7.3.34 Sardine *(Sardina pilchardus)* in divisions 8.c and 9.a (Cantabrian Sea and Atlantic Iberian waters)

ICES stock advice

ICES advises that when the management plan is applied, catches in 2016 should be no more than 12 000 tonnes. All catches are assumed to be landed. This advice for 2016 replaces the one provided in July 2015.

ICES advises that when the management plan is applied, catches in 2017 should be no more than 23 000 tonnes. All catches are assumed to be landed.

Stock development over time

The biomass of age one and older fish has decreased since 2006 and is currently around the historical low. Recruitment has been below the long-term average since 2005. Fishing mortality has decreased from a peak in 2011 and is currently at the lowest in the time-series.

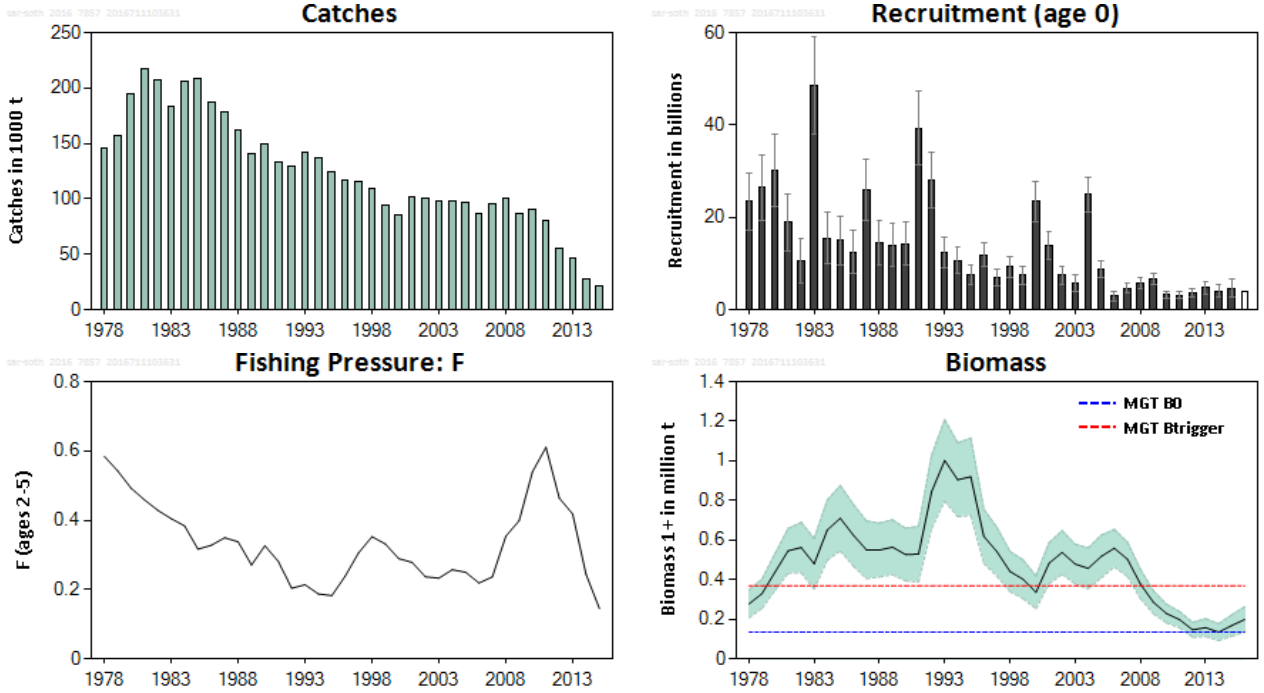

Figure 7.3.34.1 Sardine in divisions 8.c and 9.a. Summary of stock. Predicted values are not shaded. Recruitment and biomass have 95% confidence intervals.

Stock and exploitation status

Table 7.3.34.1 Sardine in divisions 8.c and 9.a. State of the stock and fishery relative to reference points.

	Fishing pressure					Stock size				
		2013	2014	2015			2014	2015	2016	
Maximum sustainable yield	F_{MSY}	?	?	?	Undefined	MSY $B_{trigger}$	?	?	?	Undefined
Precautionary approach	F_{pa},F_{lim}	?	?	?	Undefined	B_{pa},B_{lim}	?	?	?	Undefined
Management plan	HR_{MGT}	-	-	-	Not applicable	MGT B_0, MGT $B_{trigger}$	o	o	o	Between triggers

Revision of the catch advice for 2016

ICES received a special request from the European Commission to review the catch advice for 2016 based on the most recent available data. ICES has responded to this request by updating the advice based on the results of the stock assessment conducted in 2016.

Table 7.3.34.2 Sardine in Divisions 8.c and 9.a. The basis for the revised catch options for 2016.

Variable	Value	Source	Notes
F ages 2-5 (2015)	0.14	ICES, 2016a	Estimated in the 2016 assessment
B_{1+} (2016)	199 264 t	ICES, 2016a	Estimated in the 2016 assessment
R_{age0} (2015)	4 655 mill	ICES, 2016a	Estimated in the 2016 assessment
R_{age0} (2016)	4 005 mill	ICES, 2016a	Geometric mean (2011-2015)
Total catch (2015)	20 595 t	ICES, 2016a	2015 ICES catch estimate
Discards (2015)	Negligible	ICES, 2015a	

Table 7.3.34.3 Sardine in Divisions 8.c and 9.a. The catch options for the revised catch advice for 2016. Weights in thousand tonnes.

Rationale	Catches (2016)	Basis	F (2016)	Biomass 1+ (2017)	% Biomass 1+ change*	% Catch change**
Management plan	12	$Catch_{2016} = (0.36 \times (B1+_{2015} - B_0))$	0.07	211	+6	-57
Precautionary considerations	13	$F = F_{2002–2007} \times (B1+_{2015}/ B1+_{2002–2007})$	0.08	210	+5	-53
Zero catch	0	$F_{2016} = 0$	0	220	+10	-100
Other options	9	$F_{2016} = 0.05$	0.05	214	+7	-68
	25	$F_{2016} = 0.15$	0.15	202	+1	-11
	32	$F_{2016} = 0.20$	0.20	196	-2	+15
	23	$F_{2016} = F_{2015}$	0.14	203	+2	-18

*Biomass 1+ 2017 relative to Biomass 1+ 2016 (199.264 kt).
** Catch in 2016 compared to 2014 catches (27.937 kt).

Catch options for 2017

Table 7.3.34.4 Sardine in divisions 8.c and 9.a. The basis for the catch options for 2017. Weights in thousand tonnes

Variable	Value	Source	Notes
F ages 2–5 (2016)	0.07	ICES, 2016a	Corresponding to 2016 catch assumption
B1+ (2017)	211	ICES, 2016a	Short-term forecast
R_{age0} (2016)	4 005 mill	ICES, 2016a	Geometric mean (2011–2015)
R_{age0} (2017)	4 005 mill	ICES, 2016a	Geometric mean (2011–2015)
Total catch (2016)	12	ICES, 2016a	ICES updated catch advice for 2016 based on the management plan
Discards (2016)	Negligible	ICES, 2016a	

Table 7.3.34.5 Sardine in divisions 8.c and 9.a. The catch options for 2017. Weights in thousand tonnes.

Rationale	Catches (2017)	Basis	F(2017)	Biomass 1+ (2018)	% Biomass 1+ change*	% Catch change**
Management plan	23	$Catch_{2017} = (0.36 \times (B1+_{2016} - B_0))$	0.12	216	+ 2	+12
Precautionary considerations	17	$F = F_{2002–2007} \times (B1+_{2016}/ B1+_{2002–2007})$	0.09	221	+5	-17
Zero catch	0	$F_{2017} = 0$	0	233	+ 10	-100
Other options	37	F2017 = 0.20	0.20	206	-2	+ 80
	27	$F_{2017} = F_{2015}$	0.14	213	+1	+31
	13	$F_{2017} = F_{2016}$	0.07	224	+ 6	-37

*Biomass 1+ 2018 relative to Biomass 1+ 2017 (211 kt).
** Catch in 2017 compared to 2015 catches (20.595 kt).

Basis of the advice

Table 7.3.34.6 Sardine in divisions 8.c and 9.a. The basis of the advice.

Advice basis	Management plan
Management plan	The Spanish and Portuguese governments have accepted a management plan for this stock (Sardine Fishery Management Plan – (2012–2015)). The plan was evaluated by ICES (ICES, 2013) at the request of the EU and is considered to be provisionally precautionary. The plan has three clauses: when $B_{1+} \geq B_{trigger}$, catch = 86kt; when $B_{trigger} > B_{1+} \geq B_0$, catch = 0.36 x ($B_{1+}$-$B_0$); when $B_{1+} < B_0$, catch = 0. The plan tested by ICES has $B_{trigger}$ = 368.4 kt and B_0 = 135 kt.

Quality of the assessment

The current low abundance and patchy spatial distribution of sardine is likely to decrease the accuracy and precision of acoustic estimates in comparison with past periods of higher abundance.

The current assessment revised the biomass upwards and fishing mortality downwards in comparison with last years' assessment. These scaling effects result from a perception of higher abundance of ages two and older than had been expected from year class signals in recent years. Scaling effects have a retrospective impact, with the magnitude of the impact decreasing (from around 12% in recent years to 6–7% for years before 2010).

The consistency in trends between the daily egg production method (DEPM) and acoustic surveys has increased since 2008, improving the agreement between current assessment and historical results. The main uncertainties in the assessment relate to fishery selection patterns along the time-series and divergent signals in the stock trends between the DEPM and acoustic surveys until 2008. The triennial mode of the DEPM gives the last data point a large influence on the assessment. As the influence of the last data point weakens over the following two years, the assessment becomes increasingly affected by the acoustic survey.

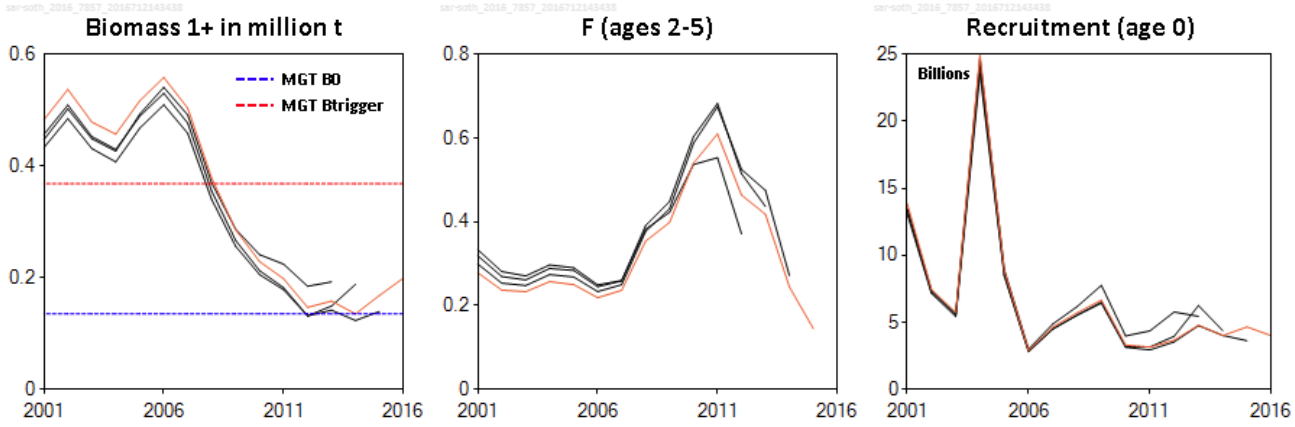

Figure 7.3.34.2 Sardine in divisions 8.c and 9.a. Historical assessment results (final-year recruitment estimates included).

Issues relevant for the advice

The upward revision of the catch advice for 2016 when the management plan is applied is a consequence of the upward revision of 2015 biomass in this years' assessment compared to last years' assessment. The upward revision of the 2015 biomass is, in turn, mainly caused by higher estimates of stock numbers for ages four and older in 2015 and an upward revision of 2015 stock weights–at-age in this years' assessment compared to last years' assessment.

The forecast for 2017 uses an assumption that catch in 2016 is 12 000 t (ICES updated catch advice for 2016 based on the management plan). If the actual catch in 2016 is in the order of the recently observed catches and, thus, higher than assumed, the forecast for 2017 will likely underestimate F in 2017 and overestimate stock biomass in 2018.

Despite the small increase in acoustic abundance in 2016, the abundance remains low and the spatial distribution is patchy. The spawning area has shrunk in recent years and is mainly concentrated in the southern areas. The stock and the catches are largely dominated by young individuals with low reproductive potential. The survival of incoming year classes until older ages may be important to improve the stock's reproductive potential. This reinforces the need to maintain low fishing mortality levels.

National quotas and effort limitations have contributed to a reduction in fishing mortality since 2011.

Reference points

Table 7.3.34.7 Sardine in divisions 8.c and 9.a. Reference points, values, and their technical basis.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	Not defined		
	F_{MSY}	Not defined		
Precautionary approach	B_{lim}	Not defined		
	B_{pa}	Not defined		
	F_{lim}	Not defined		
	F_{pa}	Not defined		
Management plan	MGT B_0	135 000 t	Level of biomass 1+ below which the fishery is closed; biomass value to ensure a recovery of the stock in the short term.	ICES, 2013; Silva and Azevedo, 2012
	MGT $B_{trigger}$	368 400 t	Biomass 1+ = 1.2 B_{loss}, where B_{loss} was calculated from the 2012 assessment.	ICES, 2013
	F_{MGT}	Not applicable		

Basis of the assessment

Table 7.3.34.8 Sardine in divisions 8.c and 9.a. The basis of the assessment.

ICES stock data category	1 (ICES, 2016a)
Assessment type	Age-based analytical assessment (SS3) that uses catches in the model and in the forecast (ICES, 2015a)
Input data	Commercial catches (international landings, age groups from catch sampling); annual acoustic survey indices (age groups from PELAGO&PELACUS-Q2) triennial spawning-stock biomass (SSB) indices (PT-DEPM&SP-DEPM); triennial maturity data from DEPM (PT-DEPM&SP-DEPM) and a fixed maturity ogive in other years; natural mortalities from Gislason formula (Gislason *et al*., 2010); weights in the stock from acoustic surveys (PELAGO&PELACUS-Q2)
Discards and bycatch	Not included and are considered negligible
Indicators	None
Other information	Benchmarked in February 2012 (WKPELA; ICES, 2012) and is planned to be benchmarked in 2017
Working group	Working Group on Southern Horse Mackerel, Anchovy and Sardine(WGHANSA)

Information from stakeholders

There is no available information.

History of advice, catch and management

Table 7.3.34.9 Sardine in divisions 8.c and 9.a. History of ICES advice, the agreed TAC, and ICES estimates of catch. Weights in thousand tonnes.

Year	ICES advice	Predicted catch corresp. to advice	Agreed TAC	Official landings 8 & 9	ICES catch*
1987	No increase in F; TAC	140	-		178
1988	No increase in F; TAC	150	-	167	162
1989	No increase in F; TAC	212	-	146	141
1990	Room for increased F	227*	-	150	149
1991	Precautionary TAC	176	-	135	133
1992	No advice	-	-	139	130
1993	Precautionary TAC	135	-	153	142
1994	No advice	118**	-	147	137
1995	No advice; apparently stable stock	-	-	137	125
1996	Lowest possible level	-	-	134	117
1997	Lowest possible level	-	-	n/a	116
1998	Significant reduction	-	-	n/a	109
1999	Reduce F to 0.2	38	-	n/a	94
2000	F below 0.2	< 81	-	n/a	86
2001	F below 0.2	< 88	-	n/a	102
2002	F below 0.25	< 95	-	n/a	100
2003	No increase in F	100	-	n/a	98
2004	No increase in F	128	-	n/a	98
2005	No increase in F	106	-	n/a	97
2006	No increase in F	96	-	n/a	87
2007	No increase in F	114	-	n/a	96
2008	No increase in F	92	-	n/a	101
2009	No increase in F	71	-	n/a	88
2010	No increase in F	75	-	n/a	90
2011	Maintain F at 2002–2007 level	75	-	77	80
2012	Reduce F to the 2002–2007 level	36	-	52	55
2013	Reduce F to the 2002–2007 level	< 55	-	46	46
2014	Reduce F to the 2002–2007 level adjusted to low biomass	< 17	-	27.937	27.937
2015	Reduce F to the 2002–2007 level adjusted to low biomass	< 16	-	20.595	20.595
2016***	Management Plan	≤12	-		
2017	Management Plan	≤23			

n/a = not available.

* Includes only divisions 8.c and 9.a.

** Estimated catch at *status quo* F.

*** Catch advice for 2016 updated in July 2016.

History of catch and landings

Table 7.3.34.10 Sardine in divisions 8.c and 9.a. Catch distribution by fleet in 2015 as estimated by ICES.

Total catch (2015)	Official landings		Discards
20 595 t	99% purse-seine	1% other gear types	Negligible
	20 595 t		

Table 7.3.34.11 Sardine in divisions 8.c and 9.a. History of catch. Official values are presented by area. Weights in tonnes.

Year	8.c	9.a North	9.a Central North	9.a Central South	9.a South Algarve	9.a South Cadiz	Total 9.a	Total catch (8.c and 9.a)
1940	66816		42132	33275	23724		99131	165947
1941	27801		26599	34423	9391		70413	98214
1942	47208		40969	31957	8739		81665	128873
1943	46348		85692	31362	15871		132925	179273
1944	76147		88643	31135	8450		128228	204375
1945	67998		64313	37289	7426		109028	177026
1946	32280	1231	68787	26430	12237		107454	139734
1947	43459	21855	55407	25003	15667		117932	161391
1948	10945	17320	50288	17060	10674		95342	106287
1949	11519	19504	37868	12077	8952		78401	89920
1950	13201	27121	47388	17025	17963		109497	122698
1951	12713	27959	43906	15056	19269		106190	118903
1952	7765	30485	40938	22687	25331		119441	127206
1953	4969	27569	68145	16969	12051		124734	129703
1954	8836	28816	62467	25736	24084		141103	149939
1955	6851	30804	55618	15191	21150		122763	129614
1956	12074	29614	58128	24069	14475		126286	138360
1957	15624	37170	75896	20231	15010		148307	163931
1958	29743	41143	92790	33937	12554		180424	210167
1959	42005	36055	87845	23754	11680		159334	201339
1960	38244	60713	83331	24384	24062		192490	230734
1961	51212	59570	96105	22872	16528		195075	246287
1962	28891	46381	77701	29643	23528		177253	206144
1963	33796	51979	86859	17595	12397		168830	202626
1964	36390	40897	108065	27636	22035		198633	235023
1965	31732	47036	82354	35003	18797		183190	214922
1966	32196	44154	66929	34153	20855		166091	198287
1967	23480	45595	64210	31576	16635		158016	181496
1968	24690	51828	46215	16671	14993		129707	154397
1969	38254	40732	37782	13852	9350		101716	139970
1970	28934	32306	37608	12989	14257		97160	126094
1971	41691	48637	36728	16917	16534		118816	160507
1972	33800	45275	34889	18007	19200		117371	151171
1973	44768	18523	46984	27688	19570		112765	157533
1974	34536	13894	36339	18717	14244		83194	117730
1975	50260	12236	54819	19295	16714		103064	153324
1976	51901	10140	43435	16548	12538		82661	134562
1977	36149	9782	37064	17496	20745		85087	121236
1978	43522	12915	34246	25974	23333	5619	102087	145609
1979	18271	43876	39651	27532	24111	3800	138970	157241
1980	35787	49593	59290	29433	17579	3120	159015	194802
1981	35550	65330	61150	37054	15048	2384	180967	216517
1982	31756	71889	45865	38082	16912	2442	175190	206946
1983	32374	62843	33163	31163	21607	2688	151463	183837

Year	8.c	9.a North	9.a Central North	9.a Central South	9.a South Algarve	9.a South Cadiz	Total 9.a	Total catch (8.c and 9.a)
1984	27970	79606	42798	35032	17280	3319	178035	206005
1985	25907	66491	61755	31535	18418	4333	182532	208439
1986	39195	37960	57360	31737	14354	6757	148168	187363
1987	36377	42234	44806	27795	17613	8870	141319	177696
1988	40944	24005	52779	27420	13393	2990	120587	161531
1989	29856	16179	52585	26783	11723	3835	111105	140961
1990	27500	19253	52212	24723	19238	6503	121929	149429
1991	20735	14383	44379	26150	22106	4834	111852	132587
1992	26160	16579	41681	29968	11666	4196	104090	130250
1993	24486	23905	47284	29995	13160	3664	118009	142495
1994	22181	16151	49136	30390	14942	3782	114401	136582
1995	19538	13928	41444	27270	19104	3996	105742	125280
1996	14423	11251	34761	31117	19880	5304	102313	116736
1997	15587	12291	34156	25863	21137	6780	100227	115814
1998	16177	3263	32584	29564	20743	6594	92747	108924
1999	11862	2563	31574	21747	18499	7846	82229	94091
2000	11697	2866	23311	23701	19129	5081	74089	85786
2001	16798	8398	32726	25619	13350	5066	85159	101957
2002	15885	4562	33585	22969	10982	11689	83787	99673
2003	16436	6383	33293	24635	8600	8484	81395	97831
2004	18306	8573	29488	24370	8107	9176	79714	98020
2005	19800	11663	25696	24619	7175	8391	77545	97345
2006	15377	10856	30152	19061	5798	5779	71646	87023
2007	13380	12402	41090	19142	4266	6188	83088	96469
2008	13636	9409	45210	20858	4928	7423	87828	101464
2009	11963	7226	36212	20838	4785	6716	75777	87740
2010	13772	7409	40923	17623	5181	4662	75798	89571
2011	8536	5621	37152	13685	6387	9023	71867	80403
2012	13090	4154	19647	9045	2891	6031	41768	54857
2013	5272	2128	15065	9084	4112	10157	40546	45818
2014	4344	1924	6889	6747	2398	5635	23593	27937
2015	1916	1946	7117	4848	1812	2956	18679	20595

Summary of the assessment

Table 7.3.34.12 Sardine in divisions 8.c and 9.a. Assessment summary with weights (in tonnes). Recruitment in thousands. High and low refer to 95% confidence intervals.

Year	Recruitment (age 0) thousands	High	Low	Biomass 1+ tonnes	High	Low	Total catch tonnes	F (ages 2–5)
1978	23397900	29535800	17260000	277842	348279	207405	146002	0.584
1979	26512200	33618320	19406080	329453	403594	255312	157001	0.542
1980	30181100	38048840	22313360	438931	531885	345977	195000	0.493
1981	18916000	25181460	12650540	545657	658342	432972	217000	0.459
1982	10675700	15508980	5842420	562347	689418	435276	207000	0.429
1983	48574500	59023940	38125060	479828	608153	351503	184000	0.404
1984	15537000	21234360	9839640	650499	802500	498498	206000	0.384
1985	14951400	20219800	9683000	710144	875343	544945	208000	0.317
1986	12487400	17143000	7831800	624728	780386	469070	187000	0.328
1987	25899500	32617340	19181660	550714	696477	404951	178000	0.349
1988	14489800	19334320	9645280	549802	685526	414078	162000	0.338
1989	13984500	18660420	9308580	564047	702438	425656	141000	0.271
1990	14338800	19041600	9636000	526637	659367	393907	149000	0.326
1991	39271100	47311080	31231120	529003	669435	388571	133000	0.282
1992	28031800	34084220	21979380	843988	1028921	659055	130000	0.204
1993	12380200	15836620	8923780	1001900	1207325	796475	142000	0.214
1994	10657400	13458500	7856300	904517	1091097	717937	137000	0.187
1995	7567130	9582530	5551730	919501	1115034	723968	125000	0.183
1996	11888000	14425520	9350480	618772	755804	481740	117000	0.239
1997	7021540	8843488	5199592	541835	664691	418979	116000	0.306
1998	9240870	11391610	7090130	441436	542991	339881	109000	0.352
1999	7519730	9502590	5536870	402631	500354	304908	94000	0.332
2000	23484100	27819880	19148320	336083	419280	252886	86000	0.289
2001	13869200	16890300	10848100	483097	586831	379363	102000	0.278
2002	7458520	9474780	5442260	537428	647374	427482	100000	0.237
2003	5737860	7578758	3896962	478915	578982	378848	98000	0.233
2004	24927400	28636300	21218500	457065	560464	353666	98000	0.257
2005	8854980	10710748	6999212	517000	624774	409226	97000	0.25
2006	2901460	3828988	1973932	558804	653679	463929	87000	0.219
2007	4645890	5747958	3543822	503711	590772	416650	96000	0.236
2008	5706010	6882368	4529652	378483	452427	304539	101000	0.354
2009	6660540	7871192	5449888	285870	343653	228087	87000	0.399
2010	3295820	4099894	2491746	228887	276126	181648	90000	0.54
2011	3152300	4002894	2301706	198134	239072	157196	80001	0.61
2012	3664570	4629620	2699520	146805	184444	109166	55000	0.464
2013	4781900	6178008	3385792	158020	202762	113278	46000	0.418
2014	4009410	5413970	2604850	135106	177467	92745	28000	0.244
2015	4655210	6581046	2729374	168221	222299	114143	21000	0.145
2016	*4005000			199264	263761	134767		
Average	13726506	17630291	10334380	481669	599415	378787	124000	0.334

* Geometric mean (2011–2015)

Sources and references

Gislason, H., Daan, N., Rice, J. C., and Pope, J. G 2010. Size, growth, temperature and the natural mortality of marine fish. Fish and Fisheries, 11:149–158

ICES. 2012. Report of the Benchmark Workshop on Pelagic Stocks (WKPELA 2012), 13–17 February 2012, Copenhagen, Denmark. ICES CM 2012/ACOM:47. 572 pp.

ICES. 2013. Management plan evaluation for sardine in Divisions 8.c and 9.a. In Report of the ICES Advisory Committee, 2013. ICES Advice, 2013. Book 7, Section 7.3.5.1.

ICES. 2015a. Working Group on Southern Horse Mackerel, Anchovy and Sardine (WGHANSA), Lisbon, Portugal, 24–29 June 2015, ICES CM 2015/ACOM:16

ICES. 2016a. General context of ICES advice. *In* Report of the ICES Advisory Committee, 2016. ICES Advice 2016, Book 1, Section 1.2.

ICES. 2016b. Working Group on Southern Horse Mackerel, Anchovy and Sardine (WGHANSA), 24–29 June 2016, Lorient, France. ICES CM 2016/ACOM:17.

Silva, A., and Azevedo, M. 2012. Portuguese sardine purse seine fishery. Revision of the catch prediction for 2012, reference points and simulation of harvest control rules. Technical document presented to the Portuguese Sardine Commission, April 2012.