

6.3.46 Sole (*Solea solea*) in Subarea IV (North Sea)

ICES stock advice

Please note: This advice was updated in November 2015 (ICES, 2015f).

ICES advises that when the second stage of the EU management plan (Council Regulation No. 676/2007) is applied, catches in 2016 should be no more than 12 835 tonnes. If this stock is not under the EU landing obligation in 2016 and discard rates do not change from the average (2012–2014), this implies landings of no more than 11 921 tonnes.

Stock development over time

The spawning stock biomass (SSB) has increased since 2007 and is estimated to be above MSY $B_{trigger}$ in 2015. Fishing mortality (F) has steadily declined since 1997 and is estimated to be above F_{MSY} in 2014.

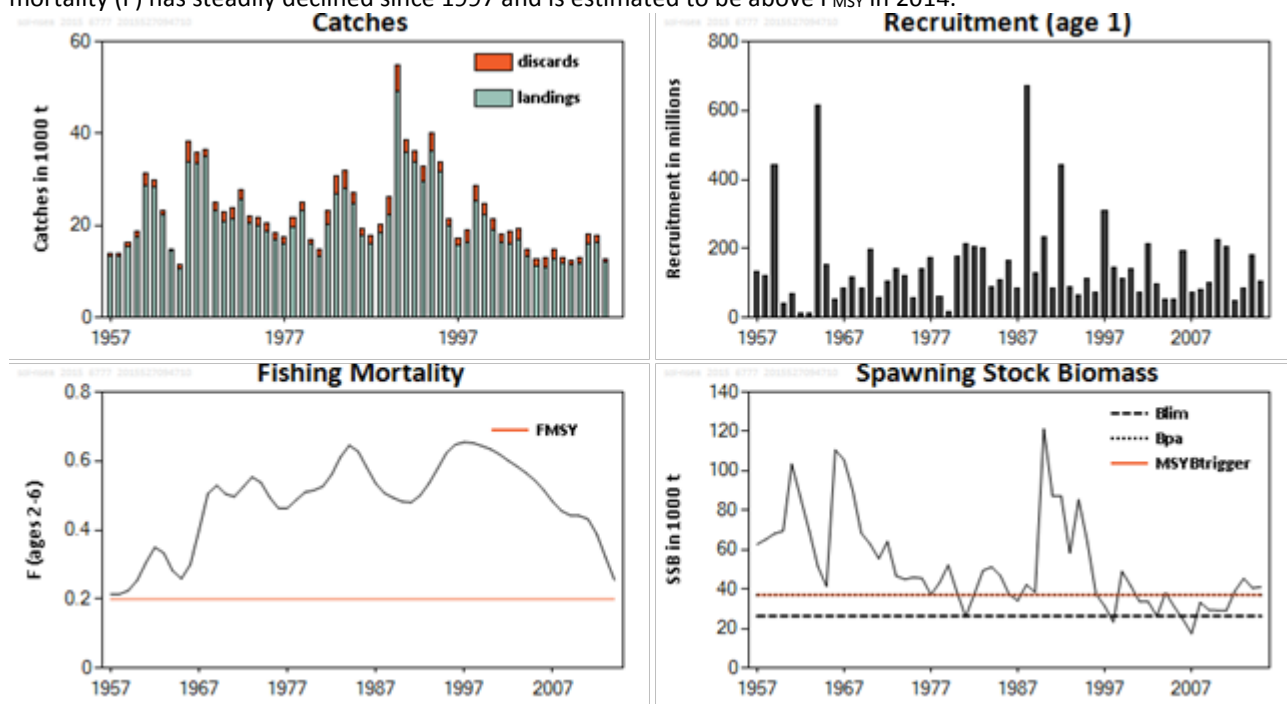


Figure 6.3.46.1 Sole in Subarea IV. Summary of stock assessment (weights in thousand tonnes).

Stock and exploitation status

Table 6.3.46.1 Sole in Subarea IV. State of the stock, relative to reference points, of the stock and fishery.

		Fishing pressure			Stock size		
		2012	2013	2014	2013	2014	2015
Maximum Sustainable Yield	F_{MSY}	✗	✗	✗	✓	✓	✓
Precautionary approach	F_{pa} , F_{lim}	?	?	?	✓	✓	✓
Management Plan	F_{MGT}	✗	✗	✗	✓	✓	✓
				Above			Above trigger
				Undefined			Full reproductive capacity
				Above			Above

Catch forecast and outlook

Table 6.3.46.2 Sole in Subarea IV (North Sea). The basis for the forecast.

Variable	Value	Source	Notes
F ages 2-6 (2015)	0.25	ICES 2015a	Landings are TAC-constrained
SSB (2016)	50022	ICES 2015a	Short term forecast (STF)
R _{age1} (2015)	103741	ICES 2015a	Thousands, RCT3
R _{age1} (2016)	111127	ICES 2015a	Thousands, geometric mean (1957-2011)
Total catch (2015)	12761	ICES 2015a	Tonnes
Commercial landings (2015)	11893	ICES 2015a	Tonnes
Discards (2015)	869	ICES 2015a	Tonnes average discard rate by age of last 3 years

Table 6.3.46.3 Sole in Subarea IV (North Sea). The forecast and catch options. All weights in thousand tonnes.

Rationale	Total Catch (2016)	Wanted catch (2016)*	Unwanted catch (2016)*	Basis	F _{wanted catch} ages 2-6 (2016)	F _{unwanted catch} ages 1-3 (2016)	Total F ages 2-6 (2016)	SSB (2017)	%SSB change **	%TAC change wanted catch** *
Management plan / MSY approach	12.835	11.921	0.914	Stage two: -F _{MSY}	0.18	0.04	0.2	54.033	8	0
Zero catch	0	0	0	F = 0	0	0	0	67.143	34	-100
Other options	10.889	10.115	0.774	TAC -15% (F ₂₀₁₅ ×0.7)	0.15	0.04	0.17	56.016	12	-15
	12.813	11.900	0.913	Stable TAC (F ₂₀₁₅ ×0.8)	0.17	0.04	0.2	54.056	8	0
	14.737	13.685	1.052	TAC+15% (F ₂₀₁₅ ×0.9)	0.21	0.05	0.23	52.098	4	15
	15.682	14.580	1.102	F ₂₀₁₅	0.22	0.05	0.25	51.118	2	23
<i>Mixed fisheries options – minor differences with calculation above can occur because of the different methodology used (ICES, 2015b).</i>										
Maximum	25.594			A			0.47	40.187	-20	
Minimum	4.525			B			0.07	61.602	23	
Cod	16.325			C			0.27	49.572	-1	
SQ effort	16.264			D			0.27	49.633	-1	
Value	16.508			E			0.27	49.385	-1	
Effort_Mgt	16.192			F			0.27	49.707	-1	

*"Wanted" and "unwanted" catch are used to described fish that would be landed and discarded in the absence of the EU landing obligation, based on the average discard rates (at age) estimates for 2012-2014. **SSB 2017 relative to SSB 2016.

***Wanted catch 2016 relative to TAC 2015.

Mixed-fisheries assumptions

(note:"fleet's stock share" is used to describe the share of the fishing opportunities for each particular fleet, which has been calculated based on the single-stock advice for 2016 and the historical proportion of the stock landings taken by the fleet):

- A. Maximum scenario: Each fleet stops fishing when its last stock share is exhausted.
- B. Minimum scenario: Each fleet stops fishing when its first stock share is exhausted.
- C. Cod scenario: Each fleet stops fishing when its cod stock share is exhausted.
- D. SQ effort scenario: The effort of each fleet in 2015 and 2016 is as in 2014.
- E. Value scenario: The effort of each fleet is equal to the weighted average of the efforts required to catch the fleet's quota share of each of the stocks, where the weights are the relative catch values of each stock in the fleet's portfolio.
- F. Effort management scenario: Effort reductions according to cod and flatfish management plans.

Basis of the advice

Table 6.3.46.4 Sole in Subarea IV (North Sea). The basis of the assessment and advice.

Advice basis	EU management plan (Council Regulation No. 676/2007)
Management plan	An evaluation of the management plan (ICES, 2010) concluded that the management plan is precautionary. The stocks are in stage two of the EU multiannual plan (EU, 2014). Application of stage two of the plan is based on transitional arrangements until an evaluation of the plan has been conducted. ICES assumes that harvesting the stock with the newest estimate of F _{MSY} is in accordance with stage two of the current plan.

Quality of the assessment

The North Sea sole assessment was recently benchmarked (ICES, 2015c). Changes made during the benchmark were (i) the adoption of a statistical catch-at-age model (AAP-model, Aarts and Poos, 2009), that is able to reconstruct historical discards, and (ii) the removal of the Dutch commercial LPUE, due to the introduction of new gears (e.g., pulse trawling and fuel-saving wings) in the Dutch beam trawl fleet. The new assessment is very similar in terms of SSB and recruitment, but has a smoother pattern of F over time.

Age compositions of the landings and discards are well sampled and the quality of the surveys is adequate. However, current survey indices do not cover the south-western part of the stock distribution. Effort should be made to derive a combined survey index.

More refined data on the type of gear used is needed in logbooks because of a rapid increase in the usage of new gears (i.e. pulse trawls) and the unknown consequences for the catchability of sole.

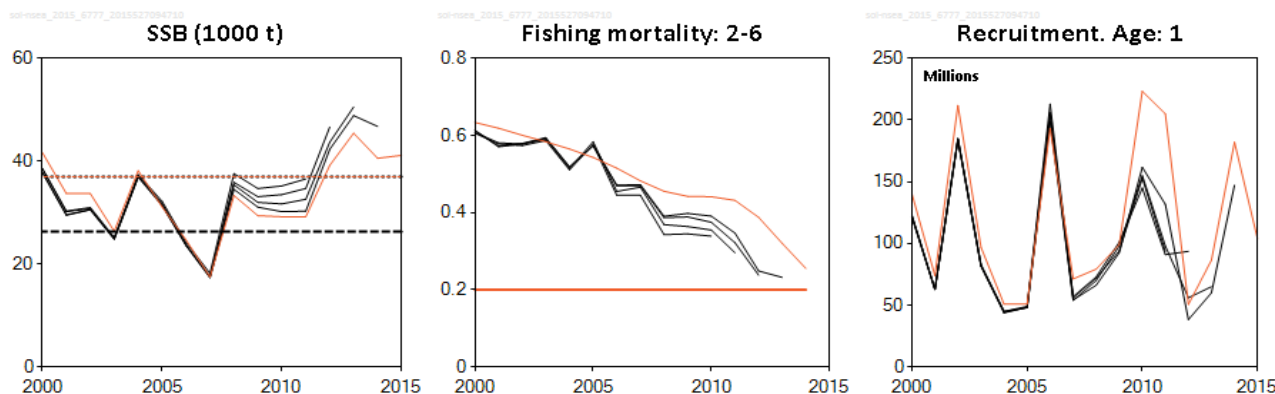


Figure 6.3.46.2 Sole in Subarea IV (North Sea). Historical assessment results (final-year recruitment estimates included).

Issues relevant for the advice

Technical measures applicable to the mixed flatfish beam trawl fishery in the southern North Sea affect both sole and plaice. The minimum mesh size of 80 mm generates high discards of plaice which have a larger minimum landing size than sole. The use of larger mesh sizes would reduce the catch of undersized plaice and sole, but would also result in loss of marketable sole in the short term (Cardinale and Hjelm, 2012).

Since 2011, the use of pulse trawls in the Dutch fishery has increased sharply to 74 vessels (of which 65 >221 kW) and only eight traditional beam trawls are now left. The increased use of pulse trawls and other adaptations like fuel-saving wings may affect catchability and selectivity of North Sea sole. Though this effect has not yet been quantified, it will increase assessment uncertainty.

Results from a North Sea mixed fisheries analysis are presented in ICES (2015d). Assuming fishing patterns and catchability in 2015 and 2016 are unchanged from those in 2014, and in the case of a strictly implemented discard ban, North Sea whiting and *Nephrops* FU6 (if it was managed with an own TAC for the FU) would be the most limiting stocks, constraining 46% and 34% of the 2014 effort respectively. Results for the sole stock are also included as additional rows in the catch options table of this advice sheet.

Reference points

Table 6.3.46.3 Sole in Subarea IV (North Sea). Reference points, values and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	37000 t	Default to value of B_{pa} .	ICES (2015a)
	F_{MSY}	0.2	Median of stochastic MSY analysis assuming a Hockey stick stock recruit relationship.	ICES (2014)
Precautionary approach	B_{lim}	26300 t	B_{loss}	ICES (2015a)
	B_{pa}	37000 t	$B_{pa}1.4 \times B_{lim}$	ICES (2015a)
	F_{lim}	Not defined.		
	F_{pa}	Not defined.		
Management plan	SSB_{MGT}	35000 t	Stage two	EU management plan (Council Regulation No. 676/2007)
	F_{MGT}	0.2	Stage two: Article 4.3 – F_{MSY} .	EU management plan (Council Regulation No. 676/2007)

Basis of the assessment

Table 6.3.46.4 Sole in Subarea IV (North Sea). The basis of the assessment and advice.

ICES Stock data category	1 (ICES, 2015e)
Assessment type	Statistical catch-at-age model with flexible selectivity functions to reconstruct historical discards (Aarts and Poos, 2009) (ICES, 2015a)
Input data	Commercial catches (age frequencies from catch sampling), three survey indices (BTS-ISIS Q3, SNS Q3, DFS Q3). Natural mortality is assumed constant. Maturity-at-age is assumed to be knife-edged (at age 3).
Discards and bycatch	Discards are included in the assessment. Discards (1957–2002) are reconstructed. In 2014, 96% of the landings had associated discarding information.
Indicators	None
Other information	The stock has been benchmarked (ICES, 2015b), main changes were the inclusion of discards and the removal of the Dutch beam trawl fleet commercial index (ICES, 2015a).
Working group	Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK), Working Group on Mixed-Fisheries Advice (WGMIXFISH-NS)

Information from stakeholders

The cumulative index of perceptions of the abundance of common sole (Figure 6.3.46.3) increased in about half of the areas (mainly in the south and east), but declined or remained the same in the others. The stock is primarily distributed in the southern areas (Areas 5 and 6) and trends in these areas generally match the assessed stock biomass trends in recent years (Napier, 2014).

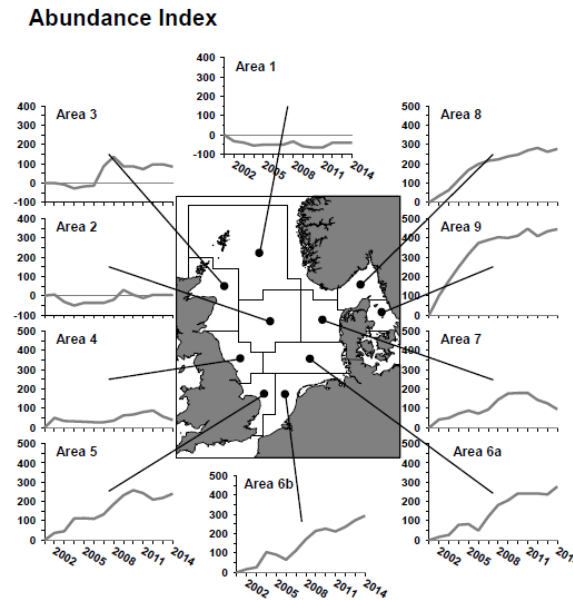


Figure 6.3.46.3 Cumulative time series of index of perceptions of abundance of common sole, by area (see page 14 for explanation of the index). From Napier (2014).

History of advice, catch and management

Table 6.3.46.5 Sole in Subarea IV (North Sea). History of ICES advice, the agreed TAC, official and ICES estimates of landings. All weights in thousand tonnes.

Year	ICES advice	Predicted landings corresponding to advice	Predicted catch corresponding to advice	Agreed TAC	ICES landings	ICES discards
1987	Rebuild SSB to 40 000 t; TAC	11.0		14.0	17.4	
1988	Increase SSB towards 50 000 t; TAC	11.0		14.0	21.6	
1989	Increase SSB towards 50 000 t; TAC	14.0		14.0	21.8	
1990	80% of F(88); TAC	25.0		25.0	35.1	
1991	SSB >50 000 t ; TAC	27.0		27.0	33.5	
1992	TAC	21.0		25.0	29.3	
1993	no long-term gains in increased F	29.0*		32.0	31.5	
1994	no long-term gains in increased F	31.0*		32.0	33.0	
1995	no long-term gains in increased F	28.0*		28.0	30.5	
1996	Mixed fishery, link plaice advice	23.0*		23.0	22.7	
1997	< 80% of F(95)	14.6		18.0	14.9	
1998	75% of F(96)	18.1		19.1	20.9	
1999	F < F _{pa} (80% of F(97))	20.3		22.0	23.5	
2000	F < F _{pa}	< 19.8		22.0	22.6	
2001	F < F _{pa}	< 17.7		19.0	19.9	
2002	F < 0.37	< 14.3		16.0	16.9	1.7
2003	F < F _{pa}	< 14.6		15.9	17.9	1.4
2004	F < F _{pa}	< 17.9		17.0	18.8	2.4
2005	F < F _{pa}	< 17.3		18.6	16.4	1.3
2006	Keep SSB above B _{pa}	< 11.9		17.7	12.6	1.0
2007	SSB above B _{pa}	< 10.8		15.0	14.6	0.9
2008	SSB above B _{pa}	< 9.8		12.8	14.1	0.5
2009	Apply management plan	< 14.0		14.0	14.0	1.3
2010	Apply management plan	< 14.1		14.1	12.6	2.2
2011	See scenarios	-		14.1	11.5	1.7
2012	Apply first stage of the management plan	< 15.7		16.2	11.6	2.5
2013	Apply first stage of the management plan	< 14		14.0	13.1	2.1
2014	Apply first stage of the management plan.	< 11.9		11.9	13.1	1.6
2015	November update: Apply second stage of the management plan (MSY)	< 11.4		11.9		
2016	Apply second stage of the management plan (MSY)		≤ 12.8			

* Catch *status quo* F.

History of catch and landings

Table 6.3.46.6 Sole in Subarea IV (North Sea). Catch distribution by fleet in 2014 as estimated by ICES.

Catch (2014)	Landings				Discards
	14.636 kt	86.2% beam trawls	9.2% gill-/trammelnets	2.2% otter trawls	
	13.060 kt				

Table 6.3.46.7 Sole in Subarea IV (North Sea). History of official and ICES landings. All weights in tonnes.

Year	BE	DK	FR	GE	NL	UK (E/W/Nl)	Other	Total reported landings	ICES Total landings	TAC
1982	1900	524	686	266	17686	403	2	21467	21579	21000
1983	1740	730	332	619	16101	435		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	318	210	10635	676	4	13829	17368	14000
1988	1199	616	487	452	9841	740	28	13363	21590	14000
1989	1596	1020	312	864	9620	1033	50	14495	21805	14000
1990	2389	1427	352	2296	18202	1614	263	26543	35120	25000
1991	2977	1307	465	2107	18758	1723	271	27608	33513	27000
1992	2058	1359	548	1880	18601	1281	277	26004	29341	25000
1993	2783	1661	490	1379	22015	1149	298	29775	31491	32000
1994	2935	1804	499	1744	22874	1137	298	31291	33002	32000
1995	2624	1673	640	1564	20927	1040	312	28780	30467	28000
1996	2555	1018	535	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	828	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		11933	12594	17670
2007	955	413	401	458	10365	1203	5	13800	14635	15000
2008	1379	507	714	513	9456	851	15	13435	14071	12800
2009	1353	NA	NA	555	12038	951	1	NA	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	9569	314	675	642	920	840	0	12547	13060	11900

Summary of the assessment

Table 6.3.46.8 Sole in Subarea IV (North Sea). Assessment summary with weights (in tonnes).

Year	Recruitment Age 1 thousands	SSB tonnes	Landings tonnes	Discards tonnes	Mean F Ages 2-6
1957	132202	62764	13265	653	0.214
1958	120132	65189	13201	612	0.214
1959	443953	68153	15512	831	0.225
1960	41337	69523	17602	1137	0.254
1961	67315	103475	28706	2519	0.306
1962	11128	86465	28470	1237	0.35
1963	12594	69695	22468	645	0.334
1964	615442	51436	14549	221	0.282
1965	151562	41429	10492	848	0.259
1966	54487	110633	33896	4464	0.299
1967	83368	105601	33565	2395	0.4
1968	116260	90301	34959	1583	0.505
1969	83165	68359	23106	1872	0.529
1970	198396	62973	20936	1988	0.504
1971	56236	55432	21394	2475	0.496
1972	106243	64110	25589	2008	0.525
1973	140931	46717	20466	1466	0.554
1974	119070	44992	19942	1903	0.538
1975	58149	45953	18717	1919	0.494
1976	139912	45461	16904	1462	0.462
1977	172918	37225	15896	1532	0.463
1978	61363	43186	19558	2155	0.487
1979	16882	52189	23214	1953	0.51
1980	175266	38542	16023	877	0.515
1981	214724	26040	13276	1564	0.526
1982	205530	37478	20124	3179	0.561
1983	199377	49493	26828	3824	0.611
1984	90799	51225	28188	3667	0.645
1985	107125	46825	24673	2506	0.628
1986	164434	37384	17675	1569	0.58
1987	85455	34096	15985	1739	0.534
1988	671031	42287	18408	1891	0.506
1989	128096	38405	22334	3771	0.493
1990	233559	121253	49054	5733	0.482
1991	85172	87197	35819	2842	0.48
1992	441748	87143	33672	2367	0.5
1993	87959	58340	29573	3245	0.534
1994	64864	85457	36116	3841	0.579
1995	113156	64139	31656	2232	0.624
1996	71297	37470	19932	1607	0.648
1997	309603	31391	15758	1556	0.655
1998	144935	23353	16205	2694	0.652
1999	112579	48977	25258	3465	0.644
2000	140476	41657	22264	2550	0.634
2001	74001	33714	19115	2309	0.619
2002	211829	33708	16437	1782	0.601
2003	96924	26379	15967	2706	0.584
2004	50766	38150	16922	2397	0.565
2005	51021	31116	13434	1433	0.543

2006	193256	24690	11330	1282	0.516
2007	71319	17465	10782	2116	0.483
2008	79249	33329	12825	1840	0.456
2009	99058	29421	11664	1267	0.442
2010	223384	29207	11414	1060	0.441
2011	205064	29191	11728	1406	0.432
2012	50595	39187	16033	1957	0.388
2013	86491	45444	16232	1458	0.32
2014	182074	40570	11960	798	0.255
2015	103741	41137			
Average	146254	52070	20812	2042	0.481

Sources and references

Aarts, G., and Poos, J. J. 2009. Comprehensive discard reconstruction and abundance estimation using flexible selectivity functions. *ICES Journal of Marine Science*, 66: 763–771.

Cardinale, M. and Hjelm, J. 2012. Short term loss and long term revenue in a size-selective fishery. *Marine Policy*, 36: 903–906.

ICES. 2010. Request from the Netherlands on the evaluation of the long-term management plan for sole and plaice in the North Sea (part 2). *In Report of the ICES Advisory Committee, 2010. ICES Advice 2010, Book 6, Section 6.3.3.4.*

ICES. 2014b. Report of the Joint ICES–MYFISH Workshop to consider the basis for FMSY ranges for all stocks (WKMSYREF3), 17–21 November 2014, Charlottenlund, Denmark. ICES CM 2014/ACOM:64. 147 pp.

ICES. 2015a. Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK), 28 April – 7 May 2015. ICES CM 2015/ACOM:13.

ICES. 2015b. Report of the Working Group on Mixed-Fisheries Advice for the North Sea (WGMIXFISH-Advice), 25–29 May 2015. ICES CM 2015/ACOM:22.

ICES. 2015c. Report of the Benchmark Workshop on North Sea Stocks (WKNSEA), 2–6 February 2015. ICES CM 2015/ACOM:32.

ICES. 2015d. Mixed-fisheries advice for Subarea IV (North Sea) and Divisions IIIa North (Skagerrak) and VIId (Eastern Channel). *In Report of the ICES Advisory Committee, 2015. ICES Advice 2015, Book 6, Section 6.2.2.2. In preparation.*

ICES. 2015e. Advice basis. *In Report of the ICES Advisory Committee, 2015. ICES Advice 2015, Book 1, Section 1.2. In preparation.*

ICES. 2015f. Sole in IV advice sheet. *In Report of the ICES Advisory Committee, 2015. ICES Advice 2015, Book 6, Section 6.2.2.2 Update*

Napier, I. R. 2014. Fishers’ North Sea stock survey 2014. NAFC Marine Centre, Shetland, Scotland. <http://nsss.eu>