

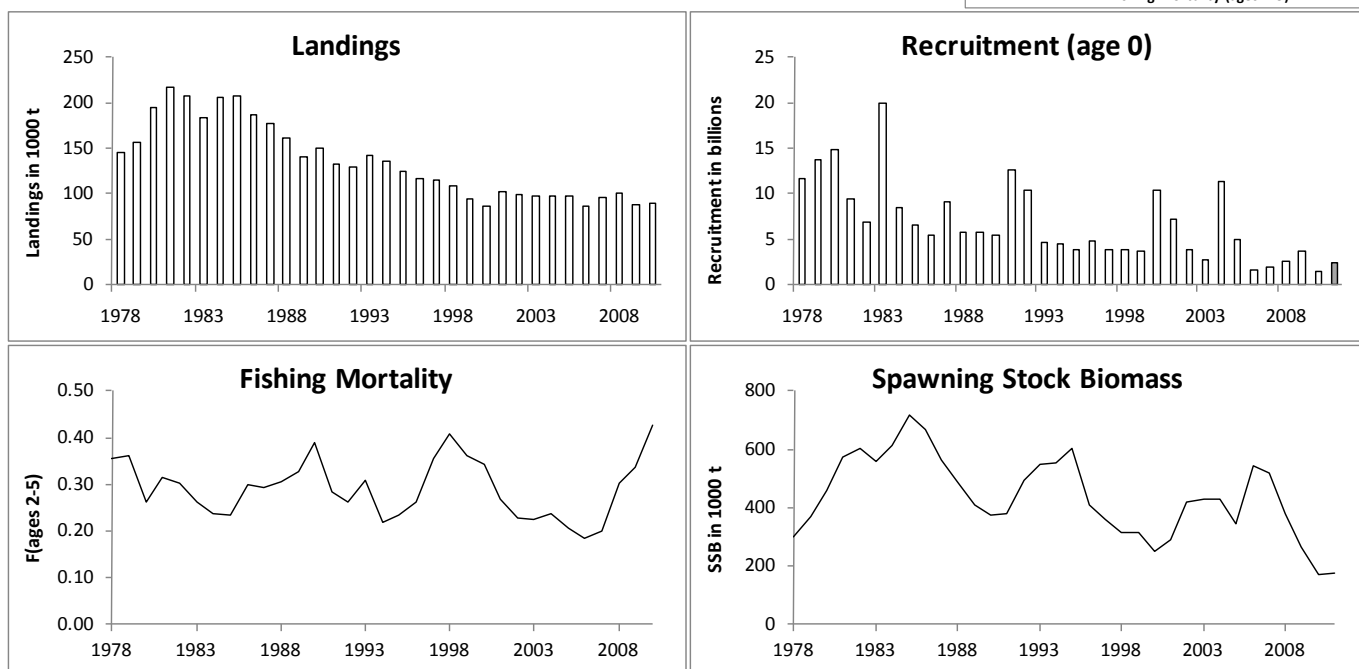
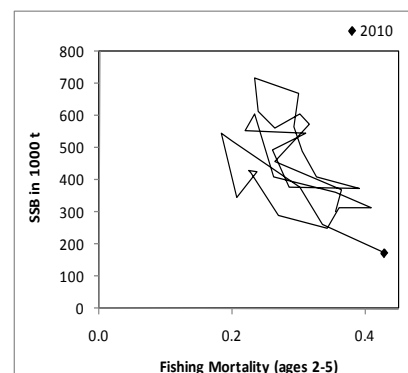
**ECOREGION** Bay of Biscay and Atlantic Iberian waters  
**STOCK** Sardine in Divisions VIIIc and IXa

**Advice for 2012**

ICES advises on the basis of precautionary considerations that landings in 2012 should be no more than 36 000 t.

**Stock status**

F (Fishing Mortality)			
	2008	2009	2010
MSY ( $F_{MSY}$ )	?	?	?
Precautionary approach ( $F_{pa}, F_{lim}$ )	?	?	?
Qualitative evaluation	↗	↗	✗
SSB (Spawning-Stock Biomass)			
	2009	2010	2011
MSY ( $B_{trigger}$ )	?	?	?
Precautionary approach ( $B_{pa}, B_{lim}$ )	?	?	?
Qualitative evaluation	↘	↘	✗



**Figure 7.4.7.1** Sardine in Divisions VIIIc and IXa. Summary of stock assessment (weights in '000 tonnes). Top right: SSB and F over the years. Predicted values on recruitment are shaded.

SSB has declined since 2006 due to the lack of strong recruitments in recent years. SSB in 2011 was 67% below the long-term average. Fishing mortality in 2010 was 28% higher than in 2009 and double the historical average. The 2010 year class is estimated as the lowest of the historical time-series.

**Management plans**

No specific management objectives are known to ICES.

## Biology

Sardine is prey for a range of fish and marine mammal species. Sardine is an omnivorous predator able to feed on both phytoplankton and zooplankton. In addition, sardines have been found to ingest their own eggs (and probably those of other species) and this cannibalism might act as a density control mechanism.

## Environmental influence on the stock

Proposed environmental drivers include several global to local scale environmental variables, integrated over the time periods identified as the most critical to ensure egg and larval survival by reducing the transport of eggs and larvae offshore. Indirect effects, e.g. on growth and condition through variations in food supply or water temperature have been given less attention. Results from different studies show that environmental effects, although present, are often weak, and in some cases findings have been contradictory.

## The fisheries

Most landings are taken by purse-seiners. In Spain, boats target anchovy, mackerel, sardine, and horse mackerel; in summer, part of the fleet switches to tuna fishing. Sardine catches are highest in summer and autumn and catches are concentrated to southern Galician and western Cantabrian waters. In Portugal, sardine is the main target species, but chub mackerel, horse mackerel, and anchovy are also landed. Discards and slippage are uncertain, with slippage estimates only available for the Portuguese fleet but with a limited coverage in time and extent.

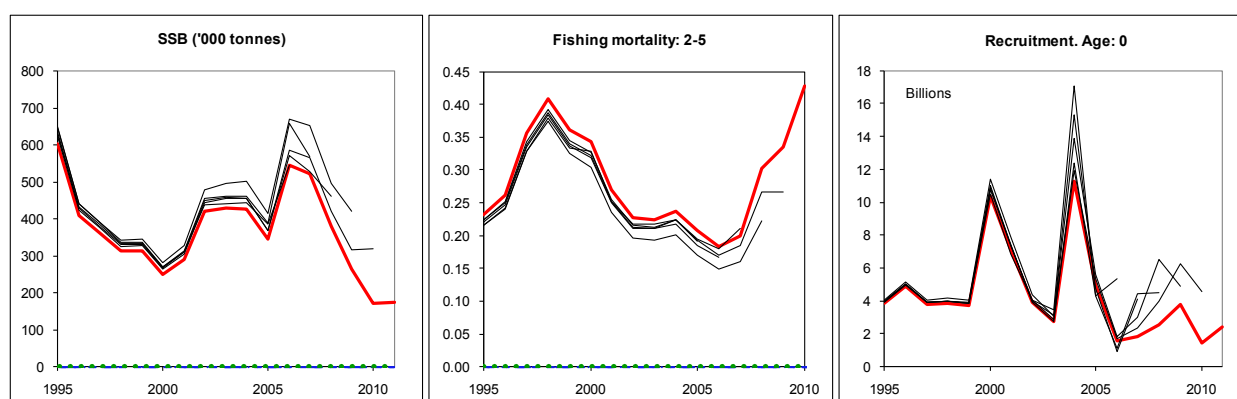
<b>Catch by fleet</b>	Total catch (2010) = 89.6 kt, where 100% are landings (99% purse seine and 1% other gear types).
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## Effects of the fisheries on the ecosystem

Unlike many other types of fishing gear, purse seines have low bycatch of non-target species: when targeting sardine, the catches are virtually monospecific. Observer data and interview surveys of fishers also indicate a low impact on charismatic megafauna (cetaceans, seabirds, and turtles) and, because purse-seiners operate in open waters, there is little impact on the seabed. The overall effect of the sardine fishery on the pelagic ecosystem of the Atlantic Iberian waters has not been evaluated. The most likely impacts will take place in alterations of prey-predator relationships via modification of sardine abundance, size structure, and behaviour.

## Quality considerations

The main uncertainties in the assessment relate to the contradictory signals about the stock trends provided by the DEPM and acoustic surveys in recent years. Uncertainty regarding the extent of sardine movement across the northern stock boundary, and the estimation of survey catchability and fishery selection pattern for the older age groups still applies.



**Figure 7.4.7.2** Sardine in Divisions VIIIc and IXa. Historical assessment results (final year recruitment and SSB estimates included).

## Scientific basis

<b>Assessment type</b>	Age-based analytical assessment (AMCI).
<b>Input data</b>	One acoustic survey index (joint SP-PELACUS and PT-PELAGO surveys), one SSB survey index (joint SP and PT DEPM surveys), and catch-at-age data
<b>Discards and bycatch</b>	Bycatch, discards, and slippage may occur but are considered to be low.
<b>Indicators</b>	None.
<b>Other information</b>	A benchmark will take place in February 2012 (WKPELA)
<b>Working group report</b>	<a href="#">WGANSA</a>

**ECOREGION** Bay of Biscay and Atlantic Iberian waters  
**STOCK** Sardine in Divisions VIIIc and IXa

**Reference points**

No reference points are defined for this stock.

**Outlook for 2012**

Basis:  $F(2011) = F_{sq} = \text{average } F(08-10 \text{ unscaled}) = 0.36$ ;  $SSB(2011)^{1)} = 174\,000 \text{ t}$ ; Landings (2011) = 65 000 t;  $R(2011) \text{ and } R(2012) = GM(2005-2010) = 2407 \text{ million}$ .

Rationale	Landings (2012)	Basis	F (2012)	SSB (2012) <sup>1)</sup>	SSB (2013) <sup>1)</sup>	%SSB change <sup>2)</sup>
Precautionary considerations	36	Maintain F at 2002–2007 average	0.21	144	140	-3%
Zero catch	0	F=0	0	150	171	14%
<i>Status quo</i>	47	$F_{sq} * 0.8$	0.28	142	131	-8%
	52	$F_{sq} * 0.9$	0.32	140	127	-9%
	57	$F_{sq} * 1.0$	0.36	139	123	-12%
	62	$F_{sq} * 1.1$	0.39	138	119	-14%
	67	$F_{sq} * 1.2$	0.43	137	115	-16%

Weights in '000 t.

<sup>1)</sup> For spring-spawning stocks, the SSB is determined at spawning time and is influenced by fisheries between 1<sup>st</sup> of January and spawning.

<sup>2)</sup> SSB 2013 relative to SSB 2012.

**MSY approach**

MSY reference points have not been defined so far.

**PA considerations**

Fishing mortality has increased and SSB has decreased in the most recent years despite advice not to increase F since 2002. F should be brought back to where it was before the start of this increase, i.e. the 2002 - 2007 average, which is 0.21. This corresponds to landings of less than 36 000 t in 2012.

**Additional considerations**

There are no management objectives for these fisheries and there is no international TAC. Almost all catches are taken by Spanish and Portuguese purse-seiners in a directed human consumption fishery. The fisheries is managed by Portugal and Spain through minimum landing size, maximum daily catch, days fishing limitations, and closed areas. A catch limit of 55 000 t was set for the Portuguese fishery for 2010 by the Portuguese authorities.

Sardine is distributed in the Iberian region, to the north in Subareas VII and VIII and in the North Sea, and to the south on the Moroccan shelf. The information presented here assumes that sardine in Divisions VIIIc and IXa is a unit stock, based on biological characteristics. However, some movement of fish between Divisions VIIIb and VIIIc is known to occur. The effect of this movement is uncertain but is presently considered to have little influence on the estimation of the stock in the assessed area (Divisions VIIIc and IXa).

Short-term predictions indicate a decrease of 20% in SSB in 2012 from SSB in 2010 at the assumed fishing mortality if recruitment is confirmed to be low in 2010 and remains low in 2011. SSB has shown a declining trend since 2006 due to the lack of strong recruitments in the last five years and fishing mortality has increased since 2006. The assessment indicates the last strong recruitment was in 2004 and recruitments in 2006–2010 are among the lowest of the historical time series. In the late 1990s, an extended period of successive low recruitments combined with high fishing mortality led to a period of low SSB, particularly in the northern areas of the stock (northern Spanish waters), which resulted in a critical phase for the sardine fisheries in that area.

The MSY reference points have not been established so far. Candidate reference points have been outlined this year. The stock–recruitment relationship for this stock is poorly defined and thus very sensitive to which data points are used to fit an S–R model. As a consequence,  $F_{MSY}$  calculated by combining an S–R model with the YPR curve is very unstable. Because of the uncertainties surrounding the form and parameters of the S–R relationship, reference points based on the spawner-per-recruit analysis (%SPR) were considered more appropriate as proxies of  $F_{MSY}$  as indicated by Clark (1991, 1993).

A long-term plan should take into account the spatial distribution of the stock and poor relationship between stock biomass and future recruitment. A long-term management plan would be useful if stability of catches is desired. Such a strategy should be sufficiently flexible with respect to catch limitation to protect the stock under periods of poor recruitment, but also avoid unnecessary fluctuations in the catches when the stock biomass is higher.

#### *The effects of regulations*

Different management measures have been enacted by Spain and Portugal since 1997. In Spain, management measures include a maximum allowable catch of 000 kg per fishing day and a 5-fishing-days week limitation. In Portugal, management measures include an overall limitation in the number of fishing days (180 days per year and a weekend ban). The effects of these fishery regulations are uncertain but may have contributed to the decline in fishing mortality observed between 1998 and 2007. A catch limit of 55 000 t was set for the Portuguese fishery for 2010 by the Portuguese fisheries authorities but was not complied to.

#### *The environment*

Proposed environmental drivers on sardine recruitment include various global to local scale environmental variables, integrated over the time periods identified as the most critical to ensure egg and larval survival by reducing the transport of eggs and larvae offshore. Indirect effects, e.g. on growth and condition through variations in food supply or water temperature have been given less attention. Results from such studies show that environmental effects, although present, are often weak and in some cases findings have been contradictory. For example, upwelling intensity has been found to affect recruitment both positively and negatively.

The Iberian sardine is considered a forage fish, i.e. a fish that provides food for predatory fish as well as marine mammals and birds. Sardine is one of the most abundant small pelagic species in western Iberian waters and has been found to be important in the diet of several species of fish and marine mammals. Forage fish such as sardine may exert bottom-up control of their predators or top-down control on their zooplanktonic prey, or they may control both prey and predators (wasp-waist control).

#### *Uncertainties in assessment and forecast*

The main uncertainties in the assessment relate to the contradictory signals provided by the relatively high 2008 DEPM SSB estimate (when compared to former DEPM estimates, namely the previous one in 2005) versus the decreasing trend provided by the acoustic estimates. This is reflected in a retrospective pattern (2008–2010) consisting of a gradual reduction of the SSB estimates and an upward shift in  $F$  with some influence backwards in time (reaching up to 2002). The outcome of short-term deterministic predictions is influenced by the high uncertainty in the population and fishing mortality estimates in 2010. Overall, this demands a cautionary use of the outputs of the current assessment, paying far more attention to the relative trends in biomass and fishing mortality than to their actual absolute values.

Uncertainties in the assessment are related to the extent of sardine movement across the northern stock boundary, the weighting of Portuguese and Spanish acoustic surveys in the combined abundance index and the estimation of fishery selection and survey catchability patterns for the older age groups.

#### *Comparison with previous assessment and advice*

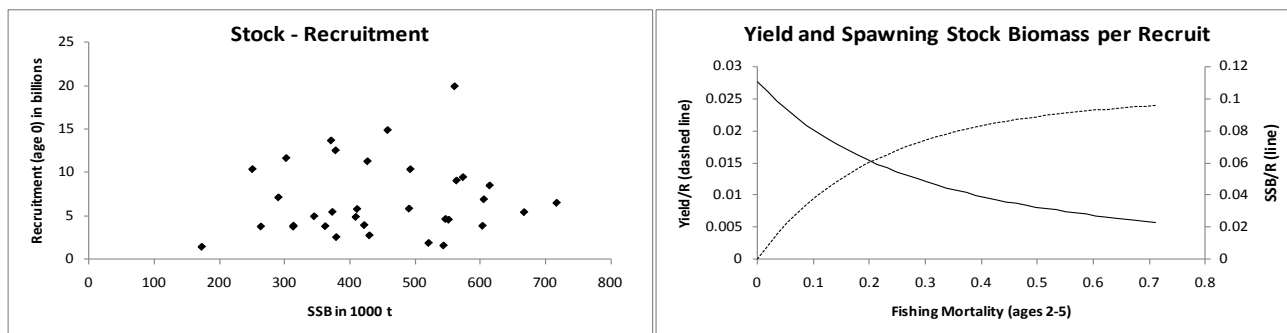
The assessment is consistent with last year, in terms of trends. In particular, the decrease in SSB and increase in  $F$  since 2006 is consistent in both assessments. The new assessment generated a 17% lower estimate of SSB and a 26% higher estimate of fishing mortality in 2009 compared with the values provided last year. The advice is consistent with that provided last year.

#### **Sources**

Clark, W. G. 1991. Groundfish exploitation rates based on life history parameters. *Canadian Journal of Fisheries and Aquatic Sciences*, Vol. 48: 741–750.

Clark, W. G. 1993. The effect of recruitment variability on the choice of target level of spawning stock biomass per recruit. *In: Proceedings of the International Symposium on management strategies for exploited fish populations. Alaska Sea Grant College Programme, AK-SG-93-02 1993. Pp. 233–246.*

ICES. 2011. Report of the Working Group on Anchovy and Sardine (WGANSAs), 24–28 June 2011, Vigo, Spain. ICES CM 2011/ACOM:16.



**Figure 7.4.7.3** Sardine in Divisions VIIIc and IXa: Yield-per-recruit analysis and stock–recruitment plot.

**Table 7.4.7.1** Sardine in Divisions VIIIc and IXa. Single-stock exploitation boundaries (advice), management, and landings.

Year	ICES Advice	Predicted catch corresp. to advice	Agreed TAC	Official landings VIII & IX	ICES landings <sup>2</sup>
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 <sup>2</sup>	-	150	149
1991	Precautionary TAC	176	-	135	133
1992	No advice	-	-	139	130
1993	Precautionary TAC	135	-	153	142
1994	No advice	118 <sup>1</sup>	-	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	-		
2011	Maintain F at 2002–2007 level	75			
2012	Reduce F to the 2002–2007 level	36			

Weights in '000 t.

n/a=not available.

<sup>1</sup>Estimated catch at *status quo* F.

<sup>2</sup>Includes only Divisions VIIIc and IXa.

**Table 7.4.7.2** Sardine in Divisions VIIIc and IXa: Iberian sardine landings (tonnes) by subarea and total.

Year	Sub-area						All sub-areas	Div. IXa	Portugal	Spain (excl.Cadiz)	Spain (incl.Cadiz)
	VIIIc	IXa North	IXa Central		IXa South Algarve	IXa South Cadiz					
			North	South							
1940	66816		42132	33275	23724	165947	99131	99131	66816	66816	
1941	27801		26599	34423	9391	98214	70413	70413	27801	27801	
1942	47208		40969	31957	8739	128873	81665	81665	47208	47208	
1943	46348		85692	31362	15871	179273	132925	132925	46348	46348	
1944	76147		88643	31135	8450	204375	128228	128228	76147	76147	
1945	67998		64313	37289	7426	177026	109028	109028	67998	67998	
1946	32280		68787	26430	12237	139734	107454	107454	32280	32280	
1947	43459	21855	55407	25003	15667	161391	117932	96077	65314	65314	
1948	10945	17320	50288	17060	10674	106287	95342	78022	28265	28265	
1949	11519	19504	37868	12077	8952	89920	78401	58897	31023	31023	
1950	13201	27121	47388	17025	17963	122698	109497	82376	40322	40322	
1951	12713	27959	43906	15056	19269	118903	106190	78231	40672	40672	
1952	7765	30485	40938	22687	25331	127206	119441	88956	38250	38250	
1953	4969	27569	68145	16969	12051	129703	124734	97165	32538	32538	
1954	8836	28816	62467	25736	24084	149939	141103	112287	37652	37652	
1955	6851	30804	55618	15191	21150	129614	122763	91959	37655	37655	
1956	12074	29614	58128	24069	14475	138360	126286	96672	41688	41688	
1957	15624	37170	75896	20231	15010	163931	148307	111137	52794	52794	
1958	29743	41143	92790	33937	12554	210167	180424	139281	70886	70886	
1959	42005	36055	87845	23754	11680	201339	159334	123279	78060	78060	
1960	38244	60713	83331	24384	24062	230734	192490	131777	98957	98957	
1961	51212	59570	96105	22872	16528	246287	195075	135505	110782	110782	
1962	28891	46381	77701	29643	23528	206144	177253	130872	75272	75272	
1963	33796	51979	86859	17595	12397	202626	168830	116851	85775	85775	
1964	36390	40897	108065	27636	22035	235023	198633	157736	77287	77287	
1965	31732	47036	82354	35003	18797	214922	183190	136154	78768	78768	
1966	32196	44154	66929	34153	20855	198287	166091	121937	76350	76350	
1967	23480	45595	64210	31576	16635	181496	158016	112421	69075	69075	
1968	24690	51828	46215	16671	14993	154397	129707	77879	76518	76518	
1969	38254	40732	37782	13852	9350	139970	101716	60984	78986	78986	
1970	28934	32306	37608	12989	14257	126094	97160	64854	61240	61240	
1971	41691	48637	36728	16917	16534	160507	118816	70179	90328	90328	
1972	33800	45275	34889	18007	19200	151171	117371	72096	79075	79075	
1973	44768	18523	46984	27688	19570	157533	112765	94242	63291	63291	
1974	34536	13894	36339	18717	14244	117730	83194	69300	48430	48430	
1975	50260	12236	54819	19295	16714	153324	103064	90828	62496	62496	
1976	51901	10140	43435	16548	12538	134562	82661	72521	62041	62041	
1977	36149	9782	37064	17496	20745	121236	85087	75305	45931	45931	
1978	43522	12915	34246	25974	23333	145609	102087	83553	56437	62056	
1979	18271	43876	39651	27532	24111	157241	138970	91294	62147	65947	
1980	35787	49593	59290	29433	17579	194802	159015	106302	85380	88500	
1981	35550	65330	61150	37054	15048	216517	180967	113253	100880	103264	
1982	31756	71889	45865	38082	16912	206946	175190	100859	103645	106087	
1983	32374	62843	33163	31163	21607	183837	151463	85932	95217	97905	
1984	27970	79606	42798	35032	17280	206005	178035	95110	107576	110895	
1985	25907	66491	61755	31535	18418	208439	182532	111709	92398	96731	
1986	39195	37960	57360	31737	14354	187363	148168	103451	77155	83912	
1987	36377	42234	44806	27795	17613	177696	141319	90214	78611	87481	
1988	40944	24005	52779	27420	13393	161531	120587	93591	64949	67939	
1989	29856	16179	52585	26783	11723	140961	111105	91091	46035	49870	
1990	27500	19253	52212	24723	19238	149429	121929	96173	46753	53256	
1991	20735	14383	44379	26150	22106	132587	111852	92635	35118	39952	
1992	26160	16579	41681	29968	11666	130250	104090	83315	42739	46935	
1993	24486	23905	47284	29995	13160	142495	118009	90440	48391	52055	
1994	22181	16151	49136	30390	14942	136582	114401	94468	38332	42114	
1995	19538	13928	41444	27270	19104	125280	105742	87818	33466	37462	
1996	14423	11251	34761	31117	19880	116736	102313	85758	25674	30978	
1997	15587	12291	34156	25863	21137	115814	100227	81156	27878	34658	
1998	16177	3263	32584	29564	20743	108924	92747	82890	19440	26034	
1999	11862	2563	31574	21747	18499	94091	82229	71820	14425	22271	
2000	11697	2866	23311	23701	19129	85786	74089	66141	14563	19644	
2001	16798	8398	32726	25619	13350	101957	85159	71695	25196	30262	
2002	15885	4562	33585	22969	10982	99673	83787	67536	20448	32136	
2003	16436	6383	33293	24635	8600	97831	81395	66528	22819	31303	
2004	18306	8573	29488	24370	8107	98020	79714	61965	26879	36055	
2005	19800	11663	25696	24619	7175	97345	77545	57490	31464	39855	
2006	15377	10856	30152	19061	5798	87023	71646	55011	26233	32012	
2007	13380	12402	41090	19142	4266	96469	83088	64499	25782	31970	
2008	13636	9409	45210	20858	4928	101464	87828	70997	23045	30468	
2009	11963	7226	36212	20838	4785	87740	75777	61835	19189	25905	
2010	13772	7409	40923	17623	5181	89571	75798	63727	21181	25843	

Div. IXa = IXa North + IXa Central-North + IXa Central-South + IXa South-Algarve + IXa South-Cadiz

**Table 7.4.7.3**

Sardine in Divisions VIIIc and IXa. Summary of stock assessment.

Year	Recruitment Age 0 thousands	SSB tonnes	Landings tonnes	Mean F Ages 2–5
1978	11659000	302000	145609	0.3555
1979	13689000	371000	157241	0.3632
1980	14888000	458000	194802	0.2633
1981	9455000	574000	216517	0.3162
1982	6897000	606000	206946	0.3017
1983	19940000	561000	183837	0.2636
1984	8495000	615000	206005	0.2380
1985	6493000	718000	208439	0.2343
1986	5414000	668000	187363	0.2988
1987	9065000	564000	177696	0.2923
1988	5824000	491000	161531	0.3050
1989	5776000	411000	140961	0.3267
1990	5442000	373000	149429	0.3901
1991	12550000	378000	132587	0.2852
1992	10368000	493000	130250	0.2607
1993	4630000	547000	142495	0.3096
1994	4540000	552000	136582	0.2184
1995	3841000	604000	125280	0.2329
1996	4868000	409000	116736	0.2618
1997	3797000	362000	115814	0.3556
1998	3854000	313000	108924	0.4089
1999	3741000	313000	94091	0.3605
2000	10382000	250000	85786	0.3429
2001	7121000	290000	101957	0.2698
2002	3922000	422000	99673	0.2273
2003	2736000	430000	97831	0.2247
2004	11289000	427000	98020	0.2375
2005	4938000	345000	97345	0.2070
2006	1568000	544000	87023	0.1835
2007	1859000	521000	96469	0.2000
2008	2534000	379000	101464	0.3022
2009	3760000	263000	87740	0.3358
2010	1419000	172000	89571	0.4284
2011	2407000*	174000		
Average	6740029	438235	135819	0.2910

\*Geometric mean (2005–2010).