Stock Assessment Form

Small Pelagics

Reference Year: 2013

Reporting Year: 2014

[A brief abstract may be added here]

Stock Assessment Form version 1.0 (January 2014)

Uploader: *Please include your name*

Stock assessment form

1   Basic Identification Data

Scientific name:	Common name:	ISCAAP Group:
Engraulis encrasicolus ponticus	[Black Sea anchovy]	[ISCAAP Group]
1st Geographical sub-area:	**2nd Geographical sub-area:**	**3rd Geographical sub-area:**
[GSA_29]		
4th Geographical sub-area:	**5th Geographical sub-area:**	**6th Geographical sub-area:**
1st Country	**2nd Country**	**3rd Country**
Turkey	Georgia	Ukraine
4th Country	**5th Country**	**6th Country**
Romania	Bulgaria	
Stock assessment method: (direct, indirect, combined, none)		
indirect		
Authors:		
[Ali Cemal Gucu]		
Affiliation:		

 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

2.1   *Stock unit*

The anchovy, *Engraulis encrasicolus* is distributed all over the Black Sea (Figure 1) and represented by at least two different stocks in the Black Sea: the Black Sea and the Azov Sea stocks (Ivanov and Beverton 1985). The later reproduces and feeds in the Azov Sea and hibernates along the northern Caucasian and Crimean coast of the Black Sea. In addition to these two distinct stocks, there are strong evidences for the existence of a resident stock, spawning within the Turkish EEZ and overwintering on the Anatolian coast. An alternative view to existence of more than two stocks is displacement in the spawning areas (Niermann et al. 1994). The degradation of ecological status of the spawning area was believed to lead anchovy to replace its spawning areas (**Error! Reference ource not found.**).

The common belief is that the Black Sea anchovy migrates to the wintering grounds along the Anatolian and Caucasian coasts in southern Black Sea in October-November. In these areas they form dense hibernating concentrations until March. During this period they are subjected to intensive fishery. In the rest of the year they occupy spawning and feeding habitats across the sea with some preference to the shelf areas characterized by high productivity (Faschuk et al. 1995).

On the other hand in the view of new findings, to what extent the different forms of anchovies are mixed and discriminated in the landings and as to whether they subjected to the same nutritious conditions for growth and reproduction and to the same level of natural and fisheries mortality, are matter of assessment concerns. It is crucial to address unit stock question for anchovy in the Black Sea. Here in this assessment it was assumed that i) there are only two stocks of anchovy in the Black Sea; ii) the Azov Sea anchovy inhabits a rather small region confined to Sea of Azov, east of Kerch, Caucasian coast and to a minor extent Georgia; iii) Azov stock is almost exclusively fished and hence regulated by Ukraine and Russian Federation. Therefore the assessment is populated with the data pertaining only to the Black Sea anchovy.
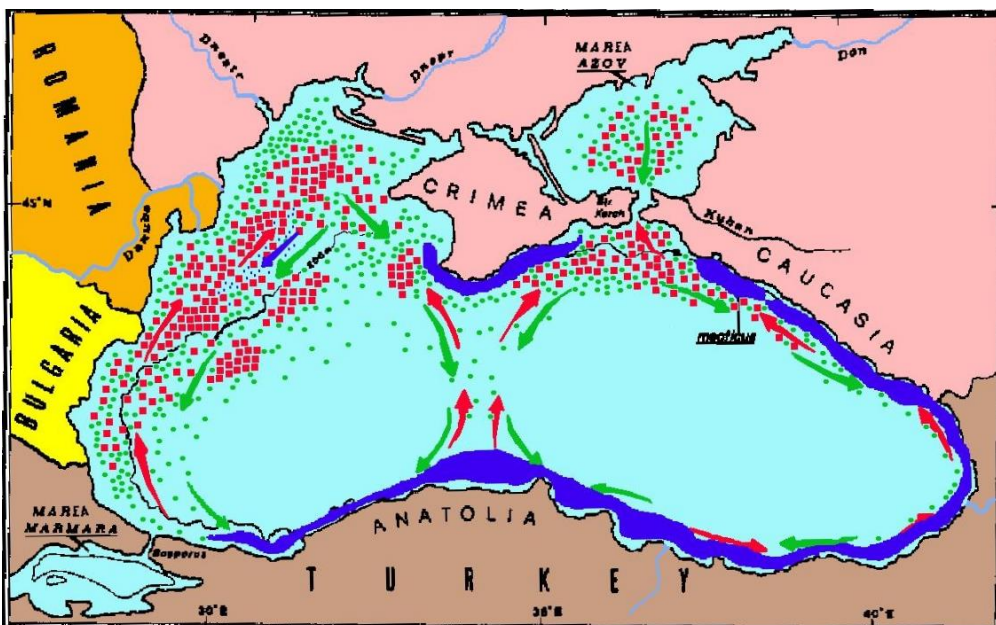
Figure 1.Distribution of the anchovy at the Romanian littoral and in the whole Black Sea.
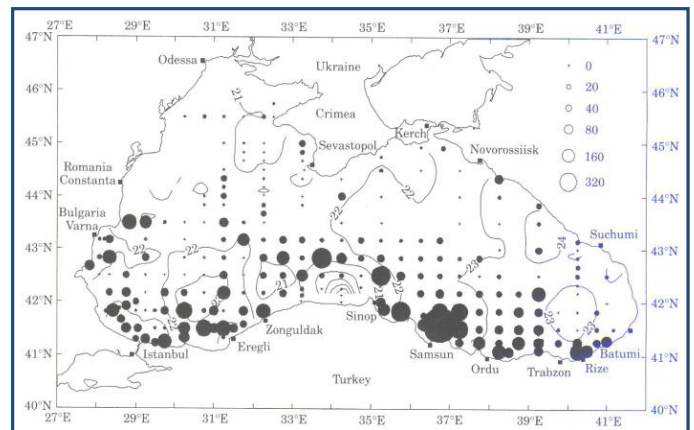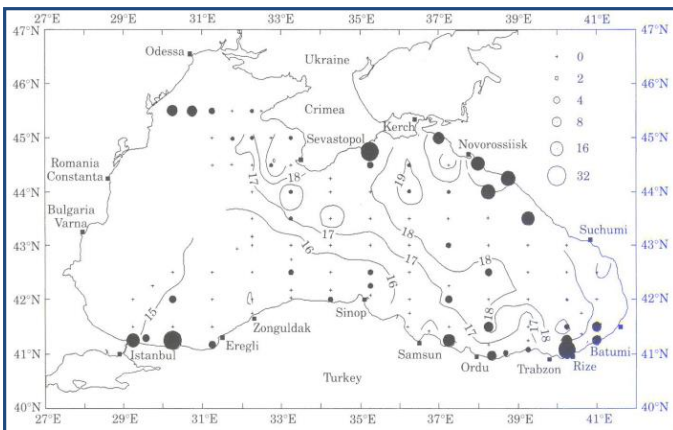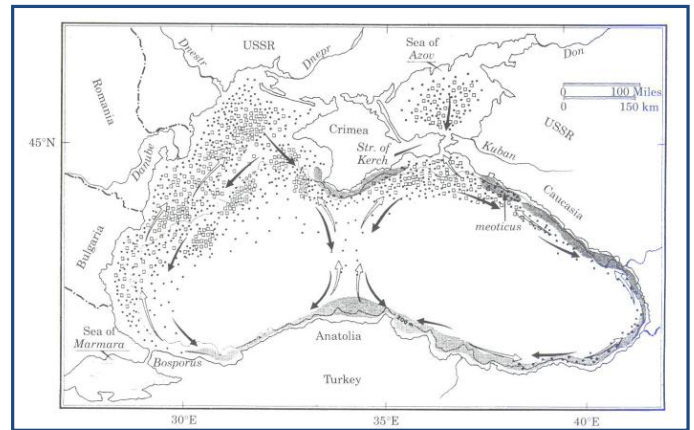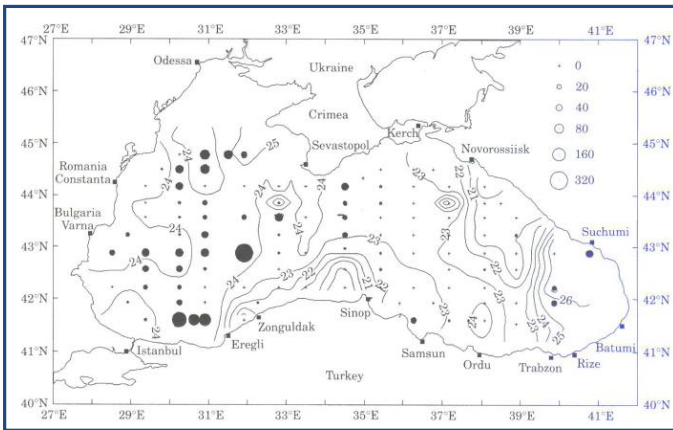
Figure 2.Egg distribution of anchovy in 1950s (upper left; Einarson and Gürtürk 1960); in 1970s (upper right, Ivanov and Beverton, 1985), and in 1990s (lower, Niermann et al. 1994).

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	**May-August**
Maximum size observed			14.5	Recruitment season	
Size at first maturity				Spawning area	
Recruitment size to the				Nursery area	

fishery					

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

Age	Natural mortality	Proportion of matures
0	1.32	0
1	0.81	1
2	0.56	1
3	0.48	1
4	0.48	1

Table 2-3: Growth and length weight model parameters

		Units	Sex female	Sex male	Sex Combined	Sex Years
Growth model	L_∞					
Growth model	K					
Growth model	t_0					
Growth model	Data source					
Length weight relationship	a					
Length weight relationship	b					
	M (scalar)				0.82	
	sex ratio (% females/total)					

3   Fisheries information

3.1   Description of the fleet

Identification of Operational Units exploiting this stock. Use as many rows as needed

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*	[Turkey]	[GSA29]	H	[Purse seine]	[ISCAAP Group]	
Operational Unit 2	[Georgia]	[GSA29]	H	[Purse seine]	[ISCAAP Group]	

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

Operational Units*	Fleet (n° of boats)*	Catch (T of the species assessed)	Other species caught (names and weight)	Discards (species assessed)	Discards (other species caught)	Effort (units)
[Turkish Purse Seiner]	218	153555				No of vessel
[Purse seiners in Georgia]	21	70700				No of vessel
[Bulgaria]	na	9.5				
[Romania]	na	111				
[Ukraine]	na	1686				
Total	239	226 062				

3.2   Historical trends

The anchovy landings during the period 1970 – 2013 by countries are presented on Figure 1. The data presented under Ukraine belong exclusively to the Black Sea anchovy (Azov anchovy excluded). In1997-2006, the Ukrainian fleet fished the Black Sea anchovy, not only in their own waters, but also in waters of Georgia. It was assumed that Russian Federations targets only Azov anchovy and the Black Sea anchovy catch of this country is negligibly low.

The stock has experienced a collapse in late 1980s and recovered, as can be seen from the landings of Turkey. The very high level of anchovy catch of former USSR has never been reached after the disintegration. The fate of the stock is not known.

T*he landings figures suggests that the annual catch of Turkey slightly increased compared to 2012; however still well below the average of the last 10 years. In contrary, Georgia raised the TAC in 2013 and the anchovy caught on the Georgian waters increased 2.1 times in 2011 and further increased by 1.3 times in 2013. A noticeable increase in the Romanian catch was also noted in 2013.*
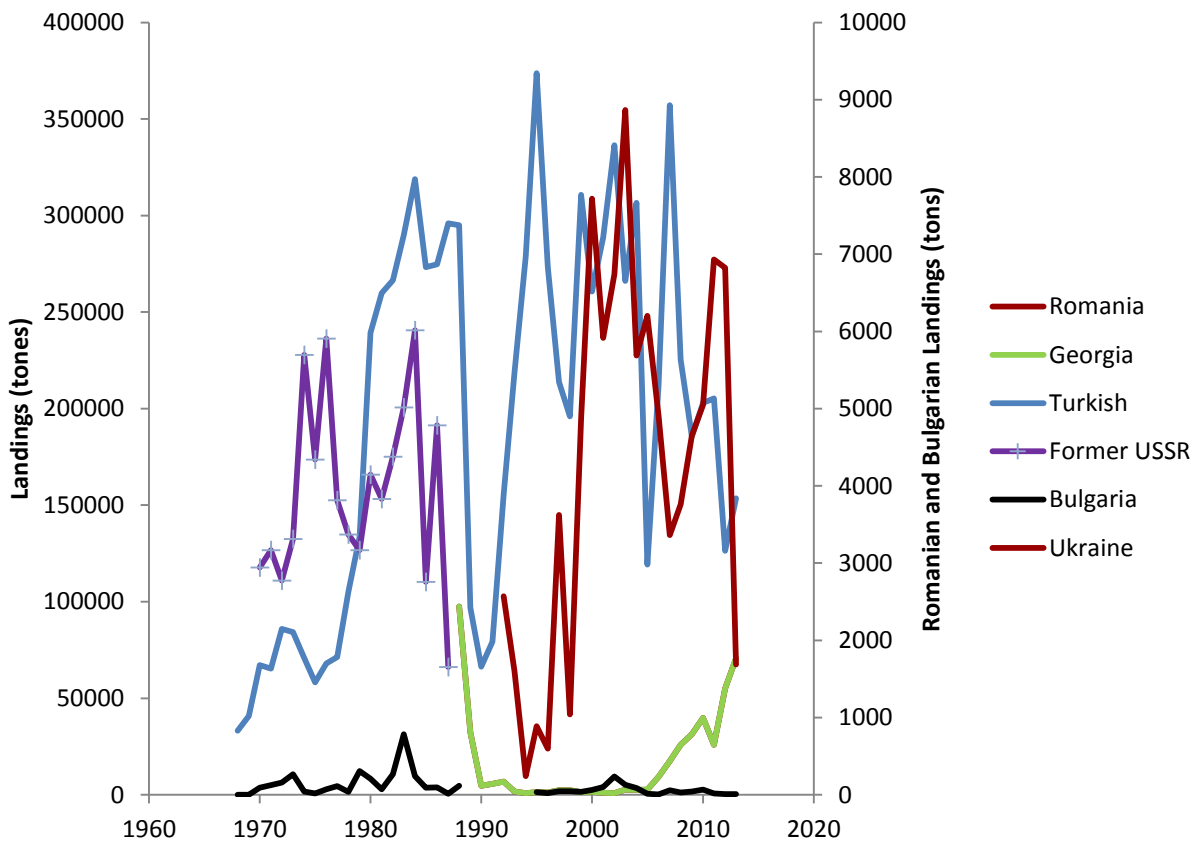

Figure 3. Annual anchovy landings of the Black Sea countries

3.3   Management regulations

In the Black Sea countries, anchovy fishing are generally regulated by i) closed seasons (May April to October/November for Bulgaria and Romania, April to September for Turkey, and no closed season for Ukraine), ii) closed areas, iii) mesh size regulations, iv) minimum landing size (9 cm total length (or equal) in general and 7 cm TL for Georgia). The Black Sea and Azov anchovy are treated as two different stocks in Ukraine and in the Russian Federation and the fishery is managed separately for each stock.

The only country applying a catch quota to Black Sea anchovy is Georgia, where the quota has been increased from 60 000 to 85 000 tones in 2013. As no information is provided by the Georgian authorities concerning the methodology applied to estimate TAC, it is not clear whether or not the increased quota is in line with the stock status

Turkey as the owner of the main fleet fishing the Black Sea anchovy enforced additional measured to control the size of the fishing fleet. These includes;

a)   The fishing capacity of the fleet had been develop over the years and finally overcapitalized beyond the profitability within the last 3 decades. The issue and its consequences on the fish stocks have been recognized in mid-1990s when a significant reduction in the stocks hit the fishery sector. However a comprehensive measure has been enforced only at the beginning of 2000's. As the first step, licensing new fishing boats has been stopped in 2002 with the aim of reducing the fishing pressure on the stocks and to maintain sustainable fisheries. Despite interruptions during 2004 and 2005, the applied policy had positive effects on control of increasing fleet capacity. Since then, new entries to the fleet are only allowed when a vessel of same size is exiting from the fleet. In summary the size of the main anchovy fishing fleet in the Black Sea is stable since 2005.

b)   Another very substantial and promising remedy is the fishing boat buyback program launched in 2012 and repeated in 2013. Given that by far greater part of the catch is landed by the industrial boats, the first phase of the program targets fishing vessels larger than 12 meters in 2012. Although the ultimate goal is to reach greater percentages in time, with the available funds allocated for the buyback program only 407 boats (156 boats of them were registered to the port on the Black Sea coast) has been removed from the fleet at this first phase in 2013. In the second phase launched in 2014 another 529 boats have been decommissioned within this campaign.

c)   A series of new regulations and methodological reforms have been enforced within the last 2 years to enhance accuracy of the landing statistics, such as transportation permits for anchovy issued at the landing site

d)   As of 18.08.2012 the minimum depth limit allowed for purse seine and for pelagic trawls has been increased from 18 to 24 meters. Considering that the anchovy overwintering on the Anatolian coast are confined to 0 to 100 meters, the regulation has noticeable positive effect on the reduction of fishing pressure on the anchovy stocks.

e)   Another practice to reduce the fishing pressure on the anchovy stock is that the anchovy

fishery is restricted to night hours (16:00-08:00)

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					
SSB					
F					
Y					
CPUE					
Index of Biomass at sea					

4 Fisheries independent information

4.1 *Hydroacoustic survey*

4.1.1 Brief description of the chosen method and assumptions used

Direct methods: DEPM

Table 4.1-1: Egg production cruise information.

Date				
Cruise			R/V	
Total area (km²)		Positive	Negative	
Egg sampler				
Adult sampler				

Table 4.1-2: Parameters of the egg mortality curve

Parameters (exponential decay model)		Value	CV
P_0 (# of eggs /0.05 m²)			
Z (days^{-1})			
Temperature range	ºC	ºC	

Table 4.1-3: DEPM Model parameters

Model parameters	value	CV
P_0 (# of eggs/0.05 m² per day)		
A (surface of region 0.05 m²)		
W (average female weight in gr)		
F (batch fecundity: eggs / batch per mature female)		
S (spawning fraction: # spawning female per mature female)		
R (sex ratio: females/total)		

Table 4.1-4: DEPM based estimates

Result	value	CV
Biomass (t)		

Direct methods: acoustics

- Specify if numbers are per km^2 or raised to the area, assuming the same catchability .
- Specify the ageing method or the age slicing procedure applied, specify the maturity scale used.
- In case maturity ogive has not been estimated by year, report information for groups of years.

Table 4.1-5: Acoustic cruise information.

Date			
Cruise		**R/V**	RV Bilim 2
Target species	Anchovy		
Sampling strategy			
Sampling season	July and November		
Investigated depth range (m)	No depth range		
Echo-sounder	SIMRAD EK-60		
Fish sampler			
Cod –end mesh size as opening (mm)	7 mm		
ESDU (i.e. 1 nautical mile)	1 nm		
TS (Target Strength)/species	B20 = -70.2		
Software used in the post-processing	EchoView		
Samples (gear used)	Pelagic trawl with depth sensors attached to bottom and head line		
Biological data obtained	Length-frequency, W/L, species composition, age composition		
Age slicing method			
Maturity ogive used			

Table 4.1-6: Acoustic results, if available by age or length class

	Biomass in metric tons	fish numbers	Nautical Area Scattering Coefficient	Indicator ...	Indicator ...

4.1.2 Spatial distribution of the resources

Include maps with distribution of total abundance, spawners and recruits (if available)

4.1.3 Historical trends

Time series analysis (if available) and graph of the observed trends in abundance, abundance by age class, etc. for each of the directed methods used.

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

The stock of Black Sea anchovy was assessed based on the assessment preformed in the 2014 experts meeting of STECF. The shortcomings and the recommendations provided by the STECF expert group was used to improve the assessment. In order to be in line with the STECF assessment, the same models were used; The XSA was based on landings (1989-2013) of all countries assuming that the age/length compositions are identical in every country. The acoustic biomass estimations conducted by Ukraine (1989-2001) and Turkey (2011-2013) were used to tune the model. The same index data were used in ASPIC which was run for Turkish + Georgian catch and number of Turkish purse seiners being indicative of the effort.

6.1 XSA

6.1.1 Model assumptions

XSA was based on landings (1989-2013) of all countries assuming that the age/length compositions are identical in every country. It should be noted that a significant violation of the assumption of uniform age/length composition is the differences in the minimum landing size in two main exploiters (Turkey and Georgia), particularly when the different minimum landing size regulations applied in two countries are considered.

6.1.2 Scripts

Provided in the sharepoint

6.1.3 Input data and Parameters

For analytical models: **catch matrix** in lengths or ages (see the example below for age). Specify if catch includes discards

	Year												
Age Class	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
0	3.3E-3	3.3E-3	2.8E-3	3.0E-3	3.1E-3	3.0E-3	2.7E-3	3.2E-3	3.5E-3	3.8E-3	4.6E-3	4.0E-3	2.0E-3
1	6.2E-3	6.2E-3	6.6E-3	6.8E-3	6.8E-3	6.9E-3	6.8E-3	6.6E-3	7.2E-3	7.9E-3	1.1E-2	1.0E-2	6.7E-3
2	1.1E-2	1.1E-2	1.3E-2	1.1E-2	1.0E-2	1.1E-2	1.0E-2	1.1E-2	1.1E-2	1.2E-2	1.4E-2	1.2E-2	1.3E-2
3	1.5E-2	1.5E-2	1.6E-2	1.5E-2	1.4E-2	1.4E-2	1.4E-2	1.4E-2	1.4E-2	1.4E-2	1.7E-2	1.3E-2	1.7E-2
4+	2.2E-2	2.2E-2	2.2E-2	2.2E-2	2.2E-2	2.2E-2	2.2E-2	2.2E-2	2.2E-2	2.2E-2	2.2E-2	2.2E-2	2.2E-2
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
0	5.1E-3	4.3E-3	5.8E-3	4.6E-3	4.4E-3	3.9E-3	4.1E-3	3.2E-3	4.0E-3	3.8E-3	3.7E-3	4.5E-3	3.4E-3
1	9.9E-3	7.9E-3	7.0E-3	8.7E-3	8.1E-3	8.1E-3	7.4E-3	8.6E-3	8.0E-3	9.3E-3	8.5E-3	8.8E-3	7.1E-3
2	1.3E-2	1.2E-2	1.4E-2	1.0E-2	1.2E-2	1.0E-2	9.9E-3	1.1E-2	1.1E-2	1.1E-2	1.3E-2	1.0E-2	9.0E-3

| 3 | 1.4E-2 | 1.6E-2 | 1.8E-2 | 1.3E-2 | 1.4E-2 | 1.5E-2 | 1.3E-2 | 1.4E-2 | 1.3E-2 | 1.4E-2 | 1.5E-2 | 1.1E-2 | 1.1E-2 |
| 4+ | 2.2E-2 | 2.2E-2 | 2.2E-2 | 2.2E-2 | 2.2E-2 | 2.2E-2 | 2.2E-2 | 2.2E-2 | 2.2E-2 | 2.2E-2 | 2.2E-2 | 2.2E-2 | 2.2E-2 |

6.1.4   Tuning data

Age Class	Year 1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	8.8E+3	6.3E+4	6.0E+4	3.7E+4	8.3E+4	6.7E+4	7.9E+4	1.6E+5	2.8E+4	2.4E+4	2.6E+4	4.4E+4	2.8E+4
1	6.1E+4	2.0E+4	4.4E+3	1.6E+4	7.4E+4	5.4E+4	6.4E+4	6.1E+4	4.7E+4	5.5E+4	6.0E+4	1.0E+5	6.6E+4
2	5.4E+4	9.6E+2	1.4E+3	3.0E+3	7.2E+3	9.2E+3	1.1E+4	1.1E+4	3.6E+4	2.5E+4	2.7E+4	4.5E+4	2.9E+4
3	2.3E+3	3.1E+2	4.5E+2	1.6E+2	1.6E+2	5.1E+2	6.1E+2	9.3E+1	4.0E+3	3.1E+3	3.4E+3	5.6E+3	3.6E+3
4	1.0E+0	1.0E+0	1.0E+0	1.0E+0	1.0E+0	1.0E+0	1.0E+0	1.0E+0	1.0E+0	1.0E+0	5.3E-1	3.4E-1	8.7E-1
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
0	5.5E+3	4.3E+3	3.3E+3	2.1E+4	1.2E+4	3.4E+4	8.5E+4	2.2E+4	3.2E+4	2.7E+4	3.6E+4	1.1E+5	6.2E+3
1	4.1E+4	3.5E+4	2.5E+4	4.3E+4	7.4E+3	2.7E+4	7.2E+4	3.2E+4	3.0E+4	3.7E+4	5.3E+4	4.8E+4	2.4E+4
2	4.0E+4	3.3E+4	2.3E+4	2.3E+4	9.3E+3	1.1E+4	2.7E+4	2.3E+4	1.6E+4	3.6E+4	2.4E+4	9.7E+3	6.7E+3
3	7.7E+3	6.4E+3	4.5E+3	1.9E+3	6.5E+2	3.8E+2	8.1E+2	8.4E+2	6.2E+2	1.6E+3	1.3E+3	9.7E+2	4.5E+2
4+	1.0E+0	1.0E+0	1.0E+0	1.0E+0	1.0E+0	1.0E+0	1.0E+0	1.0E+0	1.0E+0	1.0E+0	2.6E+2	6.6E+2	1.0E+0

6.2. ASPIC

The Turkish purse seine CPUE was expanded until 1970 and two new fleet data were added. The first is the CPUE for the former USSR for the same period concerned and the second is the Turkish purse seiners fishing in the Georgian water. In addition to the CPUE data overwintering (Chashchin, 2007) and spawning stock biomass estimates (Chashchin, 1998) were also added to the model. However, a very significant inconsistency was found between the tuning indexes, therefore the data was cropped to 1989-2013.

6.1.5 Results

The results of the XSA displayed a very strong year class entry in 2012, which, lead to an increase in the SSB in the following year. The cyclic pattern in recruitment which peaked in 1994, 1999, 2006, 2012 seems to be an environmentally driven feature of the stock which usually followed by a drop within the last 25 years. The F, which had been dropped noticeably in 2012, increased slightly in 2013. General trend in the last ten years, however, indicates a slight decrease in the fisheries mortality. The absolute values varies with the model settings for shrinkage. According to the worst scenario (highest F estimate), the current $F_{(1:3)}$ for 2013 is estimated as 1.2, which is higher than the F_{MSY} (0.56) estimated based on precautionary exploitation rate (the current exploitation rate of 0.59 exceeds the precautionary threshold 0.4 recommended for small pelagic fish. The average of the last 5 years' F estimate is 1.36 ($\pm$ 0.36) and the high variance of estimate hampers to make meaningful short term predictions.

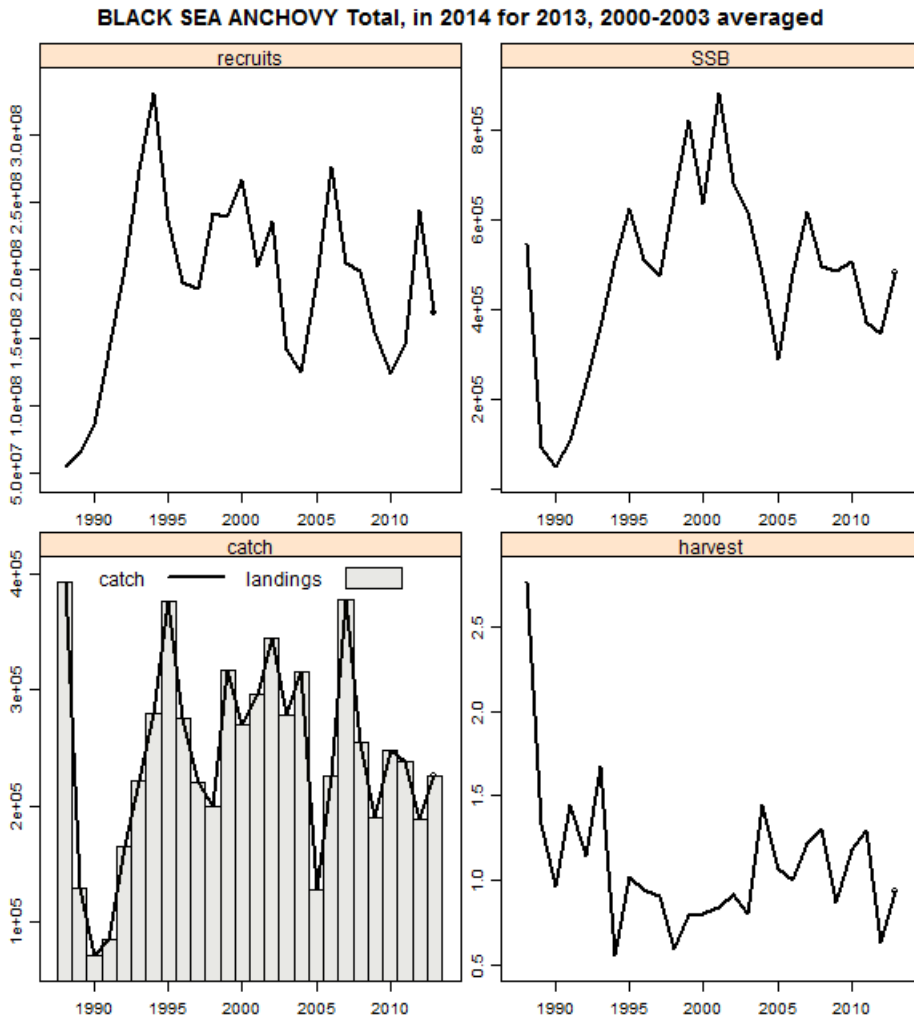**BLACK SEA ANCHOVY Total, in 2014 for 2013, 2000-2003 averaged**

Figure 4. XSA results

The F estimated by the ASPIC model is slightly lower than those of XSA however despite some differences in the absolute values, displayed a quite similar pattern of fluctuation. One of the noticeable deviances was in the estimate of last year .
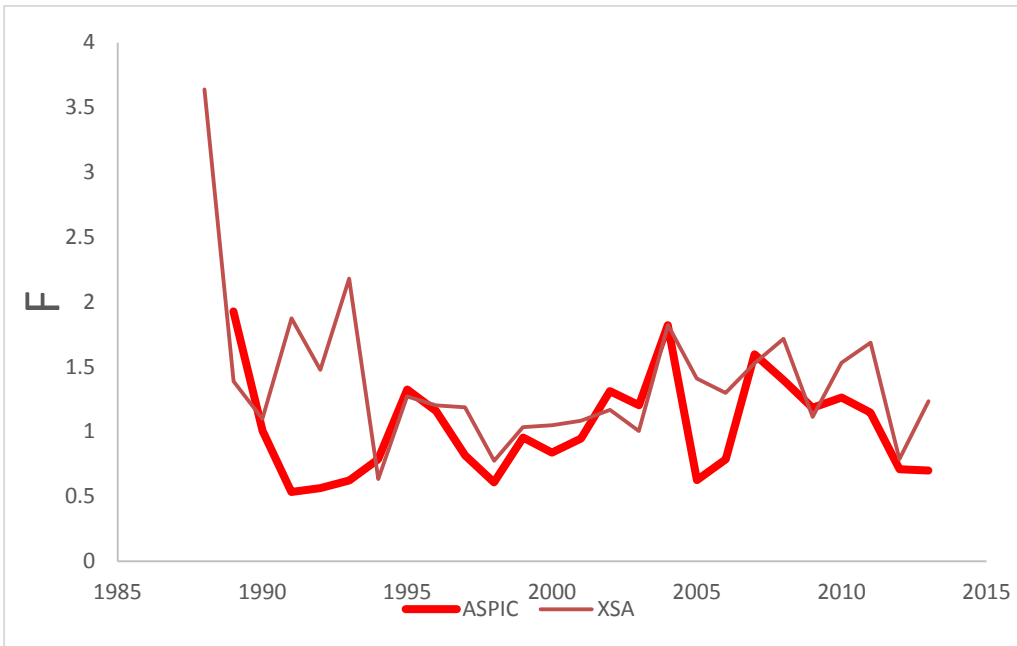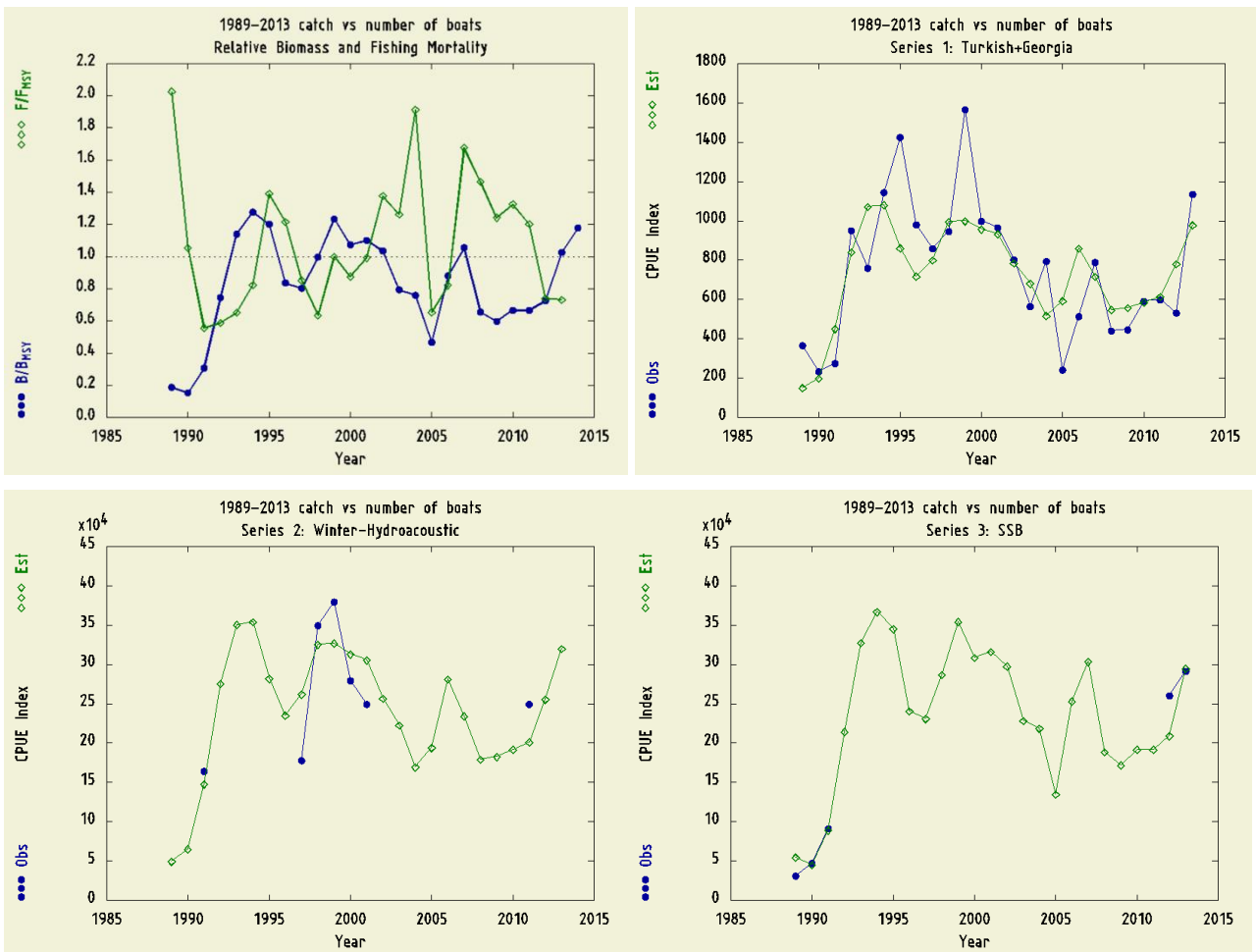
Figure 5. F estimates over the years

Figure 6. Variations of F and Biomass (average) with respect to F$_{MSY}$ and B$_{MSY}$ over the years

6.1.6 Robustness analysis

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

The XSA model was tested for its sensitivity for the shrinkage used and 4 different values, 0, 0.5, 1.5 and 2.05 were tested. The results are presented below. The group decided to use 1.5 shrinkage which produced lower and randomly distributed residuals (Figure 11) and better restrospective analysis results (Figure 10)
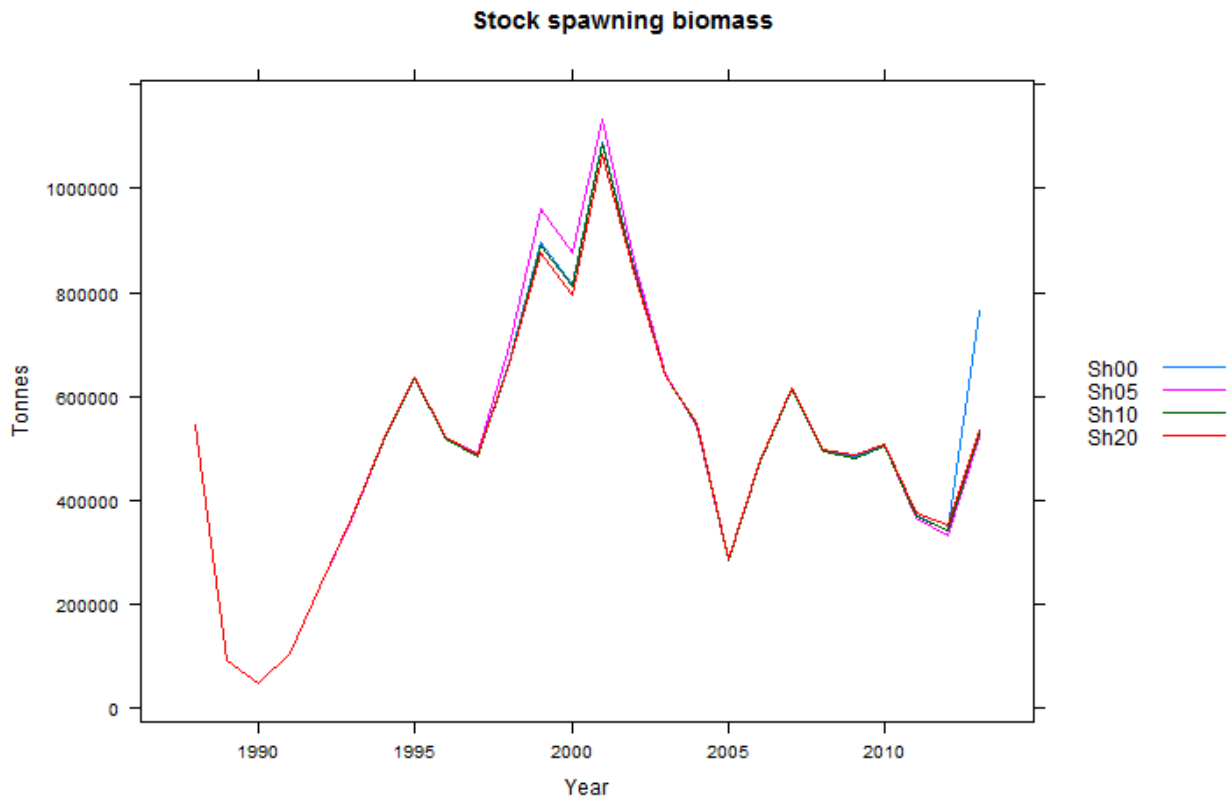
Stock spawning biomass

Figure 7. XSA results: Spawning stock biomass estimates by 0, 0.5, 1.5 and 2.5 shrinkage.
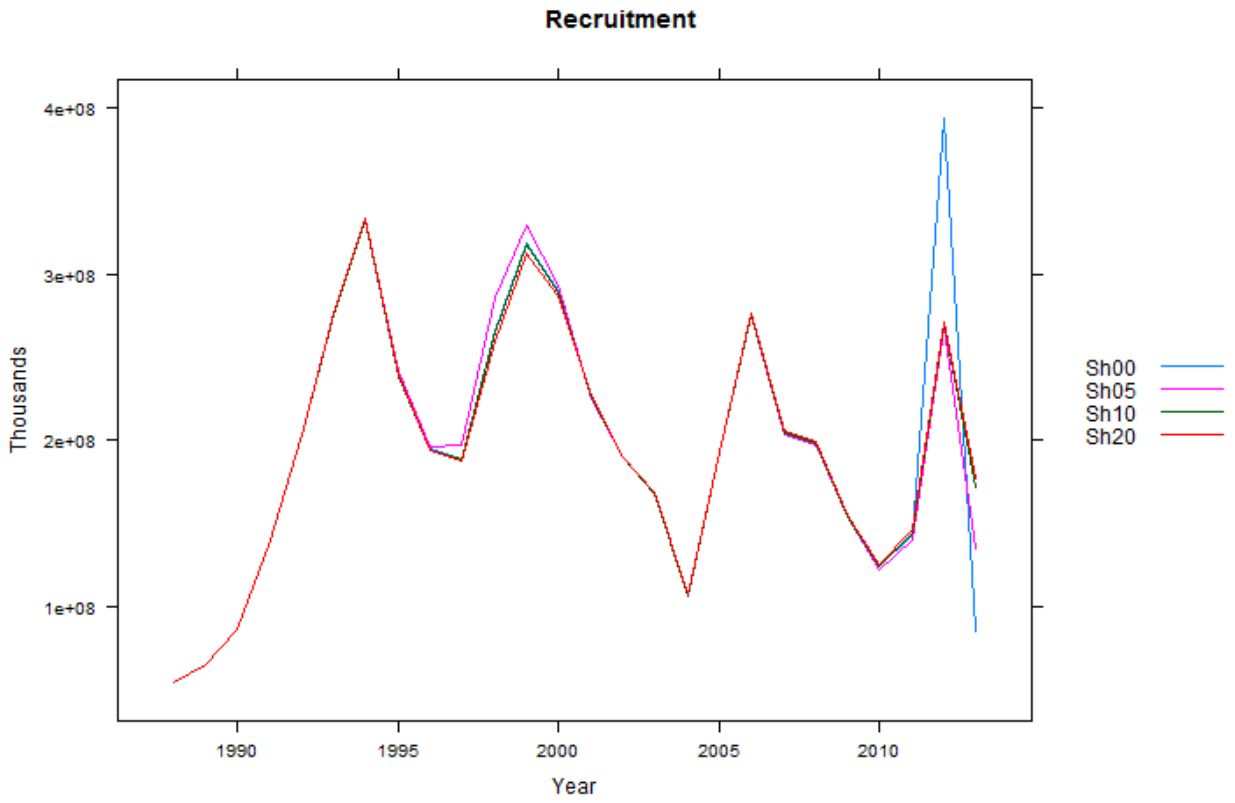
Figure 8. XSA results: Recruitment estimates by 0, 0.5, 1.5 and 2.5 shrinkage.
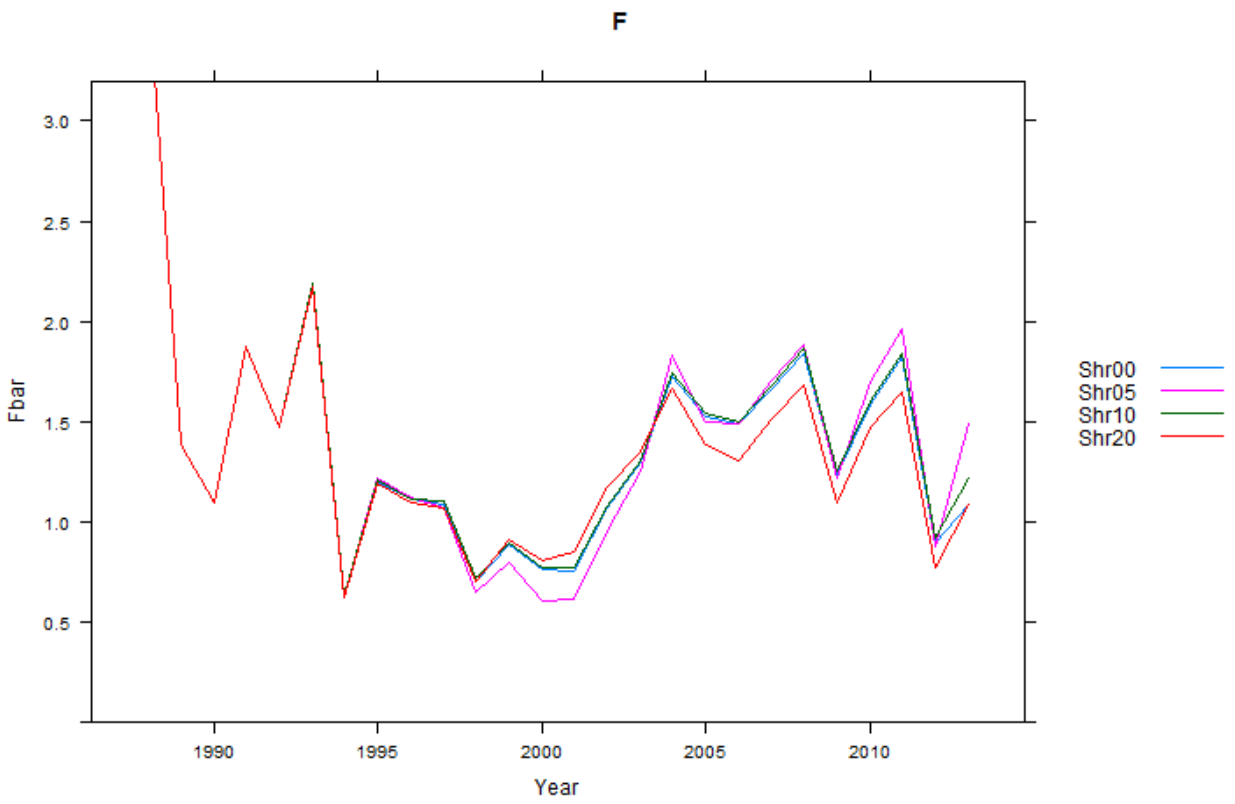

Figure 9. XSA results: Fishing mortality estimates by 0, 0.5, 1.5 and 2.5 shrinkage.
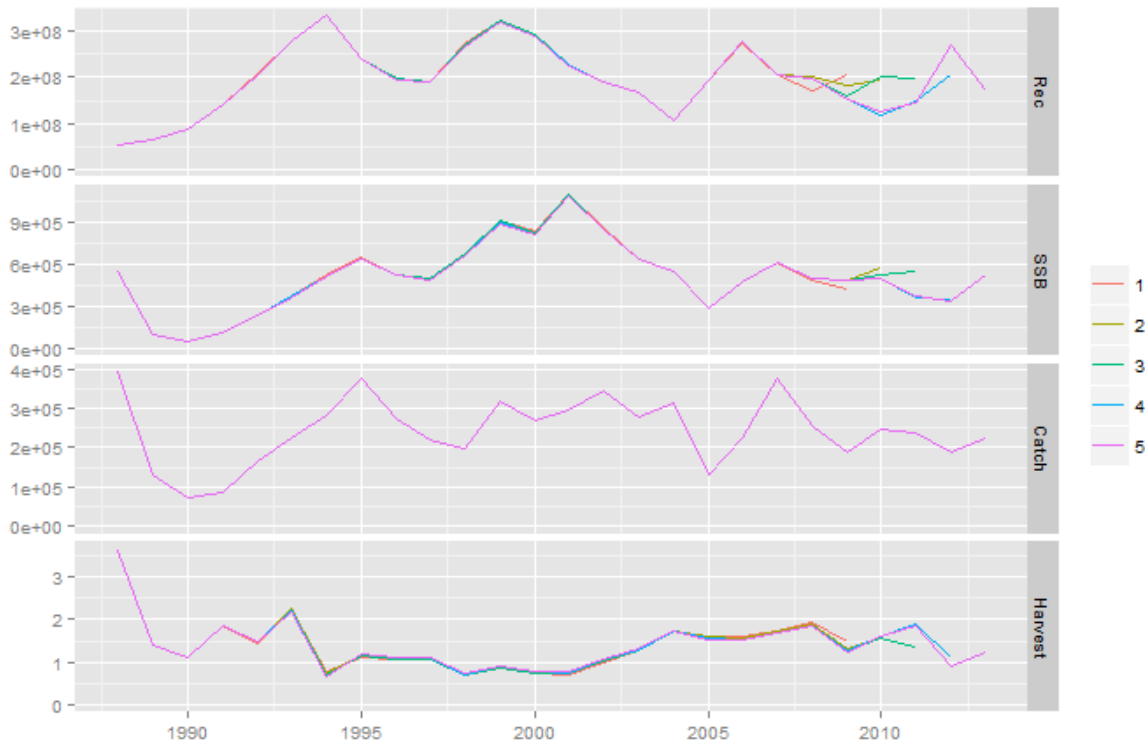
Figure 10. Retrospective analysis results of the XSA for 1.5 shrinkage (5 years @ last 2 ages)

The results of the analysis display a very strong year class entry in 2012, which, as all assessment results agrees, increased the SSB in the following year. The F, however, which had been dropped noticeably, increased again in 2013. The current exploitation rate (E=0.59) exceeds the precautionary threshold 0.4 recommended for small pelagic fish. On the other hand, the high variance of the F estimates averaged over the last 5 years hampers to make meaningful short term predictions.

In all model runs recruitment displayed a cyclic pattern with peaking values observed in 1994, 1999, 2006, 2012 (Figure 8), which usually followed by a drop within the last 25 years. The pulse of a strong year class usually effects the next years SSB. This is what happened in 2013; the strong recruitment gave rise to the number of spawners next year. F estimated for the last year is very much dependent on the level and type of shrinkage used in the XSA assessment (Figure 9). General trend in the last ten years, however, indicates a slight decrease in the fisheries mortality.

6.1.8 Assessment quality

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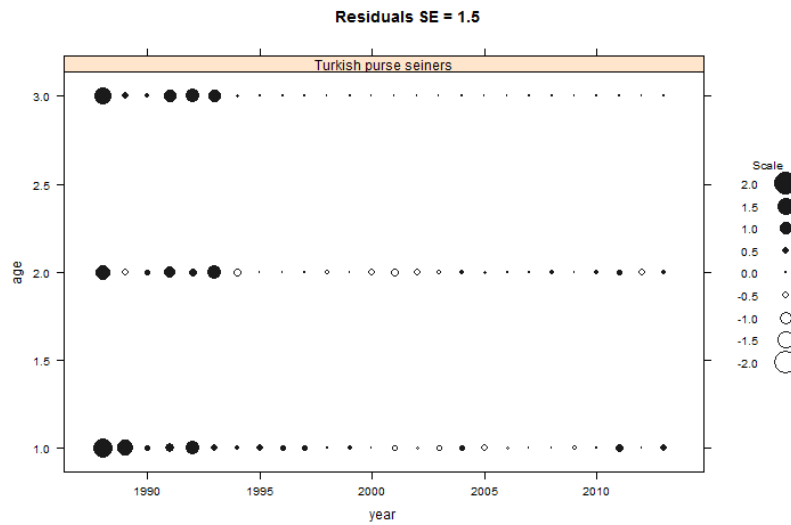

Figure 11. Residual distribution of the XSA applied with 1.5 shrinkage

The case of ASPIC, the residuals distributed randomly (Figure 12). The estimated CPUE captured the general fluctuation pattern in the Turkish+Georgian CPUE with appreciable success (Figure 6); however the deviance in USSR CPUE is very high (Figure 6) and this is reflected in the contrast index, which is slightly higher that the acceptable level (0.68; Table 7). The consistency between two independent biomass estimates and the model is at least within the same order of magnitude (**Error! Reference source not found.Error! Reference source not found.**)

Figure 12. Log residual distribution of the ASPIC model

Table 7. Correlation among input series expressed as CPUE and degrees of freedom

```
--------------------------------------------------------------------------------------------
                               |
 1  Turkish+Georgian           |   1.000
                               |    (44)
                               |
```

```
2  USSR                    |  0.567  1.000
                           |  (31)   (31)
                           |
3  Winter-Hydroacoustics   |  0.415  0.366  1.000
                           |  (15)   (12)   (15)
                           |
4  SSB                     |  0.434  0.534  0.665  1.000
                           |  (15)   (12)   (9)    (15)
         ----------------------------------------------------
                              1      2      3      4
```

The average biomass estimated by ASPIC and the spawning stock biomass resulted by XSA represented a very similar pattern of fluctuation with synchronous peaks and troughs over the years.
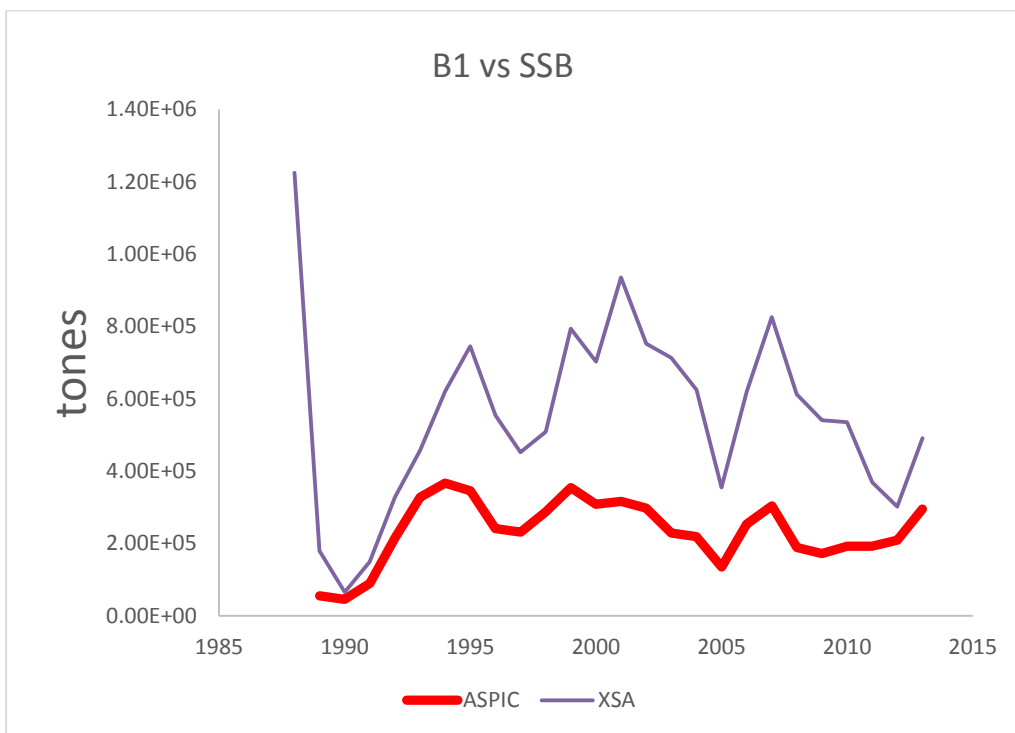

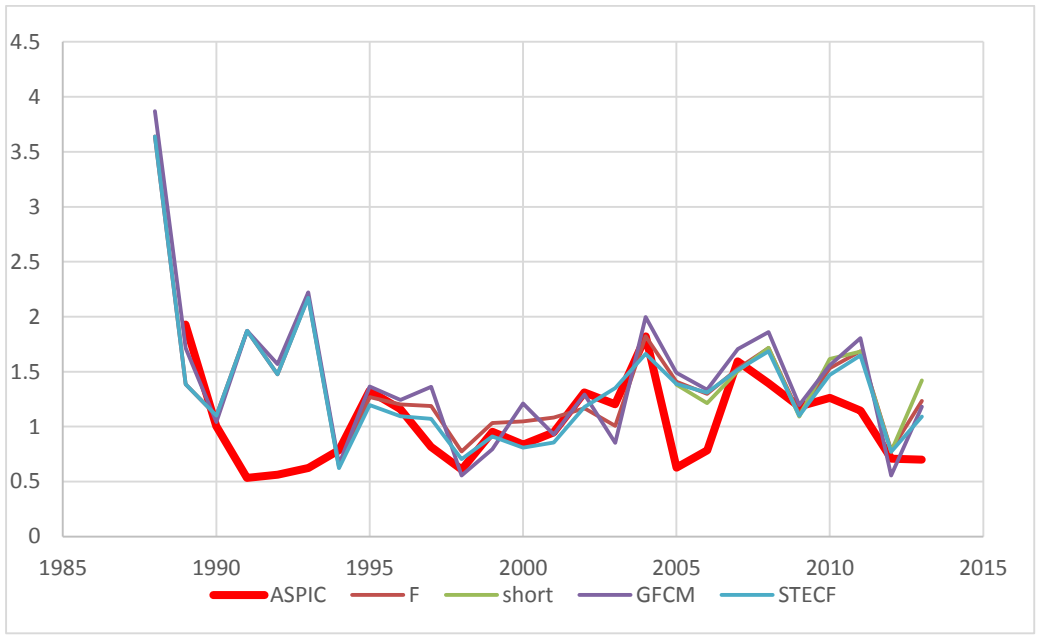*Figure 13. Spawning Stock Biomass (XSA) and average biomass (ASPIC) estimates*

Figure 14. Comparison of F estimates

According to the results of ASPIC the F, which had remained well above the F_{MSY} dropped gradually and displayed a very sharp decline in the last two year. The drop in the F is reflected on the average biomass.

7   Stock predictions

7.1   Short term predictions

The average of the last 5 years' F estimate is 1.36 (± 0.36) and the high variance of estimate undermined the reliability of short term predictions.

Table 8. Short term predictions based on XSA results

| Fscenario	Fmult	Catch_2012	Catch_2013	Catch_2014	SSB_2012	SSB_2013	SSB_2014	ChangeSSB_201
0.55	0.387178	245768.3	112988.9	146547.8	442616.4	414430.1	502069.1	13.43211
0	0	245768.3	0	0	442616.4	414430.1	598693.1	35.26228
0.142054	0.1	245768.3	33901.54	53004.06	442616.4	414430.1	569190.9	28.59688
0.284107	0.2	245768.3	64207.07	93563.85	442616.4	414430.1	543168.6	22.71768
0.426161	0.3	245768.3	91431.7	124897.1	442616.4	414430.1	520103.7	17.50666
0.568215	0.4	245768.3	116004.7	149367.7	442616.4	414430.1	499563.2	12.86595
0.710268	0.5	245768.3	138285	168714.7	442616.4	414430.1	481186.6	8.714134
0.852322	0.6	245768.3	158573.9	184219.2	442616.4	414430.1	464673	4.983225
0.994376	0.7	245768.3	177125.2	196826.6	442616.4	414430.1	449770.3	1.616271
1.13643	0.8	245768.3	194153.3	207236	442616.4	414430.1	436266.5	-1.43463
1.278483	0.9	245768.3	209840.6	215965.8	442616.4	414430.1	423982.7	-4.2099
1.420537	1	245768.3	224342.4	223401.1	442616.4	414430.1	412767.1	-6.74384
1.562591	1.1	245768.3	237791.8	229829.6	442616.4	414430.1	402490.6	-9.0656
1.704644	1.2	245768.3	250303.1	235466.4	442616.4	414430.1	393042.7	-11.2001
1.846698	1.3	245768.3	261975.2	240473.6	442616.4	414430.1	384328.8	-13.1689
1.988752	1.4	245768.3	272893.8	244973.9	442616.4	414430.1	376267.2	-14.9902
2.130805	1.5	245768.3	283133.7	249060.6	442616.4	414430.1	368787.2	-16.6802
2.272859	1.6	245768.3	292760.1	252805.3	442616.4	414430.1	361827.3	-18.2526
2.414913	1.7	245768.3	301830.6	256263.5	442616.4	414430.1	355333.9	-19.7197
2.556967	1.8	245768.3	310395.6	259478.3	442616.4	414430.1	349260.1	-21.0919
2.69902	1.9	245768.3	318500.1	262483.8	442616.4	414430.1	343564.5	-22.3787
2.841074	2	245768.3	326183.9	265307.3	442616.4	414430.1	338210.6	-23.5883
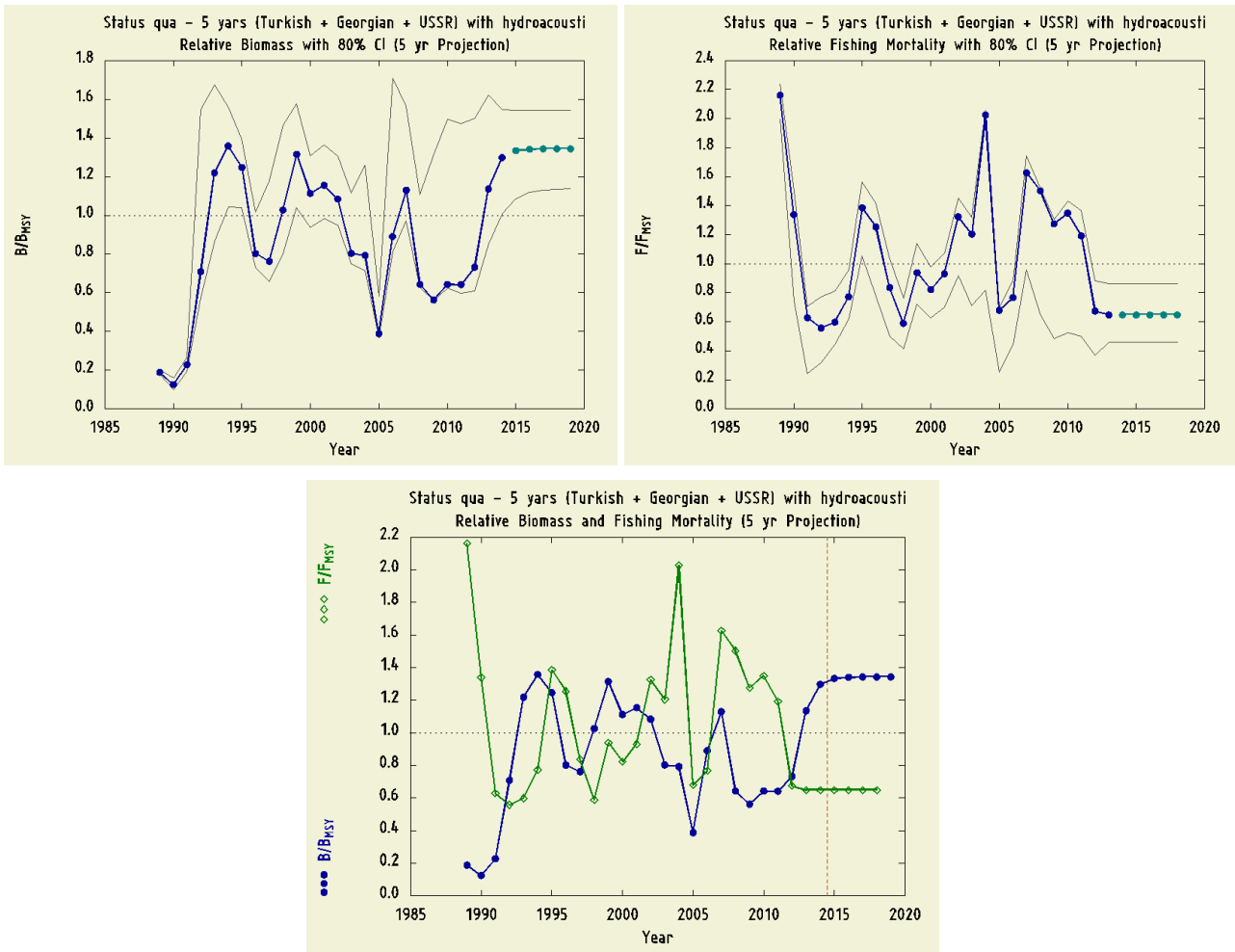
Figure 15.Short-medium term (5 years) prediction for status qua based on ASPIC results

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_{msy}= 0.56	F(1:3) = 1.2		D	IO
	Fishing effort				D	
	Catch				C	
Stock abundance	Biomass					
	SSB				C	
Recruitment					C	
Final Diagnosis	In overexploitation					

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)