Stock Assessment Form

Demersal species

Reference year: 2015

Reporting year: 2016

Trawl fishery data for the period 1996-2015 have been used to assess the *Mullus barbatus* stock in the GSA06. The assessment has been carried out applying tuned VPA (Extended Survivor Analysis, XSA) and Y/R analysis. Results from VPA indicate that average fishing mortality for ages 1-2 shows a general decreasing trend over the studied period reflecting the steady reduction observed in fishing effort. Recruitment in the last years keeps steady even though the fact that Spawning biomass has increased in the last years. This suggests a Ricker S/R relationship. F0.1<Fcurrent, so the fishery in overexploited with relative total and spawning stock biomass.

Stock Assessment Form version 1.0 (January 2014)

Uploader: *Encarnacion Garcia Rodriguez*

Stock assessment form

1 Basic Identification Data

Scientific name:	Common name:	ISCAAP Group:
Mullus barbatus	Red mullet	33 MUT[
1st Geographical sub-area:	**2nd Geographical sub-area:**	**3rd Geographical sub-area:**
[GSA_6]		
4th Geographical sub-area:	**5th Geographical sub-area:**	**6th Geographical sub-area:**
1st Country	**2nd Country**	**3rd Country**
Spain		
4th Country	**5th Country**	**6th Country**
Stock assessment method: (direct, indirect, combined, none)		
Indirect: XSA, YIELD PER RECRUIT		
Authors:		
García-Rodríguez, E. (1); Vivas, M. (1); Herrera, E; Esteban, A; Pérez-Gil, J. L. (2)		
Affiliation:		
(1)Instituto Español de Oceanografía (IEO). Murcia. Spain. (2) Instituto Español de Oceanografía (IEO). Málaga. Spain.		

The ISSCAAP code is assigned according to the FAO 'International Standard Statistical Classification for Aquatic Animals and Plants' (ISSCAAP) which divides commercial species into 50 groups on the basis of their taxonomic, ecological and economic characteristics. This can be provided by the GFCM secretariat if needed. A list of groups can be found here:

http://www.fao.org/fishery/collection/asfis/en

Direct methods (you can choose more than one):

- Acoustics survey
- Egg production survey
- Trawl survey
- SURBA
- Other (please specify)

Indirect method (you can choose more than one):

- ICA
- VPA
- LCA
- AMCI
- XSA
- Biomass models
- Length based models
- Other (please specify)

Combined method: you can choose both a direct and an indirect method and the name of the combined method (please specify)

2 Stock identification and biological information

Specify whether the assessment is considered to cover a complete stock unit. If the stock unit limits are more or less known, but for technical reasons the assessment only covers part of the stock (e.g. a GSA area but stock spreads to other GSAs), explain the state of the art of the stock unit knowledge. If there are doubts about the stock unit, state them here. If there is knowledge on migration rates between different stock units that affect the stock state them here.

2.1 Stock unit

Due to the lack of information about the structure of the population in the Western Mediterranean, it is considered that the stock limits of the assessed *Mullus barbatus* are in agreement with the limits of GSA 06.

2.2 Growth and maturity

Incorporate different tables if there are different maturity ogives (e.g. catch and survey). Also incorporate figures with the ogives if appropriate. Modify the table caption to identify the origin of the data (catches, survey). Incorporate names of spawning and nursery areas and maps if available.

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

Somatic magnitude measured (LT, LC, etc)				**Units**	
Sex	**Fem**	**Mal**	**Combined**	**Reproduction season**	May-July
Maximum size observed			28.5 (1)	**Recruitment season**	October-December
Size at first maturity			11.2 (2)	**Spawning area**	Continental shelf (4)
Recruitment size to the fishery			7.8 (3)	**Nursery area**	Coastal areas

(1) Size composition of trawl catches in GSA06.

(2) From the Spanish DCF National Programme (2011)

(3) García-Rodriguez, M. and Fernández, A. M. 2005.

(4) Lombarte, A.; L. Recasens; M. González and L. Gil de Sola (2000)

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

Table 2-2.3: M vector and proportion of matures by size or age (females)

Table 2-2.4: M vector and proportion of matures by size or age (both sex)

Size/Age	Natural mortality	Proportion of matures
Age 0	*0.99*	*0.033*
Age 1	*0.46*	*0.874*
Age 2	*0.30*	*1.000*
Age 3+	*0.24*	*1.000*

Table 2-3: Growth and length weight model parameters

			Sex			
		Units	**female**	**male**	**Combined**	**Years**
Growth model	**L_∞**	cm			34.5	cm
	K				0.34	
	t_0				-0.143	
	Data source	Demestre *et al*., 1997 (adopted by SGMED-08-03)				
Length weight relationship	**a**				0.006241	
	b				3.1597	
	M (scalar)	0.42				
	sex ratio (% females/total)	0.69				

L/W relationship from DCF; M from PRODBIOM

3 Fisheries information

3.1 Description of the fleet

Both species of red mullet, *Mullus surmuletus* and *M. barbatus*, are exploited by trawl and artisanal fleets in GSA 06, althought small gears (trammel nets and gillnets) account only for 5% of the total landings of these species (Demestre et al., 1997). Trawl fisheries developed along the continental shelf and upper slope are multi-specific. Small vessels (12-16m length) operate mainly on the shallow shelf targeting on red mullets, octopus, cuttlefish and sea breams. Medium and large vessels usually operates on deep continental shelf and slope areas targeting on hake and decapod crustaceans, but some of these units can also operate on the shallow shelf depending on weather conditions or market prices. Red mullet is more intensively exploited from September to November coinciding with the recruitment period of this species (Martín et al., 1999). The total trawl fleet in the GSA 06 has declined from 810 boats in 1998 to 458 boats in 2015; around 30% of these boats regularly operate in sallow shelf.

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

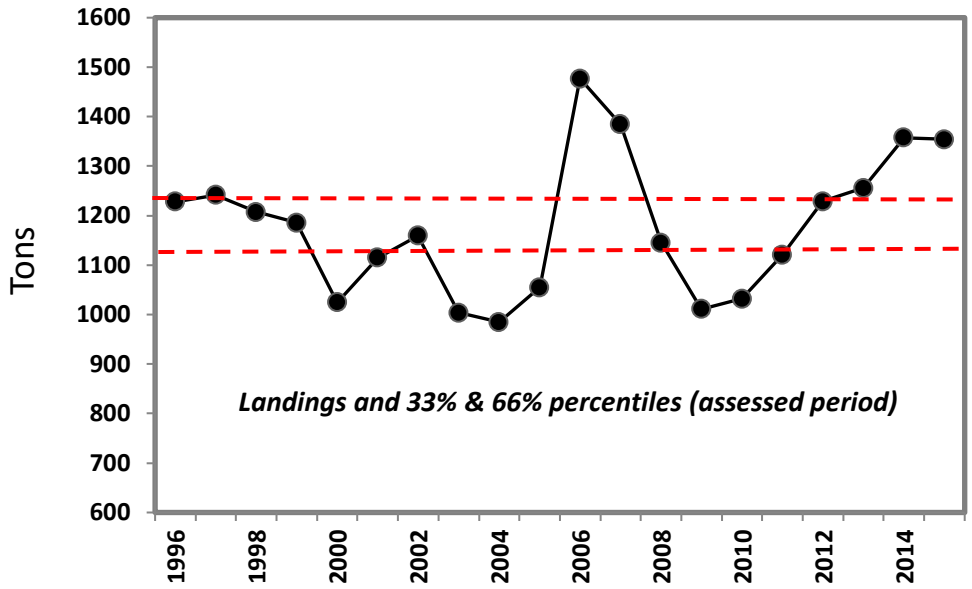
	Country	GSA	Fleet Segment	Fishing Gear Class	Group of Target Species	Species
Operational Unit 1*	ESP	06	E – Trawl (12-24 m)	03 - Trawl	33-Demersal shelf species	Pagellus acarne Pagellus erythrinus Merluccius Octopus vulgaris Sepia officinalis Eledone cirrhosa

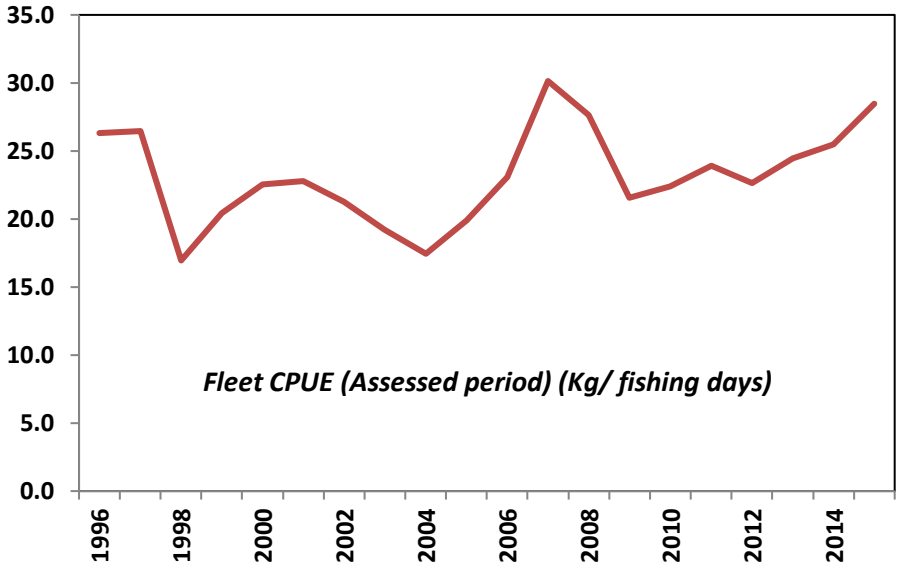
Table 3.1-2: Catch, bycatch, discards and effort by operational unit in the reference year

Operational Units*	Fleet (n° of boats)*	Catch (T or kg of the species assessed)	Other species caught (names and weight)	Discards (species assessed)	Discards (other species caught)	Effort (units)
[Operational Unit1]	458	1354 tons				59.5 Fishing days *1000
Total	458	1354 tons				59.5

3.2 Historical trends

The fishery developed in the early seventies and landings increased quickly. Since then landings widely fluctuates but a general decreasing trend is observed. In the period assessed landings fluctuate but without any clear trend. The trawl fishing fleet declines steadily and this trend become sharper since 2008. Fleet CPUE in the studied period fluctuates but no trend is observed.





3.3 Management regulations

– Engine power limited to 316 KW or 500 CV.

- Mesh size in the cod-end (50 mm diamond or 40 mm square).

- Fishing ban of trawl fishing in areas less than 50 m depth.

- Time at sea (12 hours per day and 5 days per week).

- Spatial and temporal closures of trawl fishing.

- Minimum legal size: 11 cm TL.

3.4 Reference points

Table 3.3-1: List of reference points and empirical reference values previously agreed (if any)

Indicator	Limit Reference point/empirical reference value	Value	Target Reference point/empirical reference value	Value	Comments
B		4732		3743	B mean as a referent point (B low = 2696)
SSB		1808		1244	SSB mean as a referent point (SSB low = 712)
F		0.67		0.45	F0.1 as a referent point
Y		1354		1179	Y mean as a referent point (Y low = 985)
CPUE		28.47		23.45	CPUE mean as a referent point (CPUE low = 16.95)
Index of Biomass at sea					

4 Fisheries independent information

4.1 MEDITS Trawl Survey

4.1.1 Brief description of the direct method used

Direct methods: trawl based abundance indices

Table 4.1-1: Trawl survey basic information

Survey	MEDITS 2015	**Trawler/RV**	Miguel Oliver
Sampling season	SPRING		
Sampling design	random stratified with number of haul by stratum proportional to stratum surface		
Sampler (gear used)	GOC-73		
Cod –end mesh size as opening in mm	20		
Investigated depth range (m)	40-800		

Table 4.1-2: Trawl survey sampling area and number of hauls

Stratum	**Total surface (km^2)**	**Trawlable surface (km^2)**	**Swept area (km^2)**	**Number of hauls**
A (-50m)	3026			11
B (50-100m)	11314			31
C (100-200m)	6889			29
D (200-500 m)	6719			21
E (+500m)	4558			12
Total (km^2)	32506			104

Map of hauls positions:

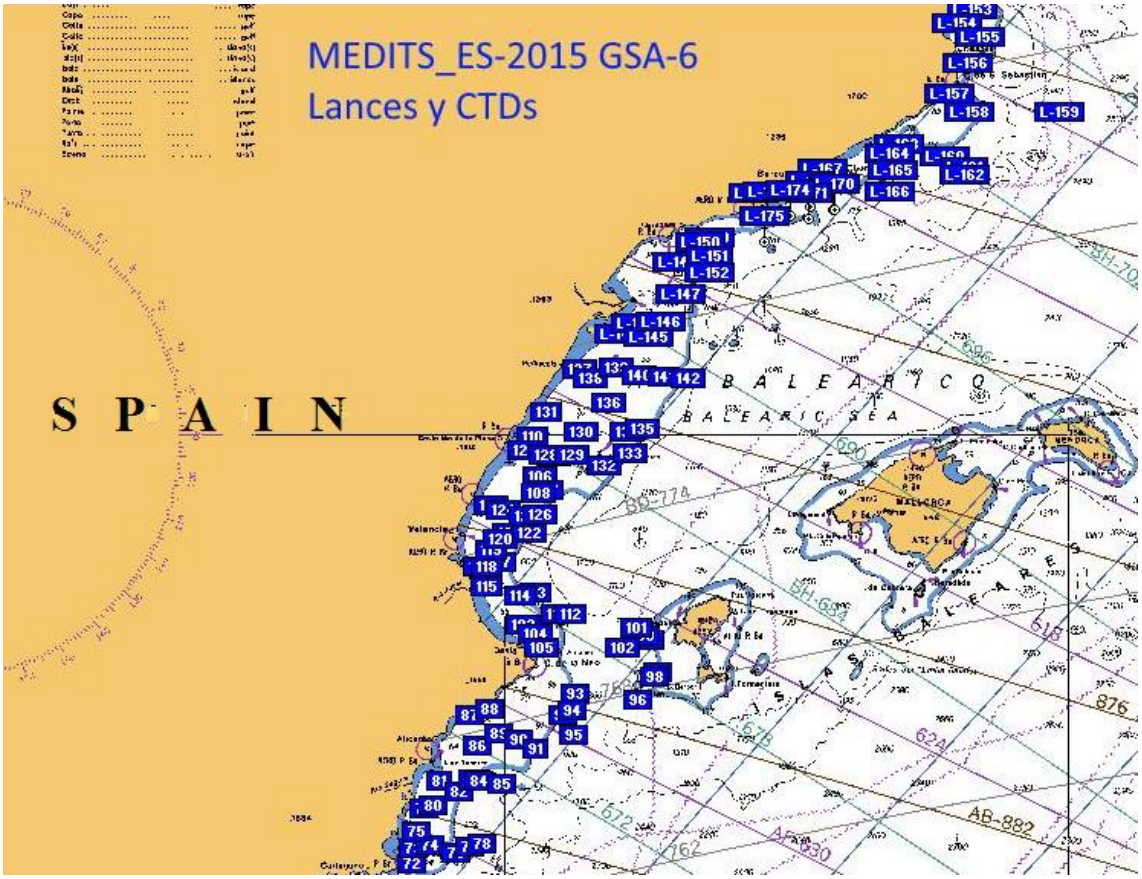

MEDITS_ES-2015 GSA-6
Lances y CTDs
SPAIN
BALEARIC SEA
BALEARIC
ISLANDS

Table 4.1-3: Trawl survey abundance and biomass results

Depth Stratum	Years	kg per km^2	CV or other	N per km^2	CV or other
	……				
	……				
	……				
	……				
	……				
Total (… – … m)	……				

*

Comments

- Specify CV or other index of variability of mean
- Specify sampling design (for example random stratified with number of haul by stratum proportional to stratum surface; or systematic on transect;…)
- Specify if catchability coefficient is assumed =1 or other

Direct methods: trawl based length/age structure of population at sea

Slicing method

Report the maturity scale and age slicing method used

Table 4.1-4: Trawl survey results by length or age class

N (Total or sex combined) by Length or Age class	Year		
	….	….	…..
Total			

Sex ratio by Length or Age class	Year		
	….	….	…..
Total			

Comments

- Specify if numbers are per km^2 or raised to the area, assuming the same catchability .
- In case maturity ogive has not been estimated by year, report information for groups of years.
- Possibility to insert graphs and trends

Direct methods: trawl based Recruitment analysis

Table 4.1-5: Trawl surveys; recruitment analysis summary

Survey		**Trawler/RV**	
Survey season			
Cod –end mesh size as opening in mm			
Investigated depth range (m)			
Recruitment season and peak (months)			
Age at fishing-grounds recruitment			
Length at fishing-grounds recruitment			

Table 4.1-6: Trawl surveys; recruitment analysis results

Years	**Area in km²**	**N of recruit per km²**	**CV or other**

Comments

- Specify type of recruitment:
  - continuous and diffuse
  - discrete and diffuse
  - discrete and localised
  - continuous and localised.
- Specify the method used to estimate recruit indices
- Specify if the area is the total or the swept one
- Possibility to insert graphs and trends

Direct methods: trawl based Spawner analysis

Table 4.1-7: Trawl surveys; spawners analysis summary

Survey		**Trawler/RV**	
Survey season			
Investigated depth range (m)			
Spawning season and peak (months)			

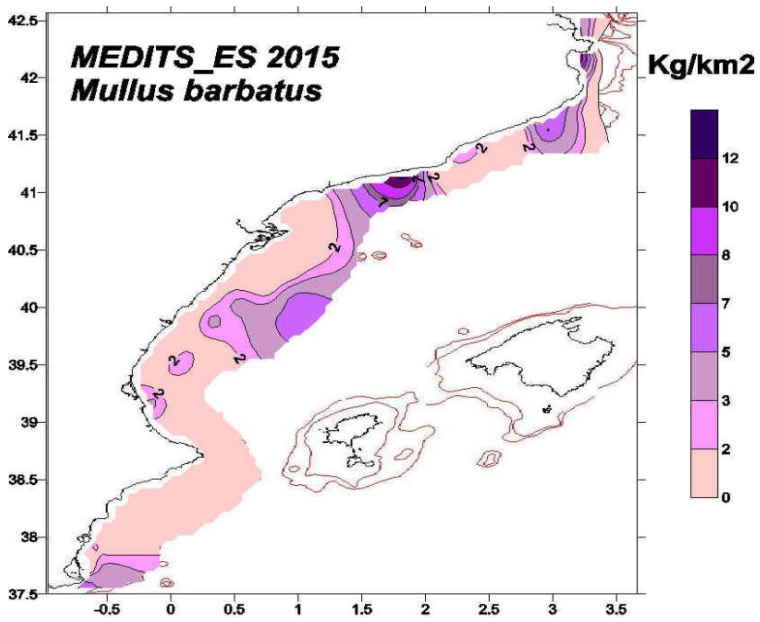
Table 4.1-8: Trawl surveys; spawners analysis results

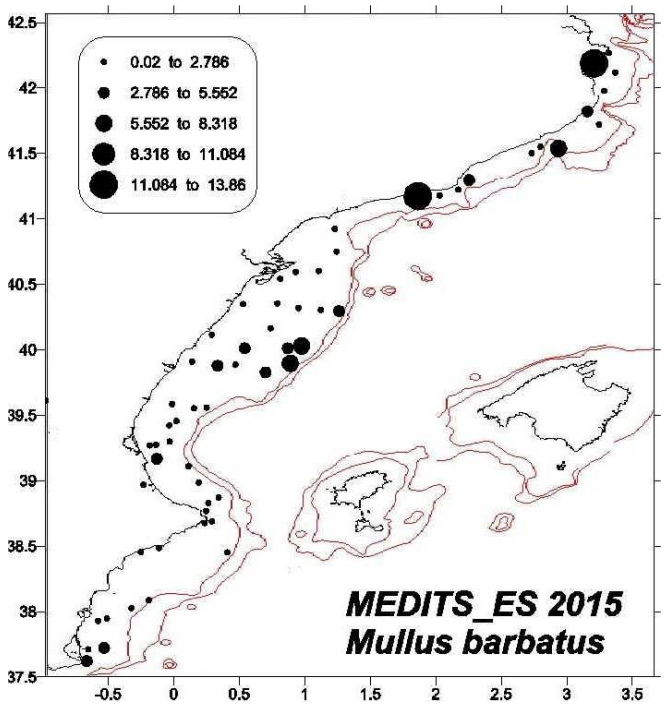
Surveys	**Area in km²**	**N (N of individuals) of spawners per km²**	**CV or other**	**SSB per km²**	**CV or other**

Comments

- Specify type of spawner:
  - total spawner
  - sequential spawner
  - presence of spawner aggregations
- Specify if the area is the total or the swept one
- Possibility to insert graphs e trends

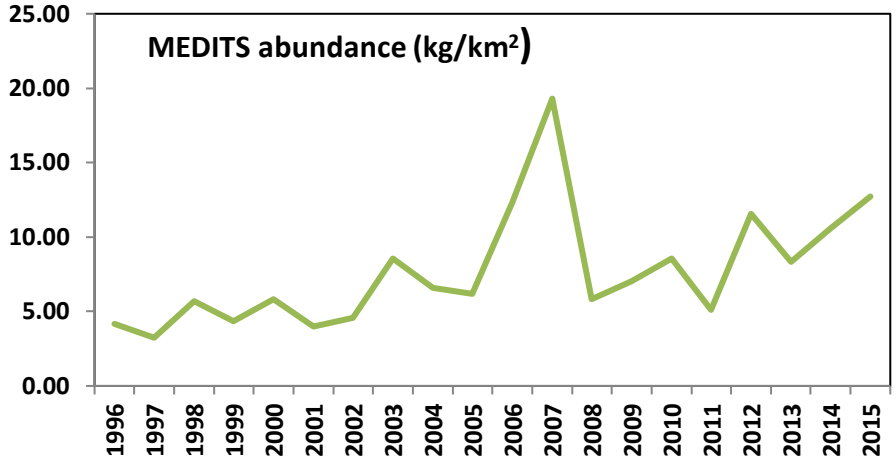
4.1.2 Spatial distribution of the resources





4.1.3 Historical trends

MEDITS surveys data show a slight increasing trend in abundance along the period.



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

If any environmental index is used as i) a proxy for recruitment strength, ii) a proxy for carrying capacity, or any other index that is incorporated in the assessment, then it should be included here.

Other environmental indexes that are considered important for the fishery (e.g. Chl a or other that may affect catchability, etc.) can be reported here.

6 Stock Assessment

In this section there will be one subsection for each different model used, and also different model assumptions runs should be documented when all are presented as alternative assessment options.

6.1 TUNED VPA (XSA) (Darby & Flatman, 1994)

6.1.1 Model assumptions

6.1.2 Scripts

If a script is available which incorporates the stock assessment run (e.g. if using FLR in R) it should be provided here in order to create a library of scripts.

6.1.3 Input data and Parameters

Input parameters and model settings

Age group	M (Prodbiom)	Maturity (DCF)
0	0.99	0.033
1	0.46	0.874
2	0.30	1.000
3+	0.24	1.000

Growth parameters (Demestre et al, 1997)

L inf = 34.5; K = 0.34; T_0 = -0.143

L/W relationship (DCF)

a = 0.006241; b = 3.1597

- Proportion Fishing Mortality Prior to Spawning: 0.5
- Proportion Natural Mortality Prior to Spawning: 0.5

MODEL SETTINGS

XSA analysis. Catchability dependent on stock size for ages < 1
Catchability independent of age for ages >= 1
S. E. of the mean to which the estimates are shrunk = 0.5
Minimum standard error for population estimates = 0.3

6.1.4 Results

Fishing mortality at age：

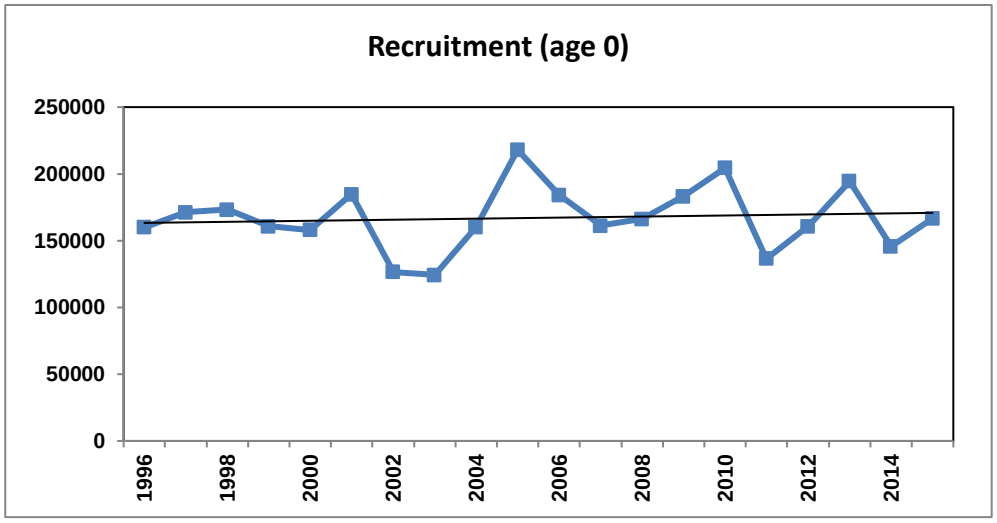
	1996	1997	1998	1999	2000	2001	2002	2003
0	0.1169	0.0984	0.1589	0.2863	0.1582	0.169	0.1332	0.088
1	1.3857	1.536	1.5865	1.2434	1.0781	1.1625	1.0905	1.1178
2	0.7632	0.8287	0.8928	0.7763	0.6359	0.6626	0.65	0.6275
+gp	0.7632	0.8287	0.8928	0.7763	0.6359	0.6626	0.65	0.6275

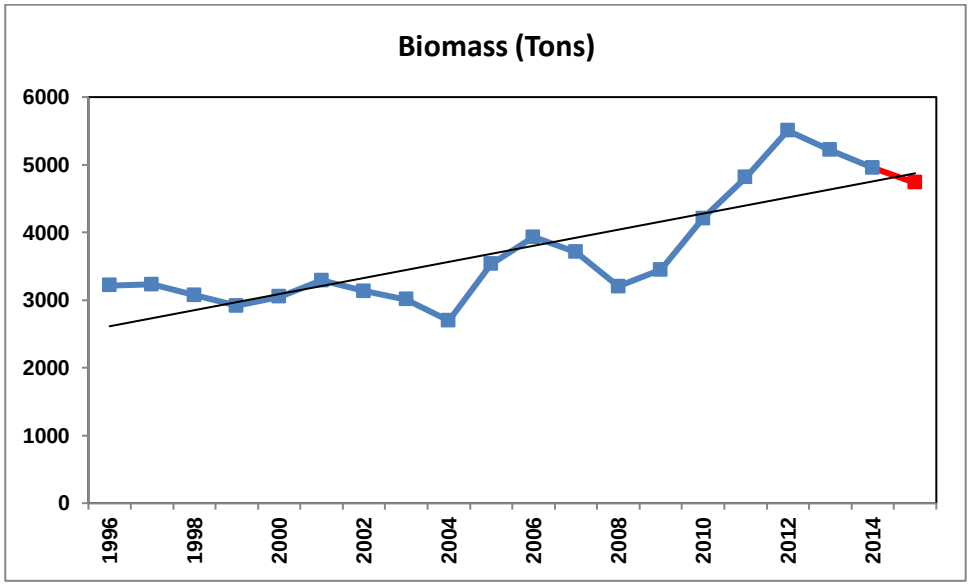
	2004	2005	2006	2007	2008	2009	2010	2011
0	0.1969	0.0974	0.11	0.1661	0.1061	0.0739	0.0456	0.0127
1	1.2103	1.3003	1.3592	1.2654	1.1845	0.9466	0.6535	0.5482
2	0.7318	0.6878	0.7858	0.6984	0.6399	0.5301	0.4711	0.4329
+gp	0.7318	0.6878	0.7858	0.6984	0.6399	0.5301	0.4711	0.4329

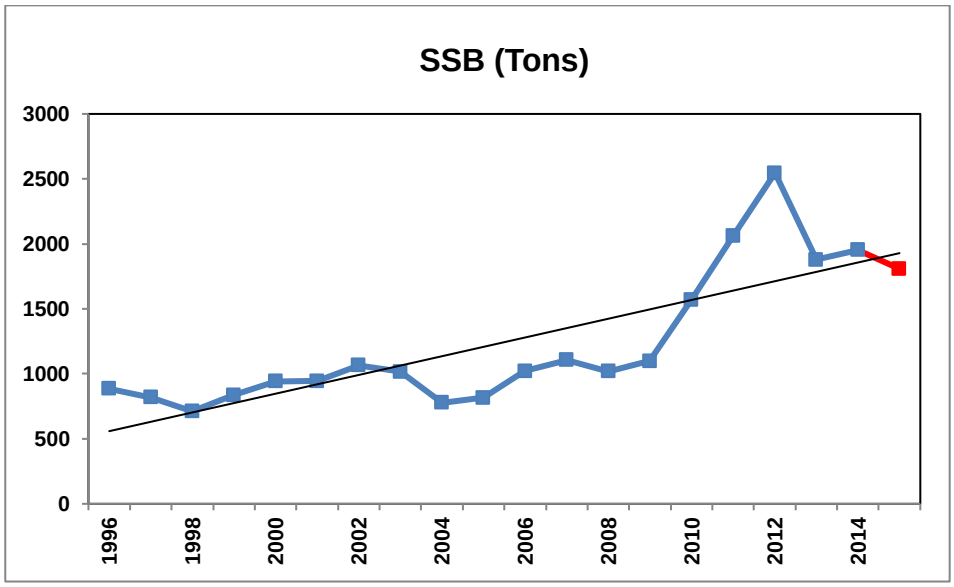
	2012	2013	2014	2015
0	0.0023	0.0036	0.0081	0.0248
1	0.4397	0.6661	0.6882	0.7876
2	0.4681	0.5721	0.5527	0.6145
+gp	0.4681	0.5721	0.5527	0.6145

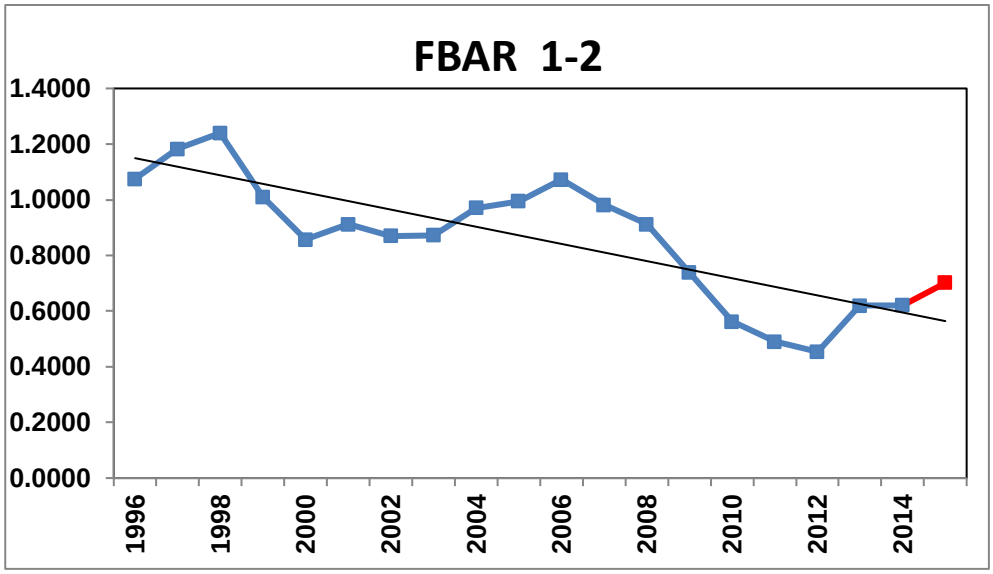
Other results：

Year	Recruits	Total B	SSB	F bar 0-2	F bar 1-2
1996	160088	3217	885	0.7553	1.0745
1997	171186	3231	820	0.8211	1.1824
1998	173310	3072	712	0.8794	1.2397
1999	160709	2916	837	0.7687	1.0099
2000	158012	3049	941	0.6241	0.8570
2001	184833	3291	944	0.6647	0.9126
2002	126648	3131	1065	0.6245	0.8703
2003	124411	3011	1017	0.6111	0.8727
2004	160198	2696	779	0.713	0.9711
2005	218031	3532	816	0.6952	0.9941
2006	184157	3932	1022	0.7517	1.0725
2007	161354	3711	1107	0.71	0.9819
2008	166301	3202	1018	0.6435	0.9122
2009	183309	3447	1099	0.5169	0.7384
2010	204472	4206	1570	0.3901	0.5623
2011	136639	4813	2062	0.3313	0.4906
2012	160839	5504	2546	0.3034	0.4539
2013	194435	5218	1878	0.4139	0.6191
2014	145682	4956	1952	0.4163	0.6205
2015	166587	4732	1808	0.4756	0.7011


Recruitment (age 0)
250000
200000
150000
100000
50000
0
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014

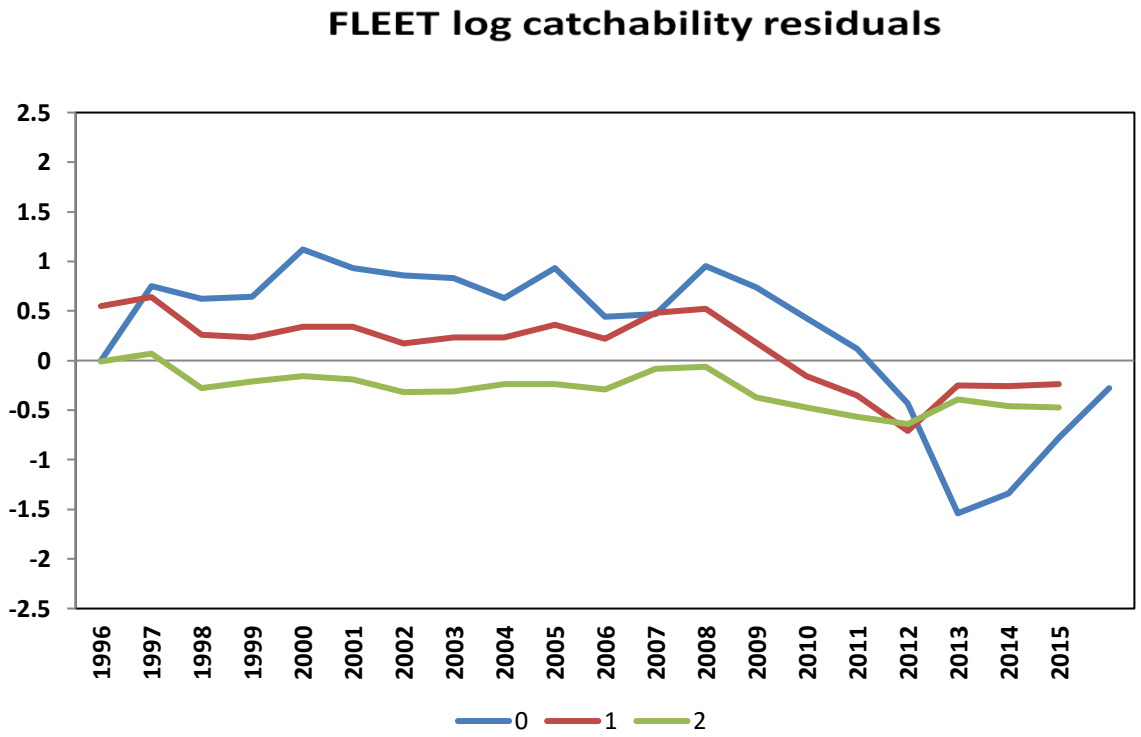

Biomass (Tons)
6000
5000
4000
3000
2000
1000
0
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014

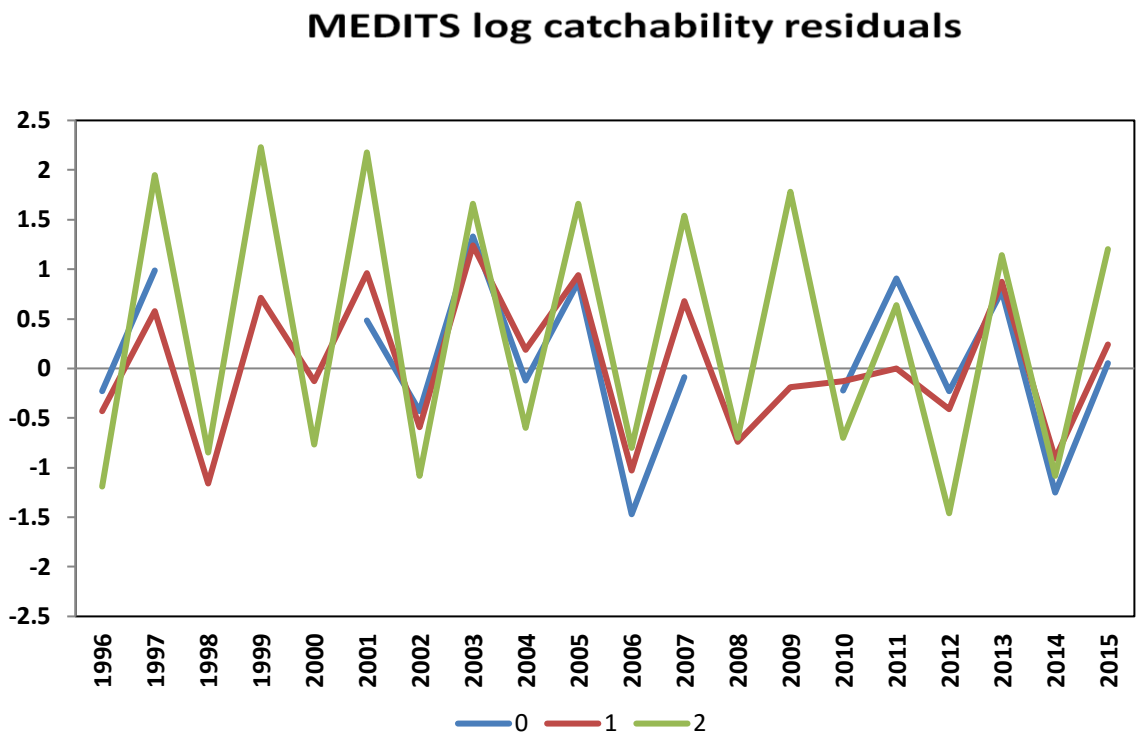

SSB (Tons)
3000
2500
2000
1500
1000
500
0
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014



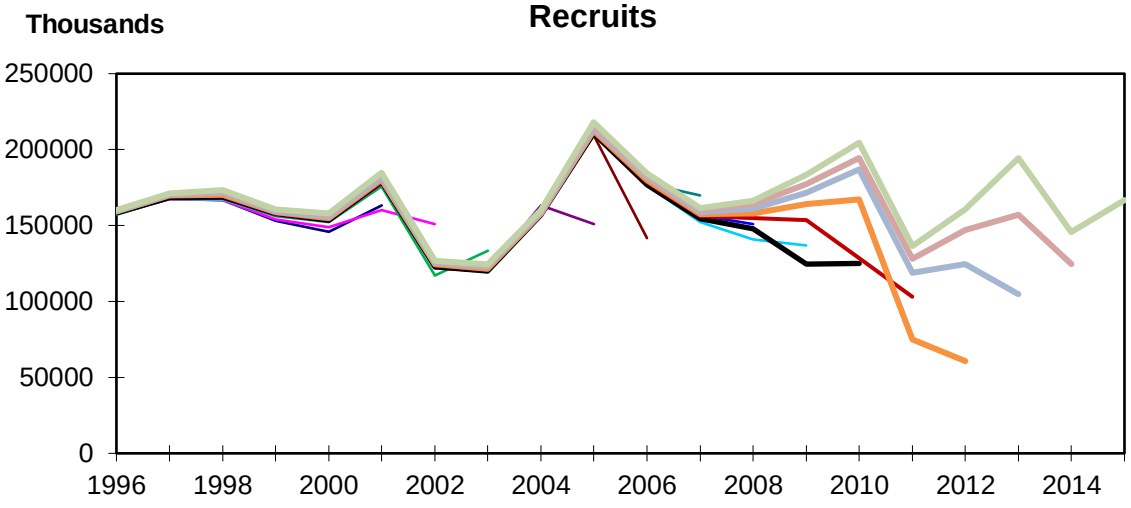
Tables and graphs of Total biomass, SSB, Recruitment, F or other outcomes of the stock assessment model with comments on trends in stock size, recruitment and exploitation.

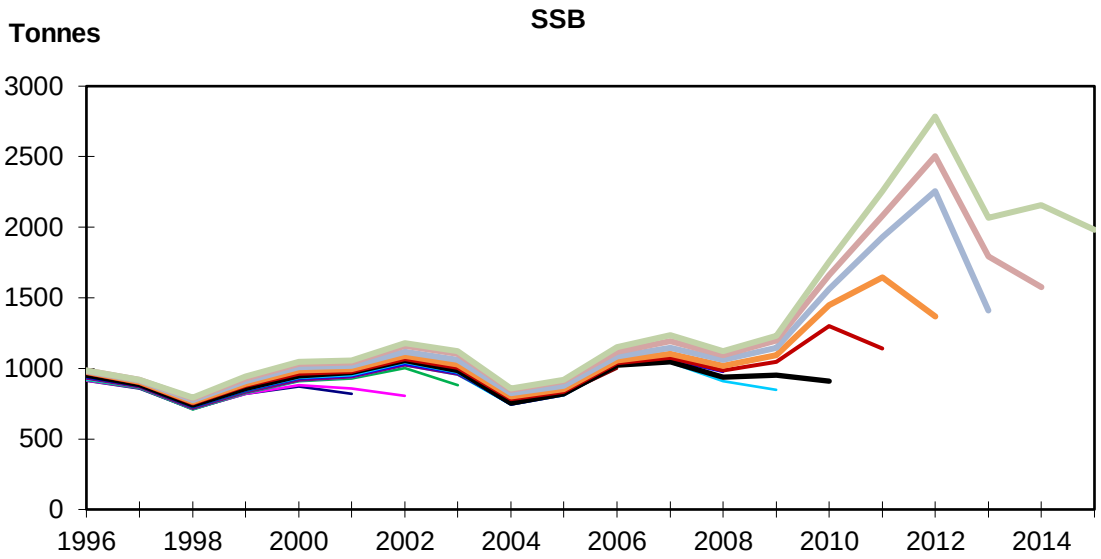
6.1.5 Robustness analysis

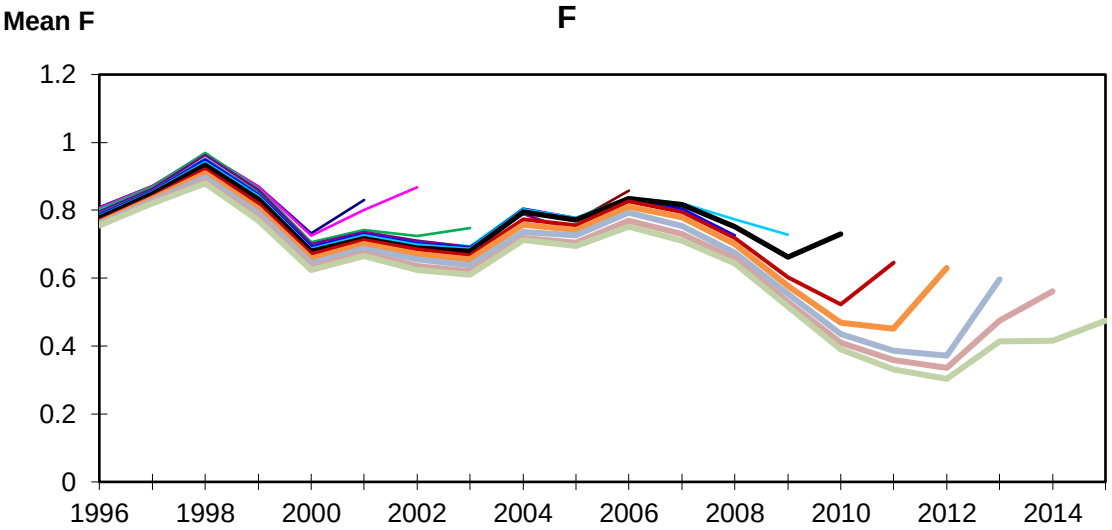




6.1.6 Retrospective analysis, comparison between model runs, sensitivity analysis, etc.




SSB
Tonnes
3000
2500
2000
1500
1000
500
0
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014


F
Mean F
1.2
1
0.8
0.6
0.4
0.2
0
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014

6.1.7 Assessment quality

Stability of the assessment, evaluation of quality of the data and reliability of model assumptions.

6.2 Y/R (version 3.1.1; NOAA Fisheries Tools)

Model parametres

Age group	Stock weight	Catch weight	SSB weight	Maturity	M	Selectivity
0	0.0106	0.0106	0.0106	0.033	0.99	0.02
1	0.0352	0.0352	0.0352	0.874	0.46	0.54
2	0.0710	0.0710	0.0710	1.000	0.30	1.00
3+	0.1403	0.1403	0.1406	1.000	0.24	1.00

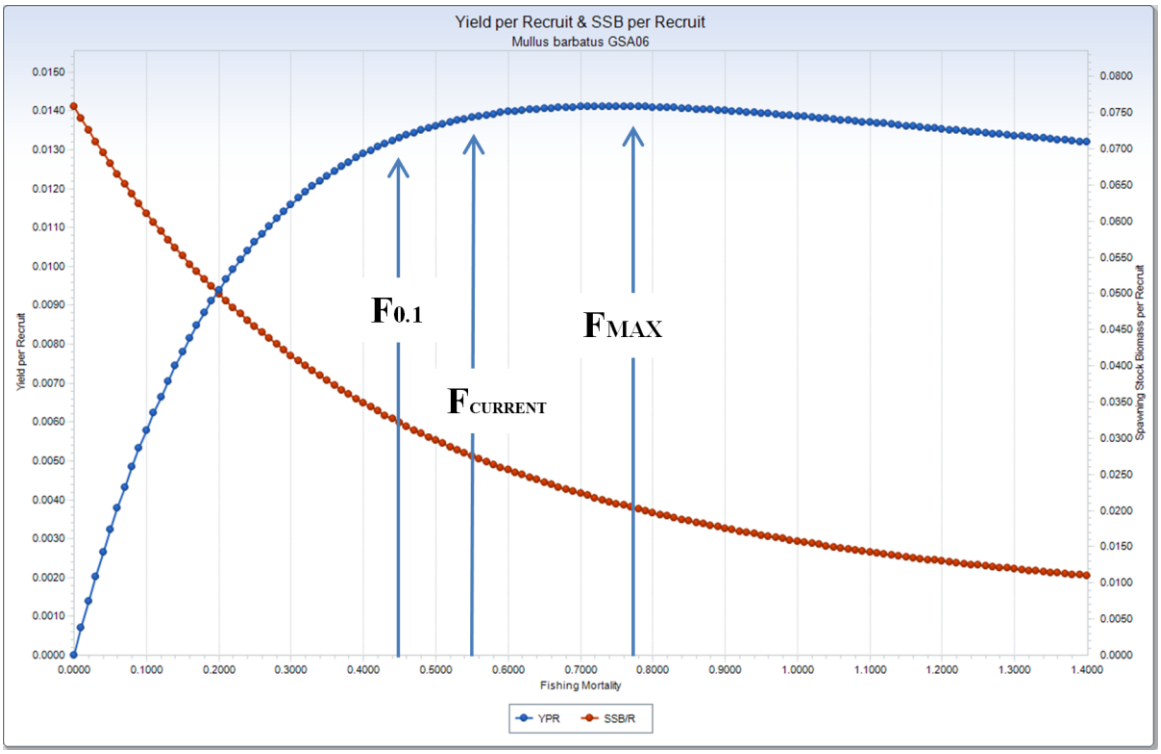
First Age in Data: 0

Last Age in Data: 5

Age in Plus Group: 3

Y/R results	
F 0.1	0.449
F max	0.740
F at 40% MSP	0.486
F current (*)	0.564

(*) From XSA. Mean F bar 1-2 in 2012-2014. F in the last year of the analysis is systematically overestimated and is not considered in the estimates of Fcurrent.



6.3 STOCK / RECRUITMENT RELATIONSHIP

7 Stock predictions

When an analytical assessment exists, predictions should be attempted. All scenarios tested (recruitment and/or fishing mortality) should be reported. The source of information/model used to predict recruitment should be documented.

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)	Stock Status
Fishing mortality	Fishing mortality	$F_{0.1}$	0.449	Fcurrent (ages 1-2) = 0.564	Decreasing	IO_L
	Catch		1354 (2015)	Mean catch (1996-2015) = 1179 tons	No trend	
Stock abundance	Total Biomass		4732 tons (in 2015)	33th percentile = 3206 tons 66th percentile = 3830 tons	Increasing	O_H
	SSB		1808 tons (in 2015)	66th percentile = 1103 tons	Increasing	O_H
Recruitment			167 x 10^6 (in 2015)	33th percentile =160 x 10^6	No trend	
Final Diagnosis	In overexplotation (Fcurrent > F0.1). Relative high Total biomass and Relative high Spawning Stock Biomass					

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)*