	293134	171033	422718	0.94	1.10	0.81
2000	245547262	338173225	178291637	142486	178219	113918	299167	0.76	0.89	0.66
2001	399210738	543265999	293353925	160653	202952	127170	531265	1.23	1.45	1.04
2002	24865702	34451844	17946881	153277	196758	119404	606466	0.84	0.98	0.73
2003	147745240	201254368	108463017	237044	313427	179275	148039	0.73	0.85	0.62
2004	64682420	86663891	48276339	90944	119754	69065	203646	0.74	0.86	0.63
2005	155320301	207485167	116270460	113210	147243	87043	123422	0.97	1.13	0.82
2006	73221526	96631353	55482942	74682	92351	60394	240646	1.18	1.39	1.01
2007	190088441	250589854	144194247	93060	122748	70553	109624	0.43	0.50	0.36
2008	67187649	91970856	49082725	130353	161094	105478	234447	0.81	0.95	0.69
2009	476987098	616025204	369330167	148301	188433	116717	290995	1.01	1.19	0.86
2010	29238591	38697772	22091587	120813	148604	98219	300508	0.60	0.71	0.51
2011	37243947	49349791	28107751	435827	566387	335362	318840	0.66	0.79	0.56
2012	87486933	113732756	67297792	145801	197837	107452	46117	0.123	0.146	0.104
2013	49377233	64946503	37540299	84204	105368	67291	214359	0.78	0.92	0.66
2014	173034231	229141867	130665100	64216	81980	50300	78830	0.46	0.55	0.39
2015	27453384	36305147	20759820	83952	104906	67184	163381	0.44	0.51	0.37
2016	214753196	277671673	166091610	239187	313304	182603	14613	0.030	0.036	0.026
2017	17192779	22896868	12909697	164555	206158	131347	241916	0.59	0.70	0.50
2018	67254871	97951457	46178156	198988	255021	155267	129525	0.61	0.73	0.52
2019	145982893	281776301	75630935	67711	90408	50711	59584***	0.55	0.65	0.46
2020	104153964**			84881*	117119	61516				

* Using mean weight-at-age from 2015 to 2019.

** Geometric mean (1983–2018).

*** This value does not include catches of age 0 in the first half of the year which accounted for 26482 tonnes of catch in 2019.

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