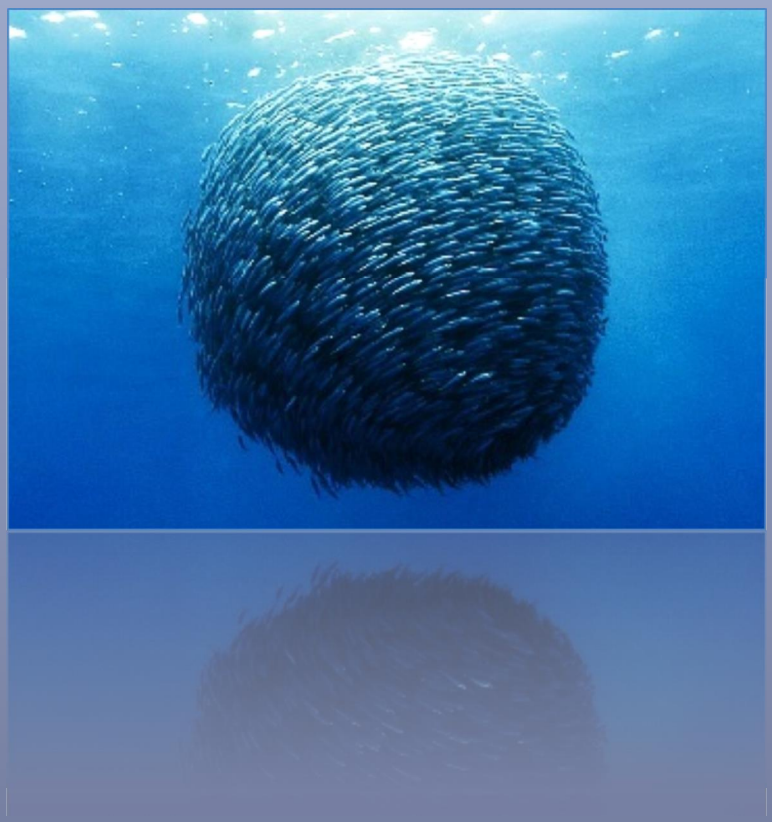


Stock Assessment Form

Small Pelagics

Reference Year: 2017

Reporting Year: 2018

Stock Assessment Form version 1.0 (November 2014)

Sardine GSA01 (Northern Alboran Sea)

Stock assessment form

1 Basic Identification Data

Scientific name:	Common name:	ISCAAP Group:
Sardina pilchardus	sardine	35
1st Geographical sub-area:	**2nd Geographical sub-area:**	**3rd Geographical sub-area:**
1		
1st Country	**2nd Country**	**3rd Country**
Spain		
Stock assessment method: (direct, indirect, combined, none)		
Indirect: : Fishery data		
Authors:		
Torres, P., A. Giráldez, M. Iglesias, M. González, and A. Ventero		
Affiliation:		
IEO. Instituto Español de Oceanografía		

2 Stock identification and biological information

2.1 Stock unit

The General Fisheries Commission for the Mediterranean (GFCM) stress the importance of making common assessments of shared stocks of priority species. The joint stock assessment of the main shared stocks in the Mediterranean Sea is considered as an important step to contribute reinforcing the subregional collaboration, and to promote agreed management recommendations for fisheries in the GFCM area.

Sponsored by Copemed II there have been two joint assessments between Spain and Morocco for the Alboran Sea sardine. These have been submitted to the WG of assessment of small pelagic GFCM, however it is necessary to promote other studies to determine if this is a shared stock.

2.2 Growth and maturity

Table 2.2-1: Maximum size, size at first maturity and size at recruitment.

Somatic magnitude measured (LT, LC, etc)			**LT**	**Units**	cm
Sex	**Fem**	**Mal**	**Combined**	**Reproduction season**	Autumn-Winter
Maximum size observed			23.5 (2017) 25 (2004-2016)	**Recruitment season**	Spring-summer
Size at first maturity			12.24 (2016) 12.95 (2003-2016)	**Spawning area**	All the coast
Recruitment size to the fishery			11 (2017)	**Nursery area**	Bays

Table 2-2.2: M vector and proportion of matures by age 2003- 2016.

Size/Age	Natural mortality *	Proportion of matures
Edad 0	0.91	0.46
Edad 1	0.67	0.94
Edad 2	0.56	0.99
Edad 3	0.51	1.00
Edad 4	0.47	1.00
Edad 5+	0.44	1.00

Table 2-3: Growth and length weight model parameters 2003-2016

			Sex			
		Units	female	male	Combined	Years
Growth model	L_∞				22.6	2003-2016
	K				-1.7507	2003-2016
	t_0				0.39	2003-2016
	Data source	DCF 2003-2016				
Length weight relationship	a				0.0062	2003-2016
	b				3.1091	2003-2016
	sex ratio (% females/total)	53.8				

3 Fisheries information

3.1 Description of the fleet

The current fleet in GSA 01 the Northern Alboran Sea is composed by 79 units, characterised by small vessels, average TJB 25.9. 14% of them are smaller than 12 m (operational Unit 1), 86% > 12 m (operational Unit 2), and no one bigger than 24m. The purse seine fleet has been continuously decreasing in the last two decades, from more than 230 vessels in 1980 to 79 in 2017. A strong reduction of larger vessels occurred from 1985 onwards, possibly linked to a decreasing in anchovy catches in Northern Morocco, where a part of that fleet fished under agreement between the countries. Subsequently the fleet continued to decline but more slowly.

Although sardine has a lower price than anchovy is an important support to the fishery as it is the most fished species. Catches in the period 1990-2017 has been highly variable, with a minimum of 3000 tons in 1997. Higher catches occurred in 1992 (11000 tons). In 2017 landings were 3800 t, very close to the historical minimum of 3200 t in 1997.

The two operational units fish the same species, there are no major differences, sardine is the most fished species by both of them. Although there is a slight difference in the percentage of mackerel catches, as bigger ships are able to fish species with more swimming ability.

Species with a lower economic value are also captured, sometimes representing a high percentage of landings: horse mackerel (*Trachurus spp*.), mackerel (*Scomber spp*.), and gilt sardine (*Sardinella aurita*). The interest about some of these species has been increasing because there is a new market for them; gilt sardine and mackerel, especially the first, are sold for tuna farming. A requirement for such sales is a high yield by fishing day, due to its low economic value. In the case of mackerel it is exported to Portugal.

Data used in the assessment correspond to EU-Data Collection Framework. Unit of effort has been effective fishing night by species. Series of CPUE shows a very similar profile to catches (Fig. 3.2.1.)

Table 3-1: Description of operational units exploiting the stock

	Country	**GSA**	**Fleet Segment**	**Fishing Gear Class**	**Group of Target Species**	**Species**
Operational Unit 1*	Spain	1	G-Purse Seine (6-12 m)	02-Seine Nets	31- Small gregarious pelagic	PIL
Operational Unit 2	Spain	1	H-Purse Seine (>12)	02-Seine Nets	31- Small gregarious pelagic	PIL

Table 3.1-2: Catch, bycatch, discards and effort by operational unit in the reference year in GSA01

Operational Units*	Fleet (n° of boats)*	Catch (T or kg of the species assessed) Tons	Other species caught (names and weight) Tons	Discards (species assessed)	Discards (other species caught)	Effort (units)
ESP 01 G 02 31-PIL	11	312	Anchovy: 99 Trachurus spp: 390 Scomber spp: 274 Sardinella: 220 Otros: 157	negligible	negligible	Effective fishing day for species
ESP 01 H 02 31-PIL	68	3343	Anchovy: 2257 Trachurus spp: 1537 Scomber spp: 3082 Sardinella: 2237 Otros: 1047	negligible	negligible	Effective fishing day for species
Total	79	3655	14945			

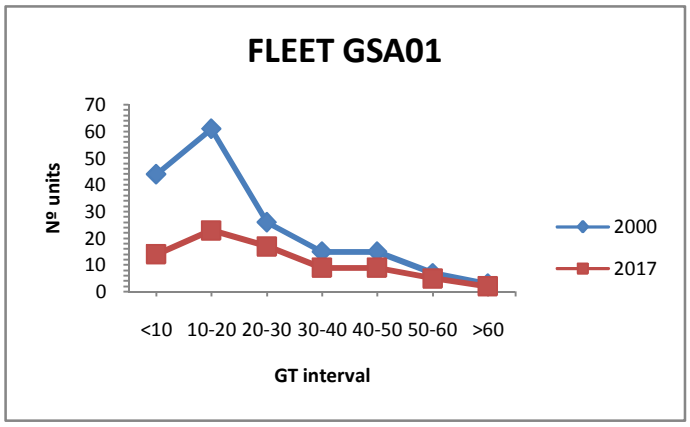


Fig. 3.2.1. Fleet GSA01 in years 2000 and 2017.

A great decrease in the smallest units (Fig. 3.2.1).

Table 3.1-3: Catches used in the assessment 2003-2017 in GSA01. RSM: landings correspond to the

***Southern Mediterranean Region (RSM)**, around 95% of catches of GSA01 1990-2017.*

YEAR	Catch (tons) RSM	CPUE Kg/fishing day RSM	Catch (tons GSA01
1990	6439	921	7908
1991	9599	1328	11733
1992	10826	1308	12754
1993	5782	1095	7462
1994	5220	926	6117
1995	4316	756	5418
1996	3589	612	4293
1997	3263	726	3672
1998	3982	839	4469
1999	5146	1143	5639
2000	8697	1369	9353
2001	6817	1255	7456
2002	5237	1019	5275
2003	7817	1189	8087
2004	3904	792	3957
2005	7066	1272	7516
2006	9376	1478	9971
2007	5683	1116	6139
2008	4329	1069	4468
2009	5896	1313	5972
2010	7164	1270	7328
2011	6065	1139	6293
2012	5431	1112	6214
2013	4456	956	4983
2014	4782	932	5174
2015	5058	977	5248
2016	3844	911	4171
2017	3483	855	3655
Average 1990-2017	5087	1060	6454

3.2 Historical trends

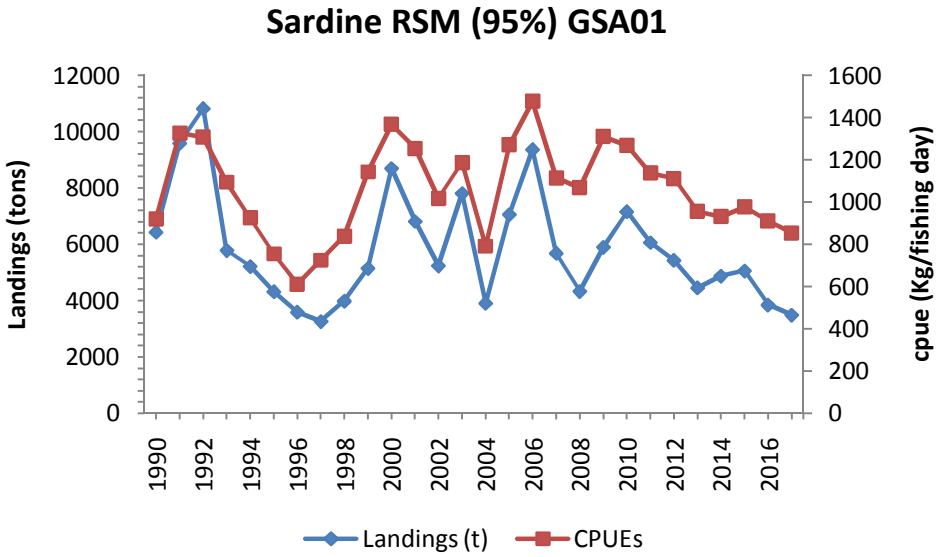


Fig. 3.2.1. Trends in sardine landings and CPUE in South Mediterranean Region (RSM), years 1990-2017.

Series of CPUEs from 1990-2017 show the same profile of landings without a clear trend (Fig. 3.2.1). Catches in 2017 were very low, similar to 2004 and 1997.

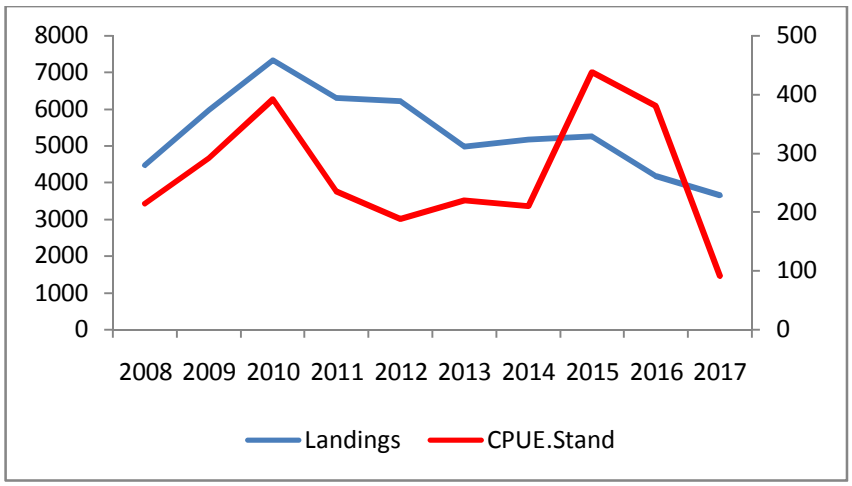


Fig. 3.2.2. Trends in sardine landings and CPUE.Stand in GSA01 years 2008-2017.

There is a significant decrease of the standardized CPUE in the last years.

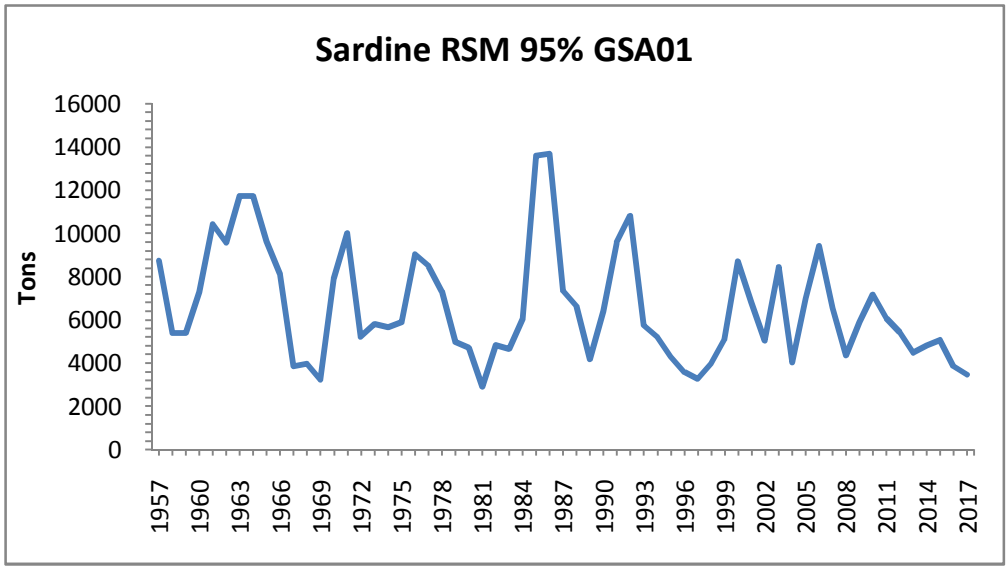
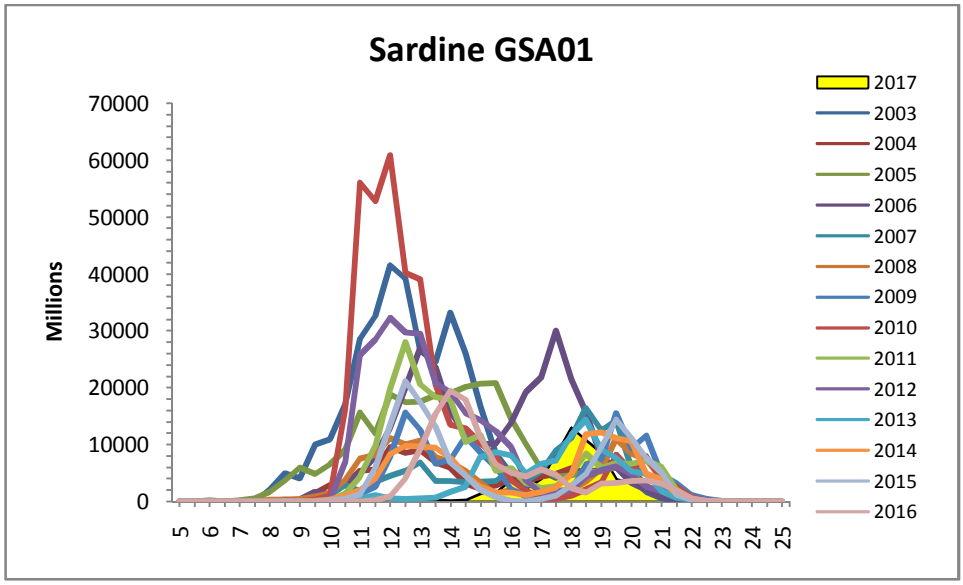
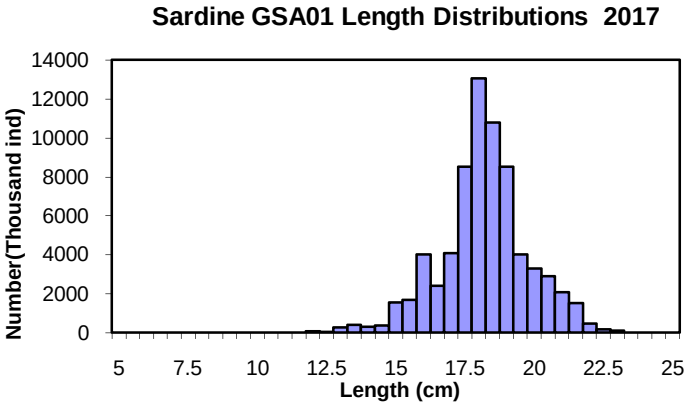


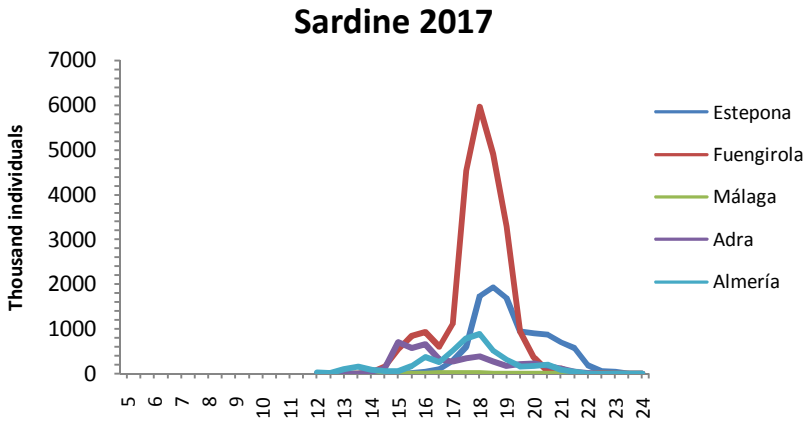
Fig. 3.2.3. Trends in sardine landings in South Mediterranean Region (RSM), years 1957-2017.

The long-term catches show large fluctuations without any significant clear trend, although in the last two they decreased.

Length distribution fishery





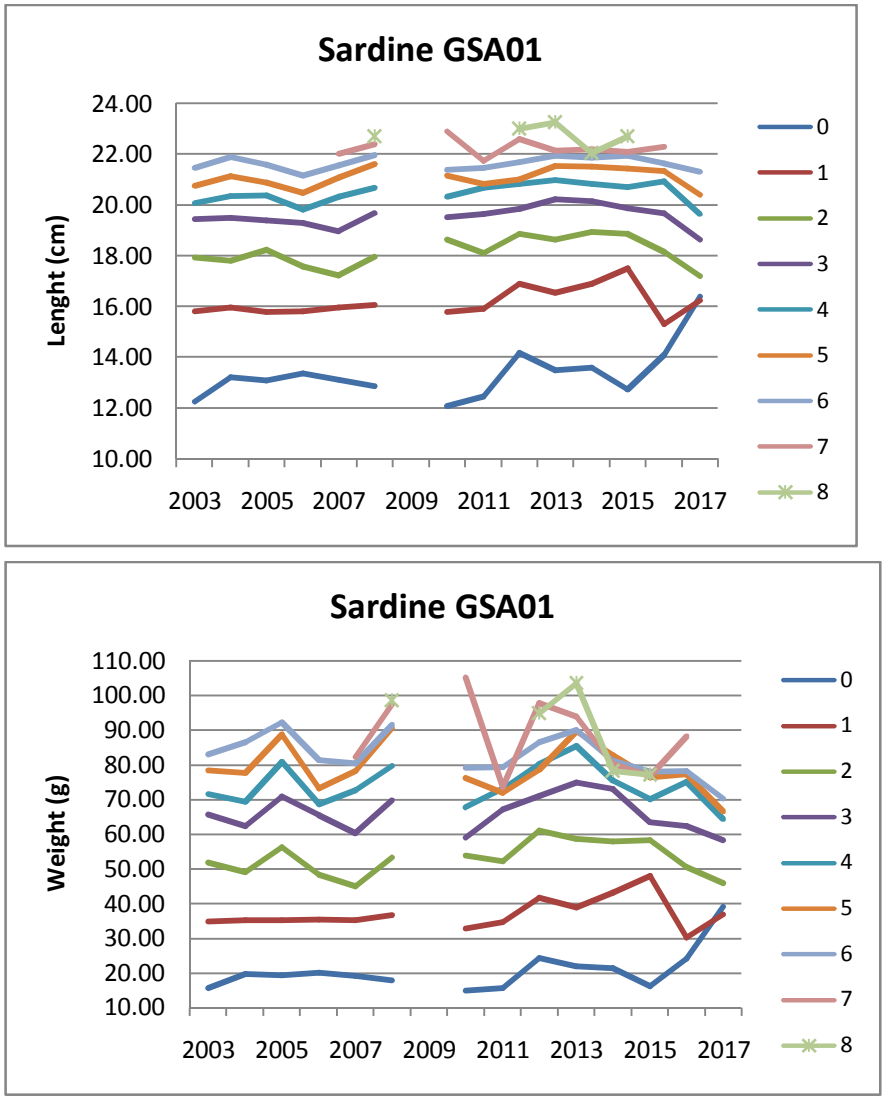


Figures 3.3.1, 3.3.2.,3.3.3. Length distribution sardine fishery 2003-2017 (above), only 2017 and 2017 by ports (below).

The fishery is based on individuals of all length classes. The smaller sardines are mainly fished in bays and the bigger ones outside of the bays.

In 2017 very low recruitment. This fact is observed in all the ports sampled *Fig. 3.3.3*

3.3 Length and Weight by age in the fishery.



Figures 3.4.1 y 3.4.2. Length and weight by age 2003-2017.

Many ages in the catches and without trend in size and weight by age

3.4 Body Condition

The formula used for the calculation of the Condition Factor was Le Cren (1951). Monthly evolution of this factor in sardine (Fig. 3.5.1) shows a good nutritional status at certain times of the year with no trend over the years.

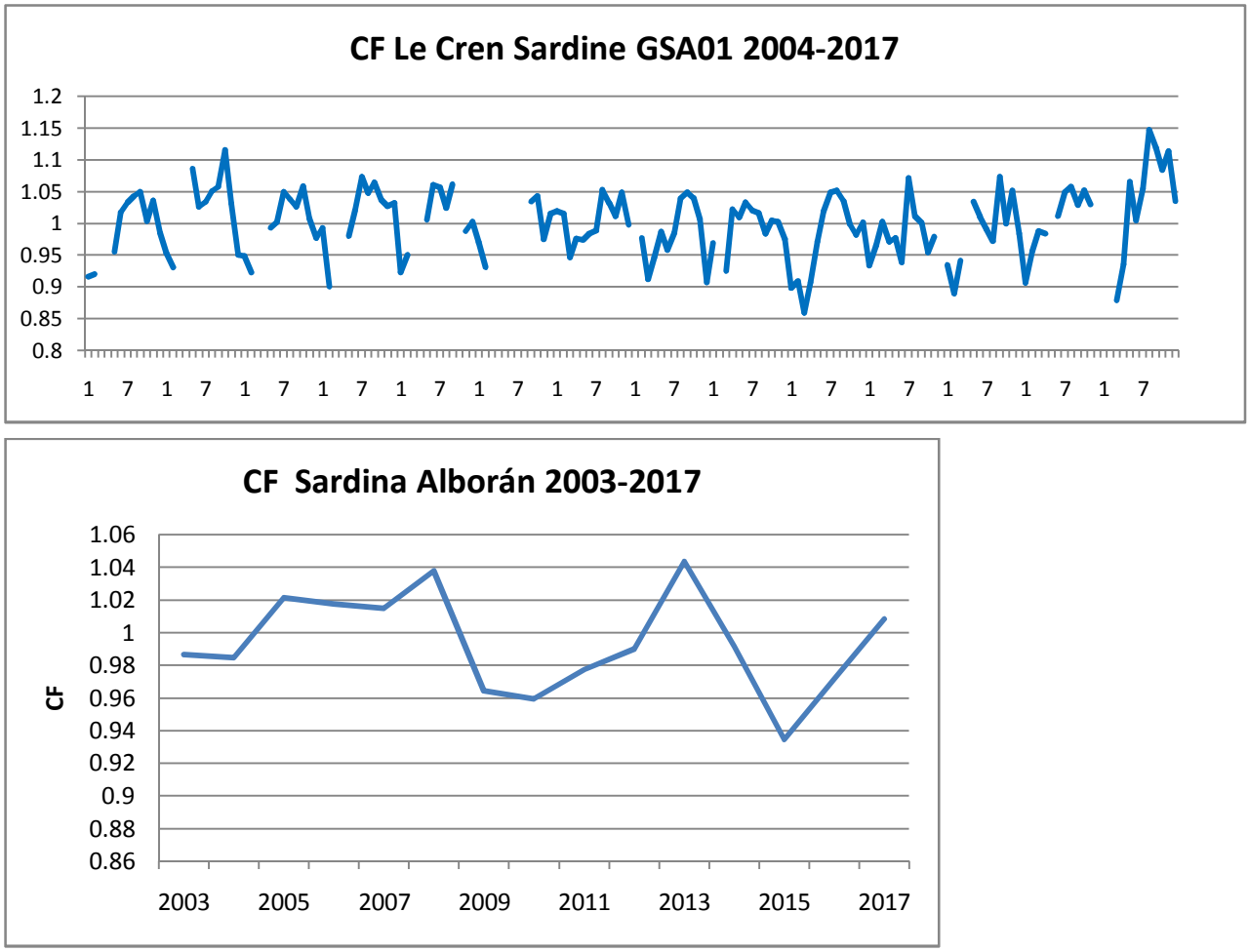


Figure 3.5.1. Monthly and annual evolution of the condition factor 2004-2017.

Management regulations

Regulated by Fishery European regulations REGULATION (EC) Nº 1967/2006 of December 21, 2006, with a more restrictive Spanish regulations.

Features gear: Minimum aperture of 14 mm mesh, The height of the purse seine shall not exceed 82 m and the use of purse seines is not allowed at a depth less than 70 percent of the net length, Length net will not exceed more than 300 m except for Alboran Sea which may be up to 450 m. **Characteristics of vessels:** No less than 9 m long, maximum power 450 hp, only one auxiliary boat and there is a Regulating for its power lights. **Fishing areas:** prohibited fishing less than 35 m deep, although at a distance of 300 m offshore it is permitted at a lower depth than 50m. There are forbidden areas to safe anchovy recruitment. **Fishing effort:** No fishing on weekend restricted fishing areas and seasonal closures in some regions. **Minimum sizes:** Minimum legal landing size 9 cm. **List of species authorized** to be fished by the gear. There is a margin of 2% of others species.

4 Fisheries independent information

4.1 Acoustic survey: ECOMED and MEDIAS

4.1.1 Brief description of the chosen method and assumptions used

In the Spanish Mediterranean waters an acoustic survey has been annually carried out since the 90'. Until 2009 the survey (ECOMED)was carried out in late autumn focusing on the anchovy (*Engraulis encrasicolus*) recruitment; since 2009 the acoustic survey season changed to summer in order to standardize with the rest of acoustic surveys carried out by the European countries in Mediterranean Sea and to start the MEDIAS (Mediterranean acoustic surveys) series. The pelagic community is nowadays assessed, focusing on the spawning stock biomass (SSB) for anchovy and the recruitment of sardine. The GFCM Geographical Sub-Area covered are the GSA 06 (Northern Spain) and 01 (Northern Alboran Sea), prospecting the continental shelf (30 to 200 m depth) by means of a scientific echosounder EK60 (Simrad), equipped with 5 frequencies (18, 38, 70, 120 and 200 kHz).

Acoustic data are recorded continuously at a constant ship speed of 10 knots from sunrise to sunset, along parallel equidistant transects lying perpendicular to the bathymetry. The echosounder is calibrated before each survey following standard techniques (Foote et al., 1987).

Midwater pelagic trawls were deployed to determine the species proportions present in the area. Acoustic data are processed using Echoview (Miryax Ltd.) software and PESMA (VisualBasic) software. Echo trace classification is based on echogram visual scrutinisation, usually the allocation is on account of representative fishing station and very few times on direct allocation. Results of biomass (tons) and abundance (nº individuals) are presented by species, length and age.

Direct methods: acoustics

Table 4.1-1: Acoustic cruise information.

Date	MEDIAS: June-July; ECOMED: November-December		
Cruise	ECOMED and MEDIAS	**R/V**	Cornide de Saavedra Miguel Oliver
Target species	Anchovy and sardine		
Sampling strategy	66 tracks normal to the coast. Inter-transect distance: 4 or 8 nautical miles		
Sampling season	MEDIAS: June-July; ECOMED: November-December		
Investigated depth range (m)	30-200 m depth		
Echo-sounder	Scientific Echo-sounder EK60 equipped with 5 frequencies (18, 38, 70, 120 & 200 kHz)		
Fish sampler	Pelagic trawls with 10, 16 & 18 m vertical opening		

Cod –end mesh size as opening (mm)	20 mm
ESDU (i.e. 1 nautical mile)	Elementary Distance Sampling Unit: 1 nautical mile
TS (Target Strength)/species	-72.6 dB for anchovy and sardine
Software used in the post-processing	SonarData Echoview, PESMA (Visual Basic)
Samples (gear used)	Pelagic trawl
Biological data obtained	Length-weight relationship, age, sex, maturity
Age slicing method	Otolith
Maturity ogive used	

Table 4.1-2: Acoustic results, if available by age or length class

	Biomass in metric tons	**fish numbers**	**Nautical Area Scattering Coefficient**	**Indicator …**	**Indicator …**
2013	2677	46 millions			
2014	8500	148 millions			
2015	10442	335 millions			
2016	1710	52 millions			
2017	4723	129 millions			

4.1.2 Spatial distribution of the resources

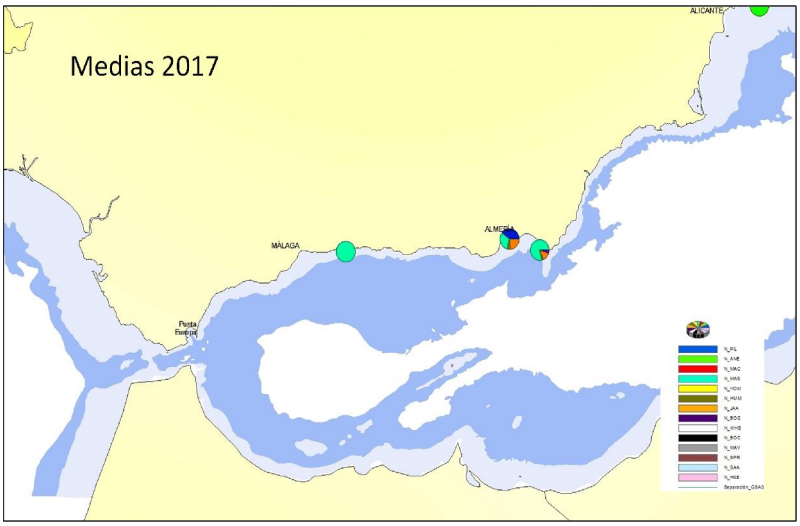


Fig. 4.1.2.1. Proportion of sardine in MEDIAS hauls in 2017.

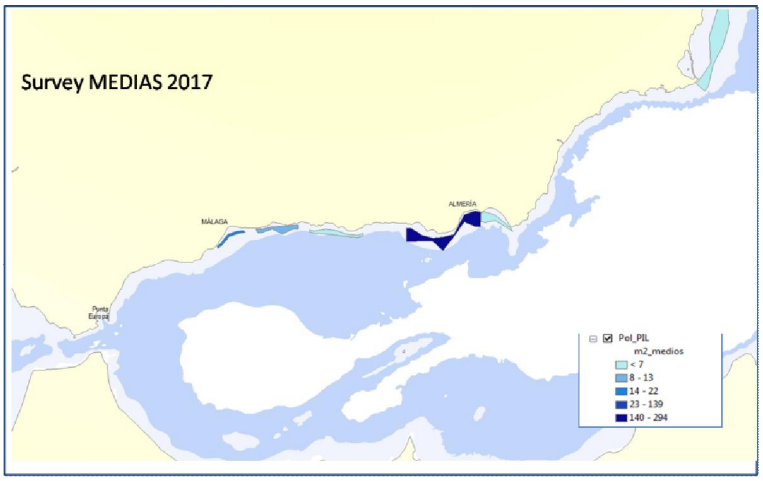


Fig. 4.1.2.1. Densities distribution of sardine *Medias 2017.*

The western area, between Marbella and Estepona ports, used to be the one with a greater biomass of sardine and mainly large sizes. The acoustic assessment in 2017 of this area has been rather low.

4.1.3 Historical trends

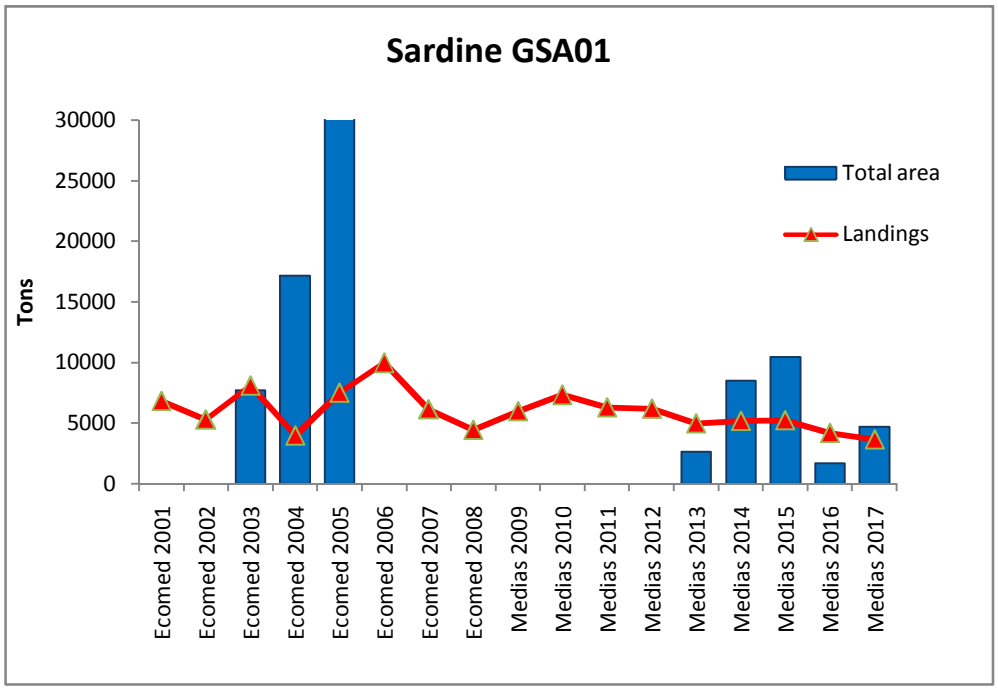


Figure 4.1.3.1. Evolution of biomass assessed in the Alboran Sea for surveys ECOMED and MEDIAS.

There are inconsistencies between landings and surveys assessments. The acoustic assessment in the area is not feasible with the actual methods. The resource is close to the shore (less than 30 m deep) where there are plenty of artificial reefs and the artisanal fleet set its gears doing unfeasible fishing with the survey net. It was consulted to experts about carrying out eggs production methods (EPM) in the area, but apparently it is not possible at such a low level of biomass.

5 Ecological information

5.1 Protected species potentially affected by the fisheries

A list of protected species that can be potentially affected by the fishery should be incorporated here. This should also be completed with the potential effect and if available an associated value (e.g. by catch of these species in T)

5.2 Environmental indexes

6 Stock Assessment

The acoustic evaluations present problems to be used in the analytical evaluation of the stock. An in-depth analysis of the usefulness of these data is needed (comparison of fishing areas and prospecting area, etc. The long-term catches show large fluctuations without any significant clear trend, although in the last two they decreased.

7 Stock predictions

7.1 Short term predictions

7.2 Medium term predictions

7.3 Long term predictions

8 Draft scientific advice

Based on	Indicator	Analytic al reference point (name and value)	Current value from the analysis (name and value)	Empirical reference value (name and value)	Trend (time period)	Status
Fishing mortality	Fishing mortality	F0.1=	Fc=		2003-2017	IO –In Overfishing status
	Fishing effort					
	Catch					
Stock abundance	Biomass					
	SSB					
Recruitment						
Final Diagnosis		Over exploited (in over exploitation)				

8.1 Explanation of codes

Trend categories

1) N - No trend
2) I - Increasing
3) D – Decreasing
4) C - Cyclic

Stock Status

Based on Fishing mortality related indicators

1) **N - Not known or uncertain** – Not much information is available to make a judgment;
2) **U - undeveloped or new fishery** - Believed to have a significant potential for expansion in total production;
3) **S - Sustainable exploitation**- fishing mortality or effort below an agreed fishing mortality or effort based Reference Point;
4) **IO –In Overfishing status**– fishing mortality or effort above the value of the agreed fishing mortality or effort based Reference Point. An agreed range of overfishing levels is provided;

    Range of Overfishing levels based on fishery reference points

    In order to assess the level of overfishing status when $F_{0.1}$ from a Y/R model is used as LRP, the following operational approach is proposed:

    - If $Fc^*/F_{0.1}$ is below or equal to 1.33 the stock is in **(O_L): Low overfishing**
    - If the $Fc/F_{0.1}$ is between 1.33 and 1.66 the stock is in **(O_I): Intermediate overfishing**
    - If the $Fc/F_{0.1}$ is equal or above to 1.66 the stock is in **(O_H): High overfishing**

    *Fc is current level of F

5) **C- Collapsed**- no or very few catches;

Based on Stock related indicators

1) **N - Not known or uncertain:** Not much information is available to make a judgment
2) **S - Sustainably exploited:** Standing stock above an agreed biomass based Reference Point;
3) **O - Overexploited**: Standing stock below the value of the agreed biomass based Reference Point. An agreed range of overexploited status is provided;

    Empirical Reference framework for the relative level of stock biomass index

    - **Relative low biomass:** Values lower than or equal to 33rd percentile of biomass index in the time series **(O_L)**

- **Relative intermediate biomass:**Values falling within this limit and 66th percentile **(O_I)**
- **Relative high biomass:**Values higher than the 66th percentile **(O_H)**

4) **D–Depleted**: Standing stock is at lowest historical levels, irrespective of the amount of fishing effort exerted;
5) **R –Recovering:** Biomass are increasing after having been depleted from a previous period;

Agreed definitions as per SAC Glossary

Overfished (or overexploited) *- A stock is considered to be overfished when its abundance is below an agreed biomass based reference target point, like B0.1 or BMSY. To apply this denomination, it should be assumed that the current state of the stock (in biomass) arises from the application of excessive fishing pressure in previous years. This classification is independent of the current level of fishing mortality.*

Stock subjected to overfishing (or overexploitation) - *A stock is subjected to overfishing if the fishing mortality applied to it exceeds the one it can sustainably stand, for a longer period. In other words, the current fishing mortality exceeds the fishing mortality that, if applied during a long period, under stable conditions, would lead the stock abundance to the reference point of the target abundance (either in terms of biomass or numbers)*

9.1 Explanation of codes

Trend categories

5) N - No trend
6) I - Increasing
7) D – Decreasing
8) C - Cyclic

Stock Status

Based on Fishing mortality related indicators

6) **N - Not known or uncertain** – Not much information is available to make a judgment;
7) **U - undeveloped or new fishery** - Believed to have a significant potential for expansion in total production;
8) **S - Sustainable exploitation**- fishing mortality or effort below an agreed fishing mortality or effort based Reference Point;
9) **IO –In Overfishing status**– fishing mortality or effort above the value of the agreed fishing mortality or effort based Reference Point. An agreed range of overfishing levels is provided;

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- If the $Fc/F_{0.1}$ is equal or above to 1.66 the stock is in **(O_H): High overfishing**

*Fc is current level of F

10) **C- Collapsed**- no or very few catches;

Based on Stock related indicators

6) **N - Not known or uncertain:** Not much information is available to make a judgment
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Empirical Reference framework for the relative level of stock biomass index

- **Relative low biomass:** Values lower than or equal to 33rd percentile of biomass index in the time series **(O_L)**

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- **Relative high biomass:**Values higher than the 66th percentile **(O_H)**

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10 BIBLIOGRAFIA

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