Stock Annex: template

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Stock Annex

Stock specific documentation of standard assessment procedures used by ICES.

Stock **Sardine in Divisions VIIIc and IXa (sar-soth).**

Working Group: **WGHANSA**

Date: **February 2012**

Revised by

A. General

A.1. Stock definition

European sardine (*Sardine pilchardus* Walbaum, 1792) has a wide distribution extending in the North-East Atlantic from the Celtic Sea and North Sea in the north to Mauritania in the south. Populations of Madeira, the Azores and the Canary Islands are at the western limit of the distribution (Parrish et al., 1989). Sardine is also found in the Mediterranean and the Black Seas. Changing environmental conditions affect sardine distribution, with fish having been found as far south as Senegal during episodes of low water temperature (Corten and van Kamp, 1996; Binet et al., 1998).

The sardine stock assessed by ICES covers the Atlantic waters of the Iberian Peninsula (ICES areas VIIIc and IXa), extending from the Strait of Gibraltar in the south to the border with France in the Inner Bay of Biscay in the north. These limits are somewhat arbitrary in that they were set for management purposes (Fig. A.1.)

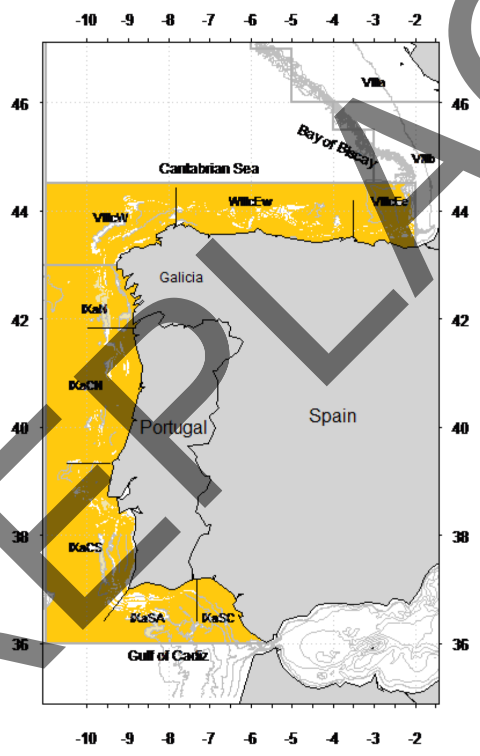

Figure A.1. Map of the current Iberian sardine stock area showing (in orange) the ICES Divisions and subdivisions currently considered in the assessment of the stock.

Because sardine distribution is continuous in the Northeast Atlantic (from the Agadir area in north Morocco to the North Sea) it is likely that there could be movement of fish to and from the stock area and it is the level and impact of this movement which is relevant for the assessment of sardine in Iberian waters. Several genetic studies have failed to demonstrate population differentiation inside the area, with only weak population structure being found using allozymes (Laurent et al. 2007, Figure 2) and microsatellite DNA (Kasapidis et al. 2012). These studies also reported that sardine taken from Azores and Madeira was genetically closer to Mediterranean samples than to those sampled in other areas of the Northeast Atlantic.

Common genetic and life history characters provide indication of the possibility of some mixing across the southern Iberian stock limit (Gulf of Cadiz) with sardine populations from southwest Mediterranean and northern Morocco. However, the absence of large sardine populations in these areas would limit the influence of such movements in the dynamics of the Iberian stock.

There are also indications of spatial population sub-structuring across Iberian waters. Although sardine shows a nearly continuous spawning ground distribution along the Iberian and French Atlantic coasts (Bernal et al 2007), there some evidence of distinct recruitment pulses off the two main recruitment areas in some years (northern Portugal and the Gulf of Cadiz) and observation that these mainly influence the demography of adjacent populations but not that of distant ones (Silva al. 2009 and Riveiro et al. 2012 WD). Persistent spatial differences in growth (Silva et al. 2008) and spawning temperature tolerance have also been found (Stratoudakis et al. 2007) and these together with the existence of a persistent gap (Bernal et al 2007) in the spawning area corroborate the hypothesis of spatial heterogeneity of sardine populations. However, indirect evidence of movements from otolith chemistry (Castro 2007) and cohort analyses (Sardyn project report) suggest that sardines recruiting on the western area move gradually north or south as they grow, crossing the above potential discontinuities.

Catch and survey_at_age data appear to indicate that some strong year-classes in the Cantabrian Sea (VIIIc East) originated from recruitment areas in the Gulf of Biscay (VIIIa,b) (Riveiro et al. 2012WD). Furthermore, the northern extent of this homogeneous population is still unclear. Sardine maturity-at-length seems to decline substantially in northern France while growth might increase in the English Channel (Silva et al 2008a). Young sardine are not usually observed in this northern area (although juveniles have been recently sampled in the North Sea), suggesting that older (2+) spawning individuals from the English Channel possibly originate in the French coast. Microsatellite analyses revealed no significant genetic differentiation among sardines in subarea VII and VIII (Shaw *et al.* 2012). The inner Bay of Biscay does not represent a barrier for other small pelagic fish populations either; as horse mackerel, anchovy and mackerel stocks are also considered to distribute across the Cantabrian Sea and Gulf of Biscay (Abaunza et al. 2008; Uriarte et al., 1996, 2001). No other barriers were evidenced within French Atlantic waters for any of these species.

In recent years there has been an increase of sardine in both the commercial landings and in fishery-independent surveys in the Celtic Sea and western Channel (VIIe-j) (Beare et al., 2004) and is forming the basis of a locally important fishery (Cornish sardine) (ICES 2010).

Further efforts should help to clarify sardine population structure in this area and their relationship with fish in the Bay of Biscay and the Iberian sardine stock, in order to take into account regional dynamics in the context of an area based assessment.

A.2. Fishery

The bulk of the landings in both Spain and Portugal (99%) are made by purse-seiners.

The Spanish purse seine fleet targets anchovy (*Engraulis encrasicolus*), mackerel (*Scomber scombrus*) and sardine, (which occur seasonally in the area) and horse-mackerel (*Trachurus trachurus*) which is available all year-round (Uriarte et al., 1996; Villamor *et al.*, 1997; Carrera and Porteiro, 2003). In summer, part of the fleet switches to trolling lines or bait boat for tuna fishing, a resource with a marked seasonal character. Since 2004, Spanish legislation requires that purse seiners must have, at least, a length of 11 m in the Atlantic coast of Spain. Moreover, the gear must have a maximum length of 600 m, a maximum height of 130 m and minimum mesh size of 14 mm (see Table A.2.1). Because of this regulation, most of the effort and catches are registered in logbooks (which are mandatory for boats larger than 10 m). Analysis of these logbook data from 2003 to 2005 (Abad *et al.*, 2008) showed that currently, sardine and horse-mackerel represent 75% of the total landings of the purse seine fleet, which is in accordance with the values observed in historical series of purse seine catch statistics, especially when the anchovy is scarce (ICES, 2007). Sardine catches show the highest values in summer and autumn and effort concentrates in southern Galician and western Bay of Biscay waters. Vessels can be characterized by 21 m length overall, 296 HP, and 57 gross tonnage.

In Portugal, sardine is the main target species of the purse seine fleet comprising 98% of the landings. The sardine fishery is of great social-economical importance for the fishing community and industry since it represents an important part of the fish production and a relevant supply for the canning sector. Other pelagic species such as chub mackerel (*Scomber japonicus*), horse mackerel and anchovy are also landed by the purse seine fishery. Currently, purse seiners in Portuguese waters have a length of about 20 m, an engine horsepower between 100 and 500 HP and use a minimum mesh size of 16 mm (see Table A.2.1). According to Stratoudakis and Marçalo (2002), fishing is usually close to the home port, on short (daily) trips where the net is set once or twice, usually around dawn. A large part of a typical fishing trip is spent searching for schools with echosounders and sonars. Once schools of pelagic fish have been detected, large nets (up to 800 m long and 150 m deep) are set rapidly with the help of an auxiliary small vessel, and hauled in a largely manual operation involving all members of the crew (usually between 15-20 people) (Mesquita, 2008).

Table B.2.1. Summary of the major existing regulatory mechanism for sardine

Species	Technical measure	National/European level	Specification	Note	Source/date of implementation
Sardine	Minimum size	European	11cm	10% undersized allowed	EU Reg 850/98 amended 1999, 2000, 2001, 2004
Sardine/Anchovy	Effort limitations	National (ES)	VIIIc,IXa: minimum vessel tonnage 20GRT, maximum engine power 450hp, max length purse seine 450m, max height purse seine 80m, minimum mesh size 14mm, max number of fishing days/week: 5, fishing prohibited in bays and estuaries Gulf of Cadiz: Maximum net length 450 m. Maximum net high 80 m.		1997
Sardine	Catch limitation	National (ES)	Max 7000 kg/day/boat fish > 15 cm, max 2000 kg/day/boat fish between 11 and 15 cm. IXaS Cadiz: 3000kg/vessel day(<10% of small sardine (<9cm))		1997
Sardine/anchovy	Area closure	National (ES)	IXaS Cádiz: fishing closures implemented annually between November-February		2008

Sardine/Anchovy	Effort limitations	National (PT)	IXa: max length of purse seine 800 m, max height of purse seine 150 m, max number of fishing days/week: 5, max number of fishing days/year: 180	Portaria n.o 1102-G/2000 de 22 de Novembro	1997
Sardine/Anchovy	Area closure	National (PT)	No purse seine fishing at depths lower than 20 m. For 2012, there is a 45 day fishing ban for sardine for all regional PO, in alternate periods between 15 february and 30 April.	Despacho n.º 1521/2012, 1 February 2012	1997
Sardine	Catch limitation	National (PT)	55 thousand tons Jan-May 2012: 9 thousand tons	Applicable to vessels associated under PO (Producer Organisation) which make 96% of the landings. Non-associated vessels have equivalent restrictions.	2010
All species	Mesh sizes	European	different specifications acc. to catch compositions	In Portugal, >16 mm, Portaria n.o 1102-G/2000 de 22 de Novembro	EU Reg 850/98 amended 1999, 2000, 2001, 2004
All species	Mesh openings	European	different specifications acc. to catch compositions		EU Reg 850/98 amended 1999, 2000, 2001, 2004

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A.3. Ecosystem aspects

There are a number of studies investigating the role of sardine in the ecosystem both as predator and prey. Sardine is widely distributed all along the Atlantic Iberian shelf in waters ranging from 10 to 100 m (e.g. Porteiro *et al*., 1996). Analysis of its stomach contents and stable isotope signature indicate an omnivorous feeding behaviour, related to its ability to feed by particle-feeding and filter-feeding (more common as fish grow older, Bode *et al.*, 2003), and its exploitation of a wide range of prey (both phytoplankton and zooplankton have been found in its diet, e.g. Bode *et al*., 2004). In addition, sardines have been found to ingest their own eggs (and probably those of other species) and this cannibalism may act as a density control mechanism (Garrido *et al.*, 2007).

The composition of nitrogen isotopes in the muscle of sardine integrates fish diet over seasonal periods and reflects the composition of plankton over large shelf areas. A differential isotopic signature in high and low upwelling zones reflects low mobility of sardines during periods of low population size (Bode *et al.*, 2007).

Sardine is prey of a range of fish and marine mammal species which take advantage of its schooling behaviour and availability. Sardine has been found to be important in the diet of common dolphins (*Delphinus delphis*) in Galicia (NW Spain) (Santos *et al.*, 2004), Portugal (Silva, 2003) and the Atlantic French coast (Meynier, 2004). Recent studies of consumption of common dolphins in Galician (Santos *et al.* 2011b) waters give figures ranging from almost 6000 tons to more than 9000 tons of sardine, wich represents a rather small proportion of the combined Spanish and Portuguese annual landings of sardine from ICES areas VIIIc and IXa (6-7%).There are also other species feeding on sardine, although to a lesser extent, such as: harbour porpoise (*Phocoena phocoena*), bottlenose dolphin (*Tursiops truncatus*), striped dolphin (*Stenella coeruleoalba*), and white-sided dolphin (*Lagenorhynchus acutus*) (e.g. Santos *et al.*, 2007).

Habitat modelling studies aim to identify which environmental processes could be defining the habitat of a species and eventually to be able to predict fish distribution. Zwolinski *et al* (2008) analysed the relationship between data on sardine distribution obtained by the Portuguese acoustic surveys and 4 environmental variables (sub-surface salinity, temperature, chlorophyll concentration and plankton presence). Sardine showed a preference for waters with low temperature and salinity, high chlorophyll content and low planktonic backscattering energy.

Populations of planktivorous fish, such as the sardine, show large fluctuations in size and distribution over the Atlantic Iberian shelf (Carrera and Porteiro, 2003). Periods of good recruitments have helped develop new industries and led to the social and economic changes while periods of continuous low recruitments have brought economic hardship in many areas. This was the case of the Iberian sardine at the end of the 90s, when several successive poor recruitments led to an all time low of the stock biomass. Sardine is a batch spawner producing batches of eggs over an extended period of time (October to May) in Iberian waters with different peaks between southern and northern regions. Although the survival of offspring is highly dependent on favourable environmental conditions (concentrations of egg/larvae in suitable areas), sardine appears to show a wide range of temperature tolerance for both habitat and spawning distribution (Bernal, 1998). Even more, the presence of sardine larvae has been recorded by a recent study (Morais *et al*., 2009) inside the Guadiana estuary. The authors suggest that this is not an accidental occurrence but that in order to migrate to that location and remain in the estuary, counteracting river inflow, these late larvae must have employed active migration and retention strategies.

Upwelling intensity was shown to affect both positively and negatively sardine recruitment (Dickson et al., 1988; Roy *et al.*, 1995) but the main direct effect was due to the transport of eggs and larvae offshore by northern winds (Guisande *et al.*, 2001). In this way, strong upwelling during the recruitment season would decrease the probability of survival of sardine larvae as they are dispersed to outer shelf and oceanic zones. In contrast, southerly winds favour the progress of the poleward current, and tend to accumulate fish larvae near the coast where plankton biomass and production are high. At high population sizes, sardine spawning and distribution areas extend over the whole continental shelf and the adults display feeding migrations to the upwelling area off Galicia, while at low population sizes a reduction in the mobility of adult sardines between the Cantabrian Sea and Galicia is expected (Carrera and Porteiro, 2003).

Santos et al.(2011a) analysed previous studies, on relationships between recruitment and environmental variables for the sardine around the Iberian Peninsula and carried out a new analysis of empirical relationships with environmental series, using dynamic factor analysis, generalized additive models, and mixed models. Relationships were identified between recruitment and global (number of sunspots), regional (NAOAutumn), and local winter wind strength, sea surface temperature (SST), and upwelling environmental variables. Separating these series into trend and noise components permitted further investigation of the nature of the relationships. Whereas the other three environmental variables were related to the trend in recruitment, SST was related to residual variation around the trend, providing stronger evidence for a causal link. After removal of trend and cyclic components, residual variation in recruitment was also weakly related to the previous year's spawning-stock biomass.

B. Data

B.1. Commercial catch

Commercial catch data are obtained from the national laboratories of both Spain and Portugal. Annual landings are available since 1940 (see Figure B.1). Landings are not considered to be significantly under reported.

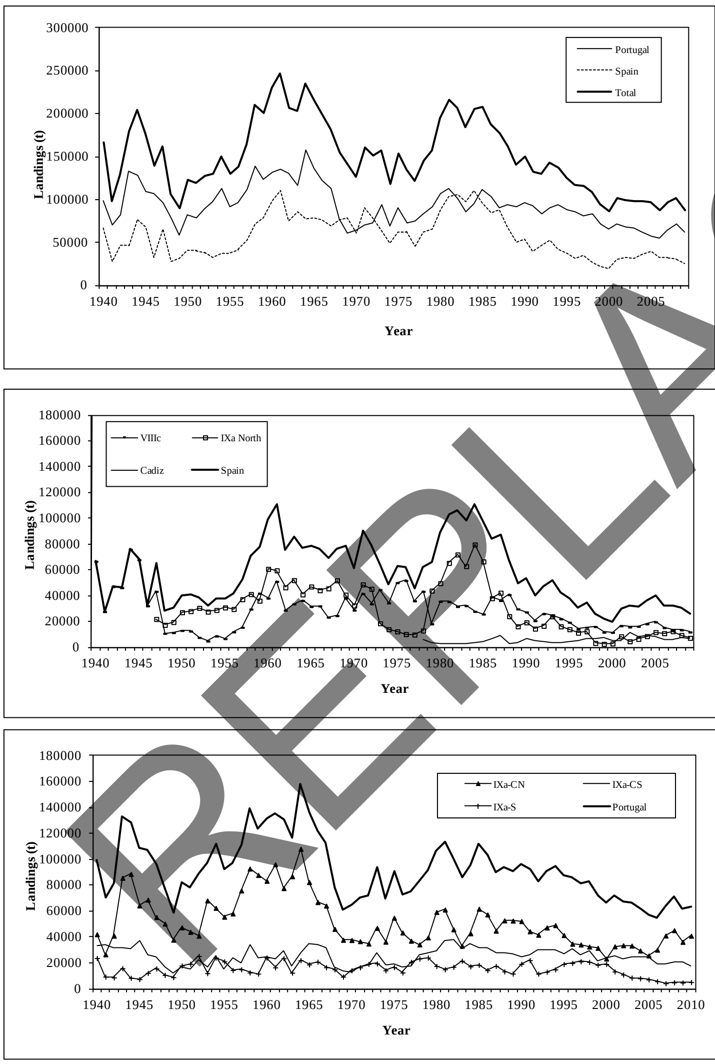

Figure B.1. Annual landings of sardine, by country and area.

Discards data on the fishery are not available and it is very difficult to measure. As with other pelagic fisheries that exploit schooling fish discarding occurs in a sporadic way and with often extreme fluctuation in discard rates (100% or null discards). Extreme discards occur especially when the entire catch is released ("slippage") which tend to be related to quota limitations, illegal size and mixture with unmarketable bycatch. Quantifying such discards at a population level is extremely difficult be-cause they vary considerably between years, seasons, species targeted and geographical region.

A discard programme, sampling purse seine vessels, has started in Portugal. Nevertheless, discard estimates are still not available. There is some slipping in northern Portugal (division IXa) but mostly in years with high recruitment. During a 12 week lasting study, the sampled fleet (nine vessels) landed 2196 t and released an estimated 4979 t (CV 33.6%) (Stratoudakis & Marcalo 2002). More than 95% of the total catch was sardine.

Sardine constituted 97% of the landings in the trips observed and >99% of the total for the whole fleet, and some of the bycatch species caught in small quantities during the trips observed never reached the market

Since 1999 (catch data 1998), both Spanish and Portuguese labs have used a common spreadsheet to provide all necessary landing and sampling data developed originally for the Mackerel Working Group (WGMHSA). The stock co-ordinators collates data using the latest version of SALLOCL (Patterson, 1998) which produces a standard output file (Sam.out). However it should be noted that only sampled, official, WG catch and discards are available in this file.

In addition, commercial catch and sampling data were stored and processed using the INTERCATCH software for the first time during the WGHMHSA in 2007. Comparisons were made between the SALLOCL and the INTERCATCH routines and a very good agreement was found (<0.3% discrepancies). These discrepancies are likely the results of the fact that for stocks where no allocations are required (as is the case of sardine), the SALLOCL application requires a 'dummy' allocation to be made in order for the program to run successfully. While a very small value is used for the allocation, it is likely to have some impact on the results and so will have added to the discrepancy when compared with the INTERCATCH output.

B.2. Biological

Catch-at-age data (catch numbers-at-age, mean weights-at-age in the catch, mean length-at-age) are derived from the raised national figures routinely provided by both Spain and Portugal. These data are obtained either by market sampling or by onboard observers. In Spain, samples for age length keys are pooled on a half year basis for each subdivision while length/weight relationships are calculated quarterly. In Portugal, both age length keys and length/weight relationships are compiled on a quarterly and subdivision basis.

Mean weights-at-age in the stock are derived from March/April acoustic surveys and maturity ogive comes from DEPM surveys, whilst for the years without DEPM surveys, a constant value of 80% full maturity at age 1 and a 100% for ages 2 and older is adopted. The 80% maturity at age 1 is about a median of former DEPM estimates.

Table B.2.1. Summary of the overall sampling intensity over recent years on the catches of the sardine stock in VIIIc and IXa.

Year	Total catch	Nº samples	Nº fish measured	Nº fish aged
1992	164,000	788	66,346	4,086
1993	149,600	813	68,225	4,821
1994	162,900	748	63,788	4,253
1995	138,200	716	59,444	4,991
1996	126,900	833	73,220	4,830
1997	134,800	796	79,969	5,133
1998	209,422	1,372	123,754	12,163
1999	101,302	849	91,060	8,399
2000	91,718	777	92,517	7,753
2001	110,276	874	115,738	8,058
2002	99,673	814	96,968	10,231
2003	97,831	756	93,102	10,629
2004	98,020	932	112,218	9,268
2005	97,345	925	116,400	9,753
2006	87,023	927	122,185	9,165
2007	96,469	797	97,187	8,607
2008	101,464	821	91,847	7,950
2009	87,740	465	52,821	8,216
2010	89,572	327	35,615	7,890

B.3. Surveys

At present, the surveys used in the sardine assessment are the Spanish and Portuguese DEPM surveys and the spring acoustic surveys which jointly provide a full coverage of the stock area (ICES areas VIIIc and IXa). Surveys not used in the assessment, which cover parts of the stock area or areas VIIIa,b (considered to be a different stock unit) are also described below for completeness.

B.3.1. DEPM surveys

The Daily Egg Production Method started being applied to sardine in the Iberian Peninsula during the 80s but surveys were interrupted for almost 10 years. Current DEPM surveys started in 1997 for both Spain and Portugal and have been carried out triennially since 1999. Sampling design and methodology have been further standardised in 2002 in order to guarantee good coordination of the surveys and analyses of the data collected Since 2011 the coordinated surveys between Spain (IEO and AZTI) and Portugal (IPIMAR) do also cover the Bay of Biscay (divisions VIIIa, b).

The extension of the surveyed area almost up to Southern Brittany results in a complete coverage of the species over most of its European Atlantic distribution (subareas IX and VIII), except for the top Northwestern limits. The methodology adopted for the processing of sardine adults data followed the general plan agreed for previous surveys (cf. ICES, 2005, 2006 and 2007) and a summary is presented in Table B.3.1.

Table B.3.1. Processing and analysis for eggs and adults (The surveys carried out by IEO and AZTI cover areas VIIIb and VIIIa,b, respectively)

DEPM	Portugal (IPIMAR)	Spain (IEO)	Spain (AZTI)
EGGS			
PairoVET eggs staged sardine (Gamulin & Hure, 1955)	All	All	Sample size 50/75 or all eggs
CUFES egg staged sardine (Gamulin & Hure, 1955)	In the lab, all or subsample if more than 100 per sample	No	No
Temperature for egg ageing	Surface (continuous underway CTF at 3m)	10m	10m
Peak spawning hour	21:00 (Sd=3 hh)	21:00 (Sd=3 hh)	21:00 (Sd=3 hh)
Egg ageing	Bayesian (Bernal et al. 2008)	Bayesian (Bernal et al. 2008)	Bayesian (Bernal et al. 2008)
Egg production	GLM (and GAMs available)	GLM (and GAMs available)	GLM (and GAMs available)
ADULTS			
Histology -Embedding material	Paraffin	Resin	Resin
-Stain	Haematoxilin-Eosin	Haematoxilin-Eosin	Haematoxilin-Eosin

S estimation	Day 1 and Day 2 POFs (according to Pérez et al. 1992a and Ganias et al. 2007)	Day 1 and Day 2 POFs (according to Pérez et al. 1992a and Ganias et al. 2007)	Day 1 and Day 2 POFs (according to Pérez et al. 1992a and Ganias et al. 2007)
R estimation	The observed weight fraction of the females	The observed weight fraction of the females	The observed weight fraction of the females
F estimation	On hydrated females (without POFs), according to Pérez et al., 1992b	On hydrated females (without POFs), according to Pérez et al., 1992b	On hydrated females (without POFs), according to Pérez et al., 1992b

B.3.2. Acoustic surveys

B.3.2.1 Spring Acoustic Surveys

Portuguese and Spanish acoustic surveys are coordinated within WGACEGG (ICES, 2011). Surveys are undertaken within the framework of the EU DG XIV project "Data Directive". There are two spring annual surveys (one Portuguese and one Spanish) used in the assessment as a single index of abundance of the stock. During the benchmark assessment carried out in 2006, a joint survey data series was made as a weighted sum of the two spring surveys and results from the exploration of survey data provided some indication of similar catchabilities. In addition, preliminary runs with a range of weighting factors the Spanish surveys indicated that the actual catchability ratio made little difference to the final outcome of the assessment. Therefore, the stock was assessed with a joint spring survey derived by just adding the Spanish and the Portuguese results. In spite of this, the merging of data from these surveys remains an outstanding issue in the current assessment and in order to address this, two calibration exercises between the Spanish and Portuguese acoustic surveys have taken place in spring 2008 and again in 2009 with the simultaneous coverage of several transects by the RVs Thalassa (Spanish survey) and Noruega (Portuguese survey) off northern Portugal. Results from these exercises were inconclusive and therefore a new intercalibration is planned in 2012. Conclusions will be analysed within WGACEGG.

In addition to the spring surveys, between 1984 and 2008 (gaps in 1988-1991 and 1993-1996) there was a Portuguese acoustic survey carried out in November and covering the Portuguese waters and, since 1997, the Gulf of Cadiz. This survey follows the same methodology as the spring surveys and is also coordinated by WGACEGG. Since it covers only part of the stock area and may not take into account changes in distribution between years, it is currently not used in the assessment model. However, it covers the main recruitment areas of the stock and is therefore used as an additional information on recruitment strength. This survey series could be potentially usefull in the context of a future area-based assessement.

Outside the assessed stock area, the spring acoustic survey PELGAS (run by IFREMER) covers the area from the south of the Bay of Biscay to south of Brittany (Figure B.3.2.1.3).

B.3.2.1.1 Portuguese Spring acoustic survey: PELAGOS

The Portuguese acoustic surveys (on board the RV "Noruega") are mainly directed to sardine and anchovy.

The survey track follow a parallel grid, with transects perpendicular to the coastline. The acoustic energy in the inter-transect track is not taken into account. The transects are spaced by 8 nautical miles in the West Coast, 6 nautical miles in Algarve and around 10 nautical miles in the Cadiz area. Acoustic data from 38 kHz is stored with MOVIES+ software as standard HAC files along the transects. Trawl hauls are performed whenever significant amounts of fish are found but mainly targeting sardine and anchovy. Trawl data is used to:

• Identify the echotraces

• Obtain the length structure of the population

• Obtain the species proportion

• Get biologic samples

The identification of the echo traces is made by eye, with the aid of the trawl hauls. If it is not possible to separate the species schools by eye, the energy of the ESDUs (Elementary Sampling Distance Unit) is split using the haul species proportion, in number, and taking into account the target strength and the species length compositions.

The weight of the hauls is always the same, since a post stratification is made and the overall area is divided into small homogeneous areas, with similar length composition. To partition the acoustic energy by species, using the trawl species proportion, the hauls are not weighted by the energy around the haul, assuming that the species mixture is independent of the acoustic energy density.

The acoustic energy is extracted from the EK500 echograms, school by school, using MOVIES+ software. Plankton and very small schools are rejected.

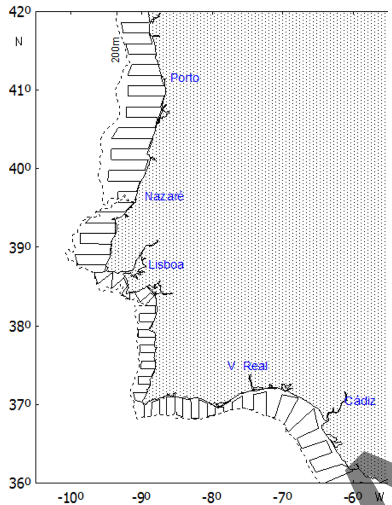

Figure B.3.2.1.1. Acoustic transects sampled during the PELAGOS acoustic survey in 2011.

For each species, the acoustic energy is also partitioned by length classes according to the length structure found in the trawl hauls. The biomass is derived from the number of individuals, applying the weight/length relationship obtained from the haul samples.

B.3.2.1.2 Spanish Spring acoustic survey: PELACUS

The spring acoustic survey PELACUS (on board the RV "Thalassa") covers the area between northern Portuguese waters and southern French waters. Acoustic sampling takes place during the day, over a grid of parallel transects separated by 8 nm and perpendicular to the coastline. The area covered by the survey extends from 30 to 200 m depth. The EDSU is fixed at 1 nm. Fish abundance estimation is only carried out with the 38 kHz frequency of a SIMRAD EK60 scientific echosounder, although echograms from 120 kHz are also used to help discrimination. No threshold is set for integration.

Backscattering energy is allocated to fish species by visual scrutiny of the echograms and based on the information provided by the fishing trawls. Fishing stations are analysed and grouped according to depth and proximity criteria and their representativeness is assessed based on the continuity in the probability density function of the length distribution for all fish species in the haul.

The main differences between surveys are related to the sampling strategy and the type of gear used. Noruega's main objective is estimating sardine and anchovy abundance while Thalassa samples all fish aggregations. Noruega's net is smaller than Thalassa's, which allows Noruega to carry out trawls closer to the shore while Thalassa can take advantage of a bigger pelagic trawl to sample schools in more offshore areas.

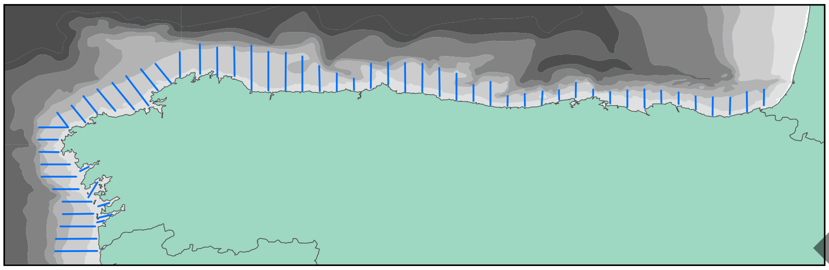

Figure B.3.2.1.2. Acoustic transects sampled during the PELACUS acoustic survey in 2011.

B.3.2.1.3 French spring acoustic survey: PELGAS

The French acoustic survey (PELGAS) is routinely carried out each year in spring in the Bay of Biscay (onboard the R/V Thalassa) and information on pelagic fish species distribution and abundance is available since 2000. The main species targeted is anchovy but the survey is part of the IFREMER programs on data collection for monitoring and management of fisheries with an ecosystemic approach for fisheries and information is therefore also collected on other pelagic species, on egg presence and abundance, on top predators abundance and distribution and on environmental variables such as temperature, salinity, plankton, etc. The survey is planned with Spain and Portugal in order to have most of the potential area to be covered from Gibraltar to Brest with the same protocol for sampling strategy. Data are made available to the ICES working groups WGHANSA, WGWIDE and WGACEGG.

Acoustic data are collected along systematic parallel transects perpendicular to the French coast. The length of the ESDU (Elementary Sampling Distance Unit) was 1 mile and the transects were uniformly spaced by 12 nautical miles covering the continental shelf from 20 m depth to the shelf break. Acoustic data are collected only during the day because of pelagic fishes behaviour in the area. These species are usually dispersed very close to the surface during the night and so "disappear" in the blind layer for the echo sounder between the surface and 8 m depth.

Since 2008, PELGAS survey has been accompanied by pelagic pairtrawlers that follow the R/V Thalassa transects. Identification hauls were carried out both by the R/V Thalassa and the commercial vessels being preferentially carried out by pairtrawlers which are more efficient (less avoidance to the vessels) and hauls close to the bottom being preferentially carried out by the R/V Thalassa.

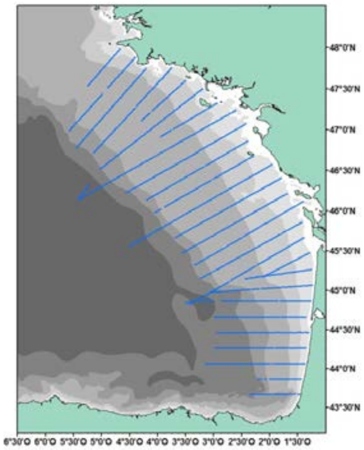

Figure B.3.2.1.3. Acoustic transects sampled during the PELGAS acoustic survey in 2011.

B.4. Commercial CPUE

CPUE indices are not considered reliable indicators of abundance for small pelagic fish (Ulltang, 1982; Csirke, 1988; Mackinson *et al.*, 1997) and are not used.

B.5. Other relevant data

C. Assessment: data and method

Model used: Stock Synthesis (SS, Methot 1990, 2005). SS is a generalized age- and length-based model that is very flexible with regard to the types of data that may be included, the functional forms that are used for various biological processes, the level of complexity and number of parameters that may be estimated. A description and discussion of the model can be found in ICES (2010).

The sardine assessment is an age-based assessment assuming a single area, a single fishery, a yearly season and genders combined. Input data include catch (in biomass), age composition of the catch, total abundance (in numbers) and age composition from a annual acoustic survey and spawning stock biomass (SSB) from a trienal DEPM survey. Considering the current assessment calendar (anual assessment WG in June in year *y+1*), the assessment includes fishery data up to year *y* and acoustic data up to year *y+1*. According to the ICES terminology, year *y* is the final year of the assessment and year *y+1* is termed the interim year.

Software used:

Stock Synthesis (SS) version 3.21d (Methot, 2011)

Model Options chosen:

The main model options are described below. A copy of the control file (sardine.ctl) including all model options is appended to the bottom of this section.

Natural mortality are age specific input values as listed in the table below.

Age 0	0.8
Age 1	0.5
Age 2	0.4
Age 3	0.3
Age 4	0.3
Age 5	0.3
Age 6+	0.3

Growth is not modelled explicitly. Weights-at-age in the beggining and mid of the year are input values and fecundity-at-age are input values, corresponding to the proportion mature-at-age * weight-at-age in the beggining of the year.

Annual recruitments are parameters, defined as lognormal deviations from a constant mean value penalized by a sigma of 0.55 (the standard deviation of log(recruits) estimated in the 2011 assessment, ICES, 2011a). Recruitment for the interim year of the assessment is assumed to be the historic geometric mean.

Fishing mortality is applied as the hybrid method. This method does a Pope's approximation to provide initial values for iterative adjustment of the continuous F values to closely approximate the observed catch.

Total catch biomass by year is assumed to be accurate and precise. The F values are tuned to match this catch.

Total catch biomas by year is assumed to be a median unbiased index of abundance.
Both the acoustic survey and the DEPM survey are assumed to be relative indices of abundance. The corresponding catchability coefficients are considered to be mean unbiased.

Age selectivity in the fishery and in the acoustic survey is such that the parameter for each age is estimated as a random walk from the previous age (however, this applies only to ages 1, 2, 3 and 6+ in the fishery, and 2 and 6+ in the survey). In the fishery, selectivity-at-age 0 is not estimated and is used as the reference age against which subsequent changes occur. A similar assumption is considered for age 1 in the survey, the first observed age. Selectivities at ages 3 to 5 years in the fishery are bound, meaning that parameters for ages 4 and 5 are not estimated but assumed to be equal to the parameter estimated for age 3. A similar assumption is accepted for ages 2 to 5 years in the survey. The initial values for the fishery and survey selectivities mimic dome-shaped patterns with a decline at the 6+ group. However, the range of initial values is wide and almost any pattern can be estimated.

The fishery selectivity is allowed to vary over time in part of the assessment period. Two periods are considered: 1978-1990 with selectivity-at-age varying as a random walk and 1991-2010 for which selectivity-at-age is fixed over time. In the random walk, log(Sy) = log(Sy-1 + delta(y)), with SD=0.1 as the penalti on the deltas, y being the year). The transition between periods is done as a random walk as well.

In the interim year of the assessment, there is data from the acoustic survey but not from the fishery (catch and age composition). The model requires input fishery data for all assessment years. Catch biomass for the interim year is assumed to be equal to the ICES advised catch (75 000 tons in 2011). Age composition data for the fishery in the interim year is included in the calculation of expected values but excluded from the objective function. Catch numbers at age in the interim year are derived from numbers-at-age in the previous year assuming the same fishing mortality, selectivity pattern and biological parameters. An arbitrary value of 4000 000 individuals was assumed as the interim recruitment.

The objective function is a log likelihood combining components for:

- Catch biomass (lognormal)
- acoustic survey abundance index (lognormal)
- DEPM survey SSB (lognormal)

- fishery age composition (multinomial)
- survey age composition (multinomial)
- recruitment deviations (lognormal)
- random walk selectivity parameters (normal)
- initial equilibrium catch (normal)

Estimates of data precision are included in the likelihood components for the abundance índices and age composition data as follows:

- a standard error of 0.25 is assumed for all years both for the acoustic index (total number of fish) and the DEPM índex (SSB). In the likelihood componentes of each survey, anual log residuals are divided by the corresponding standard errors. Therefore, the two surveys and the years within each survey have equivalent weight in the objective function. The assumed standard error corresponds to a CV of 25% which is consistent with the average level of CVs estimated for the acoustic survey by geostatistics (range 12-43%, mean=23%) and GAM methods (Zwolinski et al. 2009;) and with CVs estimated for the DEPM survey (range 14-32%, mean =22%).

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- assumed sample sizes for anual age compositions in the fishery and acoustic survey are:

Fishery		Acoustic survey	
1978-1990	50	1996-2011	50
1991-2010	75		

Sample size sets the precision of the age composition data. It should correspond to the actual number of fish in the age samples if the multinomial error model was strictly correct (i.e. the number of independent observations in a sample). In general, the levels of age sampling for the sardine stock are high in both the fishery and the acoustic survey (see Table B.1.2). Although input values for sample size can be calculated from the sampling data, it is difficult to obtain real values since there is often autocorrelation within age samples. Therefore, sample sizes were calculated approximately taking into account the harmonic mean of expected sample sizes provided by the model. The sample size for fishery age compositions was assumed to be lower in the period 1978-1990 than afterwards to reflect the poorer regional coverage of stock landings (ICES, 2012, WKPELA Report);

- indices of ageing imprecision were obtained from the most recent age reading workshop (ICES, 2011b). Three sets of otoliths from diferent stock regions were aged by readers implicated in the preparation of ALKs. Standard deviations by age and reader were calculated relative to the modal age for each regional otolith set. These SDs were averaged over all readers and a weighted average for the three sets was calculated assuming the weights in the table below. Ageing imprecision was assumed to be constant over time and to be the same in the fishery and in the survey. Within the model, a transition matrix defines the expected distribution of observed ages for each true age assuming a normal distribution with mean equal to the true age and standard deviations as given in the table below.

Age	Portuguese coast	Cantabrian Sea	Gulf of Cadiz	Weighted Average
0	0.13	0.08	0.26	0.1
1	0.17	0.19	0.16	0.2
2	0.30	0.24	0.24	0.3
3	0.23	0.26	0.30	0.2
4	0.24	0.26	0.45	0.3
5	0.27	0.19	0.45	0.3
6	0.40	0.40	0.53	0.4
7	0.25	0.33	0.48	0.3
Weights	0.60	0.30	0.10	

The initial equilibrium catch was set at 100 000 tons, the recent level of catches. The model uses the initial equilibrium catch to derive an initial fishing mortality. The population numbers-at-age in the initial year (the year before the first year of the assessment period) are calculated from the mean recruitment, the initial equilibrium catch and the selectivity in the first year. Numbers-at-age in the first year of the assessment are derived from those in the initial year assuming the mean recruitment.

Minimisation of the likelihood is implemented in phases using standard ADMB process. The phases in which estimation will begin for each parameter is shown in the control file appended to this section.

Variance estimates for all estimated parameters are calculated from the Hessian matrix.

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1978 forward	Ages 0 – 6+	
Canum	Catch at age in numbers	1978 forward	Ages 0 – 6+	
Weca	Weight at age in the commercial catch	1978 forward	Ages 0 – 6+	1978-1991 No 1992 forward Yes
West	Weight at age of the spawning stock at spawning time.	1978 forward	Ages 0 – 6+	1978-1990 No

				1991 forward Yes
Matprop	Proportion mature at age	1978 forward	Ages 0 – 6+	Estimated in DEPM years, else assumed constant
Natmor	Natural mortality	1978 forward	Ages 0 – 6+	No

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	Joint SP+PT Acoustics	1996 onwards	Ages 1 – 6+
Tuning fleet 2	Joint SP+PT DEPM	1997, 1999, 2002, 2005, triennal	Not age structured

The model estimates spawning stock biomass (SSB) and summary biomass (B1+, biomass of age 1 and older) in the beginning of the year. The reference age range for output fishing mortality is 2-5 years.

INPUT FILE WITH OPTIONS USED IN THE SARDINE ASSESSMENT

#C Sardine in VIIIc and IXa : Benchmark assessment

#C growth parameters are estimated spawner-recruitment bias adjustment Not tuned For optimality

#_data_and_control_files: sardine.dat // sardine.ctl

1 #_N_Growth_Patterns

1 #_N_Morphs_Within_GrowthPattern

1 #_Nblock_Patterns

1 #_blocks_per_pattern

begin and end years of blocks

1978 1990

#

0.5 #_fracfemale

3 #_natM_type:_0=1Parm; 1=N_breakpoints;_2=Lorenzen;_3=agespecific;_4=agespec_withseasinterpolate

0.8 0.5 0.4 0.3 0.3 0.3 0.3 #_no additional input for selected M option; read 1P per morph

1 # GrowthModel: 1=vonBert with L1&L2; 2=Richards with L1&L2; 3=age_speciific_K; 4=not implemented

0 #_Growth_Age_for_L1

6 #_Growth_Age_for_L2 (999 to use as Linf)

0 #_SD_add_to_LAA (set to 0.1 for SS2 V1.x compatibility)

0 #_CV_Growth_Pattern: 0 CV=f(LAA); 1 CV=F(A); 2 SD=F(LAA); 3 SD=F(A); 4 logSD=F(A)

5 #_maturity_option: 1=length logistic; 2=age logistic; 3=read age-maturity matrix by growth_pattern; 4=read age-fecundity; 5=read fec and wt from wtatage.ss

#_placeholder for empirical age-maturity by growth pattern

1 #_First_Mature_Age

1 #_fecundity option:(1)eggs=Wt*(a+b*Wt);(2)eggs=a*L^b;(3)eggs=a*Wt^b; (4)eggs=a+b*L; (5)eggs=a+b*W

0 #_hermaphroditism option: 0=none; 1=age-specific fxn

1 #_parameter_offset_approach (1=none, 2= M, G, CV_G as offset from female-GP1, 3=like SS2 V1.x)

2 #_env/block/dev_adjust_method (1=standard; 2=logistic transform keeps in base parm bounds; 3=standard w/ no bound check)

#

#_growth_parms

#_LO	HI	INIT	PRIOR	PR_type	SD	PHASE	env-var	use_dev	dev_minyr	dev_maxyr	dev_stddev	Block	Block_Fxn		
8	18	14	0	-1	0	-2	0	0	0	0	0	0	0	#	L_at_Amin_Fem_GP_1
20	25	23	0	-1	0	-4	0	0	0	0	0	0	0	#	L_at_Amax_Fem_GP_1
0.2	0.8	0.4	0	-1	0	-4	0	0	0	0	0	0	0	#	VonBert_K_Fem_GP_1
0.05	0.25	0.1	0	-1	0	-3	0	0	0	0	0	0	0	#	CV_young_Fem_GP_1
0.05	0.25	0.1	0	-1	0	-3	0	0	0	0	0	0	0	#	CV_old_Fem_GP_1
-3	3	2	0	-1	0	-3	0	0	0	0	0	0	0	#	Wtlen_1_Fem
-3	4	3	0	-1	0	-3	0	0	0	0	0	0	0	#	Wtlen_2_Fem
50	60	55	0	-1	0	-3	0	0	0	0	0	0	0	#	Mat50%_Fem
-3	3	-0.25	0	-1	0	-3	0	0	0	0	0	0	0	#	Mat_slope_Fem
-3	3	1	0	-1	0	-3	0	0	0	0	0	0	0	#	Eggs/kg_inter_Fem

-3	3	0	0	-1	0	-3	0	0	0	0	0	0	0	#	Eggs/kg_slope_wt_Fem
0	0	0	0	-1	0	-4	0	0	0	0	0	0	0	#	RecrDist_GP_1
0	0	0	0	-1	0	-4	0	0	0	0	0	0	0	#	RecrDist_Area_1
0	0	0	0	-1	0	-4	0	0	0	0	0	0	0	#	RecrDist_Seas_1
0	0	0	0	-1	0	-4	0	0	0	0	0	0	0	#	CohortGrowDev

#_Spawner-Recruitment

4 #_SR_function: 2=Ricker; 3=std_B-H; 4=SCAA; 5=Hockey; 6=B-H_flattop; 7=survival_3Parm

#_LOHI INIT PRIOR PR_type SD PHASE

1	12	8.9	4.5	-1	5	1	#	SR_LN(R0)
0.2	1	0.9	0.7	-1	0.05	-5	#	SR_SCAA_null
0	4	0.55	0.6	-1	0.8	-4	#	SR_sigmaR
-5	5	0.1	0	-1	1	-3	#	SR_envlink
-5	5	0	0	-1	1	-4	#	SR_R1_offset
0	0	0	0	-1	0	-99	#	SR_autocorr

0 #_SR_env_link

0 #_SR_env_target_0=none;1=devs;_2=R0;_3=steepness

1 #do_recdev: 0=none; 1=devvector; 2=simple deviations

1978 # first year of main recr_devs; early devs can preceed this era

2010 # last year of main recr_devs; forecast devs start in following year

2 #_recdev phase

1 # (0/1) to read 13 advanced options

0 #_recdev_early_start (0=none; neg value makes relative to recdev_start)

-4 #_recdev_early_phase

-1 #_forecast_recruitment phase (incl. late recr) (0 value resets to maxphase+1)

1 #_lambda for Fcast_recr_like occurring before endyr+1

1900 #_last_early_yr_nobias_adj_in_MPD

1900 #_first_yr_fullbias_adj_in_MPD

1900 #_last_yr_fullbias_adj_in_MPD

1900 #_first_recent_yr_nobias_adj_in_MPD

1 #_max_bias_adj_in_MPD (-1 to override ramp and set biasadj=1.0 for all estimated recdevs)

0 #_period of cycles in recruitment (N parms read below)

-5 #min rec_dev

5 #max rec_dev

0 #_read_recdevs

#_end of advanced SR options

#Fishing Mortality info

0.3 # F ballpark for tuning early phases

-2001 # F ballpark year (neg value to disable)

3 # F_Method: 1=Pope; 2=instan. F; 3=hybrid (hybrid is recommended)

2 # max F or harvest rate, depends on F_Method

4 # N iterations for tuning F in hybrid method (recommend 3 to 7)

#

#_initial_F_parms

#_LO HI INIT PRIOR PR_type SD PHASE

0 2 0.3 0.3 -1 0.2 1 # InitF_1purse_seine

#

#_Q_setup

Q_type options: <0=mirror, 0=median_float, 1=mean_float, 2=parameter, 3=parm_w_random_dev, 4=parm_w_randwalk, 5=mean_unbiased_float_assign_to_parm

#_for_env-var:_enter_index_of_the_env-var_to_be_linked

#_Den-dep env-var extra_se Q_type

0 0 0 0 # 1 purse_seine

0 0 0 1 # 2 Acoustic_survey

0 0 0 2 # 3 DEPM_survey

#

#_Cond 0 #_If q has random component, then 0=read one parm for each fleet with random q; 1=read a parm for each year of index

#_Q_parms(if_any)

LO HI INIT PRIOR PR_type SD PHASE

-7 5 0 0 -1 1 1 # Q_base_3_DEPM_survey

#_age_selex_types

#_Pattern ___ Male Special

17 0 0 0 # 1 purse_seine

17 0 0 0 # 2 Acoustic_survey

10 0 0 0 # 3 DEPM_survey

#_LOHI	Block	INIT	PRIOR Block_Fxn		PR_type		SD	PHASE		env-var		use_dev		dev_minyr dev_maxyr dev_stddev
-5	5	0	0	-1	0.01	-2	0	0	0	0	0.1	0	0	# AgeSel_1P_1_purse_seine
-5	5	0.9	0.5	-1	0.01	2	0	3	1978	1990	0.1	1	3	# AgeSel_1P_2_purse_seine
-5	5	0.4	0.5	-1	0.01	2	0	3	1978	1990	0.1	1	3	# AgeSel_1P_3_purse_seine
-5	5	0.1	0.3	-1	0.01	2	0	3	1978	1990	0.1	1	3	# AgeSel_1P_4_purse_seine
-5	5	0	0.1	-1	0.01	-2	0	0	0	0	0.1	0	0	# AgeSel_1P_5_purse_seine
-5	5	0	0.1	-1	0.01	-2	0	0	0	0	0.1	0	0	# AgeSel_1P_6_purse_seine
-5	5	-0.5	0.5	-1	0.01	2	0	3	1978	1990	0.1	1	3	# AgeSel_1P_7_purse_seine
-1000-1000-1000-6				-1	0.01	-2	0	0	0	0	0	0	0	# AgeSel_2P_1_Acoustic_survey
-5	5	0	0.5	-1	0.01	-2	0	0	0	0	0	0	0#	AgeSel_2P_2_Acoustic_survey
-5	9	-0.3	0	-1	0.01	2	0	0	0	0	0	0	0#	AgeSel_2P_3_Acoustic_survey

-5 9 0 0 -1 0.01 -2 0 0 0 0 0 0 0# AgeSel_2P_4_Acoustic_survey

-5 9 0 0 -1 0.01 -2 0 0 0 0 0 0 0# AgeSel_2P_5_Acoustic_survey

-5 9 0 0 -1 0.01 -2 0 0 0 0 0 0 0# AgeSel_2P_6_Acoustic_survey

-5 9 -0.8 -1 -1 0.01 2 0 0 0 0 0 0 0# AgeSel_2P_7_Acoustic_survey

1 #_custom_sel-blk_setup (0/1)

-5 5 0.9 1 -1 0.01 2 # AgeSel_1P_2_purse_seine_BLK1delta_1978

-5 5 0.4 1 -1 0.01 2 # AgeSel_1P_3_purse_seine_BLK1delta_1978

-5 5 0.1 1 -1 0.01 2 # AgeSel_1P_4_purse_seine_BLK1delta_1978

-5 5 -0.5 1 -1 0.01 2 # AgeSel_1P_7_purse_seine_BLK1delta_1978

4 #_selparmdev-phase

1 #_env/block/dev_adjust_method (1=standard; 2=logistic trans to keep in base parm bounds; 3=standard w/ no bound check)

1 #_Variance_adjustments_to_input_values

#_fleet: 1 2 3

0 0 0 #_add_to_survey_CV

0 0 0 #_add_to_discard_stddev

0 0 0 #_add_to_bodywt_CV

0 0 0 #_mult_by_lencomp_N

1 1 1 #_mult_by_agecomp_N

1 1 1 #_mult_by_size-at-age_N

4 #_maxlambdaphase

1 #_sd_offset

3 # number of changes to make to default Lambdas (default value is 1.0)

Like_comp codes: 1=surv; 2=disc; 3=mnwt; 4=length; 5=age; 6=SizeFreq; 7=sizeage; 8=catch;

9=init_equ_catch; 10=recrdev; 11=parm_prior; 12=parm_dev; 13=CrashPen; 14=Morphcomp; 15=Tag-comp; 16=Tag-negbin

like_comp fleet/survey phase value sizefreq_method

9 1 1 1 1

4 2 2 1 1

4 2 3 1 1

D. Short-Term Projection

Model and software used: Multi Fleet Deterministic Projection (MFDP)

The initial stock size corresponds to the assessment estimates for ages 1-6+ at the final year . Recruitment (Age 0) estimated in the final year of the assessment is accepted for the projection since it is supported by data from the acoustic survey in the interim year. Recruitment in the interim year and forecast year will be set equal to a pre-agreed level of recruitment according to the update assessment. This level corresponds to the geometric mean recruitment of the last 15 years. The period selected does not cover the entire assessment period because there is a decreasing trend in recruitment throughout the historical period. A 15 year period will integrate some bad and good recruitments, whitout being too much dependent to the most recent recruits estimated by the model.

The maturity ogive corresponds to the ogive used in the assessment (in years with no DEPM survey), i.e. 0% mature at age 0, 80% mature at age 1 and 100% mature at age 2+.

Input values for the proportion of F and M before spawning are zero, which correspond to the beginning of the year when the SSB is estimated by the model.

Weights-at-age in the stock and in the catch are calculated as the arithmetic mean value of the last three years of the assessment.

Natural mortality-at-age is equal to that used in the assessment.

The exploitation pattern is the average of the last three years of the assessment.

Predictions are carried out with an Fmultiplier (usually ranging from 0 to 2) assuming an Fsq equal to the average estimates of the last three years in the assessment. In the interim year, catches are constrained to be an agreed expected level (since data in not yet available), usually those corresponding to Fsq (0.36) or alternatively as duly justified by stock assessment scientists. Predicted population at the beginning and end of the forecast year will be shown according to preselected levels of fishing mortality in consonance with defined precautionary and target reference points.

E. Medium-Term Projections

Not carried out.

F. Long-Term Projections

Not carried out.

G. Biological Reference Points

	Type	***Value***	***Technical basis***
MSY Approach	**MSY $B_{trigger}$**	**xxx t**	**Undefined**
	F_{MSY}	**0.35**	**$F_{BPR50\%}$, F at which the B_{1+}/R is half of what it would have been in the absence of fishing**
Precautionary Approach	**B_{lim}**	**307 000 t**	**Blim=Bloss (2000 B_{1+}), Bloss being the lowest historical biomass which produced good recruitments**
	B_{pa}	**xxx t**	**Undefined**
	F_{lim}	**Xxx**	**Undefined**
	F_{pa}	**Xxx**	**Undefined**

Reference points are expressed in terms of B_{1+}, the biomass of age 1 and older individuas. B_{1+} corresponds to total stock biomass at the beginning of the year.

H. Other Issues

H.1. Historical overview of previous assessment methods (this subsection is optional. See example below.)

From 2003 to the current benchmark, the sardine stock was assessed using the age structured model AMCI (Assessment Model Combining Information from various sources, Skagen 2005). Because the program is not going to be maintained in the future, alternative programs have been explored. Stock Synthesis (SS3) has been chosen as the final assessment model in the 2012 benchmark since it offers the same level of flexibility of AMCI and additional features, such as the possibility to incorporate uncertainty of input data in the variance of final estimates. Other SS3 abilities which were not explored due to time limitation but might be useful in the future are: link to environmental data (e.g. to recruitment), include several fleets and areas (explain spatial differences in sardine demography) and use of the forecast module.

Summary of data ranges used in recent assessments:

Data	2006 assessment	2007 assessment	2008 assessment	2009 assessment
Catch data	Years: 1978–(AY-1) Ages: 1–8+	Years: 1978–(AY-1) Ages: 1–8+	Years: 1978–(AY-1) Ages: 1–8+	Years: 1978–(AY-1) Ages: 1–8+
Survey: A_Q1	Years: 1985–AY Ages: 1–7	Years: 1985–AY Ages 1–7	Years: 1985– AY Ages 1–7	Years: 1985– AY Ages 1–7
Survey: B_Q4	Years: 1996–(AY-1) Ages: 1–5	Years: 1996– AY-1) Ages 1–7	Years: 1996– AY-1) Ages 1–7	Years: 1996– AY-1) Ages 1–7
Survey: C	Not used	Not used	Not used	Not used

AY – Assessment year

(The historic perspective, as well as all the other section on the stock annex, should only update in a benchmark workshop. If there is any reason to deviate from the stocks annex, this should be explain in the Working Group report and only update this deviation in the historic perspective after consultation with ICES Secretariat and WG Chair).

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