Stock Assessment Form

Small Pelagics

Reference Year: 2017

ReportingYear: 2018

Stock Assessment Form version 1.0 (November 2014)

Work conducted in the framework of FAO CopeMedII Regional Project

Stock assessment form

1 Basic Identification Data 2
2 Stock identification and biologicalinformation 3
2.1 Stock unit 3
2.2 Growth and maturity 3
3 Fisheries information 8
3.1 Description of the fleet 8
3.2 Historical trends 11
3.3 anagement regulations 14
4 Fisheries independent information 15
4.1 Direct methods: Acoustic survey 15
4.1.1 Brief description of the method 15
4.1.2 Spatial distribution of the resources 17
5. Issues relevant to sardine Stock Assessment and recommendations 19

1 Basic Identification Data

Scientificname:	Commonname:	ISCAAP Group:
Sardina pilchardus	sardine	35
1st Geographical sub-area:	**2nd Geographical sub-area:**	**3rd Geographical sub-area:**
GSA 01	GSA 03	GSA 04
1st Country	**2nd Country**	**3rd Country**
Spain	**Morocco**	**Algeria**
Stock assessmentmethod: (direct, indirect, combined, none)		
None		
Authors:		
M.H. Idrissi[1], A. Giráldez[2], S. Elarraf[3], P. Hernández[4], M. Serghini[5], P. Torres[2], N. El ouamari[1], M. Malouli[3], S. Ben Smail[7], M. Guechaoui[7], K. Ferhani[7], S. ELayoubi[6],A. Bennoui[7],M. Vasconcellos[4]		
Affiliation:		
[1]National Institute of FisheriesResearch (INRH), Regional Center of Nador. Morocco [2]Spanish InstituteforOceanography (IEO), Ocenaographic Center of Fuengirola. Spain [3]National Institute of FisheriesResearch (INRH), Regional Center of Tangier. Morocco [4]FAO FIAF-CopeMed II Project [5]National Institute of FisheriesResearch (INRH), Regional Center of Casablanca. Morocco [6]National Institute of FisheriesResearch (INRH), Regional Center of Agadir. Morocco [7]National Centre forResearch and Development of Fisheriesand Aquaculture (CNRDPA). Algeria		

2 Stock identification and biologicalinformation

2.1 Stock unit

Within the framework of Copemed II five joint assessments for sardine between Spain and Morocco have been carried out: (in 2012, 2015 ,2016, 2017 and the current one). All of them have been submitted to the GFCM WGs and were validated for the last two years. However, the contradictory results between the status in GSA 01 and in GSA 03 and in the joint (GSAs 01 and 03) potentially reflect regional differences thus stressing that the issue of stock boundaries is problematic in the Alboran Sea. The SAC WGs in 2015 and 2016 recommended an in-depth analysis on stock boundaries and to continue investigating the pertinence of joining GSAs 1 and 3 for the assessment of sardine.

Following these recommendations, the Project CopeMed II, organized a "*Technical workshop for the identification of stock units in the Alborán Sea*" from 3-6 April 2017 in Alicante, Spain. Experts from Algeria, Italy, Morocco Spain and Tunisia presented andiscussed current methodologies for the delimitation of stocks and agreed on a medium-term research program to identify stocks distribution of sardine, hake and blackspot seabream in the Alborán sea (GSAs 1, 2, 3,4 and adjacent waters). The Program is essential to deepen knowledge on stock identification and will have a minimum duration of two years and will follow a multidisciplinary approach i.e.: hydrodynamics modelling, genetics techniques, parasites, life history traits, elemental composition, morphometry and fishery patterns. Sampling of individuals has been designed from the beginning of the study with this purpose, covering the entire Alboran Sea and adjacent waters. This proposal was approved by the 10th meeting of the Coordination Committee in October 2017 and started to be operational in December 2017. The outcomes will be shared with the GFCM WGs and the SAC in the coming years.

Prior to the current Working Group, the CopeMed Alboran experts met and did some exercises of joint assessments of sardine in GSA 01, and GSA 03. Furthermore, a preliminary assessment was also tried by adding data from the Alboran part of GSA 04, which is represented by the ports of Ghazauet and BeniSaf. The results of these exercises were presented to the WGs which highlighted strong uncertainties that should be addressed by an in-depth analysis of existing data. The present document reports some preliminary analysis of growth curves, length-frequency distributions and age slicing with different methods as a means to progress towards the identification of issues. A work plan for the next intersessional period was suggested for the stock of sardine in Alboran sea.

2.2 Growth and maturity

The observed maximum lengths of sardine registered during biological samplings programme were 22.1 cm for Spanish comercial landings and 22.5cm for moroccan one.

Sardine is considered a high growing level species especially during the earliest years (Pauly, 1982; Blaxter JHS and Hunter JR, 1982). The growth of this resource is influenced by environmental conditions and genetic carasteristics (Fréon, 1979). In the Alboran sea, usually, the exploited stock is mainly composed by 0, 1 and 2 year-old individuals. Sardine spawn throughout the year, but with different intensities. Arrish, 1986 and Millan, 1999 reported that females reach larger size than males, consequently, they represent a higher proportion of the population for longer lengths.

The spawning season occurs in automn-winter period. Length at first sexual maturation (L50) was assumed=12.53 cm. This value comes from Moroccan sampling data. Moreover, this values fluctuates in spatial and temporal scale (Abad and Giraldez, 1993). The annual variabilty of L_{50} value

depend on spawning period, annual recruitment as well as the differential growth of successive annual cohorts that have experienced different environmental conditions (Milllán, 1999) while, its variability in terms of areas may be dependent on the trophic resource, temperature (Blaxter, 1969), density (Parrish and Mallicoate, 1995) and genetics (Silva, 2006).

Summaries of length data, the natural mortality vector for all ages obtained from Gislason, 2008 model as well as growth parameters of Von Bertalanffy equation obtained in the three areas in recent years are presented in in the followingTables: (2.2-1, 2.2-2 and 2.2-3).

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

Spanish data:

Somatic magnitude measured (LT, LC, etc)			**LT**	**Units**	**cm**
Sex	**Fem**	**Mal**	**Combined**	**Reproduction season**	**Autumn-Winter**
Maximum size observed			**22.1 (2017)** **25 (2004-2016)**	**Recruitment season**	**Spring-summer**
Size at first maturity			**12.24 (2016)** **12.95 (2003-2015)**	**Spawning area**	**All the coast**
Recruitment size to the fishery			**11.5 (2015)**	**Nursery area**	**Bays**

Moroccan data:

Somatic magnitude measured (LT, LC, etc)			**LT**	**Units**	**cm**
Sex	**Fem**	**Mal**	**Combined**	**Reproduction season**	**Autumn-Winter**
Maximum size observed			**22.5(2017)**	**Recruitment season**	**Spring-summer**
Size at firstmaturity			**12.53(2017)**	**Spawning area**	**All the coast**
Recruitment size to the fishery			**11.5(2017)**	**Nursery area**	**Bays**

Algerian data:

Somatic magnitude measured (LT, LC, etc)			LT	Units	cm
Sex	Fem	Mal	Combined	Reproduction season	Winter
Maximum size observed	21.4	19.8	21.4(2017) 21.8(2016)	Recruitment season	Spring-summer
Size at firstmaturity			12(2017)	Spawning area	Bays and Gulfs
Recruitmentsize to thefishery				Nursery area	

Table2-2.2: M vector and proportion of matures by size or age. Calculated with Gislason method for the three GSAs (01, 03 and 04) in 2017 (Average of the three GSAs).

Age	Natural mortality	Proportion of matures
Age 0	**1.83**	**0.30**
Age 1	**0.84**	**0.90**
Age 2	**0.59**	**1**
Age 3	**0.49**	**1**
Age 4	**0.44**	**1**
Age 5+	**0.39**	**1**

Table2.2-3: Growth and length weight model parameters

Spanish data:

			Sex			
		Units	female	male	Combined	Years
Growth model	L∞	cm			22.6	2003-2016
	K	Year-1			0.39	2003-2016
	t0	year			-1.7507	2003-2016
	Data source	IEO				
Length weight relationship	a				0.00599	2003-2016
	b				3.12365	2003-2016
	M (scalar)					
	sex ratio (% females/total)					

Moroccan data:

			Sex			
		Units	female	male	Combined	Years
Growthmodel	L∞	cm			21.87	2017
	K	Year-1			0.39	2017
	t0	year			-1.95	2017
	Data source	INRH				
Lengthweight relationship	a				0.007	2017
	b				3.020	2017
	M (scalar)					
	sex ratio (% females/total)	53				

Algerian data:

			Sex			
		Units	female	male	Combined	Years
Growthmodel	L∞	cm			22.69	2017
	K	Year-1			0.39	2017
	t0	year			-0.49	2017
	Data source	CNRDPA				
Lengthweight relationship	a				0.006	2017
	b				3.0857	2017
	M (scalar)					
	sex ratio (% females/total)	50.91				

3 Fisheries information

3.1 Description of the fleet

Spanish 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.

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 correspond to EU-Data Collection Framework.

Moroccan fleet:

The Moroccan small pelagic fihery has five target species (sardine, anchovy, mackerel, horse mackerel and sardinella), of wich sardine is the most important. Sardine and anchovy are the target species of seiners: sardine for its abundance and anchovy for its high commercial value.

This fishery is mainly conducted in the coastal zone of Moroccan Mediterranean sea by costal purse seiners. The number of vessels targeting sardine last year in GSA 03 accounted for by 107 units, this number has been stable in the last decade at around 105 units) characterized by small vessels, average TJB is 50 tx and 336 horse power, 4% of them are smaller than 12 m (operational Unit 1), 91% of them are between 12 m and 24 m (operational Unit 2), and 5% are bigger than 24m (operational Unit 3).

This fleet is based mainly in 4 important ports M'diq, Nador, Al Hoceima and Ras Kebdana with high mobility of seiners between ports following the abundance of resources. In addition, there are around one hundred of small scale boats fishing in coastal areas that are not considered in this study due to the lack of reliable statistics from this segment.

Algerian fleet

Small pelagic are the most important resource in the Algeria fisheries with more than 70% of the total landings. The small pelagic landings are composed by Sardine “Sardina pilchardus”, Anchovy “Engraulis encrasicolus”, Sardinelle “Sardinella aurita”, horse makerel “Trachurus spp” and others.

The active fleet targeting small pelagics species in the Algerian Alboran region (GSA 04 W) is composed mainly by 153 purse seiners (in 2017) and secondarily by pelagic trawlers which are very poorly represented. The seiners are a small boats from 6 to 24m length with variable power depending on the length of the ship. The engine power and the average gross tonnage is respectively 308.8 HP and 32.77 TGB for vessels greater than or equal to 12m length.

Sardine is one of the most important species targeting by this fleet operating in the two ports Ghazaouet and Beni-Saf. The fishery takes place all year around. There are no closed seasons for purse seiners.

Catch per unit effort CPUE generally varies between 337 (2012) and 1694 kg/day (2009) with an average of 814 kg/day.

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

	Country	GSA	FleetSegment	FishingGearClass	Group of Target Species	Species
OperationalUnit 1	Spain	1	G-PurseSeine (6-12 m)	02-Seine Nets	**31- Small gregariouspelagic**	**PIL**
OperationalUnit 2	Spain	1	H-PurseSeine (>12)	02-Seine Nets	**31- Small gregariouspelagic**	**PIL**
OperationalUnit 1	Morocco	3	G-PurseSeine (6-12 m)	02-Seine Nets	**31- Small gregariouspelagic**	**PIL**
OperationalUnit 2	Morocco	3	H-PurseSeine (12-24 m)	02-Seine Nets	**31- Small gregariouspelagic**	**PIL**
OperationalUnit 3	Morocco	3	I-PurseSeine (>24 m)	02-Seine Nets	**31- Small gregariouspelagic**	**PIL**
OperationalUnit	Algeria	4W	PurseSeine (6-24 m)	02-Seine Nets	**31- Small gregariouspelagic**	**PIL**

Table3.1-2: Catch, bycatch, discards and effort by operational unit in the reference year

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

OperationalUnits*	Fleet (n° of boats)*	Catch (T or kg of the species assessed) Tons	Other species caught (names and weight) Tons	Discards (species assessed)	Discards (otherspeciescaught)	Effort (units)
MAR 03 G 02 31-PIL	4	5	Anchovy:0.17 Trachurusspp:19 Scomberspp:16 Sardinella: 31 Autres: 45	negligible	negligible	Effective fishing day for species
MAR 03 H 02 31-PIL	98	6869	Anchovy: 123 Trachurusspp: 370 Scomberspp: 1673 Sardinella: 541 Autres :613	negligible	negligible	Effective fishing day for species
MAR 03 I 02 31-PIL	5	314	Anchovy: 0.21 Trachurusspp: 15 Scomberspp: 144 Sardinella: 10 Autres :33	negligible	negligible	Effective fishing day for species
Total	107	4480	3635			

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 (otherspecie scaught)	Effort (units)
ALG 04	153	9395	Anchovy: 300 Sardinella: 2447 Trachurus spp: 46 Scomber spp: 6 Boopsboops : 5	/	/	Effective fishing days
Total	153	9395	2804			

3.2 Historical trends

In terms of landings, the sardine was landed at the spanish ports from 2003 to 2017 with approximately 5792 t in average per year. Higher catches occured in 2006 (9971 tons). From 2009 onwards, a slighlty decrease of CPUE was observed and shows a very similar profile to catches. Unit of effort has been effective fishing night by species from this fleet. It's variying slightly from year to year;

In the Moroccan zone, the costal seiner fleet landed 4981 tons of sardine in 2017 (a decrease of 34% compared with 2016). Although catches of sardine in the Moroccan fishery fluctuates between 4981 and 15293 tons / year, with an annual average value 11074 per year between the years 2006 and 2017. The general trend of CPUE since 2006 shows a remarkable decrease to the lowest value registered in 2017 with 808kg/fishing day. The fishing effort (expressed in effective fishing days) exerted on this ressource shows the same trend as catches.

For the annual evolution of sardine landings by purse seiners in the alboran region of Algeria (GSA04W) from 2005 to 2017, it shows an interannual fluctuations with an increase trend recorded over the last six years. Sardine landings fluctuate around a maximum value of 12217 Tons in 2007 and a minimum value of 2201 Tons in 2011 with an average annual value of 6010 Tons for the studied period. The current value (2017) is 9395 Tons, almost double that the value observed in 2016 (5587 Tons).

The landings, CPUE evolutions are given in tables (Table 3.2-1; 3.2-2), and shown in figures (Figure 3.2-1; 3.2-2).

Table 3.2-1: Landings and CPUE of Sardina pilchardus in the three GSAs(01, 03 and 04W) (2004-2017).

GSA / YEAR	GSA 01 (2004-2017).		GSA 03 (2004-2017)		GSA 04W (2005-2017)	
	Catch (tons)	CPUE (Kg/fishingday)	Catch (tons)	CPUE (Kg/fishingday)	Catch (tons)	CPUE (Kg/fishingday)
2004	3957	777	12584	5799		
2005	7516	1255	15241	6221	5692	960
2006	9971	1406	15293	3308	8596	1159
2007	6139	1073	13824	2273	12217	1337
2008	4468	1011	7937	1587	4162	386
2009	5972	1263	14982	1487	10229	1694
2010	7328	1204	12179	1238	2847	524
2011	6293	1099	6981	1014	2203	406
2012	6214	1034	9247	1321	2416	337
2013	4983	918	14158	1334	4840	770
2014	5174	895	14395	1164	4216	695
2015	5248	929	11824	1105	5732	/
2016	4171	852	7593	895	5587	691
2017	3655	827	4981	808	9395	/
Average	**5792**	**1039**	**11489**	**1399**	**6010**	**814**

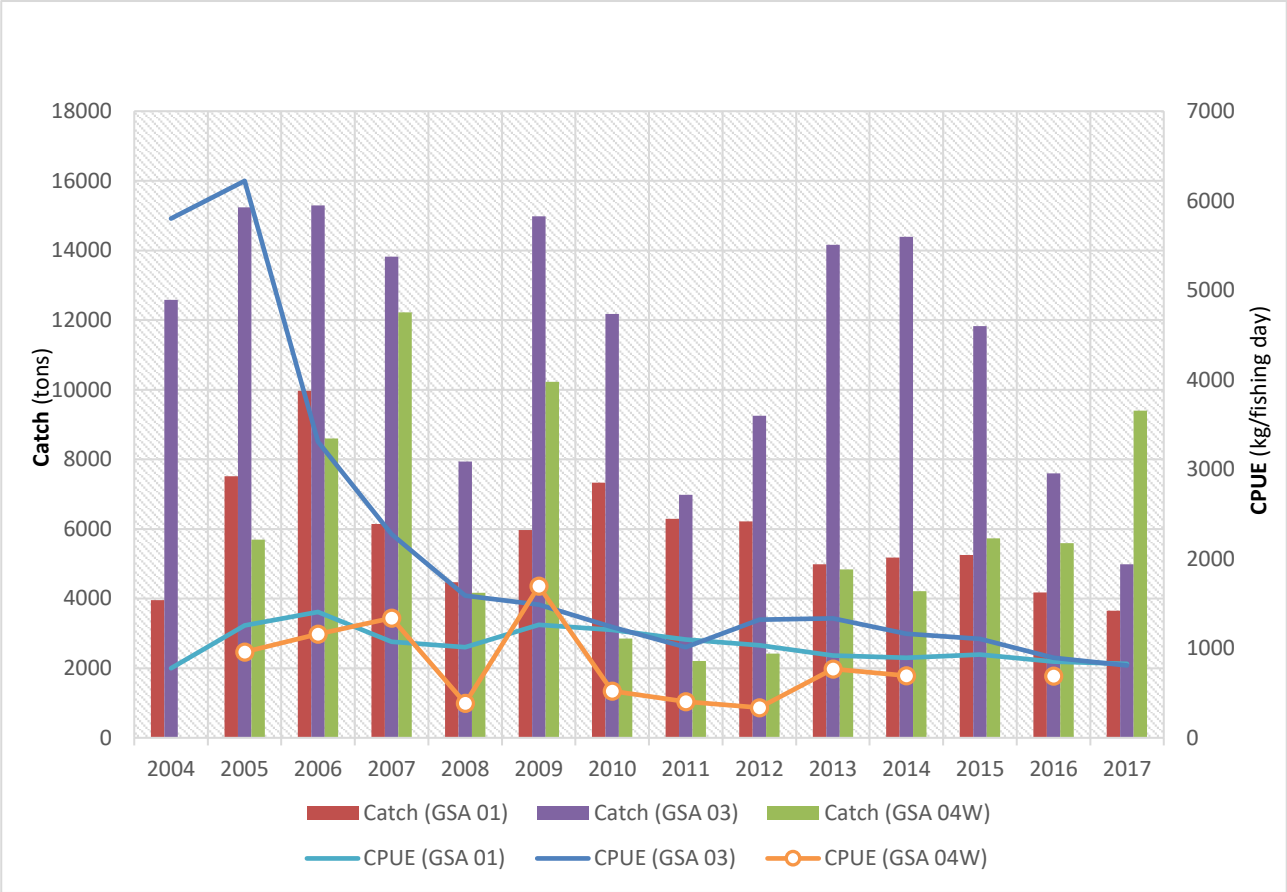

Figure 3.2-1: Evolution of anual landings, CPUE in the three GSAs (01, 03 and 04W) (2004-2017).

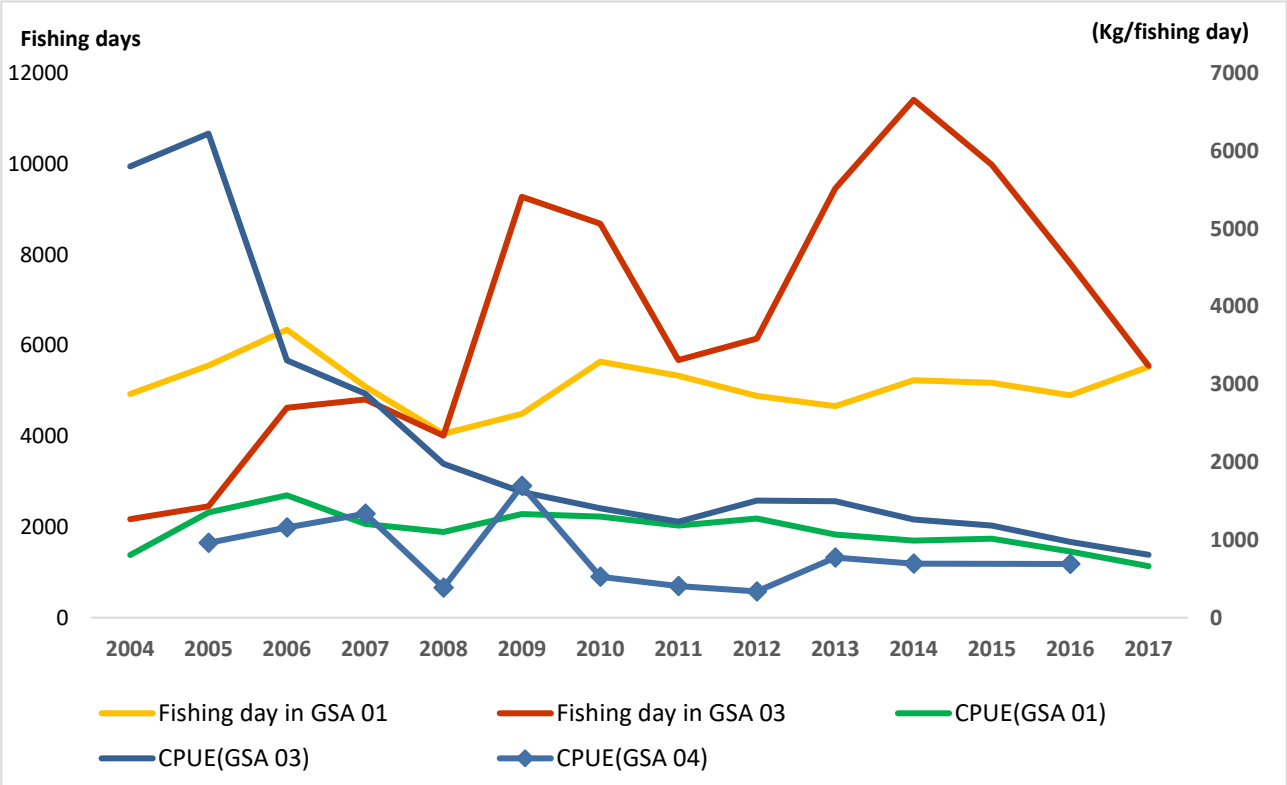

Figure 3.2-2: Trend in seiners effort on sardine and CPUE, in the three GSAs of Alobran sea.

3.3 anagement regulations

Regulations in Spanish Mediterranean Sea

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 82m and the use of purse seines is not allowed ata depth less than 70 percent of the net 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 9m long, maximum power 450 hp, only one auxiliary boat and there is a Regulating for its power lights,

Fishing areas: prohibited fishing less than 35m deep, although at a distance of 300 m offshore it is permitted at a lower depth than 50m.There are forbidden fishing areas to keep safe anchovy recruitment,

Fishing effort: No fishing on weekend restricted fishing areas and seasonal closures in some regions,

Minimum sizes: Minimum legal landing size 11 cm,

List of species authorized to be fished by the gear. Margin of 2% of others species.

Regulations in Moroccan Mediterranean Sea

Featuresgear: Minimum mesh size of11 mm.

Characteristics of vessels: No less than 3 tjb; only one auxiliary boat,

Fishing areas: prohibited fishing less than 0.5 nautical mile (1 nM in some regions).There are forbidden areas to safe sardine recruitment,

Fishing effort: No fishing on Friday, restricted fishing areas and seasonal closures in some regions.

Minimum sizes: 45 individuals/kg for sardine,

List of species authorized to be fished by the gear. Margin of 3% of other species except *Boops boops* 10%.

Regulations in Algeria

Features gear: Stretched mesh size of gear 9mm.

Characteristics of vessels: only one auxiliary boat.

Fishingareas: No fishing area prohibited.

Fishingeffort: No closed seasons for purse seiners.

Minimumsizes: Minimum landing size authorized 11cm.

4 Fisheries independent information

4.1 Direct methods: Acoustic survey

4.1.1 Brief description of the method

Table4.1-1: Acoustic cruise basic information.

Date	MEDIAS: 1 surveys/year (july) Spain ACOUMED : 1 or 2 surveys/year (spring - autumn) (Morocco) ALPEL: February -March (ALGERIA)		
Cruise	**1. MEDIAS (Spain)** **2. ACOUMED (Morocco)** **3. ALPEL (Algeria)**	**R/V**	1. Miguel Oliver 2. Al Amir My Abdellah 1. Belkacem GRINE
Target species	1. Anchovy and sardine 2. Small pelagics 3. Small pelagic		
Sampling strategy	1. 66 tracks normal to the coast. Inter-transect distance: 4 or 8 nautical miles 2. Inter-transect distance: 5 nautical miles 3. Inter-transect distance: 8 nautical miles		
Sampling season	1. MEDIAS: June-July; ECOMED: November-December (Spain) 2. ACOUMED: (April-may; September-October) (Morocco) 3. ALPEL: Winter (Algeria)		
Investigated depth range (m)	1. 30-200 m depth (Spain) 2. 20-400 m depth (Morocco) *3.* 20.200 m depth (Algeria)		
Echo-sounder	1. Scientific Echo-sounder EK60 equipped with 5 frequencies (18, 38, 70, 120 & 200 kHz) 2. Echo-sounder EK60 (38- 120-200 kHz)- scrutinizing by BI500 3. Echo-sounder EK60 equipped with 3 frequencies (38- 120-200 kHz)		
Fish sampler	1. Pelagic trawls with 10, 16 & 18 m vertical opening 2. Japanese Pelagic trawl, with gear: type O.B (Al), 1.44 m² (216.4 kg). 3. Pelagictrawlswith 18m vertical opening (Algeria)		
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	1. 72.6 dB for anchovy and sardine 2. 72 dB for sardine 3. 72.6 dB for Sardina pilchardus) ALGERIA
Software used in the post-processing	1. SonarDataEchoview, PESMA (Visual Basic) 2. BI500 and Echoview 3. Echoview
Samples (gear used)	1. Pelagic trawl 2. Japanese Pelagic trawl 3. Pelagic trawl
Biological data obtained	1. Length-weight relationship, age, sex, maturity 2. Length-weight relationship, age, sex, maturity 3. Length-weight relationship, age, sex, maturity, otoliths
Age slicing method	1. Otolith
Maturity ogive used	

4.1.2 Spatial distribution of the resources

Figure 4.1.2-1:Map of densities distribution of sardine in the GSA 01 (summerseason 2017).

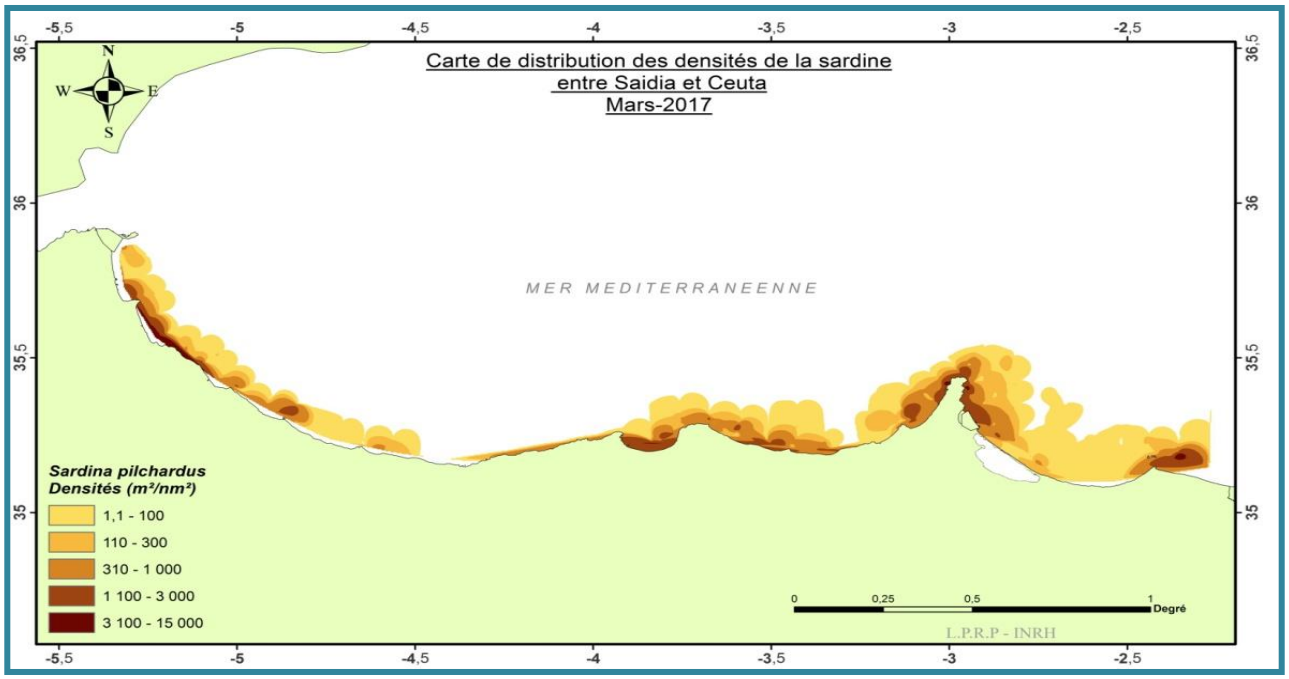

Figure 4.1.2-2: Map of densities distribution of sardine in the GSA 03 (spring season 2017).

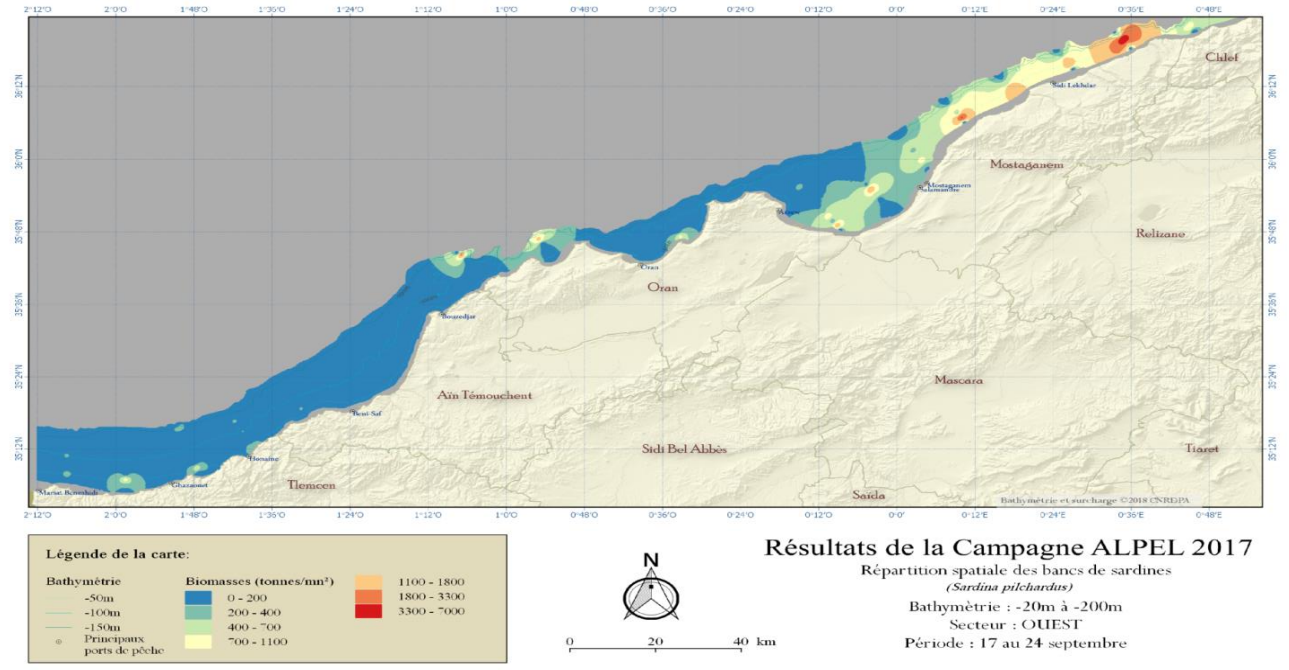

Figure 4.1.2-3. Map of Biomass distribution of sardine in the western of the GSA 04.

5. Issues relevant to sardine Stock Assessment and recommendations

In terms of assessment methodology presented during the WG, the Extended Survivors Analysis (XSA) was used as an assessment procedure for sardine stock in GSA01 and 03. Also a preliminary VIT analyses were run combining GSAs 1, 3 and 4 (data since 2016 from Algeria). The results of these stock assessment assays, have been defined uncertain and incorporating multiple sources of uncertainty wich can be described as following:

5.1 Acoustic data uncertainty

The tuning index from acoustic surveys for both GSA01 and GSA03 exhibits some problems to be used in stock assement.

- Considering that the XSA requires data on catch numbers by age and by year, supplemented by stock abundance indices and that the only age-disaggregated abundance indices can be used, the combination of the two acoustic survey indices with ACOUMED and MEDIAS index, as tuning fleet still needs to be done. An important work to disaggregate spring and autumn of ACOUMED surveys need to be performed. For the surveys in GSA1 in particular, there is an urgent need for an in-depth analysis to adress new issues identified this year as well as issues already mentioned in the last reports of the MEDIAS and a conlcusion on whether it is usefull to provide fisheries independent information. Regarding the CPUE standardisation in GSA3, it would be useful to integrate those indices in future stock assessments as complementary indices in assessment models, however in order to be able to use them in assessments, they should be converted into age or used as annual aggregated. The involvement of an external experts would be useful even about the correct use of acoustic surveys data in cases where there is more than one survey in different seasons of the same year.

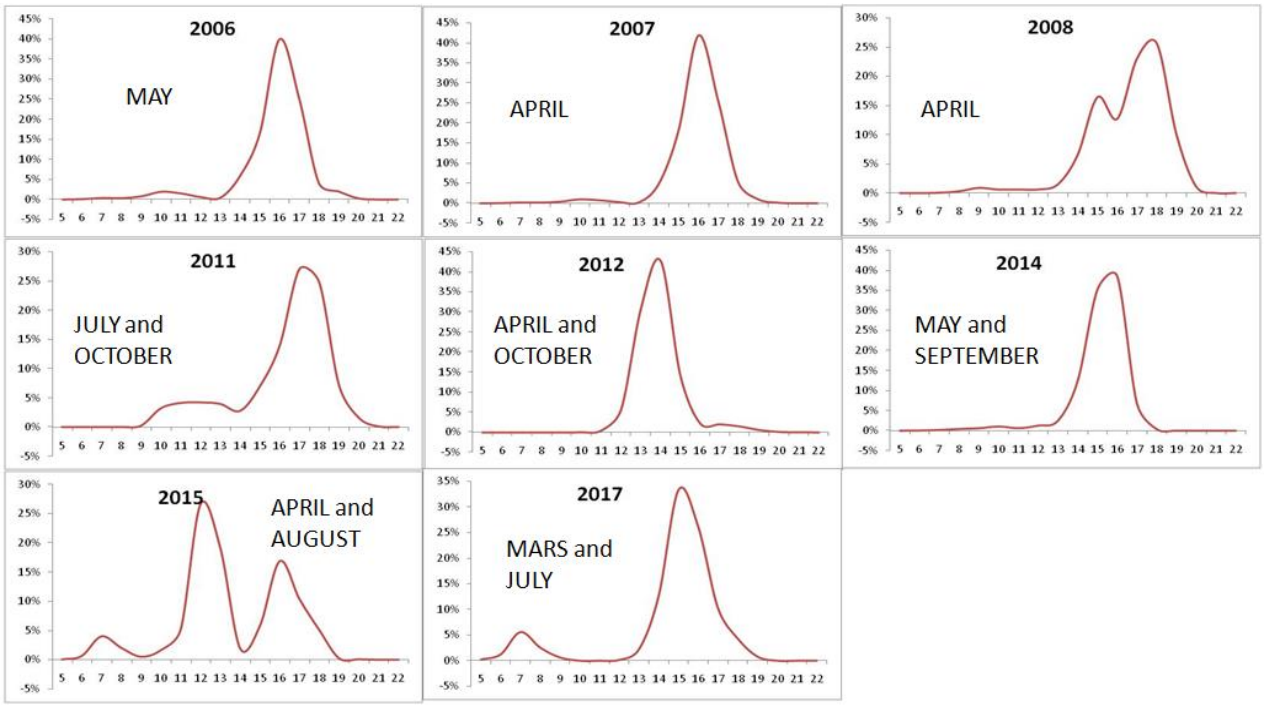

Figure 5.1: Lenghthfrenciesdictributionin surveys in The GSA03

5.2 Length frequency distribution and Growth parameters uncertainty

During the WG, there was a discusion on data issues as well as investigation of monthly length frequency distribution in sardine catches for the three GSAs. The uncertainties in the growth curves and ultimately natural mortality to give satisfactory results by using the XSA were montioned. For those issues, in-depth analysis of input data for sardine (Alboran sea) and any other thing that comes up while explorig the raw data, need to be addressed during the current intersessional period. Combine data from all GSAs about the estimation of growth parameters available, reestimates VB growth curves and compare them from year to year or consider having on for all years pooled together.

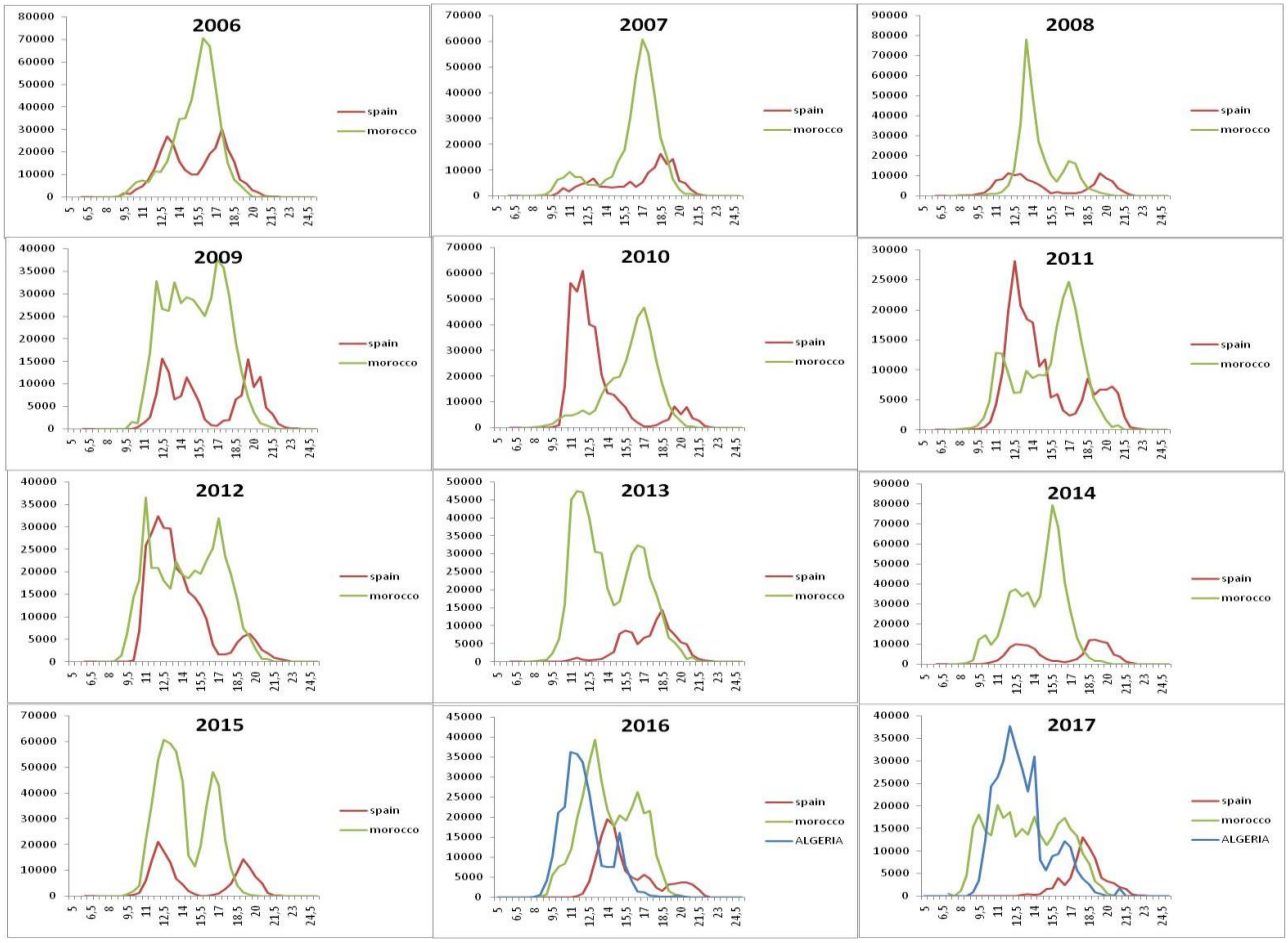

Figure 5.2-1: Length frequency distributions in the Alboran GSAs

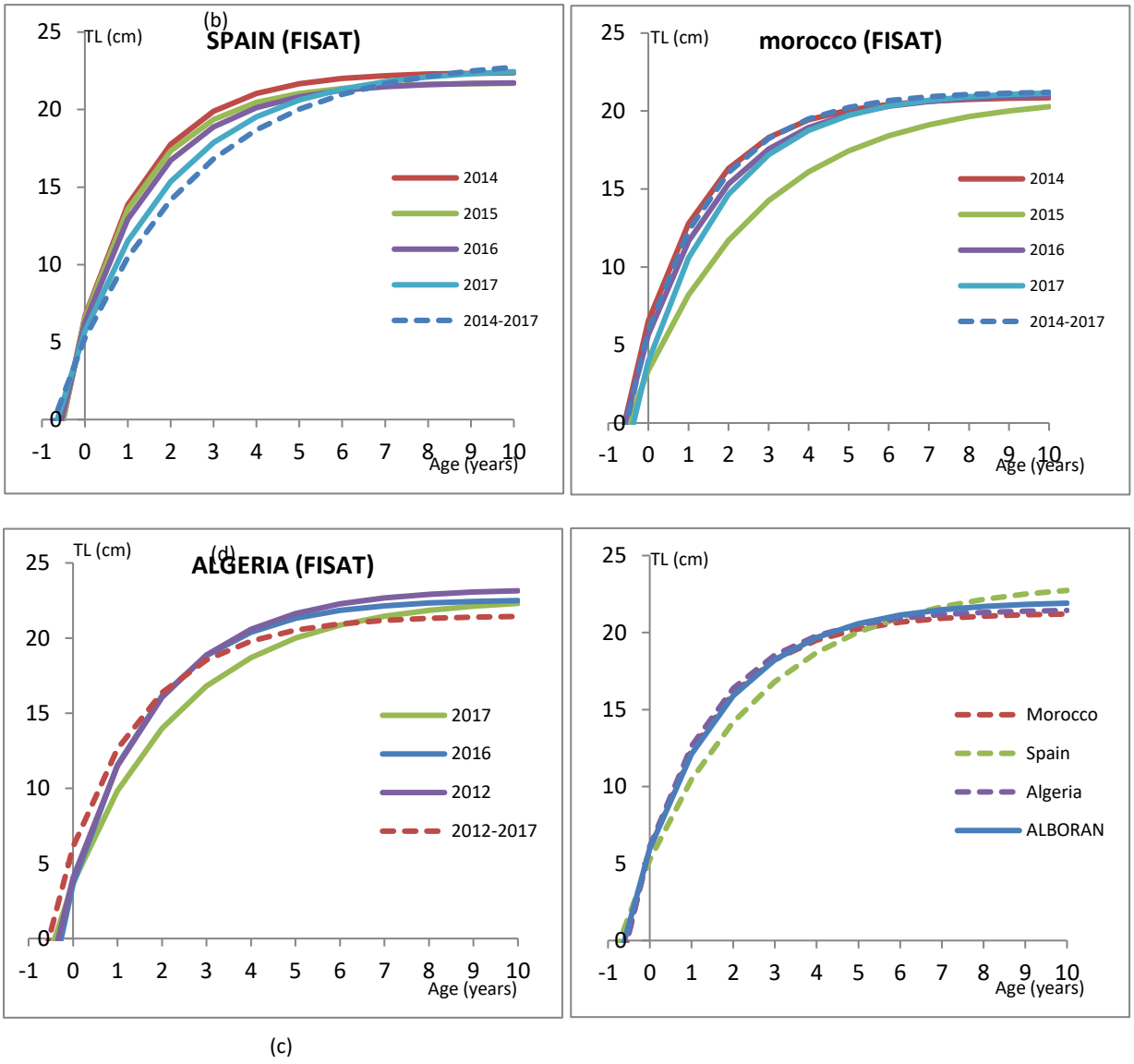

Figure 5.2-2: Growth curve for all based on the von Bertalanffy growth equation of the Alboran GSAs By using LFDA for spain (a), Morocco (b), Algeria (c) and the three countries (d).

5.3 Slicing method

The catch numbers at length was transformed in age by manual slicing (using the inverse of VB equation) and summed for the two regions GSA1 and GSA3. This was uncertain as it should be compared using von Bertallanffy grouwth curves or length frequency distribution analyses. Also the uncertainties related to ageing sardine of Alboran stock was mentioned.

- The WG strongly suggests to compare different methods of slicing (FISAT, LFDA…etc) and investigate the consistency in the results. When age length keys are available and based adequate sampling, the WG suggests to use them (either annual or per period or all years aggregated). If not, it suggests to start reading otolith and build ALK and to use slicing from VB curves or ultimately length frequency distribution analyses.

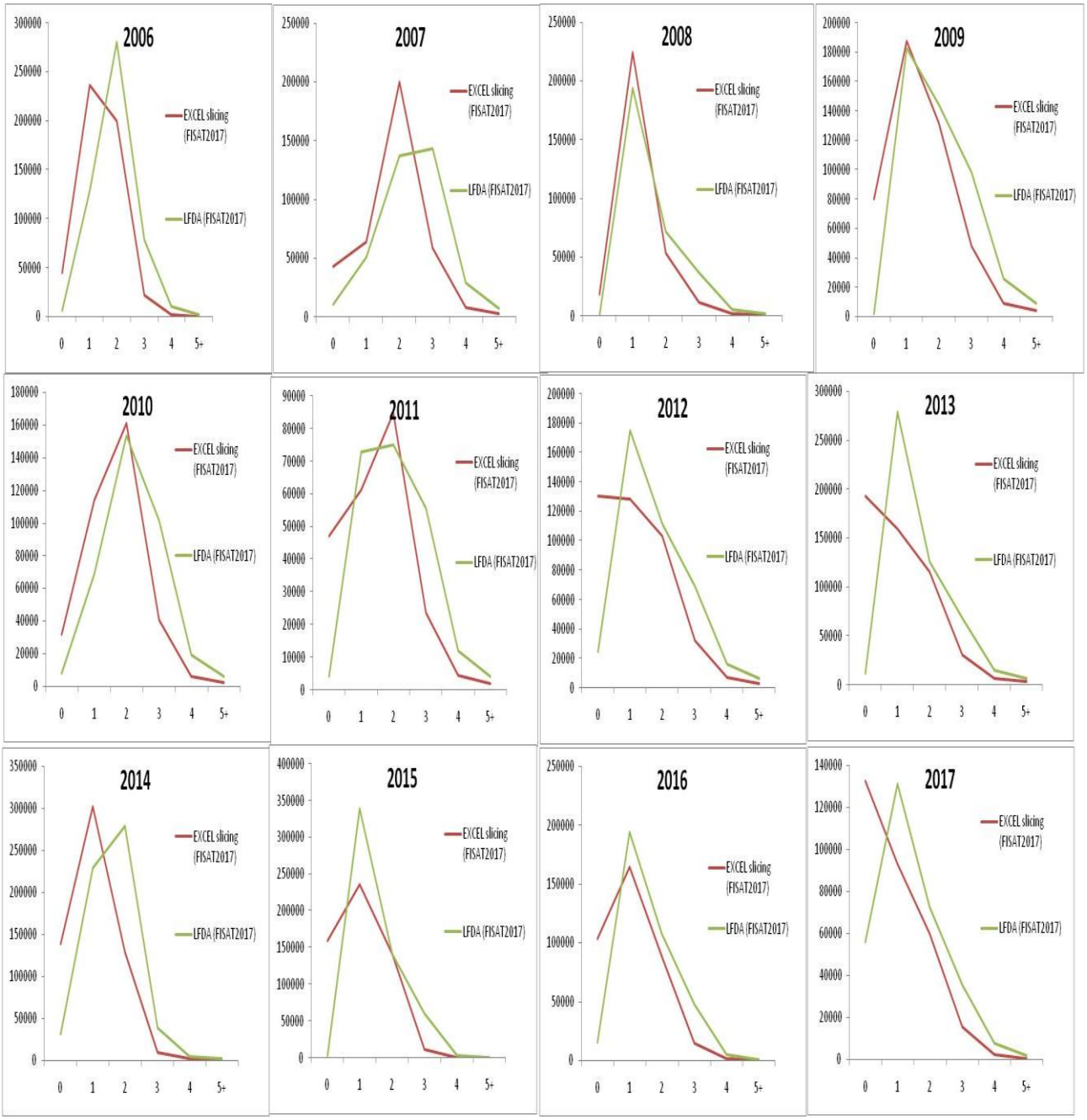

Figure 5.3: Comparison between two methods of slicing (Slicing by VB inverse and slicing by LFDA software)

5.4 Combining data issues

A lot of data issues are still pending and the assumption of equilibirium of the VIT (for three GSAs) might not be adapted for sardine assement. Due to unsatisfactory results trying to apply a single assement model for all 3 GSAs and the assessment per GSA, the WG strongly recommended to use the most complete dataset that provide all information required to perform advice using the stock assessment forms.

- In addition, it agreed to improve collecting all informations and biological data related to the assessed stock in the area and to use the longest time series available (and wich should be provided in a strandardised forms) to run the assement. In addition, the WG note that an important work and effort of all participants to run analytical assessments. In fact, it would be good to think about wich model to apply especially the one that can use more, than one index abundance (so we can use the 2 surveys independentely, it has also discussed on the need to use slightly more elaborated VPA such as statistical catch at age, as well as models that allow the use of separable periods (e.g. ICA or AMCI) that will facilitate using longer time series of catches combined with shorter time series of tuning indices or several tuning indices, in the years to come.

5.6 Stock boundaries (joint versus separate assessments issues)

Other issues relevant to stock boundaries wich need to be accounted for many stocks (even Alboran stock of sardine).

- In order to select and to decide which stock boundary should be used for sardine between GSA 1; 3 and 4 and the relevance of joint versus separate assessments needs to be further studied. The WG supports the workplan for an in-depth analysis the question on stock boundaries of Copemed to test for the pertinence of joining the three GSAs.

5.7 Further workplan to perform the framework of FAO CopeMed II Regional Project

The WG proposed a workplan for the next intersession (2018/2019) for all three countries (Algerie, Morocco and Spain) and encouraged them to pursue this work to decreas uncertainty at lowest. One of the objectives of this workplan is to adress basic data preparation and analysis issues in order to overcome these shortcoming and advance towords a quantitative assessment of this area.

This great deal could be done by the following successive steps:

1- Analysis issues pending from previous years, reconstruct past time series and combine data from all three GSAs under tested assumption to be able to correct bias in data and use them all

in a signle assessment.

2- Gather the data from all GSAs and construct a table of metadata available.
3- Examine these sources of uncertainty and address all issues associated with the sardine (Alboran sea) data (total catch, investigation of monthly lenght frequency distribution in sardine catches, lenght-frequency distribution, ageing and growth and acoustic surveys.
4- To pursue the work on defining a common methodology to start, harmonize age reading of sardine otolith.
5- Test potantial alternative assessment models : For exemple, the one can accept different indices (age structure and biomass), that can use more than one index abundance (e.g 2 surveys independently). The option of surplus model with pooled landings from the 3 GSAs using different tuning indices (e.g acoustic surveys, stadardized CPUE) should also be tested. Think about wich model to apply; it would be good to have (XSA, FLSM model or statistical catch at age model). Run different assessment models and compare the results to investigate the effect of maturity, natural mortality, slicing methods for sardine and compare different results.

6. Draft scientific advice

For sardine stock in Alboran sea, no stock assessment has been validated. The WG made UNCERTAIN as a judgment for the stock status for both GSA01 and GSA03. However, in response to its terms of reference for 2018 (to provide advice for alla presented stocks (even in a qualitative way) and based on scientific evidence and discussions undertaken, the WGSASP, establish qualitative scientific advice for sardine stock according negative trends in different indicators:

Firstly, for GSA1: Landings decrease and no long-term trends were observed. Still, CPUE were lowest in 2017, mean-length at age and mean-weight at age slightly decreased in the last years. also, no recruitment was observed in the fisheries in 2017. For GSA03, catches as well as CPUE decresead since 2000, altough the standardized CPUE are stable. Both size and mean weight have also decreased. Finally, as a precautionary approach, the WG recommends to reduce fishing mortality.

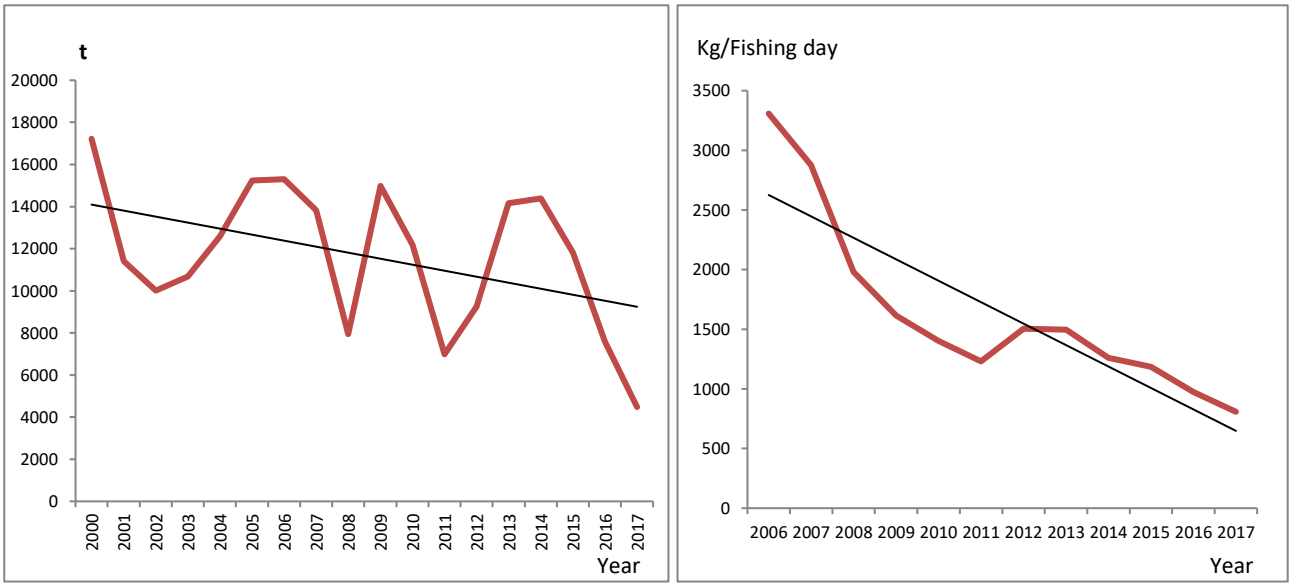

Figure 6.1: Catch (tons) and nominal CPUE trends of sardine in GSA03

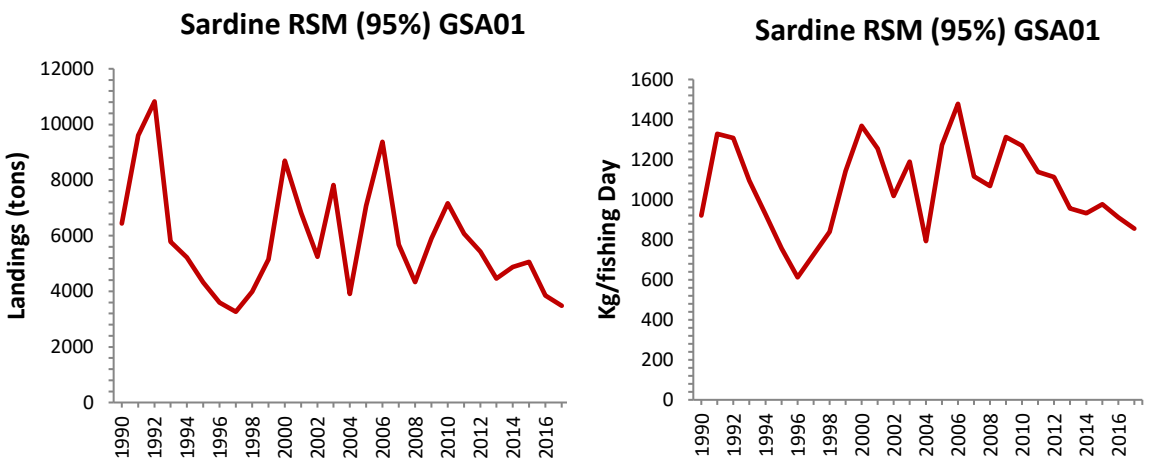

Figure 6.2: Catch (tons) and nominal CPUE trends of sardine in GSA01

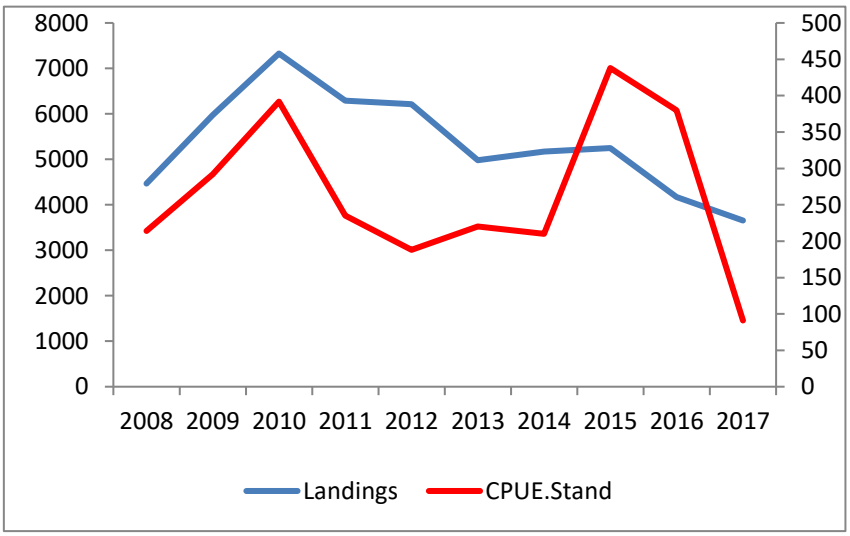

Figure 6.3*:* Trends in sardine landings and CPUE.Stand in GSA01 years 2008-2017.

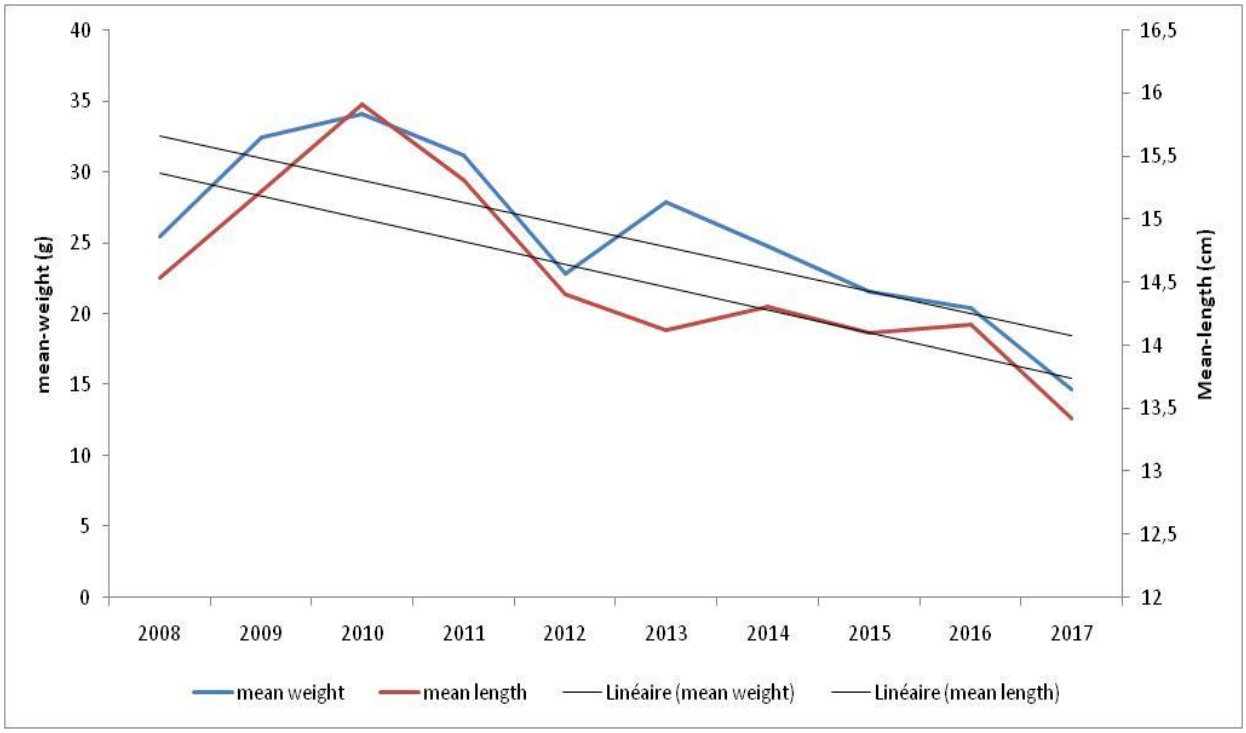

Figure 6.4: Mean weight and mean length trends of sardine in GSA03

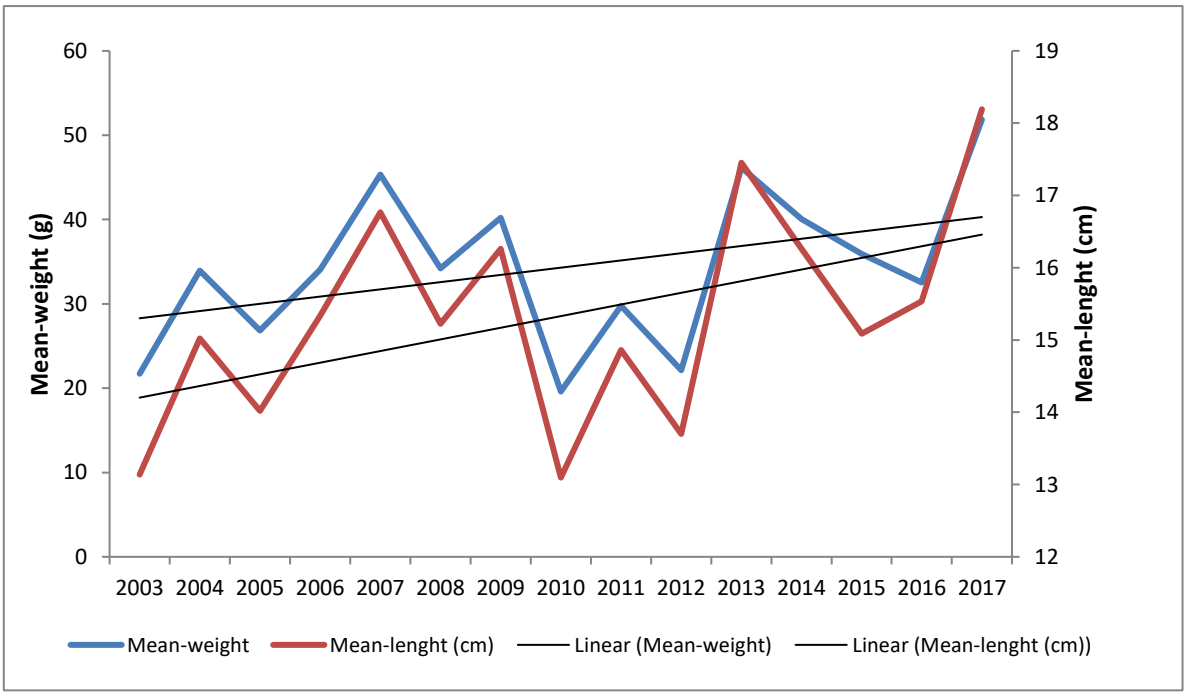

Figure 6.5: Mean weight and mean length trends of sardine GSA01

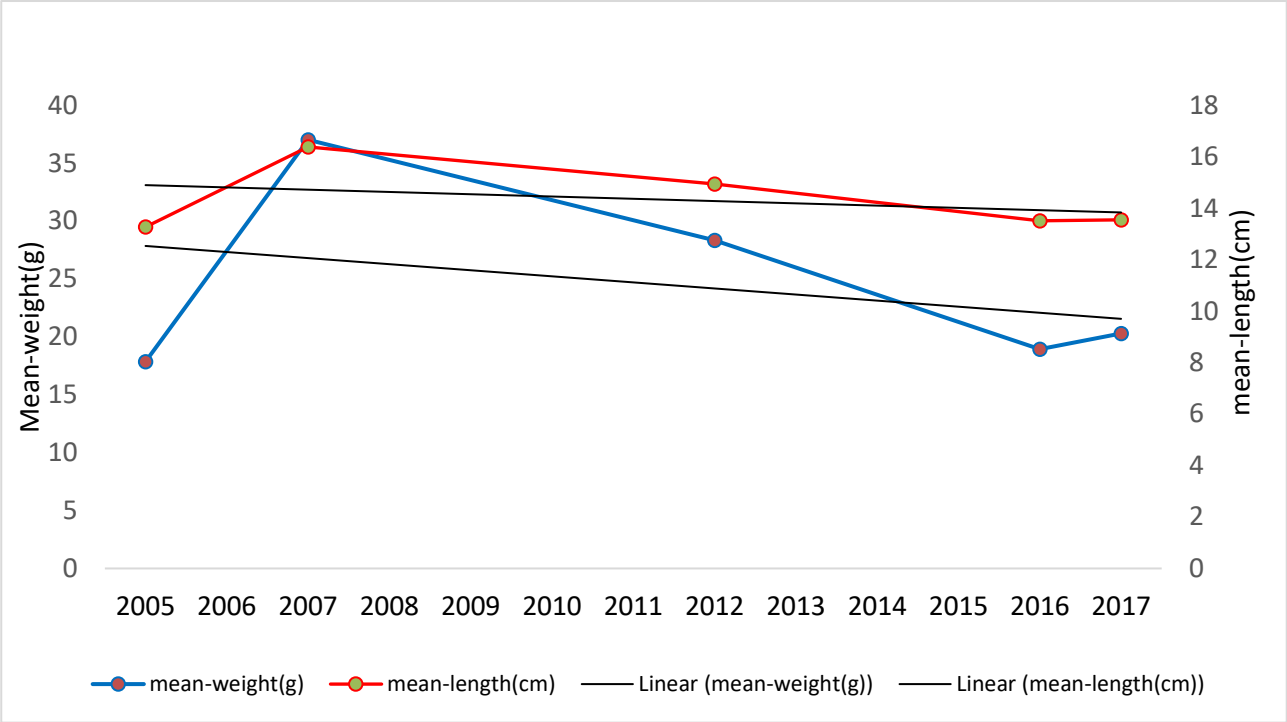

Figure 6.6: Mean weight and mean length trends of sardine GSA04