Stock Assessment Form

Small Pelagics

Reference Year: 2014

Reporting Year:2015

Stock Assessment Form version 1.0 (January 2014)

Uploader: *Please include your name*

Stock assessment form

Contents

1 Basic Identification Data

Scientific name:	Common name:	ISCAAP Group:
	[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	Bulgaria
4th Country	**5th Country**	**6th Country**
Ukraine	Romania	
Stock assessment method: (direct, indirect, combined, none)		
Authors:		
[Ali Cemal Gücü]		
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

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

The assessments conducted in GFCM and as well as in STECF, assume that the anchovy exploited by countries providing data are of a single stock. On the other hand it is well documented that there are at least two different subspecies in the Black Sea, *Engraulis encrasicolus ponticus*, and *E. e. maeticus*. (Chashchin 1996, Ivanova et al.,201X). These subspecies are typical geographic populations (races), spawning areas of which are limited to different reservoirs. The Azov anchovy breeds in summer in the Sea of Azov, and the Black sea anchovy breeds in the Black Sea at the same time. For the anchovy cannot exist at the water temperature below 6°C for a long time, its schools migrate from the northern part of the sea southward as winter cold sets in. In such event the Azov anchovy goes to the Black sea through the Kerch strait. The population structure of the anchovy in Black Sea and the Sea of Azov and the relationships between its subspecies have been studied rather well to date (Chashchin, Shlyakhov et. al, 2015). The anchovy race (subspecies) identification was carried out in the previous studies, with the use of morphological characters (otolith shape, body length, head and body proportions) (Skazkina, 1965; Gubanov& Limansky, 1968; Shevchenko, 1980; Chashchin 1985), as well as genetic methods. Last ones included the identification of blood groups by means of erythrocytes heteroagglutination reactions with pig and horse serums; as well as isocytratedehydrogenase and esterase isoenzymes allele frequencies detecting (Altukhov, 1974; Kalnin et al, 1984, 1985). Divergence by muscle proteins was found out as well (Ivanova&Dobrovolov, 2006). The individuals of two populations differ in the physiological processes directions as well. While consuming the forage zooplankton in summer in a basin which is richer with the fodder base, Azov population individuals deposit more fat in visceral cavity and in muscles, than the Black Sea individuals (Shulman, 1972). Thereby an earlier readiness to leave the Sea of Azov is being achieved, for the autumn temperature fall occurs in the Sea of Azov already in October.

Although these two forms are quite similar morphologically and cannot be distinguished easily, there are significant differences in their growth rates; Black Sea anchovy growing faster. As the fisheries targeting these different subspecies are not the same, occurrence of different forms of anchovy has not been a matter of concern from assessment point of view until recently.

However, more recently some evidences, such as cohorts with unusually low mean length and weight observed well beyond the known geographical limits of Azov anchovy, point out that the range of the species might have been expanded towards south. The most probably reason is the great increasing of Azov anchovy biomass in some years. According to YugNIRO lampara survey's data the highest level of Azov anchovy stock was registered in the period of

2011-2014 especially. And the wide spreading of Azov anchovy population all over the northern part of the Black Sea was observed in this period. (Chashchin, Shlyakhov et. al, 2015).

At the moment it is not known what the degree of mixing is in the main fishing grounds in south. The question needs to be answered is at what percentage the Azov anchovy is represented in the catch of the southern countries such as Georgia and Turkey, and if this percentage is critically high to affect the results of the assessment. In case the level of mixing is higher than a negligible level a method to distinguish the Azov anchovy and disintegrate the catch into its components and it needs to be practical and cheap.

One important tool that might be and actually being used is the otoliths. Given that the anchovy forms of different origin represents different growth rates, this evidently has imprints on the otoliths. Examination of the growth rings on the otoliths or any other hard structures on the fish, is a standard element of an age structure model used in the stock assessment. Therefore, analyzing the otoliths and give the percentages of those displaying abnormal growth pattern which supposedly mark the Azov anchovy among the Black Sea anchovies would not be an expensive work or a very heavy burden.

For that purpose, the step needs to be taken are; i) detailed comparison of otoliths of the anchovy sampled within the Azov Sea during the spawning season with those collected in the Black Sea during the same period; ii) basing on step “i” preparation of a guideline to be used by the age readers; iii) basing on new findings, re-analysis of a set of old/new otoliths to quantify the level of mixing.

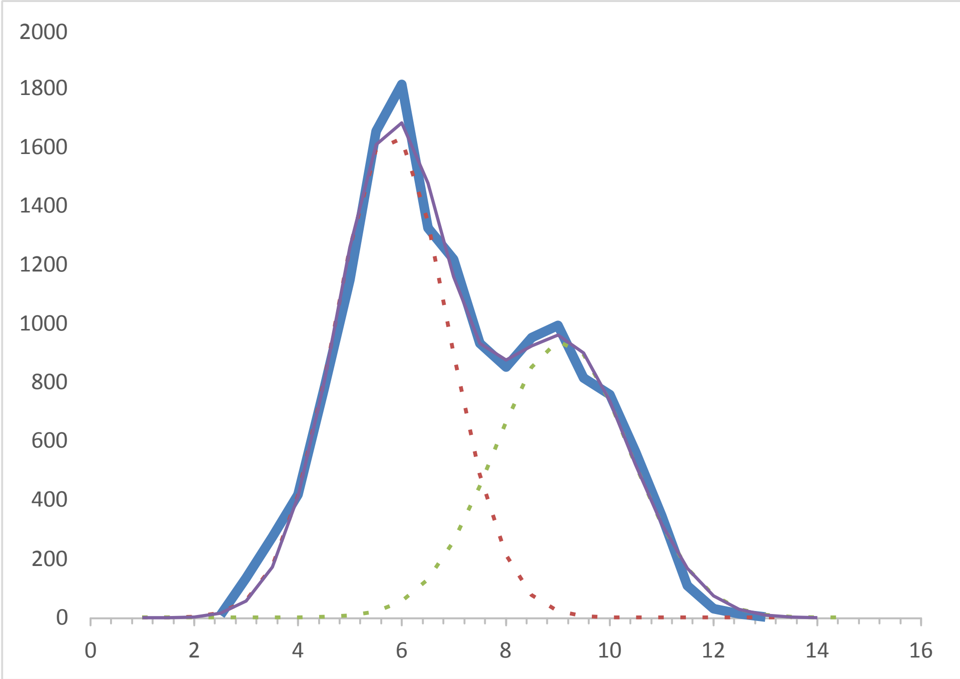
2.2 Growth and maturity

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**	
Maximum size observed			See below	**Recruitment season**	November-December
Size at first maturity			See below	**Spawning area**	Uncertain and seems variable over the entire basin
Recruitment size to the fishery			7 cm	**Nursery area**	All Black Sea

Note: The growth parameters of anchovy was used only in the estimation of natural mortality, M. As the empirical formulations used to estimate M is very sensitive to the growth parameters, instead of using a single set of parameters the parameters given in the following table (FishBase, Black Sea only) were first tested for their appropriateness. For that, of the length frequency distribution of Turkish November 2016 survey data (n=15181 fish) were used. Two normal distribution curve were fitted to the first two modes of the distribution assuming that they represent the first two cohorts (age 0 and I). The vBGF was solved for all Linf and K pairs; tuned to pass through the mean length of the first cohort (assumed to be the 0 age) in the LF distribution; and those of the parameter pairs which do not estimate a length equal to the mean length of the second cohorts (age I) in the length composition were disregarded. Table X, displays the parameters proven to be appropriate. Then Gislason (2010) M estimator were used to calculate M for all proven set of Linf and K and the corresponding length estimated for age 0, I, 2, 3 and 4 and then averaged. The results are given below



Length frequency distribution of anchovies in the Turkish November 2016 survey data and normal distribution curves fitted to the first cohorts ($\mu_0 = 5.56$ cm; $\sigma_0 = 1.07$; $\mu_1 = 8.84$ cm ; $\sigma_1 = 1.29$)

Table A. Source of vBGF parameters used to test for appropriateness (Bold&Underlined=approved)

Linf	K	Phi'	Lmax	Lmean	Ref
16.77	0.324	1.96	16.1	12.4	Erkoyuncu & Ozdamar, 1989
16.85	0.324	1.964	16.9	10.8	Karacam & Düzgünes, 1990
<u>14.14</u>	**<u>0.92</u>**	**<u>2.265</u>**	**-**	**-**	**<u>Duzgunes & Karacam, 1989</u>**
17.99	0.294	1.979	15.3	9.8	Ozdamar et al., 1994
15.65	0.282	1.84	13.5	10.6	Ozdamar et al., 1994
15.73	0.317	1.895	13	-	Unsal, 1989
16.83	0.31	1.944	15.3	9	Ozdamar et al., 1995
16.84	0.233	1.82	-	10.7	Samsun et al., 2006
18.46	0.217	1.869	-	11.3	Samsun et al., 2006
18.73	0.156	1.738	-	10.2	Samsun et al., 2006
<u>13.69</u>	**<u>1.249</u>**	**<u>2.369</u>**	**<u>14.4</u>**	**<u>11.8</u>**	**<u>Bilgin et al., 2012</u>**
<u>13.93</u>	**<u>0.994</u>**	**<u>2.285</u>**	**<u>14.6</u>**	**<u>11.8</u>**	**<u>Bilgin et al., 2012</u>**
<u>14.65</u>	**<u>0.497</u>**				
<u>15.20</u>	**<u>0.403</u>**				
<u>14.97</u>	**<u>0.426</u>**				
<u>14.61</u>	**<u>0.503</u>**				
<u>14.65</u>	**<u>0.497</u>**				

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

Size/Age	Natural mortality	Proportion of matures
0	*2.24*	*0*
1	*1.09*	*1*
2	*0.79*	*1*
3	*0.66*	*1*
4	*0.59*	*1*

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

Size/Age	Natural mortality	Proportion of matures
0	*2.24*	*0*
1	*1.09*	*1*
2	*0.79*	*1*
3	*0.66*	*1*
4	*0.59*	*1*

Table 2-3: Growth and length weight model parameters

			Sex			
		Units	**female**	**male**	**Combined**	**Years**
Growth model	**L_∞**	Cm			See Table A	
	K	year			See Table A	
	t_0	Year			See Table A	
	Data source					
Length weight relationship	**a**				0.004565	
	b				3.121759	
	M (scalar)				0.84475	
	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	Seine nets	35	Anchovy
Operational Unit 2	Georgia	GSA29	H, J	Seine nets, Trawls	35	Anchovy
Operational Unit 3	Ukraine	GSA29	J	Trawls	35	Anchovy
Operational Unit 4	Russian Federation	GSA29	J	Trawls	35	Anchovy
Operational Unit 5	Romania	GSA29	A	Other Gear (pond net)	35	Anchovy
Operational Unit 6	Bulgaria	GSA29	A	Other Gear (pond net)	35	Anchovy

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)
Turkish	198	112500				
Georgian	17	48800				
Ukrainian	?	129				
Russian	?	1439				
Bulgarian	?	53.4				
Romanian	?	102.4				
Total		161584.8				

3.2 Historical trends

Time series analysis with tables and figures showing the observed trends in catches, landings, fishing capacity or effort .

Year	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine	USSR	Total
1967					55517			55517
1968					33135			33135
1969					40787			40787
1970	90				67109		117800	67199
1971	126				65353		126700	65479
1972	156				85906		111000	86062
1973	264				84216		132500	84480
1974	41				70802		227900	70843
1975	15				58216		173626	58231
1976	72				67992		236234	68064
1977	113				71366		152607	71479
1978	37				105183		134855	105220
1979	307				133678		126763	133985
1980	209				239289		124100	239498
1981	70				259767		96222	259837
1982	266				266523		146834	266789
1983	784				289860		137918	290644
1984	239				318917		164841	319156
1985	92				273274		60395	273366
1986	96				274740		119781	274836
1987	13				295902		53482	295915
1988	115				295000		171452	295115
1989					96806		63289	96806
1990					66409		18824	66409
1991					79225		7906	79225

1992		6871			155417	2572		164860
1993		1656			218866	1598		222120
1994		857	197		278667	242		279963
1995	35	1301	190		373782	888		376196
1996	23	1232	140		273239	596		275230
1997	44	2288	45		213780	3623		219780
1998	48	2346	146		195996	1039		199575
1999	36	1264	155		310801	4872		317128
2000	64	1487	204		260670	7719		270144
2001	102	941	186		288616	5915		295760
2002	237	927	296		336419	6739		344618
2003	131	2665	160		266069	8868		277893
2004	88	2562	135		306656	5687		315128
2005	14	2600	154		119255	6200		128223
2006	6	9222	23		212081	4907		226239
2007	60	17447	87		357089	3363		378046
2008	28	25938	15		225344	3761		255086
2009	42	31338	21		185606	4653		221660
2010	65	39857	50		203026	5051		248049
2011	18	25919	41		246390	6932		279300
2012	7	55000	18		109187	6823		171035
2013	10	70700	111		255309	0		326130
2014	370	65493.46	62	300	71530	200		137955.5
2015	12.5	58548.83	111	5683[a]	195350	248		254270.3
2016	53.4	48800	102.4	1439[a]	112500	129		161584.8

a) The anchovy catch in Russian Federation is the sum of Black Sea and Azov anchovy. The figures presented here are the estimates provided by the expert from the country
b) The Turkish landings were taken from TurkStat, however for the period between 2012-2015 the landing figures were taken from the reports of a national anchovy monitoring program carried out in Turkey

Total Black Sea anchovy landings by year

3.3 Management regulations

In the Black Sea countries, anchovy fisheries 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 (0-24 m in Turkey), iii) mesh size regulations, iv) minimum landing size (9 cm total length in general and 7 cm TL for Georgia, allowable minimum length size is not applied for the Black Sea anchovy in Ukraine). 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.

Turkey, having the main fleet fishing the Black Sea anchovy, enforced additional measured to control the size of the fishing fleet. These include:

a) fishing capacity had developed over the years and finally overcapitalized beyond 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 fishing sector. However a comprehensive measure has been enforced only at the beginning of 2000's. As a 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. 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. The fishing boats that have been decommissioned within this campaign are depicted in table X, below.

Region	10-12 m	12-20 m	20-30 m	30-40 m	Total
GSA 24 – South of Turkey	134	114	13	1	262
GSA 22 – Aegean Sea	217	86	5	3	311
GSA 29 – Black Sea	247	147	38		432
GSA 28 – Marmara Sea	146	64	7	3	220
Total	744	411	63	7	1,225

c) a series of new regulations and methodological reforms have been enforced within the last 2 years to enhance accuracy of the landing statistics,

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) to reduce the fishing mortality the fishing during the day (09:00-15:00) is prohibited

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					
SSB					
F					
Y					
CPUE					
Index of Biomass at sea					

4 Fisheries independent information

4.1 {NAME OF THE DIRECT METHOD}

Fill in one section for each of the direct methods used. The name of the section should be the name of the direct method used.

4.1.1 Brief description of the chosen method and assumptions used

Description of the method and assumptions used. One of several tables would have to be chosen: Egg Production Method, Acoustic survey, Trawl.

Direct methods: DEPM

Table 4.1-1: Egg production cruise information.

Date					
Cruise				**R/V**	
Total area (km^2)		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 m^2)				
Z ($days^{-1}$)				
Temperature range	ºC	ºC		

Table 4.1-3: DEPM Model parameters

Model parameters	**value**	**CV**
P_0 (# of eggs/0.05 m^2 per day)		
A (surface of region 0.05 m^2)		
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.

5: Acoustic cruise information.

Date			
Cruise		**R/V**	
Target species			
Sampling strategy			
Sampling season			
Investigated depth range (m)			
Echo-sounder			
Fish sampler			
Cod –end mesh size as opening (mm)			
ESDU (i.e. 1 nautical mile)			
TS (Target Strength)/species			
Software used in the post-processing			
Samples (gear used)			
Biological data obtained			
Age slicing method			
Maturity ogive used			

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

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 Extended Survival Analysis, XSA

6.1.1 Model assumptions

6.1.2 Scripts

```
bsa.stk <- readFLStock("BSAn00IN.DAT", no.discards=TRUE)

bsa.stk <- setPlusGroup(bsa.stk, 4)

bsa.stk.indices<- readFLIndices("BSAn11TU.DAT")

units(harvest(bsa.stk))<-"f" range(bsa.stk)["minfbar"] <- 1 range(bsa.stk)["maxfbar"] <- 3 ##SOP corrections 1

bsa.stk@catch.n<-sweep(catch.n(bsa.stk), MARGIN=2, as.vector(sop(bsa.stk, "landings")), "/") bsa.stk@catch<-computeCatch(bsa.stk)

sop(bsa.stk,"landings")


#landings(aa.stk)*sop(aa.stk,"landings")

landingssop<-apply(landings.wt(bsa.stk) * landings.n(bsa.stk),2,sum) x<-landings(bsa.stk)/landingssop landings.n.sop<-landings.n(bsa.stk)%*%x


#newcheck

apply(landings.wt(bsa.stk) * landings.n.sop,2,sum) landings(bsa.stk)


#change to new values in FLStock object landings.n(bsa.stk)<-landings.n.sop catch.n(bsa.stk)<-landings.n.sop catch<-landings plot(bsa.stk)
```

```
catch(bsa.stk)<-landings(bsa.stk)



#new check

apply(landings.wt(bsa.stk) * landings.n(bsa.stk),2,sum) landings(bsa.stk) catch(bsa.stk) plot(bsa.stk)



  sop(bsa.stk,"landings")
  plot(bsa.stk.indices[[1]])

  #### BEST settings
  min_max_res.RQ<-1
  j=0 fsevals <- seq(0.5, 3.0, by =
  0.5) qagevals <- seq(0, 4, by =
  1) ragevals <- seq(0, 3, by = 1)
  res <- propagate(harvest(bsa.stk), length(fsevals)*length(qagevals)*length(ragevals))

  for (i in 1:length(fsevals)) {
    for (q in 1:(length(qagevals))) {
      for (r in 1:(length(ragevals))) {
      if(i==1 && q==1 && r==1) {
      next} if(i==1 && q==3 &&
      r==3) { next}
           if(i==2 && q==3 && r==3) {
             next}
#  if(i==1 && q==3 && r==3) {
#   next}
#  if(i==2 && q==3 && r==2) {
#   next}


  #  if(i==3 && q==1 && r==1) { #
  next}
#  if(i==4 && q==1 && r==1) {
#   next}
#  if(i==4 && q==1 && r==3) {
#   next}
#  if(i==3 && q==1 && r==1) {
#   next}
#  if(i==4 && q==1 && r==1) {
#   next}

        j=j+1
```

```
      xsa.control <- FLXSA.control(fse = fsevals[i], qage=qagevals[q],rage=ragevals[r]) iter(res,
      j) <- harvest(FLXSA(bsa.stk, bsa.stk.indices, xsa.control))
#   plot(bubbles(age~year|qname, data=mcf(index.res(FLXSA(bsa.stk, bsa.stk.indices, xsa.control))), main = paste("Residuals: fse=",fsevals[i],"; rage=" ,ragevals[r],"; qage=",qagevals[q] )))
      min_max_res.RQ<-rbind(min_max_res.RQ,c(rbind(fsevals[i], ragevals[r], qagevals[q],
      min(index.res(FLXSA(bsa.stk,bsa.stk.indices, xsa.control))[[1]]),
      max(index.res(FLXSA(bsa.stk,bsa.stk.indices, xsa.control))[[1]]),
      mean(abs(index.res(FLXSA(bsa.stk,bsa.stk.indices, xsa.control))[[1]])))))
    }
  }


}


min_max_res.RQ
write.csv(min_max_res.RQ,"residual_table_RQ.csv")


      xsa.control05 <- FLXSA.control(x=NULL, tol=1e-09, maxit=30, min.nse=0.3, fse=0.5, rage=1,
                              qage=2, shk.n=TRUE, shk.f=TRUE, shk.yrs=5, shk.ages=2,
                              window=100, tsrange=20, tspower=3, vpa=FALSE)
      xsa.control10 <- FLXSA.control(x=NULL, tol=1e-09, maxit=30, min.nse=0.3, fse=1.0, rage=1,
                              qage=2, shk.n=TRUE, shk.f=TRUE, shk.yrs=5, shk.ages=2,
                              window=100, tsrange=20, tspower=3, vpa=FALSE)
      xsa.control15 <- FLXSA.control(x=NULL, tol=1e-09, maxit=30, min.nse=0.3, fse=1.5, rage=1,
                              qage=2, shk.n=TRUE, shk.f=TRUE, shk.yrs=5, shk.ages=2,
                              window=100, tsrange=20, tspower=3, vpa=FALSE)
      xsa.control20 <- FLXSA.control(x=NULL, tol=1e-09, maxit=30, min.nse=0.3, fse=2.0, rage=1,
                              qage=2, shk.n=TRUE, shk.f=TRUE, shk.yrs=5, shk.ages=2,
                              window=100, tsrange=20, tspower=3, vpa=FALSE)
      xsa.control20 <- FLXSA.control(x=NULL, tol=1e-09, maxit=30, min.nse=0.3, fse=2.0, rage=1,
                              qage=2, shk.n=TRUE, shk.f=TRUE, shk.yrs=5, shk.ages=2,
                              window=100, tsrange=20, tspower=3, vpa=FALSE)
      xsa.control25 <- FLXSA.control(x=NULL, tol=1e-09, maxit=30, min.nse=0.3, fse=2.5, rage=1,
                              qage=2, shk.n=TRUE, shk.f=TRUE, shk.yrs=5, shk.ages=2,
                              window=100, tsrange=20, tspower=3, vpa=FALSE)
      xsa.control30 <- FLXSA.control(x=NULL, tol=1e-09, maxit=30, min.nse=0.3, fse=3.0, rage=1,
                              qage=2, shk.n=TRUE, shk.f=TRUE, shk.yrs=5, shk.ages=2,
                              window=100, tsrange=20, tspower=3, vpa=FALSE)



      xsa05<-FLXSA(bsa.stk, bsa.stk.indices , xsa.control05)
      xsa10<-FLXSA(bsa.stk,  bsa.stk.indices,  xsa.control10)
      xsa15<-FLXSA(bsa.stk,  bsa.stk.indices,  xsa.control15)
      xsa20<-FLXSA(bsa.stk,  bsa.stk.indices,  xsa.control20)
      xsa25<-FLXSA(bsa.stk,  bsa.stk.indices,  xsa.control25)
      xsa30<-FLXSA(bsa.stk, bsa.stk.indices, xsa.control30)
```

```
bsa.stk05 <- bsa.stk + xsa05 bsa.stk10
<- bsa.stk + xsa10 bsa.stk15 <-
bsa.stk + xsa15 bsa.stk20 <- bsa.stk +
xsa20 bsa.stk25 <- bsa.stk + xsa25
bsa.stk30 <- bsa.stk + xsa30

bsa.rec2 <- FLQuants(fs05=rec(bsa.stk05),fs10=rec(bsa.stk10),fs15=rec(bsa.stk20),fs20=rec(bsa.stk20),fs25=rec(bsa.stk25),fs30=rec(bsa.stk30))
xyplot(data ~ year, groups = qname, data = bsa.rec2, type = "l", main = "Recruitment", ylab = "Thousands",xlab="Year", auto.key =
        list(space = "right", points = FALSE, lines = TRUE))

bsa.ssb2 <- FLQuants(fs05=ssb(bsa.stk05),fs10=ssb(bsa.stk10),fs15=ssb(bsa.stk20),fs20=ssb(bsa.stk20),fs25=ssb(bsa.stk25),fs30=ssb(bsa.stk30))
xyplot(data ~ year, groups = qname, data = bsa.ssb2, type = "l", main = "SSB", ylab = "Tons",xlab="Year", auto.key =
        list(space = "right", points = FALSE, lines = TRUE))

bsa.fbar2 <- FLQuants(fs05=fbar(bsa.stk05),fs10=fbar(bsa.stk10),fs15=fbar(bsa.stk20),fs20=fbar(bsa.stk20),fs25=fbar(bsa.stk25),fs30=fbar(bsa.stk30)) xyplot(data ~ year, groups = qname, data =
bsa.fbar2, type = "l", main = "Fbar", ylab = "Fbar",xlab="Year", auto.key = list(space = "right", points = FALSE, lines = TRUE))


xsa.control <- FLXSA.control(maxit = 50, fse=1.5, rage=1, qage = 2, shk.ages=2)
xsa.control bsa.stk.xsa <- FLXSA(bsa.stk, bsa.stk.indices, xsa.control)

bsa.stk.new <- bsa.stk + bsa.stk.xsa
bsa.stk.ssb <- ssb(bsa.stk.new) bsa.stk.rec
<- rec(bsa.stk.new) bsa.stk.fbar <-
fbar(bsa.stk.new)

plt1<-ggplot(data=catch.wt(bsa.stk), aes(year, data)) + geom_line(aes(group=age, colour=factor(age))) +
  labs(x="", y="") #+ theme(legend.position = "none") plt2<-ggplot(data=catch.n(bsa.stk), aes(year, data)) + geom_line(aes(group=age, colour=factor(age) , linetype = factor(age)))

+ labs(x="", y="") #+ theme(legend.position = "upper")

plt3<-ggplot(data=stock.n(bsa.stk.new), aes(year, data)) + geom_line(aes(group=age, colour=factor(age))) +
  labs(x="", y="") #+ theme(legend.position = "none")

plt4<-ggplot(data=harvest(bsa.stk.new), aes(year, data)) + geom_line(aes(group=age, colour=factor(age))) +
  labs(x="", y="") #+ theme(legend.position = "none")

grid.arrange(plt1, plt2,plt3,plt4, nrow=4) names(bsa.stk.xsa@index.res)

<- names(bsa.stk.indices)

plot(xyplot(data ~ year | ac(age) + qname, data = index.res(bsa.stk.xsa),
```

```
        panel = function(x, y, ...) {
          panel.xyplot(x, y, ...) panel.loess(x, y,
          ...) panel.abline(h = 0, col = "grey", lty
          = 2)
        }))

retro.years <- 2012:2016 bsa.stk.retro <- tapply(retro.years,
1:length(retro.years), function(x){
  window(bsa.stk,end=x)+FLXSA(window(bsa.stk,end=x),bsa.stk.indices,xsa.control)
})

# coerce into FLStocks object
bsa.stk.retro <- FLStocks(bsa.stk.retro) #
full retrospective summary plot
bsa.stk.retro@names=ac(c(retro.years))###Add years to legend plot(bsa.stk.retro)

bsa.summary
bsa.summary<-cbind(c(ssb(bsa.stk.new)),c(rec(bsa.stk.new)),c(fbar(bsa.stk.new)))
write.csv(bsa.summary,file="Ane29_2016.csv")
```

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

Catch-at-age	1988	1989	1990	1991	1992	1993
0	3866622	29129217	22656837	13809063	15648196	21712899
1	26799679	9254617	1688343	5940390	14046724	17585989
2	23871979	447418	547670	1122638	1368975	2967917
3	1033904	143613	170647	59437	30706	166631
4+	0.002	0.002	0.001	0.001	0.001	0.001
	1994	1995	1996	1997	1998	1999
0	47146253	28462447	17140400	6096421	4303769	7802281
1	17812096	24378378	16623235	14125069	9946308	17838565
2	3293789	9516435	7362892	6427203	4516001	7941322
3	27322	1375436	1001839	802078	563136	989384
4+	0.001	0.001	0.001	0.001	89	60
	2000	2001	2002	2003	2004	2005
0	8116332	1543026	1878667	1584716	9337072	7014587
1	19262177	11457326	15126854	11839501	18917023	4263544
2	8431139	11094357	14425273	11047040	10380734	5346125
3	1050629	2166400	2817183	2150805	826720	378043
4+	254	0.001	0.001	0.001	0.001	0.001
	2006	2007	2008	2009	2010	2011
0	16738873	28285695	9470954	13453726	7148397	2649107
1	13389730	23925514	14128528	12511067	9787254	15504518
2	5574349	9106071	9875001	6805860	9662632	12691471
3	187235	269980	366624	261579	418234	2177832

4+	0.001	0.001	0.001	0.001	0.001	280777
	2012	**2013**	**2014**	**2015**	**2016**	
0	12097424	4938477	3009810	4012205	13588663	
1	20198873	32634848	11514880	18120872	8389166	
2	5167813	11824565	6077847	10113079	5365775	
3	430366	933229	591444	1820643	2173667	
4+	222536	172801	103115	248270	5664	

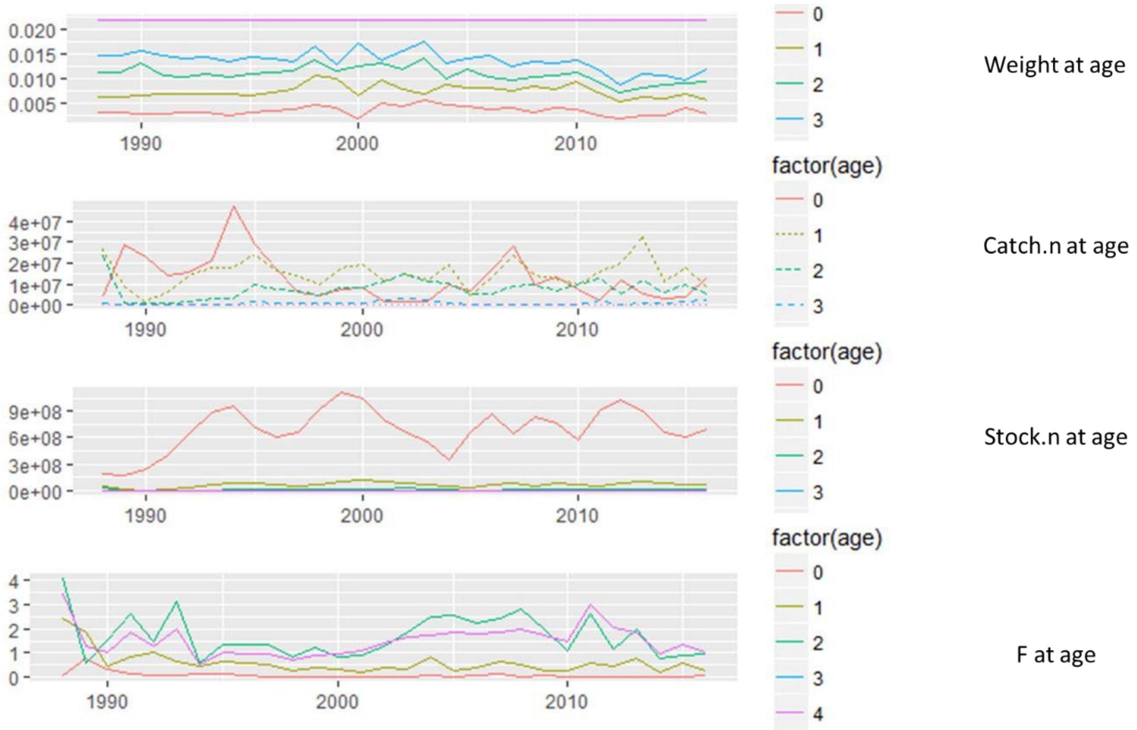
6.1.4 Tuning data

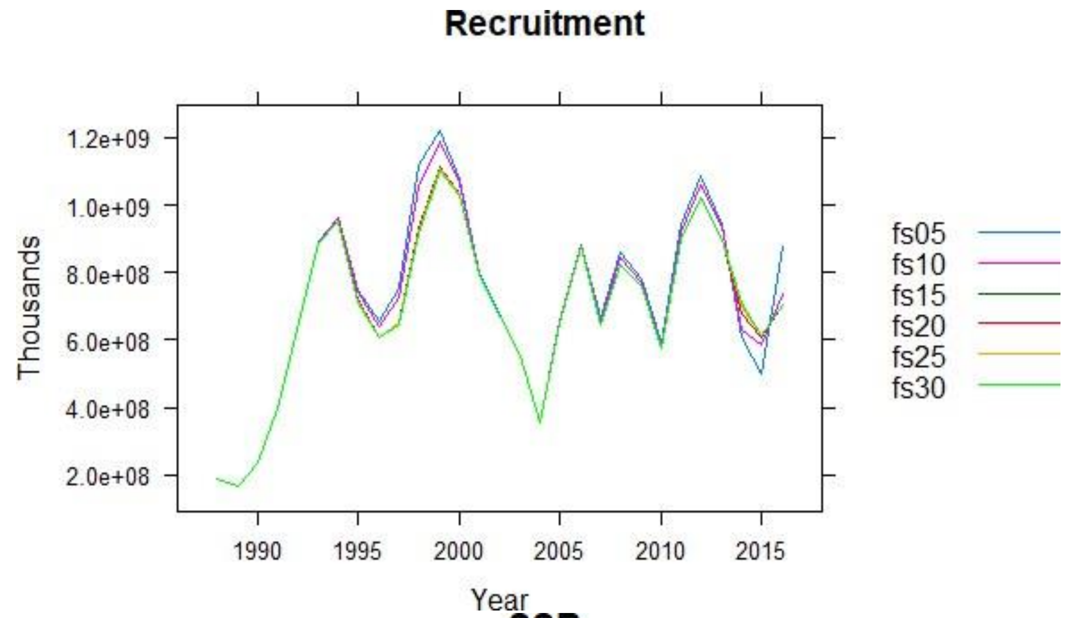
	1988	1989	1990	1991	1992	1993
0	9898	67228	63046	40980	93459	74816
1	68603	21359	4698	17629	83894	60596
2	61108	1033	1524	3332	8176	10226
3	2647	331	475	176	183	574
4+	0	0	0	0	0	0
	1994	1995	1996	1997	1998	1999
0	192814	107958	60976	23905	20333	38398
1	72846	92467	59136	55386	46991	87791
2	13471	36096	26193	25202	21336	39082
3	112	5217	3564	3145	2661	4869
4+	0	0	0	0	0	0
	2000	2001	2002	2003	2004	2005
0	29952	5019	4355	2970	20822	11863
1	71085	37269	35066	22188	42185	7210
2	31114	36088	33440	20703	23149	9041

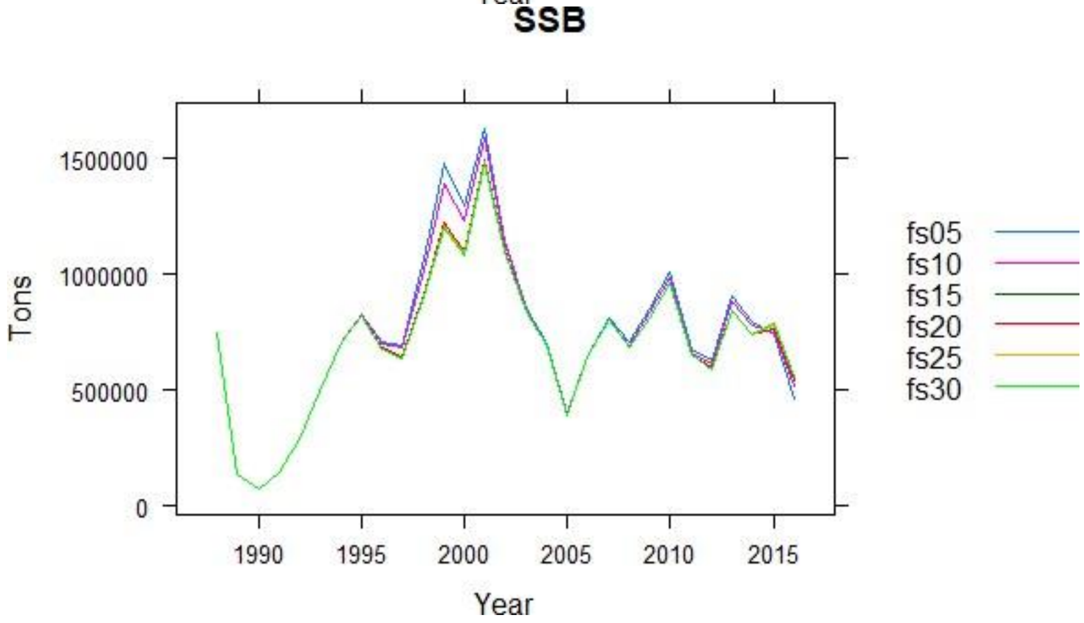
3	3877	7047	6531	4031	1844	639
4+	1	0	0	0	0	0
	2006	**2007**	**2008**	**2009**	**2010**	**2011**
0	31473	51903	15514	25310	17328	22865
1	25176	43903	23143	23536	23724	33664
2	10481	16709	16176	12803	23422	15084
3	352	495	601	492	1014	809
4+	0	0	0	0	0	165
	2012	**2013**	**2014**	**2015**	**2016**	
0	52776	24549	12400	18862	10952	
1	24183	96775	52200	97505	35895	
2	4863	26418	27500	57968	23622	
3	485	1786	2960	5585	9814	
4+	331	0	440	1046	11	

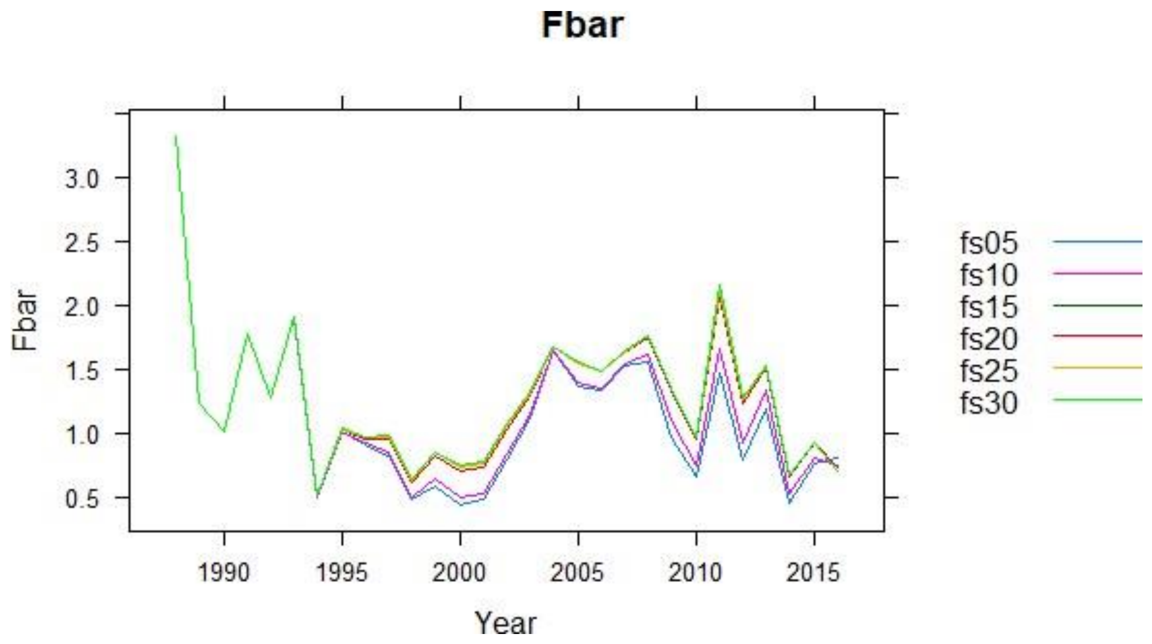
6.1.5 Results

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.



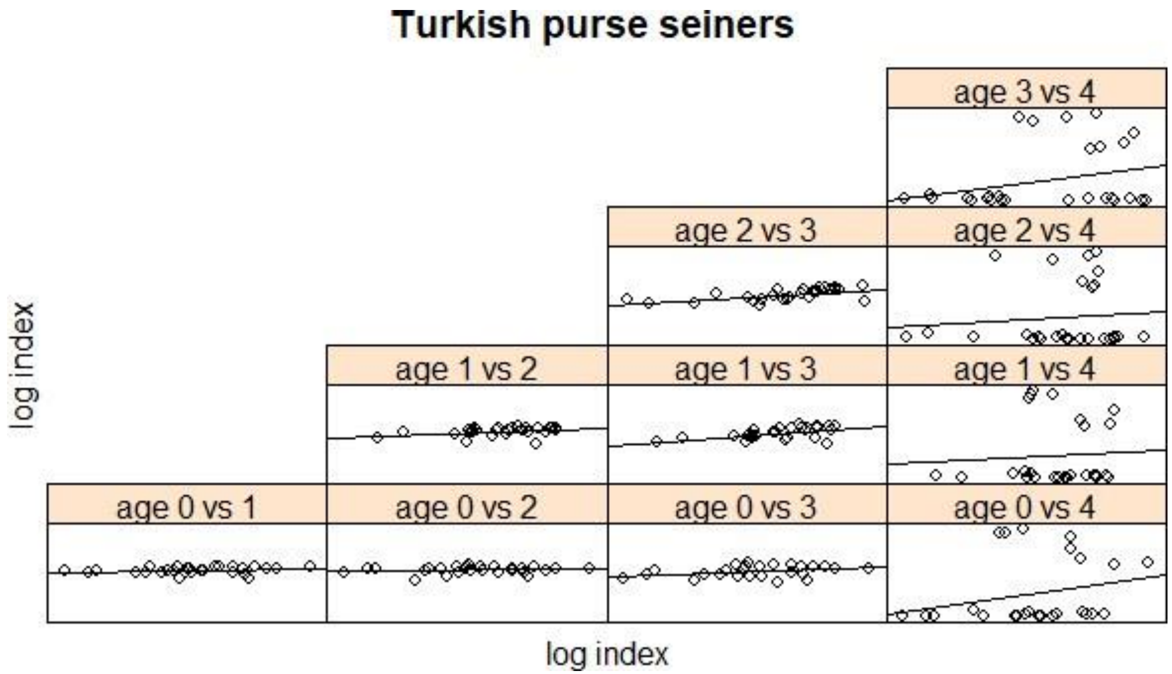

Recruitment
Thousands
1.2e+09
1.0e+09
8.0e+08
6.0e+08
4.0e+08
2.0e+08
1990
1995
2000
2005
2010
2015
Year
fs05
fs10
fs15
fs20
fs25
fs30


SSB
Tons
1500000
1000000
500000
0
1990
1995
2000
2005
2010
2015
Year
fs05
fs10
fs15
fs20
fs25
fs30

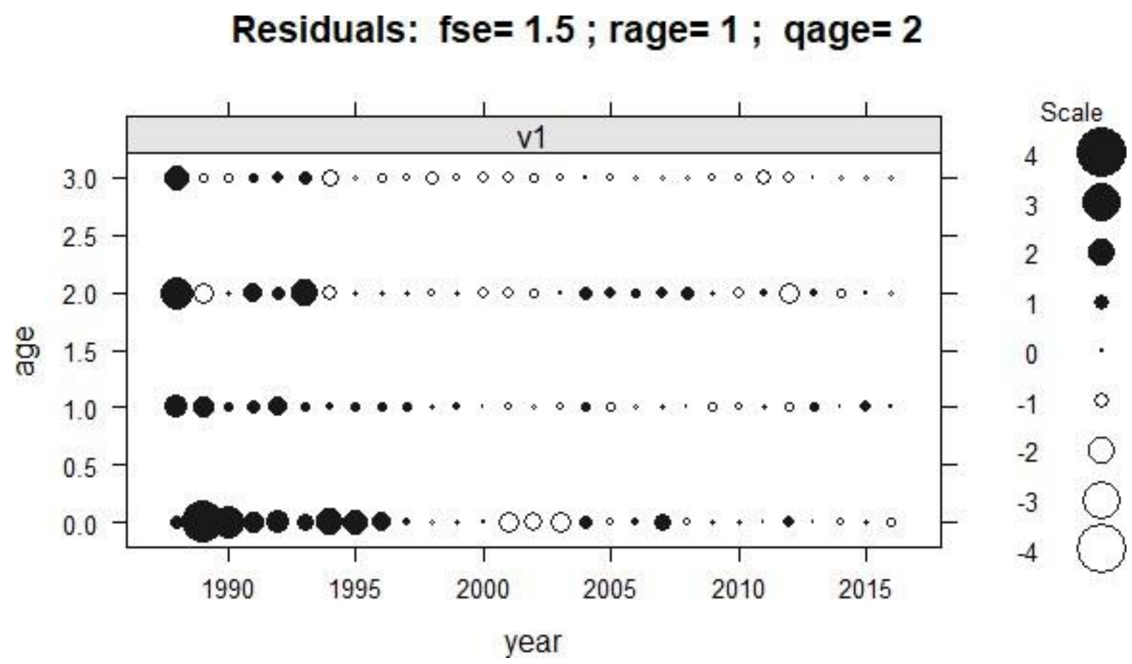


SSB and Recruits by year

The results of the analysis display a decrease in the F and increase in the Recruitment, however SSB keeps its decreasing trend. The current exploitation rate (E=0.47), estimated based on the average $F_{[1:3]}$ of the last 3 years ($F_{[2014-16:1-3]}$ = 0.76) , exceeds the precautionary threshold 0.4 recommended for small pelagic fish (Patterson, 1992).

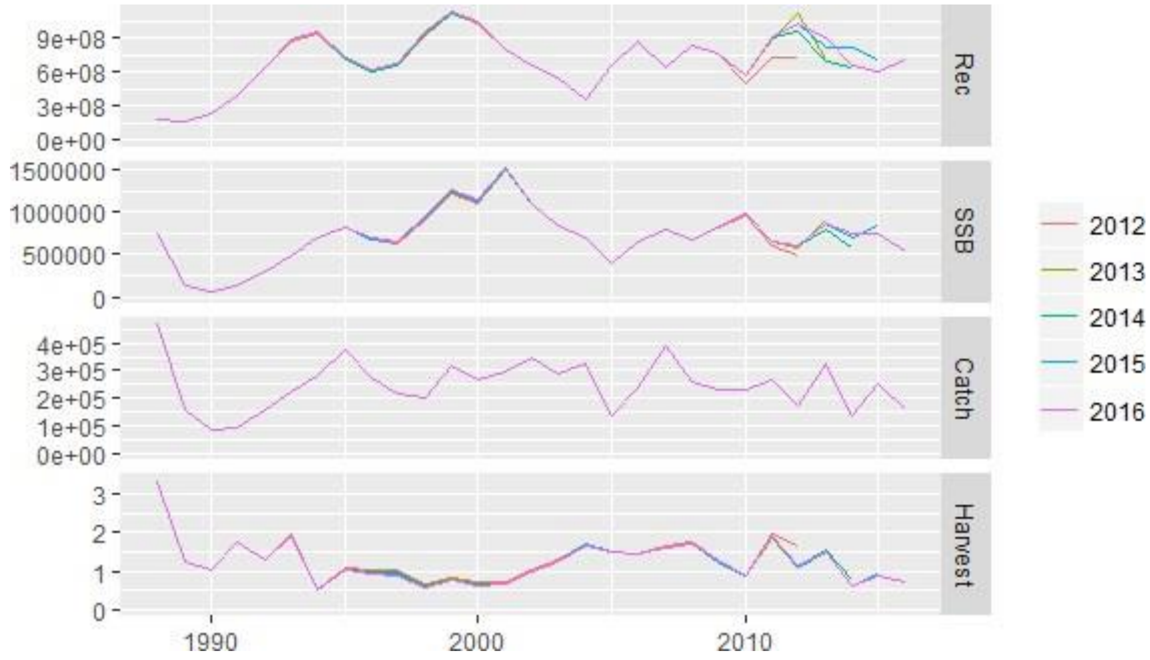

Turkish purse seiners
age 3 vs 4
age 2 vs 3
age 2 vs 4
age 1 vs 2
age 1 vs 3
age 1 vs 4
age 0 vs 1
age 0 vs 2
age 0 vs 3
age 0 vs 4
log index
log index

6.1.6 Robustness analysis



Magnitude and distribution of the residuals

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



Retrospective analysis for fse=1.5; rage =1 ; qage=2

6.1.8 Assessment quality

The problem in ageing, which has been underlined in every assessment so far, has been repeated in this assessment too. Combining data from different countries has also been discussed and instead of using official figured reported for the calendar years, the catch of the countries within a fishing season October- April was used for Georgia and Turkey. For the other countries whose catch was negligibly low, were used as they were reported.

The age composition of the catch was estimated using the length frequency distribution of the landings collected regularly by the Trabzon Central Fisheries Institute. The missing data for 1999-2004 were completed from the data published in literature. The results of the analysis covering that part displays extremely high SSB value. Various test has been done to check whether or not these high values are the outcomes of incompatibility of the data used to fill the gap; however no clear answer has been reached.

The survey data (hydro-acoustic) displayed very high internal inconsistency and increased the residuals remarkably, therefore they were not used. The reason is most probably due ALK used to convert length frequency distribution into ages. It may also be due to the shortage of the area coverage in the surveys. Anchovy is a transboundary fish, however the surveys are limited to one country. It is necessary to enlarge the geographical coverage of the surveys.

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*

(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	$E_{0.4}$	$E_{[2014\text{-}16:1\text{-}3]}$ = 0.47 $F_{[2014\text{-}16:1\text{-}3]}$ =0.76	E=0.4	N	IO_L
	Fishing effort				D	
	Catch					
Stock abundance	Biomass			33_{th} percentile		O_L
	SSB		532358			
Recruitment		D				
Final Diagnosis		Example: In intermediate level of overfishing and overexploited with low level of 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)*