Stock Assessment Form

Small Pelagics

2012

[A brief abstract may be added here]

Stock Assessment Form version 1.0 (January 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: Surplus production model (BioDyn package; FAO, 2004)		
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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 2012 25 (2004-2012)	**Recruitment season**	Spring-summer
Size at first maturity			12.94 (2012) 12.90 (2003-2012)	**Spawning area**	All the coast
Recruitment size to the fishery			11 (2012)	**Nursery area**	Bays

Table 2-2.2: M vector and proportion of matures by size or age (Males)

Size/Age	Natural mortality	Proportion of matures
Edad 0		*0.38*
Edad 1		*0.85*
Edad 2		*0.99*
Edad 3		*100*
Edad 5	…	*100*

Table 2-3: Growth and length weight model parameters

			Sex			
		Units	female	male	Combined	Years
Growth model	**L_∞**				25	2012
	K				0.25	2012
	t_0				-2.94	2012
	Data source	CFD 2012				
Length weight relationship	**a**				0.0051	2012
	b				3.1787	2012
	M (scalar)	0.59			Pauly (1980) Temp.=16,2*	
	sex ratio (% females/total)	55.9				

* Average temperature of the last 50 years to 100 m deep. Removed the surface temperature. MEDAR Group, 2002 - MEDATLAS/2002 database Mediterranean and Black Sea database of temperature salinity and bio-chemical parameters. Climatological Atlas

3 Fisheries information

3.1 Description of the fleet

The current fleet in GSA 01 the Northern Alborán Sea is composed by 91 units, characterised by small vessels, average TJB 23.8. 16% of them are smaller than 12 m (operational Unit 1), 84% > 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 91 in 2012. 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 1990-2012 has been highly variable, with a minimum of 3000 tons in 1997. Higher catches occurred in 1992 (11000 tons). All period average is about 6000 tons.

The two operational units fish the same species, there are no major differences, sardine is the most fished species in their both. 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 economical 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 is exported to Portugal.

Data used in the assessment correspond to DCF. Unit of effort has been effective fishing night by species. Series of CPUE shows a very similar profile to catches

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

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	15	229	Anchovy: 27 Trachurus spp: 248 Scomber spp: 155 Sardinella: 32 Otros: 153	negligible	negligible	Effective fishing day for species
ESP 01 H 02 31-PIL	76	5988	Anchovy: 514 Trachurus spp: 3480 Scomber spp: 4137 Sardinella: 2278 Otros: 3733	negligible	negligible	Effective fishing day for species
Total	91	6217	20971			

Table 3.1-3: Catches used in the assessment 1990-2012.

YEAR	Catch (tons)	CPUE Kg/fishing day
1990	6439	921
1991	9599	1328
1992	10826	1308
1993	5782	1095
1994	5220	926
1995	4316	756
1996	3589	612
1997	3263	726
1998	3982	839
1999	5146	1143
2000	8697	1369
2001	6817	1255
2002	5031	1010
2003	8435	1292
2004	4012	851
2005	6988	1302
2006	9412	1505
2007	6536	1252
2008	4339	1070
2009	5894	1315
2010	7173	1213
2011	6064	1140
2012	5430	1114
Average 1990-2012	6217	1100

3.2 Historical trends

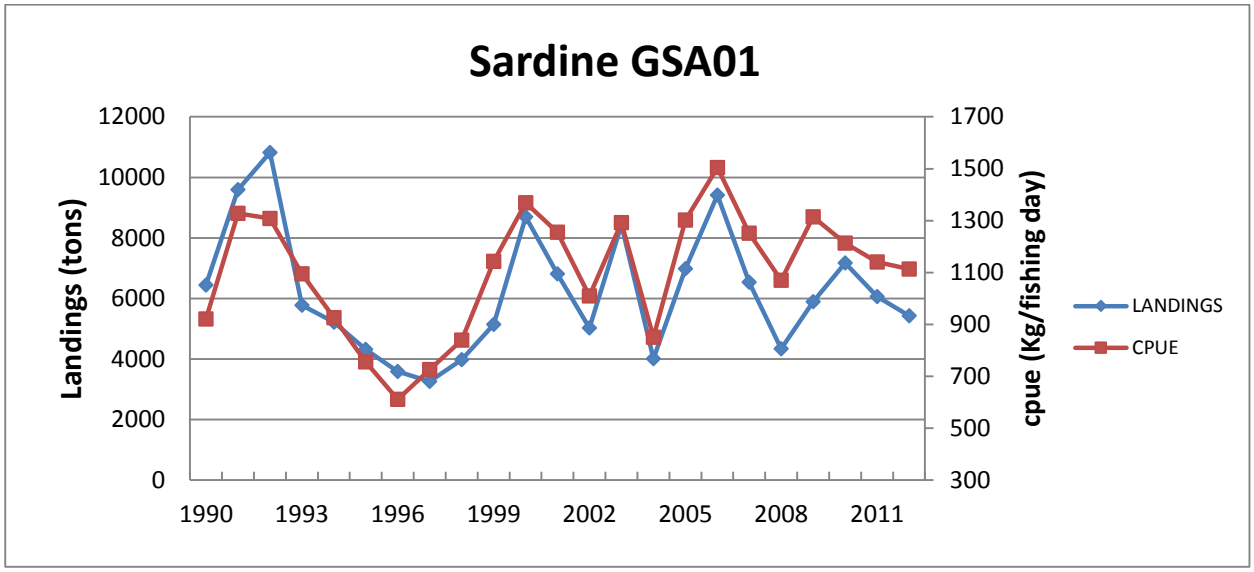

Fig. 3.2.1. Trends in sardine landings and CPUEs, years 1990-2012.

3.3 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 a forbidden areas to safe anchovy recruitment. **Fishing effort:** No fishing on weekends, 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.

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 (20 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
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)	20-200 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 …**
2004	67964				
2005	17177				

4.1.2 Spatial distribution of the resources

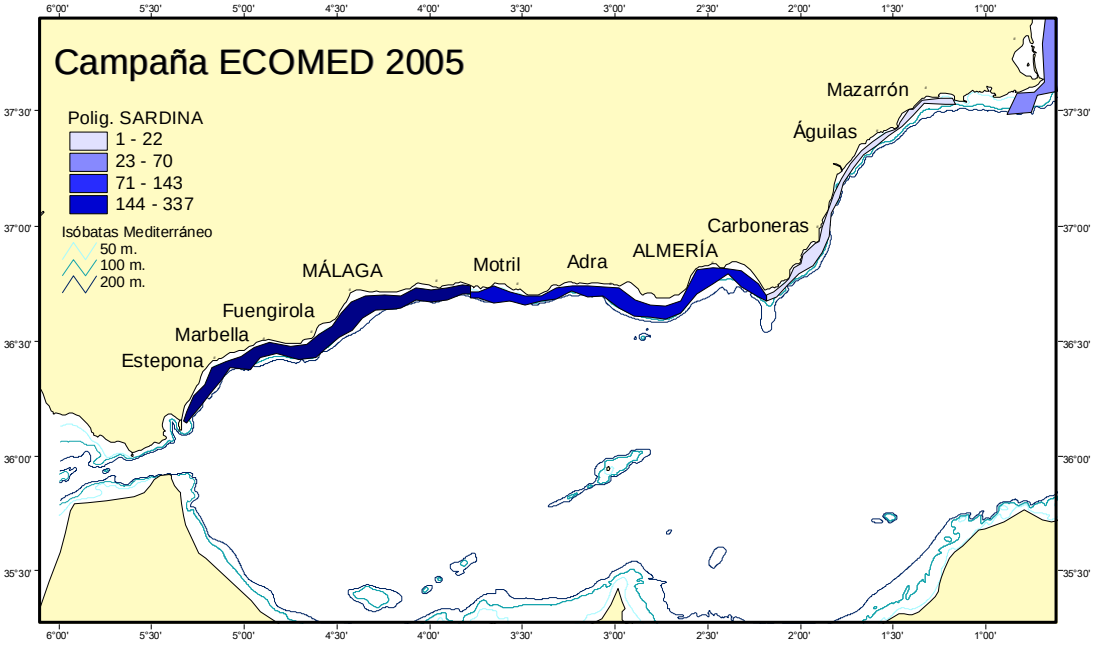

Fig. 4.1.2.1. Sardine distribution area in Northern Alboran Sea in 2005, the whole area was assessed.

Although abundance is highly variable between years, the general scheme is as it shows on the map, with sardine population in all the area and with greater abundance in the western area.

4.1.3 Historical trends

Until 2009 the IEO carried out a acoustic survey assessment (ECOMED) in the Spanish Mediterranean Sea. In 2009 began the survey MEDIAS. Both surveys are not comparable because the first is done in autumn and the second in summer. MEDIAS assesses spawning anchovies and ECOMED recruitment of this species.

Unfortunately the surveys only have cover all the area in 2004 and 2005. The biomass were 67964 and 17177 tons respectively.

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. bycatch of these species in T)

5.2 Environmental indexes

6 Stock Assessment

A modelling approach based on the fitting of a non-equilibrium surplus production model (BioDyn package; FAO, 2004) on the series of observed abundance indexes, allowing for the optional incorporation of an environmental index, so that the r and/or K parameters of each year can be considered to depend on the corresponding value of the applied index. In the actual case were tested two different environmental indexes: average chlorophyll-a concentration over the continental shelf and North Atlantic Oscillation (NAO), neither of them showed any improvement in the model fit.

6.1.1 *Non-equilibrium surplus production model*

The sardine stock in the area was assessed using a non-equilibrium surplus production model based on the Schaefer (logistic) population growth model.
The model was implemented in an MS Excel spreadsheet, modified from the spreadsheets distributed by FAO under the BioDyn package. Details about the implementation of the applied logistic modelling approach can be found in a FAO report on the Assessment of Small Pelagic Fish off Northwest Africa (FAO, 2004).
The report is available at the web site http://www.fao.org/docrep/007/y5823b/y5823b00.htm.

The model uses four basic parameters:

–virgin biomass K

–intrinsic growth rate of the population r

–initial rate of reduction D (initial biomass related to K)

–catchability q

–All other estimated parameters derive from these four.

6.1.2 Model assumptions

Basic Assumptions:

- Stock can be described solely by its biomass
- “Natural” Rate of change in biomass depends on current biomass only
- There is a maximum biomass that the system can support (K)
- The relative rate of increase of biomass is maximum when the biomass is close to zero, and zero when the biomass is at the maximum level
- Simplest model: Logistic (Schaefer) model

6.1.3 Input data and Parameters

The model uses four base parameters:

– Carrying capacity (or virgin biomass) K

–Population Intrinsic growth rate r

–Initial depletion BI/K (or rate of reduction D), starting biomass related to K.

–Catchability q

Environmental effect is also estimated if included in the model. Given the best parameter estimates, the model calculates the MSY, BMSY and FMSY reference points.

Given the best parameter estimates, the model calculates the MSY, BMSY and FMSY reference points. It also calculates the reference points BRatio, B CurB/ B MSY (the ratio between the estimated biomass for the last year in the data series and BMSY), and FRatio, F Cur/F SYCur (the ratio between the effort actually exerted on the stock in the last year of the data series and the effort that would have produced the sustainable yield in the same year).

BRatio, B CurB/ B MSY indicates the current status of the stock biomass in the last year of the data series BCur, relative to the biomass that would produce MSY, BMSY. Values smaller than 100% indicate a stock abundance below BMSY,while values larger than 100% indicate a stock abundance larger than BMSY.

FRatio, F Cur/F SYCur measures the fishing effort in the last year of data available, as a proportion of the fishing effort that would have been necessary to extract the sustainable catch at the Biomass levels estimated for the same year. The value of this ratio is the same as the Yield ratio YRatio, the current yield as a proportion of the sustainable yield at the current stock biomass level, YCur/SYCur. Values below 100% indicate that the catch currently being extracted is lower than the natural production of the stock, and so stock biomass can be expected to increase, while values above 100% suggest that the catch exceeds the production from the stock and so this will decrease next year.

The input data used for the adopted modelling approach was total yearly catch (tons) and as an abundance index CPUE (Catch per unit effort, kg fished considering only trips of the gear with landing of the specie) over the period (1990-2012). Assuming that CPUE is an indicator of the stock abundance.

Trends of these ratios and whether or not they are above/below 100% provide useful information for management purposes.

Von-Bertalanffy growth parameters, necessary for the calculation of natural mortality, were estimated with DCF data collected in GSA01 in 2012, running the last version of the program INBIO 2.0 (Sampedro et al., 2005, up dated 2012 pers. Comm.). Natural mortality was estimated following Pauly (1980) and a reference exploitation rate E=0.4 following Patterson (1992).

Table 6.1.4.1. Parameters limits to minimization, tolerance ratio and parameters calculated by Biodyn. (K in Tons)

Parameter	Initial Value	Tolerance Ratio	Min Value	Max Value	Calculated by Biodyn
R	0.66	2	0.32	2.2	1.12
K	10000	4	2500	40000	24819
BI/K	60%		25%	95%	50%

6.1.4 Results

The results based on the implementation of a non-equilibrium logistic surplus production model are consistent with the previous considerations about trends observed in the landings, showing a current stock of 16.314 tons for 2012. The fishery would be at a sustainably exploited situation.

Furthermore, the exploitation rate corresponding to F=0.33 and M=0.59, estimated with Pauly (1980) empirical equation, is E= 0.36 which is a lower than the reference point for the exploitation rate of 0.4 suggested by Patterson (1992), so this stock could be considered as being sustainably exploited.

Table 6.1.4.1. Reference points

MSY	BMSY	FMSY	F0.1	FCur	BCur/BMSY	Fcur/FSYCur	Fcur/FMSY
6961	12409	0.56	0.50	0.33	1.31	0.87	0.59

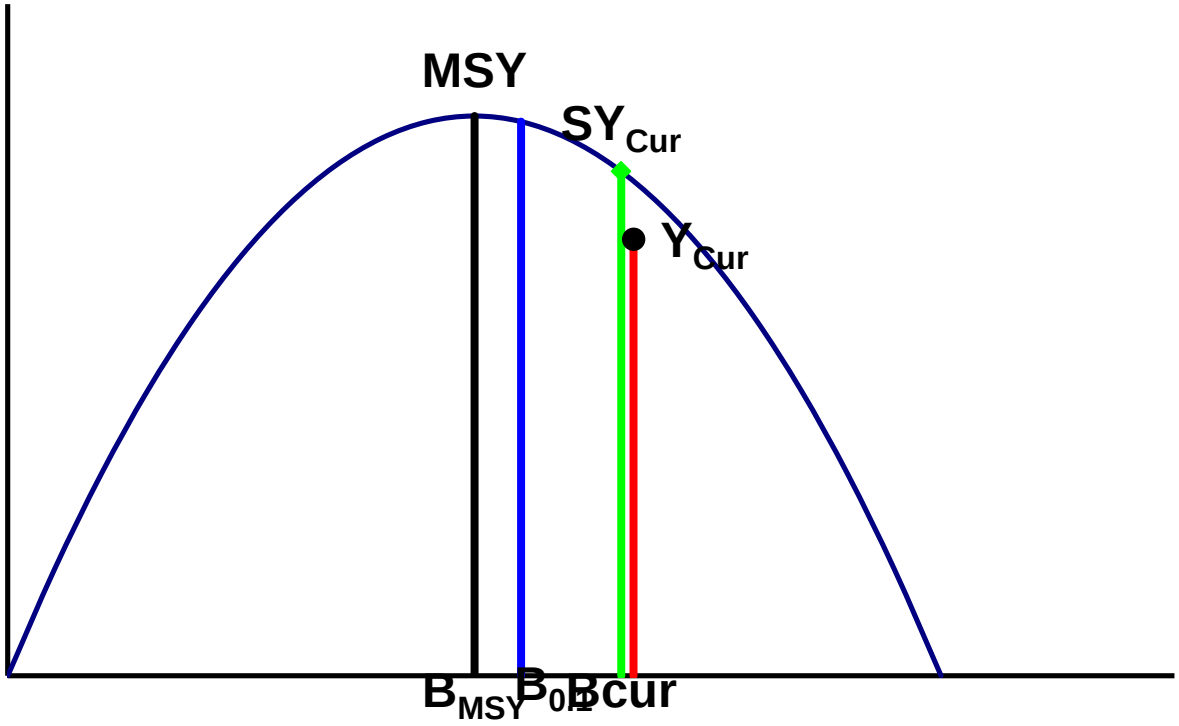

Fig 6.1.4.2. Stock current situation

6.1.5 Robustness analysis

The quality of input data is excellent and the obtained output is satisfactory. Hence the results of the adopted modeling approach are consistent with the trend of the longer landing series.

The goodness of the best fit obtained using the surplus production modeling approach is also satisfactory (RpearsonIndex=0.53). Pearson linear regression coefficient will not detect a non-linear relation, but will measure how closely the predicted abundance indices follow the observed ones. This plot presents, in a graphical way, the relation between the Abundance Index observed (or given to the model) and the Abundance index estimated by the model, on the basis of the

estimated biomass. The desirable characteristic for this plot is a linear relation between the predicted and observed indices, with slope 1.

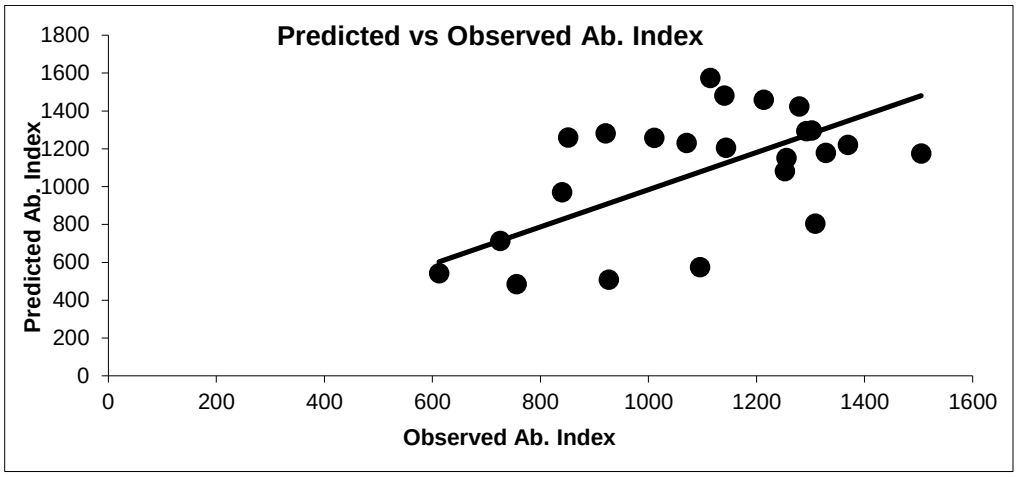

Figure 6.1.4.3. Plot of the relation between the predicted and the observed abundance indices. This plot can be used to detect severe deviations from the linear relationship between the observed abundance indices and those predicted by the model

7 Stock predictions

7.1 Short term predictions

7.2 Medium term predictions

7.3 Long term predictions

8 Draft scientific advice

(Examples in blue)

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		F=0.33			
	Fishing effort					
	Catch	5430 tons				
	Exploitation	E=0.36				
Stock abundance	Biomass					
	SSB					
Recruitment					D	
Final Diagnosis		Sustainable exploitation				

State the rationale behind that diagnoses, explaining if it is based on analytical or on empirical references

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