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Assessment of Black Sea Stocks (STECF-12-15)

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SCIENTIFIC, TECHNICAL AND ECONOMIC COMMITTEE FOR FISHERIES (STECF)

Assessment of Black Sea Stocks (STECF-12-15)

THIS REPORT WAS REVIEWED DURING THE PLENARY MEETING HELD IN BRUSSELS BELGIUM 5-9 NOVEMBER 2012

Request to the STECF

STECF is requested to review the report of the **EWG-12-16** held from October 8 – 12, 2012 in Ispra (Italy), evaluate the findings and make any appropriate comments and recommendations.

STECF observations

STECF reviewed the report of the EWG 12-16 and noted the progress made regarding the Assessment of Black Sea stocks. STECF acknowledges the considerable efforts of the WG participants in undertaking its work and notes that the EWG adequately addressed all of the Terms of Reference.

Relevant data were compiled and stock assessments for the following 7 species were undertaken: sprat, turbot, anchovy, whiting, horse mackerel, piked dogfish, and red mullet. The available information was considered insufficient to perform a whole Black Sea assessment of the rapa whelk.

STECF notes that international research on gillnet selectivity of turbot was reviewed by the EWG 12-16 and that the current gaps in knowledge and data were documented. The EWG-12-16 report also provides a list of recommendations to address the existing gaps in data and knowledge.

STECF conclusions

Based on it's review of the Report of the EWG 12-16, STECF draws the following conclusions:

The Report of the EWG 12-16 contains the best and most comprehensive assessments of fish resources in the Black Sea currently available.

The assessments for Black Sea resources are compromised by the paucity of fishery-independent survey data. In addition, in the absence of fishery-independent estimates of recruitment, the results of short-term catch predictions are also uncertain.

Four of the stock assessments undertaken, sprat, turbot, anchovy and whiting, were of sufficient quality to provide analytical estimates of recent exploitation rates and stock status in relation to proposed biological reference points. Although the assessments for sprat, anchovy and whiting are considered sufficiently reliable to be used as a basis for short-term catch forecasts, the assessment results for for turbot are less reliable and are indicative of relative trends only.

Similarly, the the assessment results for horse mackerel and red mullet should be treated as provisional, are only indicative of trends and are not sufficiently reliable to be used as a basis for catch forecasts. The results of the assessment of piked dogfish were inconclusive with respect to stock status.

Based on the results of assessments for sprat, turbot, anchovy and whiting, STECF proposes that the following limit reference points be adopted as appropriate proxies for F_{MSY} and which are consistent with high long-term yields:

Sprat: $F_{MSY} = F \leq 0.64$, consistent with the exploitation rate $E \leq 0.4$

Turbot : F_{MSY} = Range ($F_{0.1}$-F_{MAX})is F=0.07 – F= 0.15

Anchovy $F_{MSY} = F \leq 0.54$, consistent with the exploitation rate $E \leq 0.4$

Whiting: $F_{MSY} = F \leq 0.40$

In relation to the above proposed reference points the current status of sprat, turbot anchovy and whiting in the Black Sea can be summarised as follows

Sprat: Fishing mortality in 2011 is estimated to be F = 0.8. STECF concludes that in 2011, the stock was subject to overfishing ($F>F_{MSY}$). STECF notes that results of the 2012 assessment are consistent with those from the 2011 assessment.

Turbot: Fishing mortality appears to be at an historical high and is almost 6 times F_{MAX}. Survey indices and relative trends in the stock from the assessment indicate that the stock size is at a historical low and SSB is less than 10% of the estimated SSB at the end of the 1970s. STECF concludes that the stock is severely depleted and is being exploited at an unsustainable rate.

Anchovy: Fishing mortality in 2011 is estimated to be F = 1.3. STECF concludes that in 2011, the stock was subject to overfishing ($F>F_{MSY}$).

Whiting: Fishing mortality in 2011 is estimated to be F = 0.66. STECF concludes that in 2011, the stock was subject to overfishing ($F>F_{MSY}$).

Based on the EWG 12=16 review of gill net selectivity for turbot in the Black Sea, STECF concludes that further work is required before new recommendations on gill net selectivity as a potential management instrument can be provided.

STECF advice

Based on the results of the assessments for Black Sea anchovy, sprat and whiting, STECF proposes that catch limits in 2013 for these stocks be set in line with the fishing mortality reference points proposed above.

Adopting such an approach implies that catches in 2013 should be less than or equal to the following:

Sprat	64,000 t
Anchovy	141,616 t
Whiting	4,971 t

As there is no international allocation key for either of the above species, STECF is unable to advise on a specific EU TAC for sprat anchovy or whiting.

Given the estimated dramatic decline in the stock biomass of turbot in the Black Sea and the extremely high annual estimates of fishing mortality, STECF advises on the basis of precautionary considerations that there should be no fisheries for turbot and individuals caught unintentionally should be promptly released. STECF considers also that an international management plan should be initiated to restore spawning stock biomass to the level capable producing maximum sustainable yield.
.

STECF notes the recommendations of the EWG 12-16 with regard to future work and urges the Commission to take then into account in future planning and act accordingly.

Expert Working Group report

REPORT TO THE STECF

EXPERT WORKING GROUP ON ASSESSMENT OF BLACK SEA STOCKS (EWG-12-16)

Ispra, Italy, 8-12 October 2012

1 EXECUTIVE SUMMARY

In response to the ToR the STECF EWG 12-16 on Black Sea stock assessments has endeavoured eight stock assessments approaches of sprat, turbot, anchovy, whiting, horse mackerel, piked dogfish, rapa whelk and red mullet. Relevant data have been compiled and reviewed, including those called officially by DG Mare through the 2012 DCF data call for the Mediterranean and Black Sea. Expert knowledge completed the data underlying the stock assessment approaches. The methods and data of the eight stock assessment approaches are documented in section 6 of the present report.

Among the eight stock assessment approaches, four stock assessments resulted in analytical estimations of the status of stock size and exploitation, i.e. sprat, turbot, anchovy and whiting. For these four stocks biological reference points consistent with high long term yields and low risk of stock collapses were determined as Fmsy approximations. In addition to the detailed assessment sections, the present report provides short summary sheets to describe the stock and fisheries status and provide catch advice as appropriate. While the stock biomass estimates of turbot are considered to reflect relative changes only, the stock assessments of sprat, four and whiting concluded in short term predictions of stock size and catches over a range of management options.

The remaining four stock assessments approaches did not deliver such detailed results and are considered indicative of trends only, i.e. for horse mackerel and red mullet, or did not provide conclusive results, i.e. piked dogfish. The available information was considered insufficient to perform a whole Black Sea assessment of the Rapa whelk.

The STECF EWG 12-16 reviewed national and international research work on the issue of selectivity of turbot gillnets fisheries in the Black Sea.

STECF EWG 12-16 reviewed gaps in current knowledge and data, evaluated the progress made in addressing such gaps since last year, and formulated recommendations for addressing such gaps in future. Several gaps were identified such as: limitations in performing of scientific surveys, insufficient training in assessment methods, lack of harmonisation in data collection and age reading, insufficient knowledge of stock units, and lack of monitoring programs for assessing the IUU and discards.

2 CONCLUSIONS OF THE WORKING GROUP

The STECF EWG 12-16 notes that the presented analytical assessments of sprat, turbot, and whiting in the Black Sea are considered imprecise due to various data deficiencies. Yet there are no consistent frameworks developed to aggregate and raise national landings and/or discards to international figures. The assessments provided are based on the best estimates available.

The STECF EWG 12-16 notes that fishery independent scientific surveys to monitor the living resources in the Black Sea (mortality and recruitment) are either lacking or very limited in area coverage and cover short periods only. This lack generally increases the uncertainty in the recent parameters of the stock assessments and the short term predictions of stock size and catch.

The STECF EWG 12-16 acknowledges the urgent need for training of the experts in the region in stock assessment methods.

The STECF EWG 12-16 proposes the exploitation rate E≤0.4 (equals F≤0.64) as limit management reference point consistent with high long term yields (Fmsy proxy) for sprat in the Black Sea. The current 2011 F=0.811, makes the EWG to considers the stock of being at risk of overexploitation.

The STECF EWG 12-16 propose Fmsy to between =0.07-0.15 as limit reference point consistent with high long term yields for turbot in the Black Sea. F is at the historical high level around 1.00, almost 6 times Fmax.The EWG classifies the stock of turbot in the Black Sea as being exploited unsustainably and at the risk of collapse. The EWG notes that despite the recently low TACs the fishing mortality remains at a level with no signal of reduction. STECF advises on the basis of precautionary considerations that there should be no directed fisheries and bycatch should be minimized.

The EWG 12-16 proposes Fmsy (1-4)≤0.4 as limit reference point consistent with high long term yields and low risk of fisheries collapse for whiting in the Black Sea As the estimated F(1-4)= 0.66 exceeds Fmsy, the EWG 12-16 classifies the stock of whiting in the Black Sea as being exploited unsustainably.

The STECF EWG-12-16 proposes the exploitation rate E≤0.4 as limit reference point consistent with high long term yield and low risk of fisheries collapse for anchovy in the Black Sea. The EWG classifies the stock as being subject to overfishing as the estimated F(1-3)=1.3 exceeds such exploitation rate E≤0.4 which equals Fmsy(1-3) = 0.54, given M 1-3 = 0.81

The STECF EWG 12-16 considers that further work is needed in order to have a clearer idea of the selectivity aspects of the gillnet fishery for turbot in the Black Sea.

3 RECOMMENDATIONS OF THE WORKING GROUP

EWG 12-16 recommends that the exploitation of sprat in the Black Sea for 2013 does not exceed the Fmsy level of 64 000 t . In the absence of an allocation key for the international sprat catches, EWG is unable to advice on a specific EU TAC for sprat in the Black Sea.

The EWG 12-16 advises on the basis of precautionary considerations that there should be no directed fisheries of turbot in the Black Sea, bycatch should be minimized and control over illegal catches should be improved in order to allow the stock to recover. The EWG notes that despite the recently low TACs the fishing mortality remains at a level with no signal of reduction.

EWG 12-16 recommends that the exploitation of anchovy in the Black Sea does not exceed the Fmsy level of 141 616 t . In the absence of an allocation key for the international anchovy catches, EWG is unable to advice on a specific EU TAC for anchovy in the Black Sea.

The EWG 12-16 recommends total catch whiting in the Black Sea not larger than 4 971 t corresponding to catches at Fmsy. In the absence of an allocation key for the international whiting catches, EWG 12-16 is unable to advice on a specific EU TAC for whiting in the Black Sea.

The EWG 12-16 recommends that an international study of selectivity of turbot fishing gears in the Black Sea is launched according to a harmonised methodology. The EWG invites the EU to explore whether such study could be supported by the EU budget.

The EWG 12-16 recommends to extend the demersal and hydroacoustic survey in order to cover the full areas of distribution of the most important stocks. The EWG 12-16 recommends that national agencies in EU members (Bulgaria and Romania) provide funding, under the DCF, to research institutes to unable the collection of input data for stock assessments (age and size composition, fishing effort, CPUE) from commercial fisheries.

The EWG 12-16 recommends that a training course in population dynamics, stock assessment methods and using of specialised software is organised to answer the needs of the majority of the scientists in the region.

The EWG 12-16 recommends to organise workshop(s) for inter-calibration of age readings between different laboratories and scientists in the region, and harmonisation of the frameworks and methods of sampling of commercial fisheries and scientific surveys.

The EWG 12-16 identified the stock of the Atlantic bonito as very important and suggests to start exploring the state of data and knowledge in order to perform assessment of this stock in the near future. The EWG 12-16 acknowledged that the state of knowledge of the population biology and the available data are not enough to perform a whole Black Sea assessment of Rapa whelk. The EWG recommends that more efforts are made by national institutions, to collect the necessary data and develop methods for assessing of the Rapa whelk.

4 INTRODUCTION

The STECF Expert Working Group EWG 12-16 meeting was held during 8-12 October 2012 in Ispra, Italy. The chairman called the group to order by 9 am on 8 October 2012, and adjourned the meeting by 6 pm on 12 October 2012. The meeting was attended by 14 experts from Bulgaria (4), Romania (3), Sweden (1), Turkey (4), Ukraine (2) and one observrer from the GFCM-FAO.

The present report of the EWG 12-16 is divided into two main parts. The first part presents short summary sheets of stock assessment results and respective scientific advice. Such summary sheet are provided if the expert working group succeeded to agree on analytical assessments of stock and fisheries parameters and biological reference points consistent with high long term yields and low risks of fisheries collapses. In such cases, the status of the stocks is assessed against such biological reference points and respective fisheries management advice is provided. The second part presents all the details of the stock and fisheries assessments undertaken by the group of experts, fully documented data and data reviews as well as assessment methods applied.

4.1 Terms of Reference for EWG-12-16

Background

The European Union adopted for the first time in 2008 and then for subsequent years catch limitations and associated technical measures for sprat and turbot fisheries in the Black Sea. Those measures were adopted in the light of scientific advice provided by STECF.

Last year, the STECF Experts Working Group for the Black Sea met in Sofia (Bulgaria) with the objective, among others, of assessing the state of the main stocks in the Black Sea Region. As an outcome of this meeting, STECF provided stock summary sheets for turbot and sprat, based on the available information. In these summary sheets STECF underlines that, despite substantial progress in the analytical assessment of sprat, turbot, anchovy and whiting there is still a considerable level of uncertainty. STECF states that these uncertainties are largely due to data deficiencies and lack of standardised or consistent methodology to raise national landings/discards data to derive reliable international estimates.

Regarding other relevant stocks, the assessment for Mediterranean horse-mackerel was considered as being indicative of trends only, while for Picked dogfish and Rape Whelk STECF was not in the position of providing scientific advice given the inconclusiveness of the assessments.

With a view to improve and update the assessments and catch forecast compatible with high yields and low risk of stock depletion (i.e. MSY perspective), of the concerned stocks and fisheries in the area, which will be the basis for further management measures STECF is requested to provide scientific advice on the exploitation levels (i.e. fishing mortalities or alike) and present status and recent development of stocks and the marine ecosystem of the Black Sea and evaluate the existing measures.

With a view to facilitate transfer of knowledge and expertise to the regional multilateral body, it is particularly relevant that to this meeting the GFCM Secretariat will be invited. Actually the first meeting of the ad hoc GFCM Working Group for the Black Sea held in Constanta (Romania) in January 2012 foresaw the possibility to hold a Black Sea Stock Assessment Working Group in cooperation with STECF. This year the meeting will be held under the umbrella of STECF following the same scheme as in previous years with a view to fulfil with the calendar of the EU decision-making process. The results of this meeting will be an STECF report which will provide valuable information as a basis for further joint analysis and discussions that will be held in the Second Meeting of the GFCM ad-hoc Working Group on the Black Sea to be held early in 2013 and in future GFCM Assessment Working Groups. All these sources of information will provide GFCM-SAC with valuable elements for its scientific deliberations and advice.

A second point of discussion during this meeting will concern the issue of fishing gear selectivity affecting the bottom gillnets fisheries for turbot in the Black Sea. The EU presented to the last GFCM Annual Session a proposal for a recommendation to establish minimum standards for bottom-set gillnet fisheries for turbot. The proposal was not adopted given that other Black Sea coastal states considered necessary some further scientific scrutiny. It was therefore agreed continuing technical work on the various elements of the proposal during the inter-sessional period (bilaterally ad in the framework of the GFCM Black Sea Working Group) in order to get this proposal as soon as possible. It is therefore absolutely essential that all scientific work undertaken so far on bottom gillnets selectivity is scrutinised and validated by STECF, with a view to agree on a common opinion on minimum mesh size and minimum landing size affecting this fishery in the Black Sea.

It is particularly appreciated the participation in STECF work of scientists from non-EU countries (Turkey, Ukraine and Russian Federation), that will allow a strengthen cooperation namely for the assessment of shared stocks.

This is another step toward a deeper cooperation on fisheries related matters amongst Black Sea scientists which will help feeding coastal states' reflections on the direction ahead to improve fisheries management and governance at multilateral level in the Black Sea Region and in the framework of GFCM.

Terms of Reference

Without prejudice, STECF is requested to advice in particular on 2013 catch forecasts compatible with high yields and lower risk of stock depletion as well as on the state of the most relevant exploited stocks with a view to inform management choices, including technical measures, in line with EU policy objectives and principles for sustainable fisheries management for the stocks listed in Annex I, in line with a MSY perspective.

EWG 2012-16 is requested to address the following ToR for Black Sea stocks:

- Compile and provide complete sets of national annual data on landings, discards, landings at age, discards at age, mean weight at age in the landings, mean weight at age in the discards, maturity ogives at age and natural mortality at age by area for the longest time series available up to and including 2011. The data should be compiled based on official data bases, best expert knowledge and by using the results of scientific surveys.
- Compile and provide all fishery independent data (pelagic, demersal, hydro-acoustic surveys) for the stocks as available, their juveniles, eggs or early life stages. In order to allow the use of such data to potentially calibrate virtual population analyses, the abundance, biomass and spawning stock biomass indices at age should be compiled for the longest time series available up to and including 2011.
- Compile and provide complete sets of annual fishing effort data (number of vessels, kW*days, GT*days, fished hours) by nation, for fleets and gears (by mesh size where applicable), and area for the longest time series available up to and including 2011.
- Assess trends in historic stock parameters for the longest time series available up to and including 2011 (fishing mortality at age) and up to and including 2011 (spawning stock biomass, stock biomass, recruits at age). Different assessment models should be applied as appropriate, including analyses of retrospective effects.
- Propose and evaluate candidate limit and precautionary reference points consistent with maximum sustainable yield and precautionary approach;
- Review and evaluate existing fisheries management measures and comment about their adequacy to ensure sustainable exploitation of stocks while delivering higher yields and low risk of stock depletion;
- Predict spawning stock biomass, stock biomass, recruits and catches at age and in weight in, 2012, 2013 and the beginning of 2014 under different management scenarios including the status quo fishing (mean F at age 2008-2011, rescaled to 2011) and with a TAC constraint for 2012. Specifically comment on the consequences for the listed stock parameters with regard to reference points consistent with maximum sustainable yield;
- Up-date the description of EU fisheries exploiting these stocks, in terms of fleets, fishing gears, deployed fishing effort (capacity in N°-GT-kW, activity in days at sea, gear characteristics), catches and catch composition, size composition, discards, fishing grounds and seasonality;
- Identify knowledge and monitoring gaps for fisheries, stocks, vital fish habitats and other environmental aspects relevant to fisheries in the area and provide information on the reasons for this deficiency and suggest monitoring and scientific actions that need to be developed in the short and mid-term to fill these gaps;
- Evaluate the progress made in addressing such gaps since last year;
- Prepare and/or up-date maps showing geographic density patterns in annual abundance indices derived from surveys aggregated for age groups selected by the fisheries and compare them with maps of geographical distribution patterns in annual landings and discards of the stocks listed in Annex I by fishing gear;
- Identify other important fisheries and stocks that may be in need of specific management measures to ensure sustainable exploitation and analyze whether the scientific basis is adequate or needs to be further developed;
- Establish an inventory of national and international research work on the issue of selectivity of turbot gillnets fisheries in the Black Sea, with a view to launch discussions on technical aspects.
- Report all results to the STECF Plenary in November 2012 for further scrutiny and endorsement.

Annex I: ***List of stocks to be assessed***

Species common name	**Species scientific name**	**FAO CODE**
Sprat	*Sprattus sprattus*	SPR
Turbot	*Psetta maxima*	TUR
Whiting	*Merlangius merlangus*	WHG
Anchovy	*Engraulis encrasicolus*	ANE
Mediterranean horse mackerel	*Trachurus mediterraneus*	HMM
Horse mackerel	*Trachurus trachurus*	HOM
Red mullet	*Mullus barbatus*	MUT
Striped red mullet	*Mullus surmuletus*	MUR
Piked dogfish	*Squalus acanthias*	DGS
Rapa Whelk	*Rapana venosa*	RPW

In support of its advice STECF shall provide for each stock:

a) A full methodological description of the assessment and advisory procedure updated whenever a significant change is made;

b) Estimates of landings, fishing mortality, recruitment and spawning stock together with information or estimates of the uncertainty with which these parameters are estimated;

4.2 Participants

The full list of participants at EWG-12-16 is presented in Appendix 1. Antonio Cervantes from DG Mare attended all sessions of the Working Group.

5 SUMMARY SHEETS

The stock specific summary sheets in the following section provide short summaries and scientific advice on stock status and fisheries management. Such short summaries are provided in the case that the detailed assessments succeeded an analytical assessment of the stock status and biological reference points. The full description of data and methods can be found in section 6 of the detailed assessments.

5.1 Summary sheet of sprat (*Sprattus sprattus*) in GSA 29

Species common name:	Sprat
Species scientific name	*Sprattus sprattus*
Geographical Sub-area(s) GSA(s):	GSA 29

Most recent state of the stock

- State of the adult abundance and biomass (SSB):

According to the present assessment the SSB ranges at medium to high levels: in the range of 300 - 400 000 t in recent years. Under a constant recruitment scenario and status quo F, SSB is expected to stay at the approximate same level by 2014. Since no precautionary level for the stock size of sprat in GSA 29 was proposed, EWG 12-16 cannot fully evaluate the stock status in relation to the precautionary approach.

- State of the juveniles (recruits):

Recruitment estimates since 2007 are estimated to range at a high level as compared with a long term trend. Such estimates are considered rather imprecise due to the lack of survey data.

- State of exploitation:

EWG 12-16 proposes the exploitation rate E ≤0.4 (=F≤0.64) as limit management reference point consistent with high long term yields (F_{MSY} proxy). Over the last few years the fishing mortality has piqued in 2004-2005 and 2009-2011 at a level of 0.6 - 0.8. The current 2011 F=0.811, that equals an exploitation rate of about E=0.46 (natural mortality M=0.95) makes the EWG to considers the stock exploited unsustainably.

- Source of data and methods:

International landings data at age were constructed and the Integrated Catch Analyses (ICA) is applied. Discards are believed to be low. Short term prediction is provided based on a short term geometric average recruitment.

Outlook and management advice

EWG 12-16 classifies the stock exploited unsustainably, , the present exploitation rate E=0.46 being above the reference point of E≤0.4 (F_{MSY} proxy). EWG 12-16 recommends the exploitation for 2012 to not exceed the Fmsy level of 64 000 t which is bellow the expected status quo catch of 85 000 t. In the absence of an allocation key for the international sprat catches, EWG 12-16 is unable to advice on a specific EU TAC for sprat in the Black Sea.

Short and medium term scenarios:

A short term prediction of stock size and catches assuming a sustainable status quo fishing scenario has been provided together with a range of management options. Considering the short life span of sprat in the Black Sea and the high variation in estimated recruitment, EWG 12-16 emphasises that the short term projections based on a geometric mean recruitment and the resulting catch advice are subject to high uncertainty. The poor knowledge about the recruitment dynamics prevented the formulation of medium term projections.

Fisheries

The following table list the landings (tons) by nation.

	Bulgaria	*Bulgaria	Romania	Romania*	Ukraine	Turkey	Georgia	Russian Federation	Total
1970	1407		2678		353				4438
1971	2473		2517		846				5836
1972	2962		23		884			16	3885
1973	3383		22		878			22	4305
1974	4468		1245		477			23	6213
1975	5565		731		787			43	7126
1976	7199		161		1594			16	8970
1977	8754		1463		4346			2354	16917
1978	10596		149		1949		1	3317	16012
1979	13541		2269		36757		3466	17700	73733
1980	16568		989		47635		4571	14687	84450
1981	1888		2283		49175		5781	20165	79292
1982	16524		3004		3862		2462	15266	41118
1983	12023		3406		20755		886	3843	40913
1984	13921		4456		18021		847	5270	42515
1985	15924		6836		23657		1817	3365	51599
1986	1169		8979		33147		2939	7010	53244
1987	10979		9474		43158		697	8972	73280
1988	6199		6454		39835		7172	7157	66817
1989	7403		8911		63239		9708	16045	105306
1990	2651		3198		33174		6895	6955	52873
1991	1909		729		11094		2313	2675	17082
1992	2353	3266	2074		11492		830	3221	20883
1993	2174	3705	2439		9154	640	32	694	16664
1994	2200	3500	2203		12615	700	308	1013	20339
1995	2874	3200	1982		15218	157	288	1263	22108
1996	3535	3500	2014		20720	937	185	1537	28893
1997	3646	3646	3318		20208	468	85	706	28431
1998	3275	3275	3293		30282	1236	24	1243	39353
1999	3595	3595	1933		29238	421	45	4473	39705
2000	1737	3500	1803		32644	6225	42	5543	49757
2001	695	6961	1792		48938	1008	40	11122	69861
2002	11595	11595	1617		45430	1965	34	11218	71859
2003	9155	9155	1219		31366	5775	2	204	47721
2004	2889	7997	135		30891	5186	12	143	44364
2005	2575	6500	1487		35707	5271	19	1316	50300
2006	2655	8183	492		21308	6681		8157	44821
2007	2559	2985	208		18013	11725		6077	39008
2008	4304	4304	234		21111	39903		7814	73366
2009	4551	4551	92		24603	53385		8744	91375
2010	4041	4041	39		24652	57023		5839	91594
2011	3958		134		24379	87141		5098	120710

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 12-16

E (mean)	≤ 0.4

Table of limit and precautionary management reference points agreed by fisheries managers

F_{msy} (age range)=	none
B_{pa} (B_{lim}, spawning stock)=	none

Comments on the assessment

The detailed assessment of sprat in GSA 29 can be found in the following section 6. EWG 12-16 recommends an international hydro-acoustic survey to monitor the sprat across all national waters of the Black Sea be established including Bulgaria, Romania, Georgia, Russia, Turkey and Ukraine.

5.2 Summary sheet of turbot (Scophthalmus maximus) in GSA 29

Species common name:	Turbot
Species scientific name	*Scophthalmus maximus*
Geographical Sub-area(s) GSA(s):	GSA 29

Most recent state of the stock

- State of the spawning stock size:

Uncertainties regarding the actual landings constrains STECF EWG 12-16 Black Sea to interpret the SAM assessment results only in relative terms, i.e. they are considered indicative of trends only. In the absence of a biomass precautionary reference points the EWG is unable to fully evaluate the stock size in respect to this. However, survey indices and the SAM analyses indicate that the stock size is at a historic low and it is less than 10% of the SSB estimated in the end of the 1970s.

- State of recruitment:

Recruitment has increased since 2003 but this has not yet materialized in a significant increase in SSB. However, the last year classes (2009-2011) are among the lowest observed in the time series.

- State of exploitation:

The STECF EWG 12-16 propose Fmsy to between =0.07-0.15 as limit reference point consistent with high long term yields. F is at the historical high level around 1.00, almost 6 times Fmax.The EWG classifies the stock of turbot in the Black Sea as being exploited unsustainably. The EWG notes that despite the recently low TACs the fishing mortality remains at a level with no signal of reduction.

STECF advises on the basis of precautionary considerations that there should be no fisheries for turbot and individuals caught unintentionally should be promptly released. STECF considers also that a management plan should be initiated to restore spawning stock biomass to the level capable producing maximum sustainable yield.

- Source of data and methods:

International landings data at age are believed to be underestimated due to illegal catches, discards are considered negligible. The available data from both fisheries dependent and fisheries independent sources is considered good enough in order to perform a reliable assessment of the stock. SAM method tuned by bottom trawl survey and commercial fleet is applied.

Outlook and management advice

STECF advises on the basis of precautionary considerations that there should be no fisheries for turbot and individuals caught unintentionally should be promptly released. STECF considers also that a management plan should be initiated to restore spawning stock biomass to the level capable producing maximum sustainable yield.

Short and medium term scenarios:

Uncertainty about catch figures prevented a precise stock assessment which could provide the basis for short and medium term projections of stock size and catches.

Fisheries

The following table list the landings (tons) by nation [1].

Year	Bulgaria	Romania	Ukraine west	Ukraine east	Turkey west	Turkey east	Russian Federation	Georgia	Black Sea total	Black Sea west
1989	0.90	0	2	0	448	1001	0	8	1459.9	450.90
1990	0.00	0	9	0	908	475	0	1	1393	917.00
1991	0.00	2	17.1	0.9	600	315	0	0	935	619.00
1992	0.00	1	18	1	308	110	1	0	439	327.00
1993	0.00	6	10	0	400	1185	2	0	1603	416.00
1994	0.00	6	18	1	1293	821	5	0	2144	1317.00
1995	60.00	4	10	0	2006	844	19	0	2943	2080.00
1996	62.00	6	37	2	1414	510	17	0	2048	1519.00
1997	60.00	1	40	2	777	134	11	0	1025	878.00
1998	64.00	0	40	2	1056	412	14	0	1588	1160.00
1999	54.00	2	69	4	1579	225	15	5	1953	1704.00
2000	55.10	2	76	4	2321	318	4	9	2789.1	2454.10
2001	56.50	13	123	6	2169	154	24	11	2556.5	2361.50
2002	135.50	16.681	99	5.47	193	142	15	11	617.97	444.50
2003	40.80	23.978	118	5.876	126	93	15	1	423.676	308.80
2004	16.20	42.031	126	7.157	118	116	1.7	7	434.357	302.20
2005	12.69	36.53	123	6	273	275	7.5	7	747.69	445.69
2006	14.81	35.108	154	8	266	481	7.6	0	962.81	466.81
2007	66.85	48.064	205.2	10.58	346	353	5.7	0	1035.396	666.12
2008	54.62	47.112	239	12.353	224	234	4.7	0	815.786	564.73
2009	52.47	48.767	247	16	223	119	24.3	0	730.537	571.24
2010	46.45	48.248	166	41	218	77	25	0	621.69507	478.70
2011	37.80	43.248	211	25	108.1	36.4	24.09	0	485.638	400.15

1). Expert assessments accounting for unreported catches were used in assessment instead of official landings

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 12-16

F_{msy} (4-8)	0.07- 0.15

Table of limit and precautionary management reference points agreed by fisheries managers

F_{msy} (4-8)=	none
B_{pa} (B_{lim}, spawning stock)=	none

Comments on the assessment

The detailed assessment of turbot in GSA 29 can be found in the following section 6. EWG 12-16 recommends an international bottom trawl survey to monitor the turbot across all national waters of the Black Sea be established including Bulgaria, Romania, Georgia, Russia, Turkey and Ukraine.

5.3 Summary sheet of whiting (*Merlangius merlangus*) in GSA 29

Species common name:	Whiting
Species scientific name	*Merlangius merlangus*

Geographical Sub-area(s) GSA(s):	GSA 29

Most recent state of the stock

- <u>State of the adult abundance and biomass (SSB):</u>

Since 1994 the SSB has varied without a trend. In the absence of a biomass biological reference points the EWG 12-16 is unable to fully evaluate the stock status in respect to it.

- <u>State of the juveniles (recruits):</u>

Since 1994 the recruitment has varied without a trend. There is no fishery independent recruitment index (survey) available as none of the surveys cover the entire stock area.

- <u>State of exploitation:</u>

The EWG 12-16 proposes F_{MSY} (1-4)≤0.4 as limit reference point consistent with high long term yields and low risk of fisheries collapse. As the estimated F(1-4)= 0.66 exceeds F_{MSY} the EWG 12-16 classifies the stock of whiting in the Black Sea as being exploited unsustainably. If the stock is fished at F_{MSY} (1-4) = 0.4 the status quo catch for 2013/2014 would be 4218 and 4971 t respectively. The EWG 12-16 therefore recommends a total catch not larger than 4218 t for 2013 corresponding to catches at F_{MSY}.

- <u>Source of data and methods:</u>

International landings at data at age were constructed while discards are considered negligible. XSA analyses tuned by a short (4 years) single survey (Romanian bottom trawl) applied on a limited area. Short term prediction is provided based on short term geometric mean recruitment.

Outlook and management advice

The EWG-12-16 recommends the exploitation of whiting to be sustainable and the catch in 2012 not to exceed 4218 t. In the absence of an allocation key for the international whiting catches, EWG 11-16 is unable to advice on a specific EU TAC for whiting in the Black Sea.

<u>Short and medium term scenarios:</u>

A short term prediction of stock size and catches assuming a sustainable status quo fishing scenario in 2012 has been provided together with a range of management options. Considering the short life span of whiting in the Black Sea and the high variation in estimated recruitment, EWG 12-16 emphasises that the short term projections based on a geometric mean recruitment and the resulting catch advice are subject to high uncertainty. The poor knowledge about the recruitment dynamics and lack of discard estimates in the catch statistics prevented the formulation of medium term projections.

Fisheries

The following table list the landings (tons) by nation.

Year	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine	Un. Sov. Soc. Rep.
1970	-	.	115	.	4312	.	.
1971	-	.	442	.	5855	.	.
1972	-	.	416	.	5284	.	.
1973	-	.	329	.	2476	.	.
1974	-	.	1305	.	2844	.	.
1975	454	.	346	.	3913	.	.
1976	347	.	541	.	4213	.	.
1977	218	.	1495	.	5726	.	.
1978	407	.	1345	.	21265	.	531
1979	71	.	1205	.	20778	.	11377
1980	30	.	618	.	6838	.	2690
1981	1	.	894	.	4669	.	2238
1982	4	.	800	.	4264	.	1513
1983	-	.	1080	.	11696	.	2381
1984	-	.	1192	.	11595	.	4738
1985	-	.	3138	.	16036	.	2655
1986	-	.	1949	.	17738	.	2652
1987	-	.	615	.	27103	.	2764
1988	-	5	1009	736	28263	1482	.
1989	-	5	2738	7	19283	579	.
1990	-	-	2653	235	16259	87	.
1991	-	-	59	-	18956	24	.
1992	-	70	1357	-	17923	.	.
1993	-	172	599	16	17844	5	-
1994	-	187	432	125	15084	64	-
1995	-	146	327	91	17562	17	-
1996	-	223	372	11	20326	3	-
1997	-	58	441	10	12725	29	-
1998	-	53	640	119	11863	55	-
1999	-	41	272	184	12459	18	-
2000	9	37*	275	341	15343	20	-
2001	8	32	306	642	7781	18	-
2002	16	37	85	656	7775	9	-
2003	13	45	113	93	7062	21	-
2004	2	29	118	55	7243	43	-
2005	3	30	92	78	6637	30	-
2006	2	37	113	60	7797	15	-
2007	16	41	118	22	11232	64	-
2008	0	15	92	96	10986	9	-
2009	2	15*	40	52	8979	17	-
2010	15	15*	24	23	11894	17	-
2011	1	42	0	21	8122	36	-

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 11-16

Fmsy(1-3) proxy derived from F0.1	≤ 0.40

Table of limit and precautionary management reference points agreed by fisheries managers

F_{msy} (age range)=	none
B_{pa} (B_{lim}, spawning stock)=	none

5.4 Summary sheet of anchovy (*Engraulis encrasicolus*) in GSA 29

Species common name:	Anchovy
Species scientific name	*Engraulis encrasicolus*
Geographical Sub-area(s) GSA(s):	GSA 29

Most recent state of the stock

- State of the adult abundance and biomass (SSB):

Following some drastic changes in stock size, the SSB is indicated to have remained rather stable around 600 000 -700 000t since 2007. Since no precautionary level for the stock size of anchovy in GSA 29 was proposed, EWG 12-16 cannot fully evaluate the stock status in relation to the precautionary approach.

- State of the juveniles (recruits):

During the period 2002 to 2011 the recruitment has varied without a clear trend.

- State of exploitation:

STECF EWG-12-16 proposes E≤0.4 as limit reference point consistent with high long term yield and low risk of fisheries collapses. The EWG classifies the stock as being subject to overfishing as the estimated $F(_{1-3})$=0.1.295 exceeds such exploitation rate E≤0.4, which equals $Fmsy(_{1-3})$ in the range of 0.54 given M 1-3 = 0.81

The EWG-12-16 recommends the exploitation of anchovy should be reduced 41 % to be sustainable and the catch in 2013 not to exceed 141 616 t..

- Source of data and methods:

International landings at data at age were constructed while discards are considered negligible. XSA analyses tuned by a single commercial CPUE of the major Turkish purse seiner fishery is applied. Short term prediction is provided based on short term geometric mean recruitment.

Outlook and management advice

The EWG-12-16 recommends the exploitation of anchovy to be sustainable and the catch in 2012 not to exceed 141 616 t..Considering the short life span of anchovy in the Black Sea and the high variation in estimated recruitment, EWG 12-16 emphasises that the short term projections based on a geometric mean recruitment are subject to high uncertainty. In the absence of an allocation key for the international anchovy catches, EWG 12-16 is unable to advice on a specific EU TAC for anchovy in the Black Sea. In the case of better assessments from landing data, assessments should be supported by hydroacoustic surveys.

Short and medium term scenarios:

A short term prediction of stock size and catches assuming a sustainable status quo fishing scenario has been provided together with a range of management options. Considering the short life span of anchovy in the Black Sea and the high variation in estimated recruitment, EWG 12-16 emphasises that the short term projections based on a geometric mean recruitment and the resulting catch advice are subject to high uncertainty. The poor knowledge about the recruitment dynamics prevented the formulation of medium term projections.

Fisheries

The following table list the landings (tons) by nation.

YEAR	BULGARIA	GEORGIA	ROMANIA	RUSSIAN FEDERATION	TURKEY	UKRAINE	TOTAL
1994		857	197	0	293167	4797	299018
1995	35	1301	190	11	389298	10260	401095
1996	23	1232	140	4	276137	3092	280628
1997	44	2288	45	11	221475	3328	227191
1998	48	2346	146		199363	2611	204514
1999	36	1264	155		315989	2423	319867
2000	64	1487	204		272390	5496	279641
2001	102	941	186		300569	7952	309750
2002	237	927	296		346869	9567	357896
2003	131	2665	160		278238	8159	289353
2004	88	2562	135		312603	7458	322846
2005	14	2600	154		125635	6860	135263
2006	6	9222	23		219171	3936	232358
2007	60	17447	87		361662	4935	384191
2008	28	25938	15		229632	9515	265128
2009	42		21		193630	9948	203641
2010	65		50		203026	5051	208192
2011	18	25919	41		205243	6932	238153

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 11-16

E=0.4 equals Fmsy(1-3)	≤ 0.54

Table of limit and precautionary management reference points agreed by fisheries managers

F_{msy} (age range)=	none
B_{pa} (B_{lim}, spawning stock)=	none

Comments on the assessment

The detailed assessment of anchovy in GSA 29 can be found in the following section 6. EWG 12-16 recommends an international hydro-acoustic survey to monitor the anchovy across all national waters of the Black Sea be established including Bulgaria, Romania, Georgia, Russia, Turkey and Ukraine.

6 DETAILED ASSESSMENTS

6.1 Sprat in the Black Sea

6.1.1 Biological features

6.1.1.1 *Stock Identification*

The Black Sea sprat (*Sprattus sprattus L.*) is a key species in the Black Sea ecosystem. Sprat is a marine pelagic schooling species sometimes entering in the estuaries (especially as juveniles) and the Azov Sea and tolerating salinities as low as 4‰. In the daytime it keeps to deeper water and in the night moves near the surface. It forms big schools and undertakes seasonal movements between foraging (inshore) and spawning (open sea) areas (Ivanov and Beverton 1985). Adults tend to remain under the seasonal thermocline, penetrating above its only during the spring and autumn homothermia. Juveniles are distributed in a larger area near the surface. Sexual maturity is attained at the age of 1 year and length of 7 cm. In Turkey it was found that males reached maturity at 7.5 cm and females at 7.8 cm at age 1 year (Avşar & Bingel, 1994).

Sprat is one of the most important fish species being fished and consumed traditionally in the Black Sea countries. It is most abundant small pelagic fish species in the region together with anchovy and horse mackerel and accounts for most of the landings in the north-western part of the Black Sea. Whiting is also taken as a by-catch in the sprat fishery although there is no targeted fishery beyond this (Raykov, 2006) except for Turkish waters.

Sprat fishing takes place on the continental shelf on 15-110 m of depth (Shlyakhov and Shlyakhova, 2011). The harvesting of the Black Sea sprat is conducted during the day time when its aggregations become denser and are successfully fished with trawls. The main fishing gears are mid-water otter trawl pelagic pair trawls and uncovered pound nets.

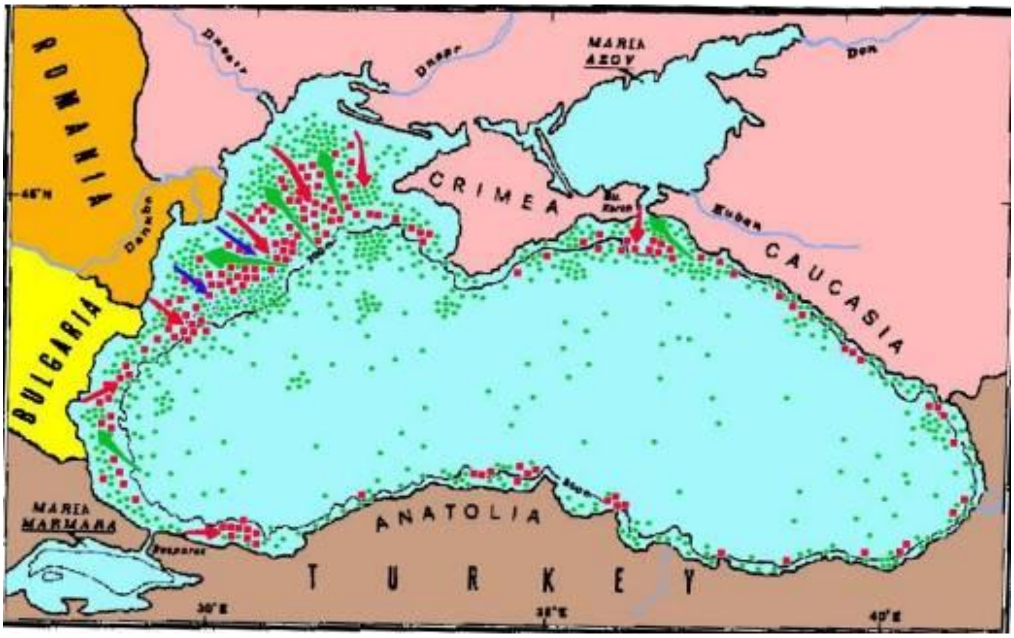


Fig. 6.1.1.1.1. Sprat distribution and migration in the Black Sea

Legend:

Wintering areas and migration to

Spawning areas and migration to them

Feeding areas and migration to them

6.1.1.2 *Growth*

The species is fast growing; age comprises 4-5 age groups. The von Bertlanffy Growth Parameters VBGF by countries is given in Table 6.1.1.2.1. In Romanian waters asymptotic length and growth rate is comparable with the growth parameters derived in Bulgarian and Ukrainian Black Sea waters (Table 6.1.1.2.1).

Table 6.1.1.2.1. VBGF parameters calculated in the Black Sea

	L∞	**k**	**t_0**	**a**	**b**
Bulgaria	12.57	0.82	-0.662	0.0009	2.8811
Romania	12.63	0.533	-1.565	0.0089	2.8121
Ukraine	12.42	0.286	-1.504	0.008475	2.9691
Turkey	14.23	0.14	-3.27	0.05	3.065

Sprat has lengths comprised between 50 and 115 mm. the highest frequency pertaining to the individuals of 70-100 mm lengths. While the share of eldest age decreased the prevalence of 0+ especially 1-1+ ages became increased. During last years the age structure show the presence of the specimens of 1-1^+ and 3; 3^+ years. The catch base was the individuals of 1-1^+ and 2-2^+ years (Figure 6.1.1.2.1.).

Fig. 6.1.1.2.1. displays the length distribution of sprat in western Black Sea from commercial catches in 2011.

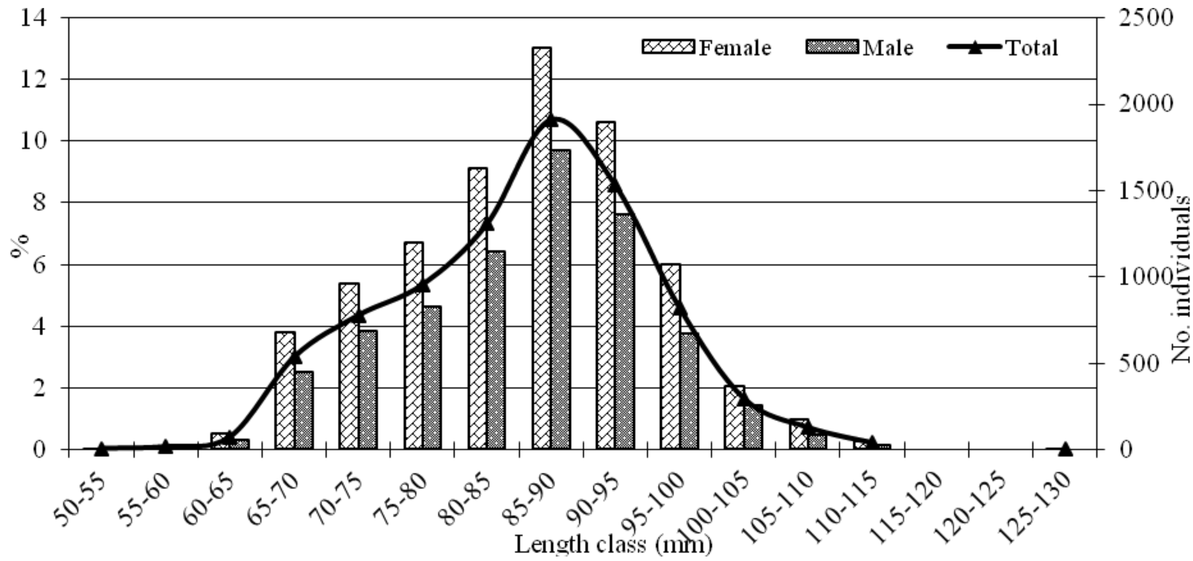


Fig. 6.1.1.2.1. Length distributions of sprat (%. No. of individuals) in the catch from the western Black Sea

The modal length classes from 2010 and 2011 (Figure 6.1.1.2.2.) are similar as the largest specimen over 11.5 cm was presented in the catch with low percent.

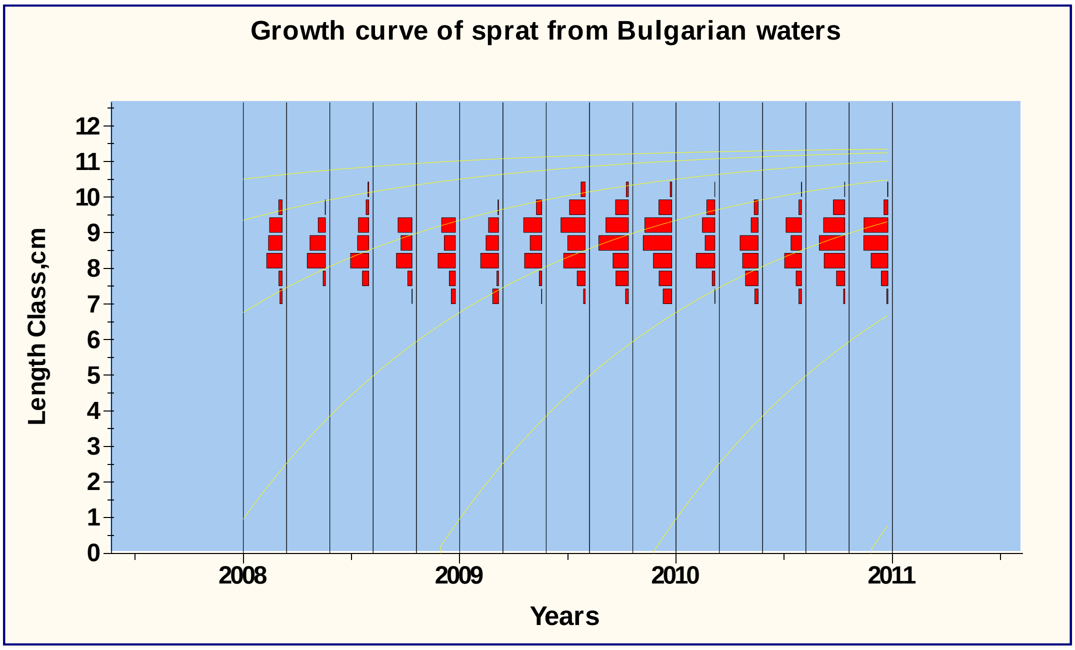


Fig. 6.1.1.2.2. Growth curve of sprat from Bulgarian Black Sea waters, 2008-2011

The length and weight frequency distributions (for Turkish waters in 2011) were presented in Figure 6.1.1.2.3. The age range was determined as 1-5 years.

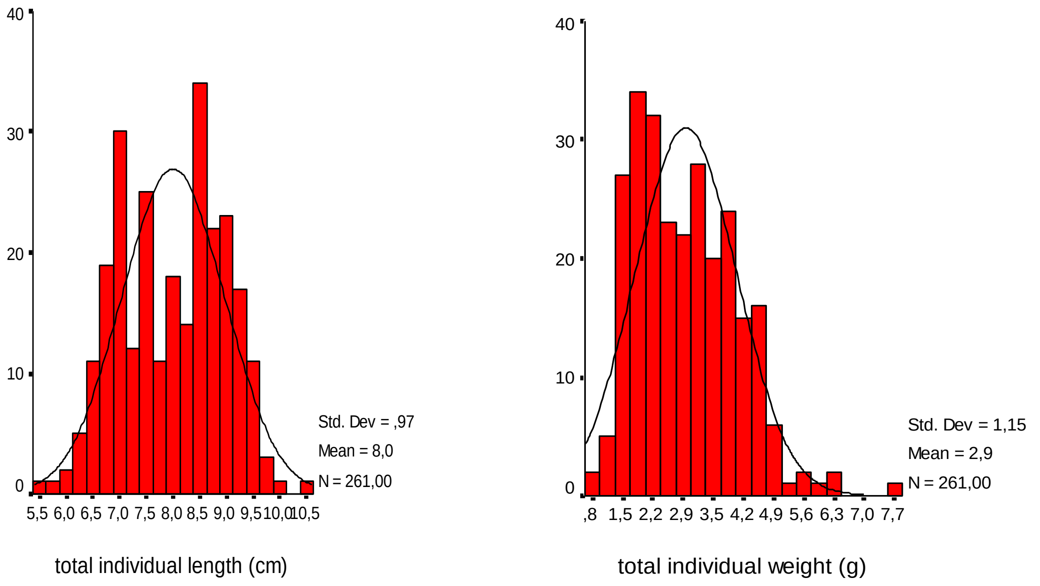


Fig. 6.1.1.2.3. Length and weight frequency distributions of sprat for spring 2011 from Samsun shelf area (Turkey). On the next figure (Figure 6.1.1.2.4) the length-weight relationship of sprat from Turkish coast was presented.

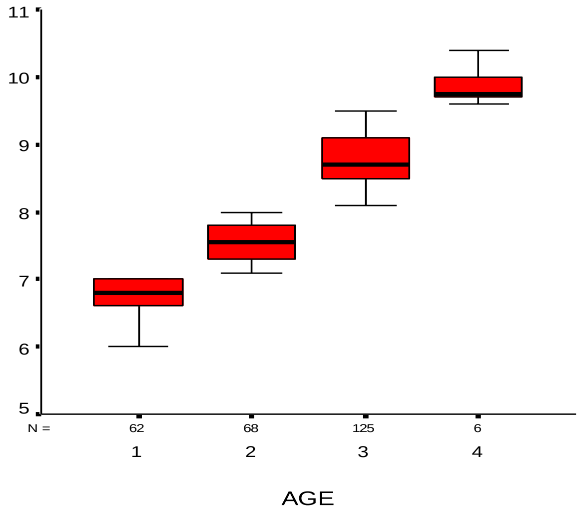


Fig. 6.1.1.2.4. The age-length relationship in sprat for spring 2011 from Samsun shelf area.

6.1.1.3 *Maturity*

No maturity studies conducted in 2011

6.1.2 Fisheries

6.1.2.1 *General description*

The sprat fishery is taking place in the Black Sea (GFCM Fishing Sub-area 37.4 (Division 37.4.2) and Geographical Sub-area (GSA) 29). The opportunities of marine fishing are limited by the specific characteristics of the Black Sea. The exploitation of the fish recourses is limited in the shelf area. The water below 100-150 m is anoxic and contains hydrogen sulphide. In Bulgarian, Romanian, Russian and Ukrainian waters the most intensive fisheries of Black Sea sprat is conducted in April till October with mid-water trawls on vessels 15- 40 m long and a small number vessels >40m. Beyond the 12-mile zone a special permission is needed for fishing. Harvesting of Black Sea sprat is conducted during the day when the sprat aggregations become denser and are successfully fished with mid-water trawls (Shlyakhov and Shlyakhova, 2011; Shlyakhov *et al*., 2012; Kumantsov and Raykov, 2012). The use of paired vessels in pelagic trawling along Yesilirmak - Kizilirmak shelf area in southern Black Sea gained importance by 1990s and became widespread by 2000s. At present nearly 40 pairs of vessels are operating along the mentioned area. The total catch of sprat -as a target species- is directly transported to fish meal and oil fabrics as raw material (Knudsen and Zengin, 2006).

The significance of the sprat fishery in Turkey in the last three years has increased and the landings reached 87 141 t in 2011. In contrast the catches in 2010 was 57 023 t which is close for the 5 years average value of the Turkish sprat catches in the Black Sea. The main gears used for sprat fishery in Turkey (fishing area is constrained in front of the city of Samsun) are pelagic pair trawls working in spring at 20 - 40m depth and in autumn - in deeper water: 40-80m depths.

6.1.2.2 *Management regulations applicable in 2010 and 2011*

A quota (Table 6.1.2.2.1) is allocated in EU waters of the Black Sea (Bulgaria and Romania). No fishery management agreement exists between other Black Sea countries. In the EU Black Sea waters a global (both Romania and Bulgaria) TAC 12 750 tons has been allocated in 2009 and 2010. In 2011 the quota was set at 8032.5 t (for Bulgaria) and 11475 t for Bulgaria and Romania.This figure is a result of a reduction of the 2008 TAC of 15 000 t and further reduction in 2011 based on the precautionary principle. Ukraine and Russian Federation also apply TAC in their national waters (Table 6.1.2.2.2). Minimum landing size of sprat is applied across the region except in Turkish waters (Table 6.1.2.2.3.).

Table 6.1.2.2.1. EC quota and recommended Total allowable catch of sprat in Bulgarian waters

Year / *National data*	*2008*	*2009*	*2010*	*2011*
Spicies	*Sprat* *(SPR)*	*Sprat* *(SPR)*	*Sprat* *(SPR)*	*Sprat* *(SPR)*
Quota. t	15 000[2]	12 750[2]	12 750[2]	8 032.5[1] 11475[1+]
Total catch. t	4 300.0363	4541	4 039.966	3 957.895
Biomass. t	32 718.3[3]	41 761.398[3]	75 080.20[4]	48 201.70[3,4]
Recommended TAC	13747	11470	12 500[4]	-
Days at sea	2320	2598	2548	3106

NB: [1] - *Bulgaria's quota according to Regulation (EU) № 1579/2007. Regulation (EU) № 1139/2008. Regulation (EU) № 1287/2009. Regulation (EU) № 1004/2010. Regulation (EU) № 1256/2010* [1+]*Quota for Bulgaria and Romania*

[2] - *EC's quota*

[3] - *Source of data: Institute of Oceanology – BAS. Bulgaria*

[4] - *Source of data: Institute of Oceanology – BAS. Bulgaria; National Institute for Marine Research and Development. Romania*

Sprat fishery in Turkey was firstly promoted by the Commercial Fishery Advice of General Directorate of Fishery with date of 02.08.2002 and number of 24 834 regarding the years 2002-2004 (Section 2. Article 5) (Anonymous, 2002). New management criteria were brought into force for sprat fishery. These criteria were summed up in four topics as:

(1) **Regulations about fishing area:** Sprat fishery by pelagic trawls should be conducted only along Samsun shelf area. The coordinates of this area were specified. But except sprat, the fishery was allowed for anchovy, horse mackerel and bluefish along other trawling areas in Black Sea.

(2) **Regulations about fishing gear:** In Turkey pelagic trawls operate as paired vessels. Vessels engaged in sprat fishery need to receive licence eligible only for one fishing period from Samsun City Directorate of Food. Agriculture and Livestock. The single vessel operation in pelagic fishery seems to be inconvenient for Turkey at least for now as the fisherman can quickly change the gear to bottom trawling during operation.

(3) **Regulations about time periods:** Though pelagic fishing period starts in 15 September as same as bottom trawling. it lasts to 15 May. Bottom trawling ends with 15 April. There is no limitation in distance from land for pelagic trawling.

(4) **Regulations about depth:** The pelagic fishery is banned in waters shallower than 18 m in fishing area between 15 September and 15 April. But between 15 April-15 May it is allowed in waters deeper than 36 m limited with offshore of Çayağzı Cape (Samsun-Yakakent) in west and Akçay estuary (Samsun - Ordu city border) in east (Anonymous, 2006). Sprat catch reaches a maximum in this one month-period and provide a great economic input for fishermen. Conversely with bottom

trawling depth limitations are in force in pelagic fishery instead distance from land. But as mentioned above the depth limitation is increased to 36 m by 15 April in order to protect spawning adults and juveniles on coastal zone.

Table 6.1.2.2.2.Sprat TAC applied in Ukraine and Russian Federation in tons.

Year	Russian Federation	Ukraine
2005	42 000	60 000
2006		70 000
2007		40 000
2008	21 000	50 000
2009	21 000	50 000
2010	21 000	50 000
2011		60 000
2012		70 000

Table 6.1.2.2.3. Minimum landing size of sprat in the Black sea region

	BG	GE	RO	RU	TR	UA
Sprattus sparttus	TL=7cm	SL=6cm	TL=7cm	SL= 6cm	NO	SL=6cm

Legend: TL-total length; SL-standard length;

6.1.2.3 *Catches*

6.1.2.3.1 Landings

Catch and landings of the sprat in the Black Sea were reported by the Black Sea countries and data from Bulgaria and Romania were collected and reported for the Data Collection Program from National agencies for fisheries and aquaculture in both countries. Mid-water trawl catches dominate the landings.

Landings significantly increased in the last years due to intensification of the sprat fishery in Turkey (2010 toward 2011 the total landings increased with 29 115 t); but also a gradual increase is reported by Bulgaria. Russia. and Ukraine). Romanian catches decreased to 134 tons in 2011 (Table 6.1.2.3.1.1).

Table 6.1.2.3.1.1. Sprat landings in the Black Sea.

	Bulgaria	*Bulgaria	Romania	Romania*	Ukraine	Turkey	Georgia	Russian Federation	Total
1970	1407		2678		353				4438
1971	2473		2517		846				5836
1972	2962		23		884			16	3885
1973	3383		22		878			22	4305
1974	4468		1245		477			23	6213
1975	5565		731		787			43	7126
1976	7199		161		1594			16	8970
1977	8754		1463		4346			2354	16917
1978	10596		149		1949		1	3317	16012
1979	13541		2269		36757		3466	17700	73733
1980	16568		989		47635		4571	14687	84450
1981	1888		2283		49175		5781	20165	79292
1982	16524		3004		3862		2462	15266	41118
1983	12023		3406		20755		886	3843	40913
1984	13921		4456		18021		847	5270	42515
1985	15924		6836		23657		1817	3365	51599
1986	1169		8979		33147		2939	7010	53244
1987	10979		9474		43158		697	8972	73280
1988	6199		6454		39835		7172	7157	66817
1989	7403		8911		63239		9708	16045	105306
1990	2651		3198		33174		6895	6955	52873
1991	1909		729		11094		2313	2675	17082
1992	2353	3266	2074		11492		830	3221	20883
1993	2174	3705	2439		9154	640	32	694	16664
1994	2200	3500	2203		12615	700	308	1013	20339
1995	2874	3200	1982		15218	157	288	1263	22108
1996	3535	3500	2014		20720	937	185	1537	28893
1997	3646	3646	3318		20208	468	85	706	28431
1998	3275	3275	3293		30282	1236	24	1243	39353
1999	3595	3595	1933		29238	421	45	4473	39705
2000	1737	3500	1803		32644	6225	42	5543	49757
2001	695	6961	1792		48938	1008	40	11122	69861
2002	11595	11595	1617		45430	1965	34	11218	71859
2003	9155	9155	1219		31366	5775	2	204	47721
2004	2889	7997	135		30891	5186	12	143	44364
2005	2575	6500	1487		35707	5271	19	1316	50300
2006	2655	8183	492		21308	6681		8157	44821
2007	2559	2985	208		18013	11725		6077	39008
2008	4304	4304	234		21111	39903		7814	73366
2009	4551	4551	92		24603	53385		8744	91375
2010	4041	4041	39		24652	57023		5839	91594
2011	3958		134		24379	87141		5098	120710

EWG 12-16 notes that the landings listed are largely consistent with the quantities submitted to JRC through the DCF 2012 Med and Black Sea data call.

6.1.2.3.2 Discards

No discards of sprat have been reported with the exception of Romanian reports giving figures of sprat discards. Such discards are very low.

6.1.2.4 *Fishing effort*

The following Tables 6.1.2.4.1 and 2 list the fishing effort data received from Member States through the official DCF data call in units of kW*days at sea and number of vessels. According to the first table 76% of the total sprat landings in Bulgarian marine area were realized by fleet segment 24<40 m LOA.

Table 6.1.2.4.1. DCF nominal fishing effort (GT and *kw*days* at sea) associated to the LOA segments and % from the total catch as submitted to JRC through the DCF 2012 Med and Black Sea data call by major gear type 2008-2011 in Bulgaria.

	31.12.2008			**31.12.2009**			**31.12.2010**			**31.12.2011**			**% of tot.catch**
													FAO code
LOA	**vessels**	**GT**	**kW**	**vessels**	**GT**	**kW**	**vessels**	**GT**	**kW**	**vessels**	**GT**	**kW**	**SPR**
0 < 6	846	601	6 606	708	507	5 463	762	546	5 943	773	554	5 987	1
6<12	1 593	3 462	42 117	1 392	2 986	37 160	1 471	3 199	39 925	1 464	3 164	39 730	6
12<18	68	1 318	9 026	65	1 290	9 106	67	1 308	9 275	62	1 200	8 403	11
18<24	29	1 309	4 819	28	1 253	4 774	27	1 214	4 424	25	1 104	4 119	6
24<40	12	1 586	3 304	13	1 665	3 878	13	1 665	3 878	12	1 351	3 069	**76**
TOTAL	**2 548**	**8 276**	**65 871**	**2 206**	**7 702**	**60 380**	**2 340**	**7 931**	**63 444**	**2 336**	**7 373**	**61 307**	

Table 6.1.2.4.2. DCF fishing effort (number of vessels) as submitted to JRC through the DCF 2012 Med and Black Sea data call by major gear type. 2011 in Bulgaria (A) and Romania (B)

COUNTRY	YEAR	QUARTER	VESSEL_LENGTH	GEAR	MESH_SIZE_RANGE	FISHERY	AREA	GT_DAYS_AT_SEA
BUL	2011	-1	VL0006	SB	00D14	MDPSP	SA 29	7195983
BUL	2011	-1	VL0612	FPO	00D14	MDPSP	SA 29	15660
BUL	2011	-1	VL0612	OTM	00D14	MDPSP	SA 29	160684
BUL	2011	-1	VL1218	OTM	00D14	SPF	SA 29	96325
BUL	2011	-1	VL1824	OTM	00D14	MDPSP	SA 29	2718507
BUL	2011	-1	VL2440	OTM	20D40	SPF	SA 29	238

(A)

COUNTRY	YEAR	QUARTER	VESSEL_LENGTH	GEAR	MESH_SIZE_RANGE	FISHERY	GT_DAYS_AT_SEA
ROM	2011	-1	VL2440	OTM	14D16	SPF	8012
ROM	2011	-1	VL2440	OTM	14D16	MDPSP	1290
ROM	2011	-1	VL0612	FPN	14D16	MDPSP	26371
ROM	2011	-1	VL0006	FPN	14D16	MDPSP	151

(B)

6.1.2.5 *Commercial CPUE*

Commercial CPUE *kg.h*$^{-1}$ has decreased in Bulgarian and Ukrainian waters in the 2010-2011. The same trend is detected for the 2010-2011 in Turkey sprat fishery. In Romanian waters a significant drop of CPUE has been observed due to drastic reduction of the fishing fleet (Figure 6.1.1.2.5.1).

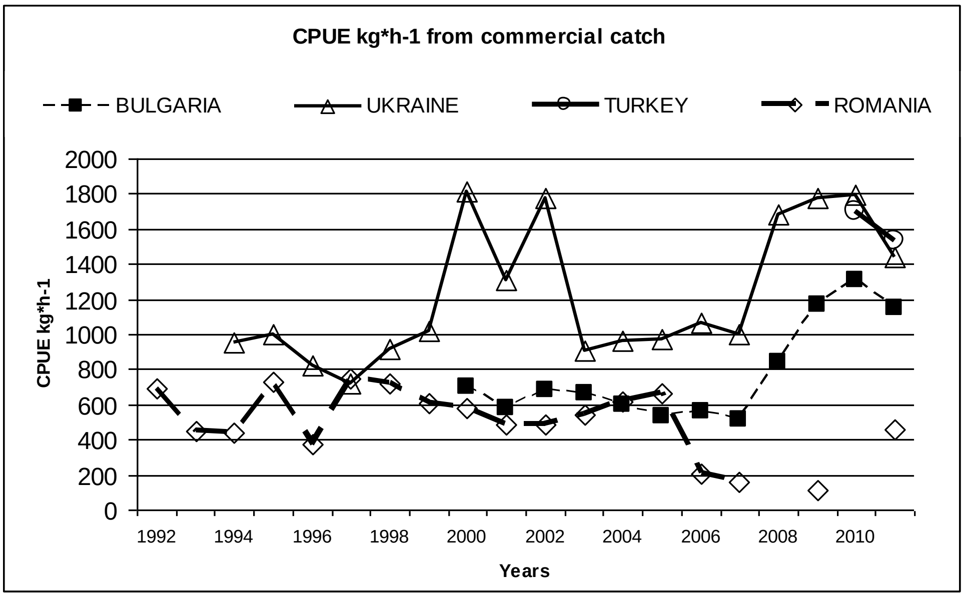


Fig. 6.1.1.2.5.1. CPUE *kg*h*$^{-1}$ derived from commercial fishery in Bulgaria, Ukraine and Romania.

The main fishing gears targeting sprat in Bulgaria are OTM, FPO and BS. The distribution of CPUE to the corresponding fishing fleet segments are presented on Table 6.1.1.2.5.1.

Table 6.1.1.2.5.1. Average CPUE *kg.h*$^{-1}$ of sprat caught by trawls uncovered pound nets and beach seines in Bulgaria. 2011.

	Gear	Fleet segment	CPUE 2008	CPUE 2009	CPUE 2010	CPUE 2011
		0-6	422.44	49.79	150.94	63.5
	FPO	6-12	425	250.8	294.9	333.85
		0-6	174.77	113.95	45.56	128.24
SPR	SB	6-12	195.1	142	74.63	93.03

	6-12	107.8	142.2	241.25	128.29
	12-18	790	1356.25	1967.54	582.12
	18-24	1418.84	1650.86	656.99	592.06
OTM	24-40	2442.48	2457.01	2035.4	1846.63

The Ukraine sprat fishing has been carried out by 16 fishing vessels from March to October 2009.

In the figure 6.1.1.2.5.2 are presented the official landings and effort in terms of vessel number in 1993-2011 in Samsun shelf area. The whole total landing is processed by fish oil and flour fabrics operating in the region.

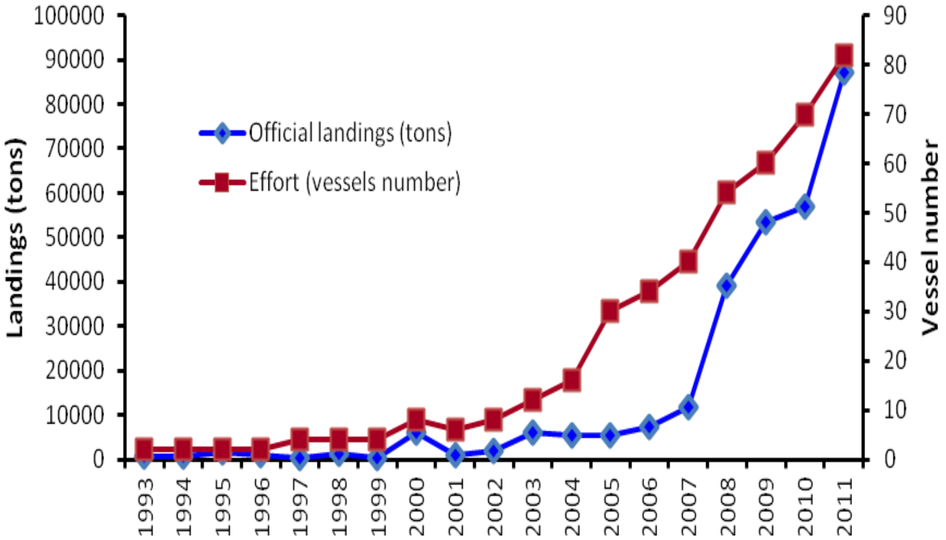


Figure 6.1.1.2.5.2 Data regarding the sprat landing and vessel number in 1993-2011 in Samsun shelf area.

The CPUE in the Turkish waters (Table 6.1.1.2.5.2.) increased in the last years as the highest level was reached in 2011 (for the long term period 1993-2011).

Table 6.1.1.2.5.2 Operating vessels and CPUE in the Turkish waters for sprat (1993-2011)

YRS	Catch	Vessels	CPUE kg/yr/vessel
1993	640	2	320
1994	700	2	350
1995	1570	2	785
1996	937	2	468.5
1997	468	4	117
1998	1236	4	309
1999	421	4	105.3
2000	6225	8	778.1

2001	1008	6	168
2002	2 050	8	256.3
2003	6 025	12	502.1
2004	5 411	16	338.2
2005	5 500	30	183.3
2006	7 311	34	215
2007	11 921	40	298
2008	39 303	54	727.8
2009	53 385	60	889.8
2010	57 023	70	814.6
2011	87 141	82	1062.7

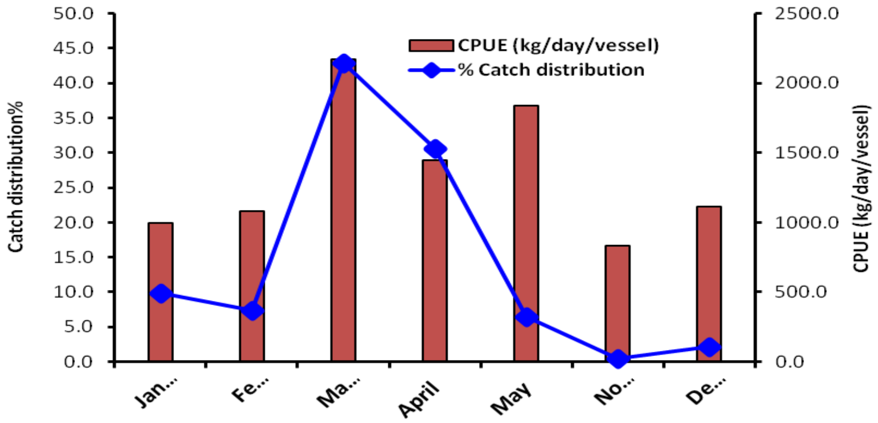


Figure 6.1.1.2.5.3. Yearly catch composition and CPUE values of sprat in 2011.

It is suggested that increase in spring months is possibly related with the vertical migration behaviour of sprat depending on season and sea water temperature (Zengin et al., 2002). Of the landed data in 2011, 80% is obtained between March-May. The relative decrease in May is related with the fishery ban starting at 15 May. Of the total catch, 40% and 30% was landed in March and April respectively. Controversially, CPUE decreased to its minimum in winter. During the whole fishing period, the lowest catch was landed at the beginning of the period as 0.5% for November and 2% for December. The rate of total catch in January was 9.8% and 7.4% for February.

At 15 May, though the catch is profitable, by the alteration of legal fishery depth to 36m, already ‘tired” fisherman prefer to finish the fishery in the first week or up to 10th of May and took their vessels to ports for maintenance. However, CPUE was estimated as 1.8 ton/hour/vessel for May reflecting the general trend of spring season. The maximum CPUE was estimated as 2.2 ton/hour/vessel for March.

The sprat production tends to increase slightly by the beginning of 2000s, remarkably by 2006 and reaches nearly ten times by 2011.

The Features of Pelagic Fishery Fleet in Turkey

Pelagic trawl vessels are generally 18-30 m in length. The frequency distribution of sprat fishing vessels in size is presented in Figure 6.1.1.2.5.4 and the frequency distribution of engine power in Figure 6.1.1.2.5.5. Though the number of vessels licensed for pelagic fishery is totally 120, only 82 of them actively operated in 2011/12 fishing period.

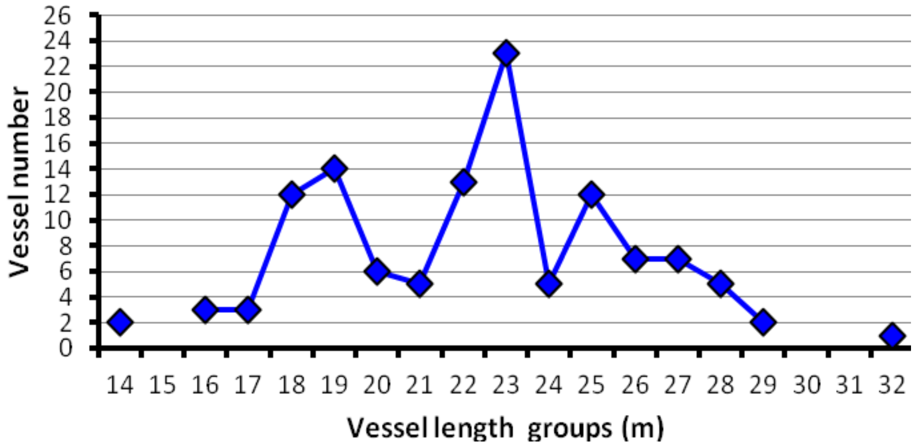


Figure 6.1.1.2.5.4. The frequency distribution of pelagic fishery vessels in size.

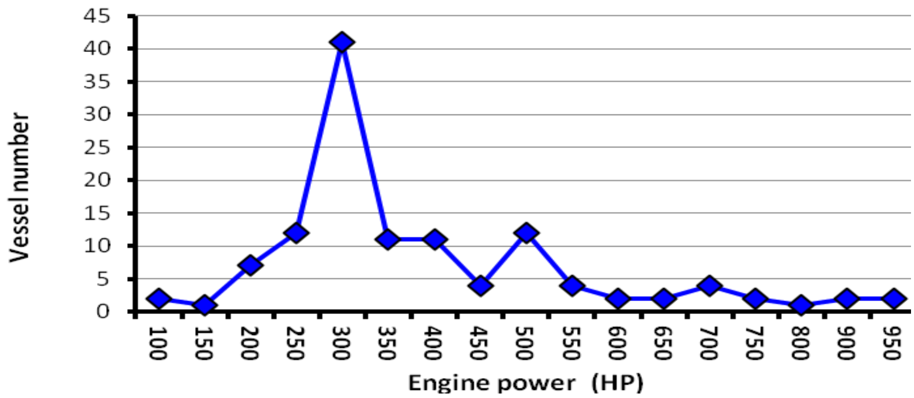


Figure 6.1.1.2.5.5. The frequency distribution of engine power in pelagic fishery fleet.

Actually, the fleet is dynamic and the number of vessels operating on sprat changes in years.

The smallest of these licensed vessels was 14.9 m and the biggest is 32.2 m. Mean length was estimated as 22.7 cm. 71.1% of vessels are over 20m length and the rest percent 28.3 are 19 m and below. The size distribution has a mode around 22 and 23 m lengths. Engine power ranges between 140 HP and 970 HP. The mean engine power of this fleet is approximated as 415.7 HP and the mode appears around 300 HP.

Composition of CPUE

The monthly composition of sprat total landing and CPUE values for 2011 estimated for Samsun shelf area is presented in Table 6.1.1.2.5.3. The mean landing is nearly 10 tons/day per vessel (Table 6.1.1.2.5.3.). The individual experience of fisherman and the quality of technical equipment of the vessel are determinative in the amount of daily catch. Sprat catch reaches its maximum especially in spring months; especially between March-May.

Table 6.1.1.2.5.3. The monthly composition and CPUE values of sprat landing from Samsun shelf area in 2011.

Months	Landing (kg)	Catch composition(%)	CPUE (kg/vessel/day)	CPUE *(kg/vessel/hour)
January	8578.3	9.8	7975.9	997.0
February	6414.7	7.4	8672.5	1084.1
March	37409.7	42.9	17369.5	2171.2
April	26733.1	30.7	11556.9	1444.6
May	5615.7	6.4	14683.9	1835.5
November	456.6	0.5	6683.1	835.4
December	1932.9	2.2	8891.4	1111.4

* The active operation duration of a vessel is generally 8 hours.

The maximum CPUE has been recorded in June-July (Tab. 6.1.2.5.7).

Table 6.1.1.2.5.4. CPUE *kg/h* *1000 of Ukrainian fishing vessels. 1996-2011 (Shlyakhov *et al*., 2012)

Ukrainian commercial fleet CPUE $kg*h^{-1}$ by years and quarters					
	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	average
1996	0.41	0.96	1.27	0.64	0.82
1997	0.36	0.84	1.11	0.56	0.72
1998	0.46	1.08	1.42	0.72	0.92
1999	0.50	1.20	1.58	0.80	1.02
2000	0.85	2.22	2.80	1.41	1.82
2001	0.65	1.55	2.00	1.03	1.31
2002	0.85	2.12	2.75	1.39	1.78
2003	0.45	1.10	1.45	0.65	0.91
2004	0.40	1.20	1.50	0.75	0.96
2005	0.48	1.10	1.55	0.75	0.97
2006	0.50	1.25	1.67	0.85	1.07
2007	0.45	1.20	1.55	0.80	1.00
2008	0.83	2.00	2.60	1.30	1.68
2009	0.85	2.10	2.75	1.40	1.78
2010	0.80	2.15	2.80	1.40	1.79
2011	0.55	1.77	2.17	1.15	1.44

6.1.3 Scientific Surveys

6.1.3.1 *Method 1: International (Bulgarian and Romanian) hydroacoustic survey (Nov-Dec, 2011)*

Stratified sampling methodology was applied in Bulgarian (for the period of 2007-2010 by Raykov *et al.* 2007; Raykov, 2008; Raykov *et al*., 2008;Raykov *et al*., 2009; Raykov *et al*., 2010; Raykov *et al*.,2011). and Romanian waters (Radu *et al*., 2010a; Radu *et al*., 2010b;Radu *et al.*, 2010c).Taking into account exact depths (isobaths), the whole area was divided to sub areas,. “strata”, depending on depth: first stratum 15-35 – second 35- 50 m., third 50-75m, and fourth 75-100m. The examined area was divided into equal sized fields - with total number 55; each sector equal to about 63 $км^2$ (5' Lat. × 5' Long.). The trawling activities were carried out in meridian direction. The duration of each haul was 60 min; average velocity 2.8 knots (5.19 $km* h^{-1}$). Biological data collection using mid-water trawl supply scientists with valuable information of population parameters such as size, age, sex composition, condition (Fulton’s coefficient) and relative indices of abundance used in tunning later in the analysis. The CPUE derived from pelagic surveys was used for tunning series in the ICA for sprat.

The acoustic survey was accomplished under National Data Collection Programs of Bulgaria and Romania for 2011 during the period 15th November – 6th December 2011 with duration of 20 working days (Panayotova et.al, 2012). The survey covers partially the territorial waters and EEZ of Bulgaria and Romania in FAO GSA 29 – Black Sea. The study area includes continental shelf and slope up to 2000 m in front of Bulgarian and Romanian coasts. The design for the acoustic sampling was adapted to the characteristics of the spatial structures of small pelagic fish in the Black Sea as well as the peculiarities in the topography. The survey design includes parallel transects, perpendicular to bathymetry with inter-transect distance of 5 nm – Fig. 6.1.3.1.1, to achieve the minimization of the coefficient of variation of the acoustic estimates for the target species (Panayotova *et.al*, 2012).

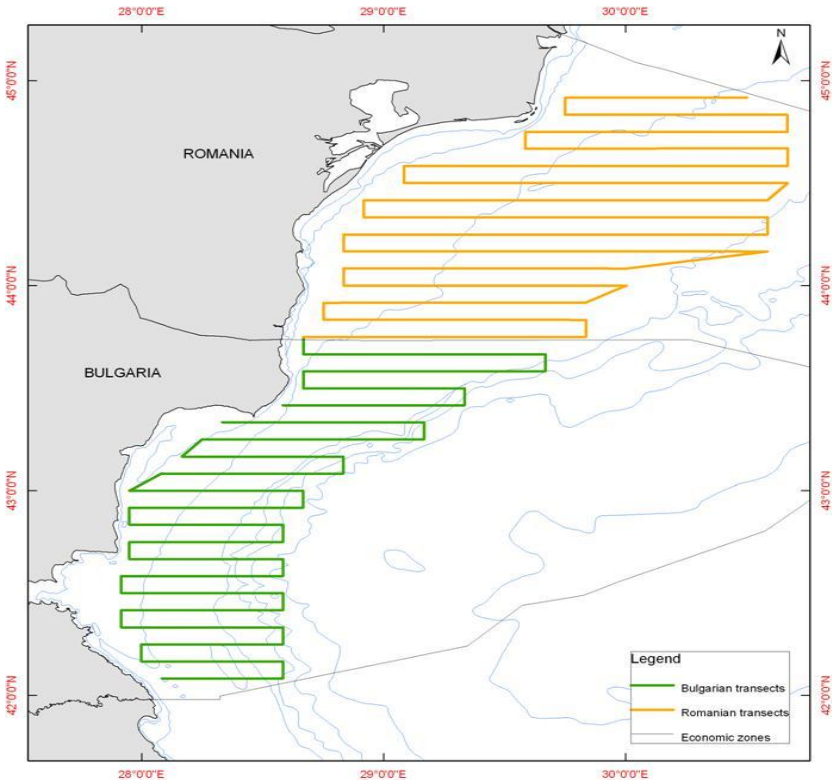


Figure 6.1.3.1.1. Acoustic survey design (Panayotova et.al, 2012).

Time for acoustic sampling was Day time & Night time. The echo allocation into species was based on school shape identification during the daytime and trawl data – during the night time. The vessel speed was adjusted depending on vessel noise at 7.5 - 8.5 knots and recommendations of ICES-WGFAST (WGFAST 2006). The transects were extended to the coast as close as possible with minimum possible bottom depth (min, m) of 20 m due to RV "Akademik" size and depth limitations. The minimum echo sounding depth (min, m) was 20 m and the maximum – 200 m. The Elementary Distance Sampling Unit (EDSU) for echo integration was set at 1 nautical mile (NM). The acoustic energy in the inter-transect tracks was not taken into account for assessment purposes.

The echo-sampling was performed by multi-frequency echosounder (38, 120, and 200 kHz) SIMRAD EK60 configured with split-beam transducers (Simrad ES38B, ES120-7C and ES200-7C, respectively). Operational parameters for the 38 kHz echosounder were a 1ms pulse duration and ping interval – maximum depending on depth. The acoustic data are indexed by time and geographic position using navigational data from a GPS receiver input to the echosounder software (Simrad ER60). The threshold set to - 80 dB for data acquisition and - 70 dB for data processing. The frequency for assessment was 38 kHz, while the 120 and 200 kHz operated as complementary frequencies. Standard sphere acoustic system calibration was made prior and at the end of the survey for measure acoustic system performance at each frequency. Acoustic data were collected with Simrad ER60 software and subsequently analyzed on LSSS software.

The fish samples were taken by using of scientific mid-water trawl with mesh size of codend of 5 mm (10 mm bar length). The trawling depth and the vertical net opening were controlled by ITI Trawl Eye net sound. The trawl depth was chosen in accordance to the indications on the echogram. The speed 3.0 - 3.3 knots and the vertical net opening of about 20 - 30 m was achieved during the trawling. The trawling time was set at 30 minutes. For each haul, species composition was examined and sub-samples were taken to determine the length composition, mean weight at length-class, ALKs for target species and species composition. Environmental sampling was carried out together with each haul, covering:

- Zooplankton sampling by Juday Net
- Temperature of sea water by depths
- Salinity by depths – by CTD system
- Oxygen by depths – determined in laboratory conditions.

The target species of the survey were European sprat (*Sprattus sprattus*) and whiting (*Merlangius merlangus*).The echo partitioning into species was based on echogram visual scrutinisation. This was done either by direct allocation based on the identification of individual schools and allocation on account of representative fishing stations (Panayotova et.al, 2012).

Following the results from the survey, abundance indices of the species sprat, whiting and horse mackerel were estimated by 3 strata (Panayotova et.al, 2012). As a result from fishing hauls, mono-specific catches were observed in 89.47 % of hauls, composed by sprat over 75% of total weight (Panayotova et.al, 2012). Estimated relative sprat biomass is 48 201.70 t in the investigated area, from which biomass of mature fish amounts of 48 173.18 t (Panayotova et.al, 2012) – Table 6.1.3.1.1.

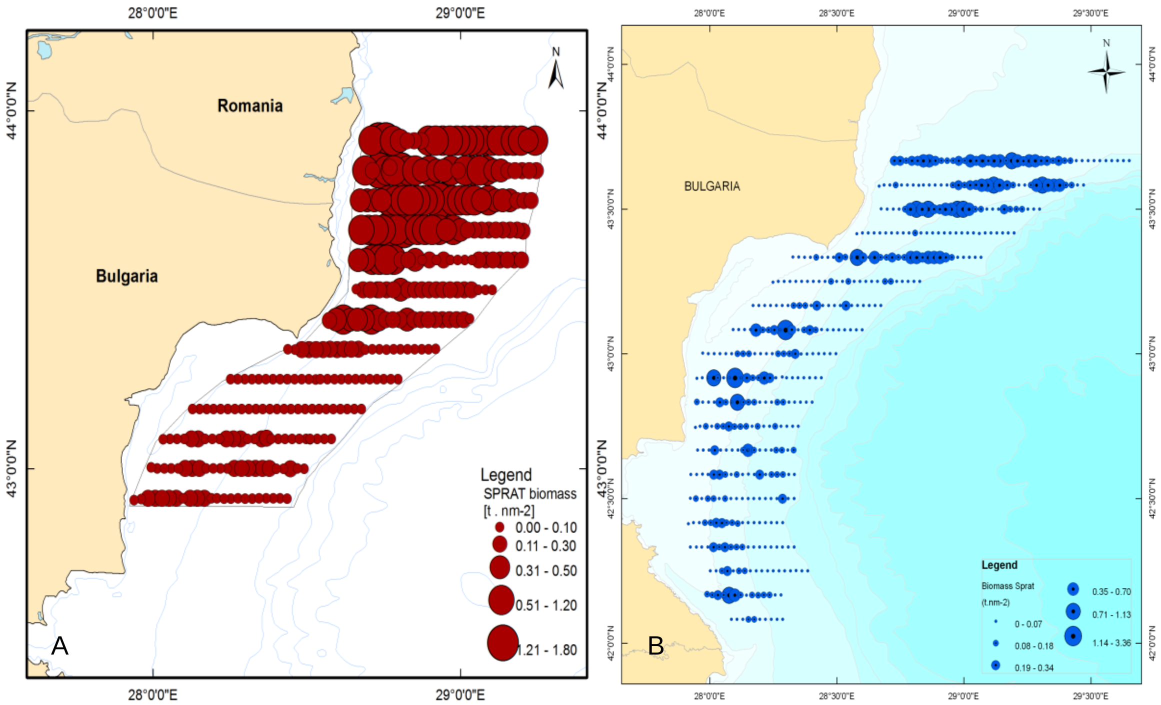
Table 6.1.3.1.1 Estimated relative biomass (tones) of sprat by age groups and polygons, November - December 2011.

Polygon	**Total (t)**	**Age**				
		0	**1**	**2**	**3**	**4**
1	8827.96		2807.42	4576.26	1444.28	
2	30776.65	24.83	11696.45	15123.44	3898.82	33.11
3	8597.092	3.69	4523.81	3526.73	542.86	
Total	**48201.70**	**28.52**	**19027.68**	**23226.43**	**5885.96**	**33.11**

6.1.3.1.1 Geographical distribution patterns

Sprat in Bulgarian Black Sea area

Sprat distribution pattern was studied during the acoustic surveys in 2010 and 2011 (Panayotova, 2011, 2012). In 2011, sprat schools were found scattered over most of the surveyed area. Their main concentrations were found on northern (Kaliakra – Shabla) and central (Obzor – Kamchia) areas with NASC values range between 12 – 31 ($m^2.nm^{-2}$) and, to a lesser extent, in the southern (Fig. 6.1.3.1.1.1).



Figure

Figure 6.1.3.1.1.1. Distribution map of sprat relative biomass along Bulgarian coast, obtained during the

acoustic surveys in November – December (A) 2010 and (B) 2011 on board of R/V “Akademik” (Panayotova, 2011, 2012).

6.1.3.1.2 Trends in abundance at length or age

Due to change in the fishing gear and method for stock assessment for sprat in 2011, we were unable to compare abundance indices with the previous assessments (in line with the previous indices derived in pelagic trawl surveys).

In 2011, 9316 individuals of sprat, caught during acoustic survey in Bulgarian area, were measured and the length distribution by hauls is given on Fig. 6.1.3.1.2.1 (Panayotova et.al, 2012).

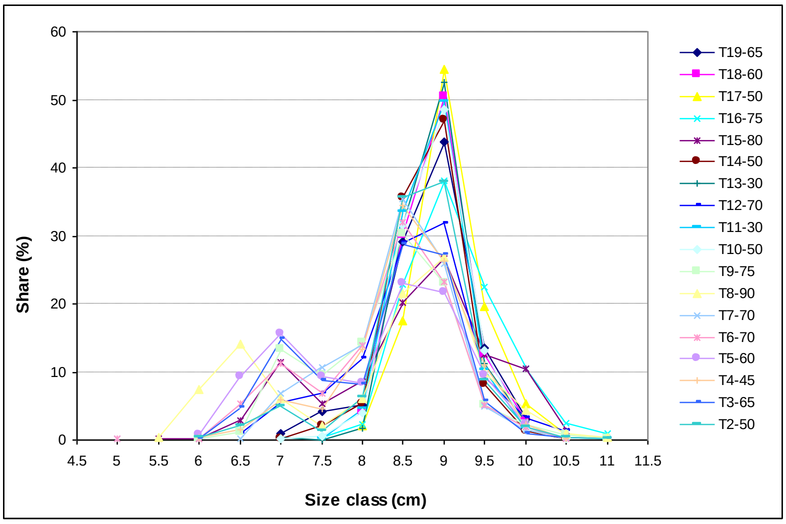


Figure 6.1.3.1.2.1. Length distribution of Sprat (*Sprattus sprattus*) by hauls during acoustic survey along Bulgarian coast in 2011.

Size structure of sprat catches during the survey encompasses fish with total lengths between 5 and 11 cm. Two maxima of abundance in length classes were distinguished - in 7 cm and 9 cm, which correspond mainly to age groups 1 and 2 – Fig. 6.1.3.1.2.1. The average length of all measured fish over all hauls was estimated at 8.59 cm.

6.1.3.1.3 Trends in growth

Length has bimodal distribution in terms of (85-90mm) and (90-95mm). Sub dominated are the ranges 80-85 and 95-100mm.

6.1.3.1.4 Trends in maturity

No trends in maturity were estimated.

No analyses were conducted in 2011.

6.1.3.1.5 Abundance and biomass

Estimated abundance and biomass of sprat in the Turkish Black Sea area (Zengin, Gumus, 2012) are presented in Table 6.1.3.1.1.

Abundance indices were estimated by ‘swept area method’ for the period of intense fishing (March-May) from commercial vessels (Sparre and Venema, 1992). The mean abundance index is estimated as 4178.3±1018.3

kg/km^2 in trawl samplings conducted between 50-100 m (minimum 42.7 m, maximum 83.0 m) depths along Samsun shelf area in spring 2011 (Table 6.1.3.1.2.1).

Table 6.1.3.1.2.1 Descriptive data regarding abundance indices of sprat for spring 2011 in Samsun shelf area (Turkey).

Mean Abundance index (kg/km^2)	Minimum-maximum kg/km^2	Standard error	No of hauls (N)	Depth range (m)
4178.3	820.7-15917.1	±1018.3	14	50-100

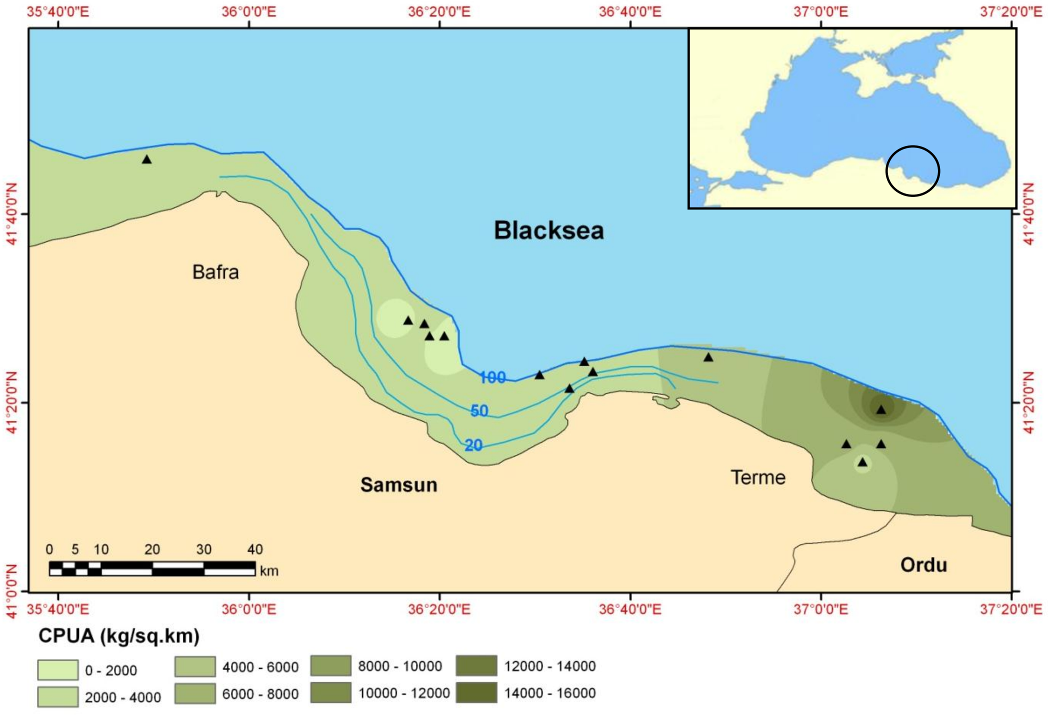


Figure 6.1.3.1.2.1 Distribution of sprat CPUA kg/km^2 for spring 2011 along Samsun Shelf Area (Turkey).

The relative biomass (tones) of sprat by age groups and polygons were presented (Table 6.1.3.1.1). The bulk of the biomass were distributed between age 1 and 2. The oldest age group estimated in this research belong to 4 years. No five years old specimens were found in this research.

6.1.4 Assessment of historic parameters

6.1.4.1 *Method 1: ICA*

6.1.4.1.1 Justification

We used Integrated Catch-at-age Analysis (ICA; Patterson and Melvin, 1996). ICA is a statistical catch-at-age method based on the Fournier and Deriso models (Deriso et al., 1985). It applies a statistical optimization procedure to calculate population numbers and fishing mortality coefficients-at-age from data of catch numbers-at-age and natural mortality. The dynamics of a cohort (generation) in the stock are expressed by two non-linear equations referred to as a survival equation (exponential decay) and a catch equation:

$N_{a+1,y+1} = N_{a,y} * exp(-F_{a,y} - M),$

$C_{a,y} = N_{a,y} * [1 - exp(-F_{a,y} - M)] * F_{a,y} / (F_{a,y} + M),$

where C, N, M, and F are catch, abundance, natural mortality, and fishing mortality, respectively, and a and y are subscript indices for age and year.

The algorithm initially estimates population numbers and fishing mortality fitting a separable model, when F is assumed to conform to a constant selection pattern (fishing mortality-at-age), but fishing mortality by year is allowed to vary. The F matrix is then modelled as a multiplication of the year-specific F and the specified selection pattern. This procedure substantially diminishes the number of parameters in the model.

In its second stage, the ICA algorithm minimizes the weighted Sum of Square Residuals (SSR) of observed and modelled catch and relative abundance indices (CPUE), assuming Gaussian distribution of the log residuals:

$min\ [\sum_{a,y} pc_{a,y} (log\ C_{a,y} - log\ \hat{C}_{a,y})^2 + \sum_{a,y,f} pi_{a,f} (log\ I_{a,y,f} - log\ \hat{I}_{a,y,f})^2,$

where C, Ĉ, I, and Î are observed and estimated catch and age-structured index, respectively, and a, y, and f are subscript indices for age, year, and fleet, respectively. Weights associated with catches and different indices (pc, pi) are ideally set equal to the inverse variances of catch and index data, and can be calculated based on the residuals between modelled and observed values. However, weights are usually set by the user on the basis of some information about the reliability of different indices and current experience with modelling the stock. Indices are defined as related to population numbers by the equations:

$\hat{I}_{a,y} = N_{a,y} * exp(-F_{a,y} - M)$

$\hat{I}_{a,y} = q_a * N_{a,y} * exp(-F_{a,y} - M)$

$\hat{I}_{a,y} = q_a * (N_{a,y} * exp(-F_{a,y} - M))^{k}{}_{a}\ .$

The two unknown parameters (qa, an age-specific catchability, and k, a constant) are estimated according to the assumed relationship between the population and the abundance index, which has to be specified as being one of the above – identity, linear, or power, respectively.

ICA combines the power and accuracy of a statistical model with the flexibility of setting different options of the parameters (e.g. a separable model accounting for age effects) and for this raison is suitable for a short living species (age 5 at maximum) such as the Black Sea sprat. ICA has previously been applied to Black Sea sprat by Daskalov (1998), Pilling et al. 2008, and Daskalov et al. 2010.

6.1.4.1.2 Input parameters

Catch and weight at age, natural mortality, and 4 age structured indices are used to run ICA (Table 6.1.4.1.2.1).

Total catch at age data were compiled by summing catch at age matrices from Bulgaria, Romania, Russia, Turkey and Ukraine. Catch at age matrix from Russia was derived by applying age composition and mean weight in the catch of Ukraine to Russia catch. Tuning index from the Bulgarian Pelagic Trawl Survey (PTS) was applied for 2007-2010 (Table 6.1.4.1.2.1).

Table 6.1.4.1.2.1. Sprat input parameters.

```
Output Generated by ICA Version 1.4
 ----------------------------------

        SPRAT 2011
        ----------

        Catch in Number
        ---------------
```

AGE	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
0	51.	255.	115.	21.	108.	278.	236.	1009.	406.	809.	415.	1202.	445.	528.	1158.
1	2673.	2673.	2072.	1712.	2496.	2741.	2278.	3838.	4877.	10352.	6829.	5654.	6878.	6024.	5976.
2	2114.	1453.	2182.	2792.	2773.	2600.	2831.	3086.	3340.	6646.	7655.	5454.	3580.	4652.	2705.
3	528.	218.	442.	418.	579.	830.	1741.	1302.	1313.	1269.	3090.	3024.	2666.	1602.	785.

4	96.	14.	13.	13.	17.	43.	82.	121.	110.	109.	182.	674.	278.	372.	92.
5	7.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

x 10 ^ 6

Catch in Number

AGE	2007	2008	2009	2010	2011
0	3180.	1299.	1558.	2934.	2581.
1	5351.	7774.	12266.	7940.	10080.
2	1876.	3248.	7833.	7120.	12677.
3	802.	1327.	3278.	4378.	8236.
4	113.	168.	369.	316.	377.
5	0.	0.	0.	6.	14.

x 10 ^ 6

Predicted Catch in Number

AGE	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
0	656.	857.	747.	1132.	1056.	1233.	1367.	1826.	1656.	2581.
1	6528.	5268.	4539.	5935.	4800.	4652.	7085.	14947.	11706.	15319.
2	6084.	6716.	3511.	4407.	3083.	2771.	3610.	9828.	11243.	11237.
3	3241.	3188.	2187.	1630.	1064.	917.	1168.	2548.	3304.	4241.
4	172.	529.	297.	311.	105.	90.	117.	269.	246.	377.

x 10 ^ 6

Weights at age in the catches (Kg)

AGE	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
0	.001700	.001700	.002300	.002500	.002500	.002300	.002400	.002800	.002300	.001700	.001800	.001700	.001900	.002100	.002000
1	.002100	.002500	.003400	.003800	.003800	.003300	.004000	.003200	.003500	.002500	.002700	.002800	.002900	.003500	.003300
2	.004500	.003600	.004000	.004600	.005200	.004900	.005100	.005000	.004500	.004000	.004100	.004000	.004400	.004700	.004300
3	.006800	.006000	.004700	.005400	.006000	.006300	.007600	.006500	.006000	.006300	.005800	.006100	.006000	.006200	.006000
4	.008600	.007700	.007700	.006900	.007400	.007200	.009400	.007300	.007800	.006900	.007700	.006800	.007300	.007700	.007300
5	.010800	.010800	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000

Weights at age in the catches (Kg)

AGE	2007	2008	2009	2010	2011
0	.001700	.002300	.002400	.002100	.002100
1	.003300	.003400	.003100	.002900	.002700
2	.004900	.004300	.004000	.004400	.003700
3	.007200	.005200	.004900	.006500	.004600
4	.008700	.007000	.006000	.008000	.008700
5	.010000	.010000	.010000	.016000	.000000

Weights at age in the stock (Kg)

AGE	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
0	.001700	.001700	.001000	.001000	.001000	.001000	.001000	.001000	.001000	.001000	.001000	.001000	.001000	.001000	.001000
1	.002100	.002500	.003500	.003300	.002800	.002700	.003400	.002500	.003200	.003500	.003600	.003500	.003400	.003600	.003600
2	.004500	.003600	.004100	.004300	.004300	.004700	.004600	.004700	.004400	.004400	.004500	.004400	.004400	.004600	.004600
3	.006800	.006000	.004800	.004800	.004700	.005700	.006400	.005900	.005600	.005200	.006100	.005900	.006000	.006100	.005700
4	.008600	.007700	.006200	.005500	.005300	.006900	.008200	.007300	.007200	.006700	.007400	.007400	.007200	.007400	.007400
5	.010800	.010800	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000	.010000

Weights at age in the stock (Kg)

AGE	2007	2008	2009	2010	2011
0	.001000	.001000	.001000	.001000	.001000
1	.003600	.003100	.003100	.002500	.003000
2	.004700	.004200	.004100	.003500	.004000
3	.006300	.005600	.004700	.004500	.004800
4	.007600	.007000	.005400	.007100	.007300
5	.010000	.010000	.010000	.016000	.010000

Natural Mortality (per year)

AGE	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
0	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000	0.64000
1	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000
2	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000

3	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000
4	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000
5	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000	0.95000

Natural Mortality (per year)

AGE	2007	2008	2009	2010	2011
0	0.64000	0.64000	0.64000	0.64000	0.64000
1	0.95000	0.95000	0.95000	0.95000	0.95000
2	0.95000	0.95000	0.95000	0.95000	0.95000
3	0.95000	0.95000	0.95000	0.95000	0.95000
4	0.95000	0.95000	0.95000	0.95000	0.95000
5	0.95000	0.95000	0.95000	0.95000	0.95000

Proportion of fish spawning

AGE	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Proportion of fish spawning

AGE	2007	2008	2009	2010	2011
0	0.0000	0.0000	0.0000	0.0000	0.0000
1	1.0000	1.0000	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000

AGE-STRUCTURED INDICES

Bul

AGE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	9.78	19.59	41.06	53.32	52.36	101.06	96.51	87.64	69.14	73.95	80.74	58.86	73.12	65.32	77.50
2	57.49	48.77	38.16	28.37	58.52	30.60	68.95	60.47	66.09	64.79	54.65	38.78	38.98	37.62	70.25
3	16.27	7.36	9.45	6.21	5.28	4.54	6.28	3.43	21.45	18.67	19.65	13.08	7.58	11.60	50.73
4	0.25	0.23	0.59	0.61	0.54	0.30	0.61	0.20	1.16	3.34	4.85	1.31	2.35	1.98	5.04

x 10 ^ 3

Bul

AGE	2009	2010	2011
1	125.36	81.34	57.04
2	109.76	88.80	62.24
3	37.33	68.20	45.51
4	5.98	7.80	6.75

x 10 ^ 3

Ukr

AGE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	124.38	80.94	111.12	58.09	59.67	97.40	222.49	193.27	158.30	76.22	125.47	113.57	180.31	127.15	284.84
2	74.90	103.68	118.27	50.40	68.14	85.43	146.35	118.28	179.30	76.02	46.40	88.14	69.18	24.19	55.49
3	8.05	9.43	9.43	10.52	46.52	37.49	66.40	22.53	76.56	47.52	54.76	29.98	24.67	16.90	37.53
4	0.51	0.14	0.66	0.72	2.36	0.56	6.10	2.15	4.65	10.87	5.06	8.06	2.52	0.10	3.07

x 10 ^ 3

Ukr

AGE	2009	2010	2011
1	335.38	352.09	253.76
2	143.30	67.33	70.76
3	37.47	4.84	14.37
4	0.66	0.24	0.11

x 10 ^ 3

Bul survey

AGE	2007	2008	2009	2010
1	19352.	44034.	55081.	88238.
2	30667.	40393.	55722.	84987.
3	25733.	12928.	40543.	53350.
4	999.	1081.	9585.	749.

6.1.4.1.3 Results

ICA was run assuming a constant selection pattern in 2002-2011 (Fig. 6.1.4.1.3.1, Table 6.1.4.1.3.1) with reference F at age 2 and Selection at the last 'real' age (S4) equal 1.

The results of the ICA show a reasonable agreement with tuning data (Fig. 6.1.4.1.3.3. Fig. 6.1.4.1.3.4. Fig. 6.1.4.1.5.). The overall fit and partial SSR converged to unique minima (Fig. 6.1.4.1.3.6).

Shrinking of the terminal Fs in the last year was applied using the last 5 years of the originally estimated F matrix (Table 6.1.4.1.3.1.).

The analysis of the main population parameters (abundance, catch, fishing mortality, Fig. 6.1.4.1.3.6. Table 6.1.4.1.3.1.) shows that the sprat stock has recovered from the depression in the 1990s due to good recruitment in 1999-2001 and the biomass and catches have gradually increased over the 1990s and during the 2000s reached levels comparable to the previous period of high abundance 1975-1989 (Fig. 6.1.4.1.3.8). The stock estimates reveal the cyclic nature the sprat population dynamics. The years with strong recruitment were followed by years of low to medium recruitment which leads to corresponding changes in the the Spawning Stock Biomass (SSB). High fishing mortalities (F_{1-3}) were observed during the stock collapse in the early 1990s, in 2004-2005, and 2009-2011. In 2011 the highest ever total catch of 120 710t (Table 6.1.2.3.1.1) was recorded due mainly to the intensive development of the Turkish sprat fishery. Over the last 4 years the levels of recruitment, biomass and catches are comparable with the highest figures reported, but in 2009-2011 a decreasing trend in recruitment becomes evident (Fig. 6.1.4.1.3.6.).

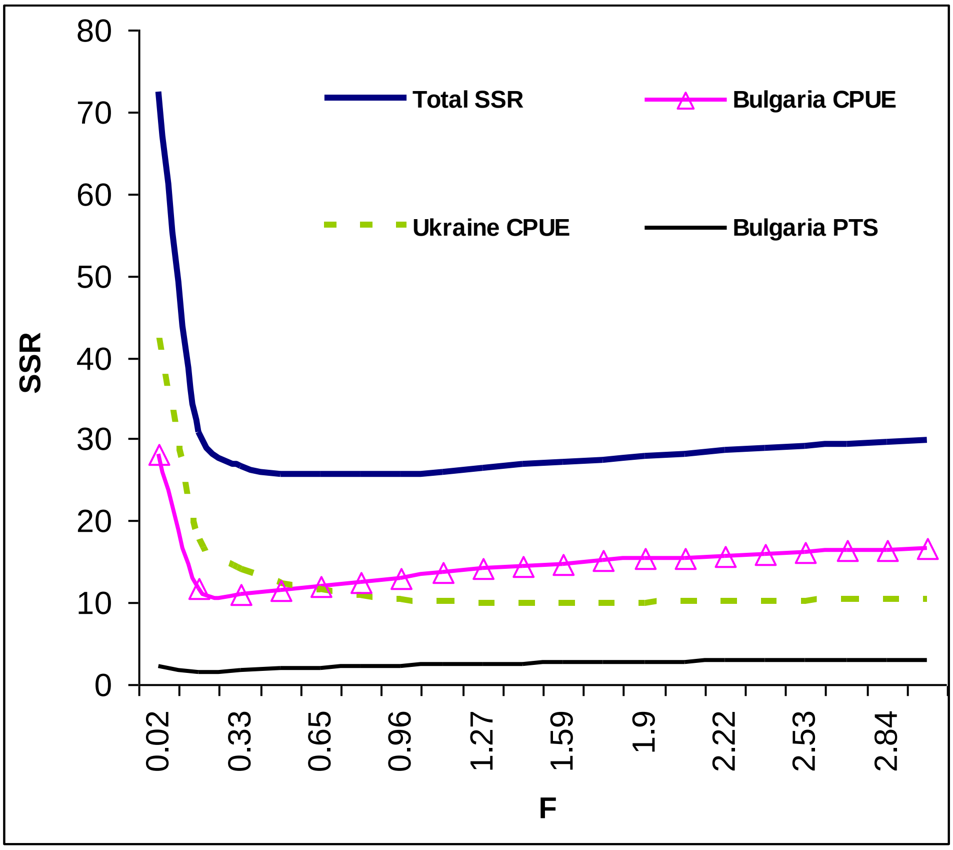


Fig. 6.1.4.1.3.1. Trajectories of the total Sum of Squared Residuals (SSR) and the partial SSRs of the two tuning fleets as functions of the reference F.

Fig. 6.1.4.1.3.2. Selection pattern estimated by the separable model

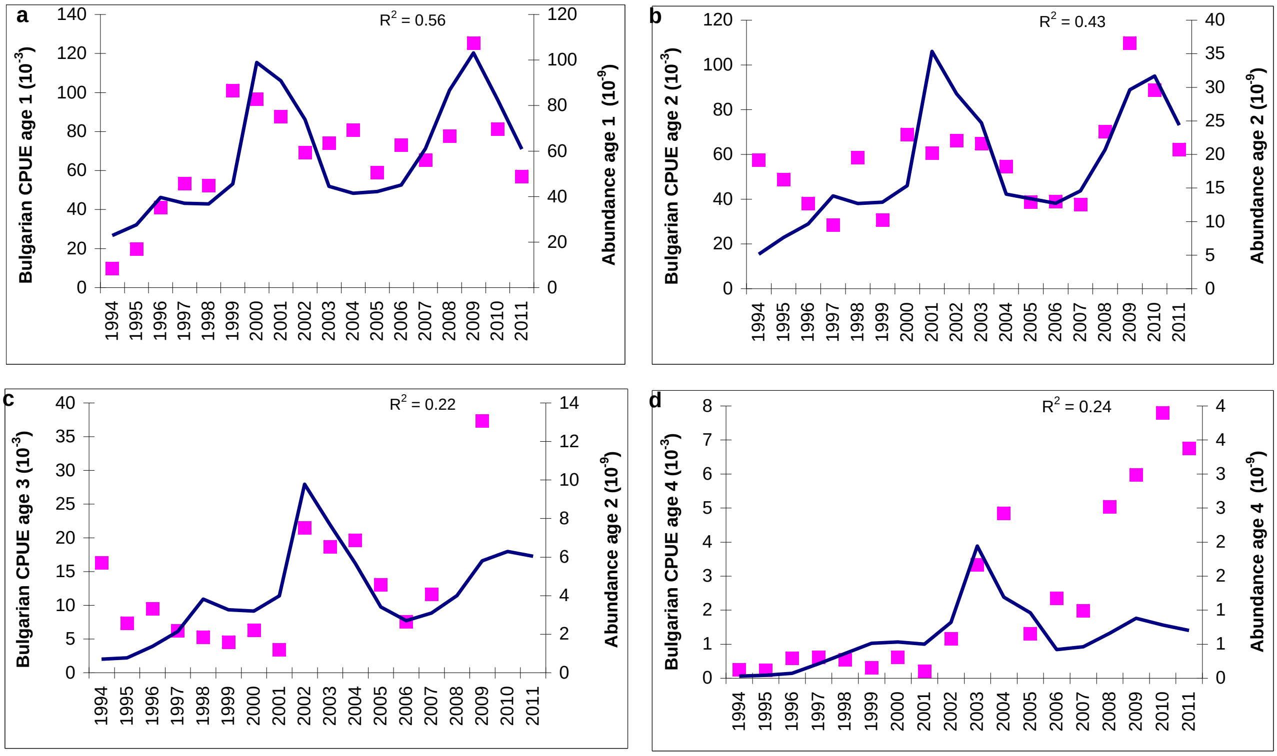


Fig. 6.1.4.1.3.3. Adjustment of ICA: time-series of estimated abundance-at-age and age-structured Bulgarian CPUE (best fit is given by linear relationships and r^2 are displayed): (a) Age 1, (b) Age 2, (c) Age 3, (d) Age 4.

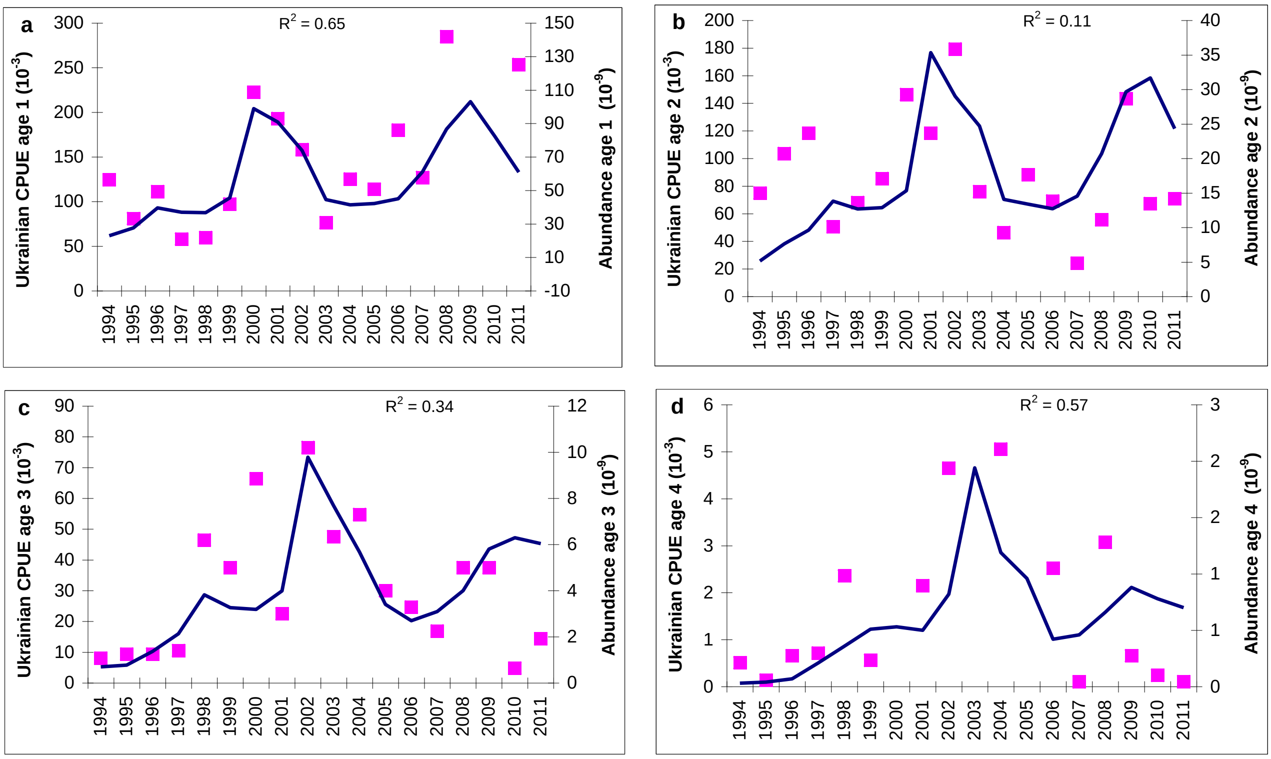


Figure 6.1.4.1.3.4. Adjustment of ICA: time-series of estimated abundance-at-age and age-structured Ukrainian CPUE (best fit is given by linear relationships and r^2 are displayed): (a) Age 1, (b) Age 2, (c) Age 3, (d) Age 4.

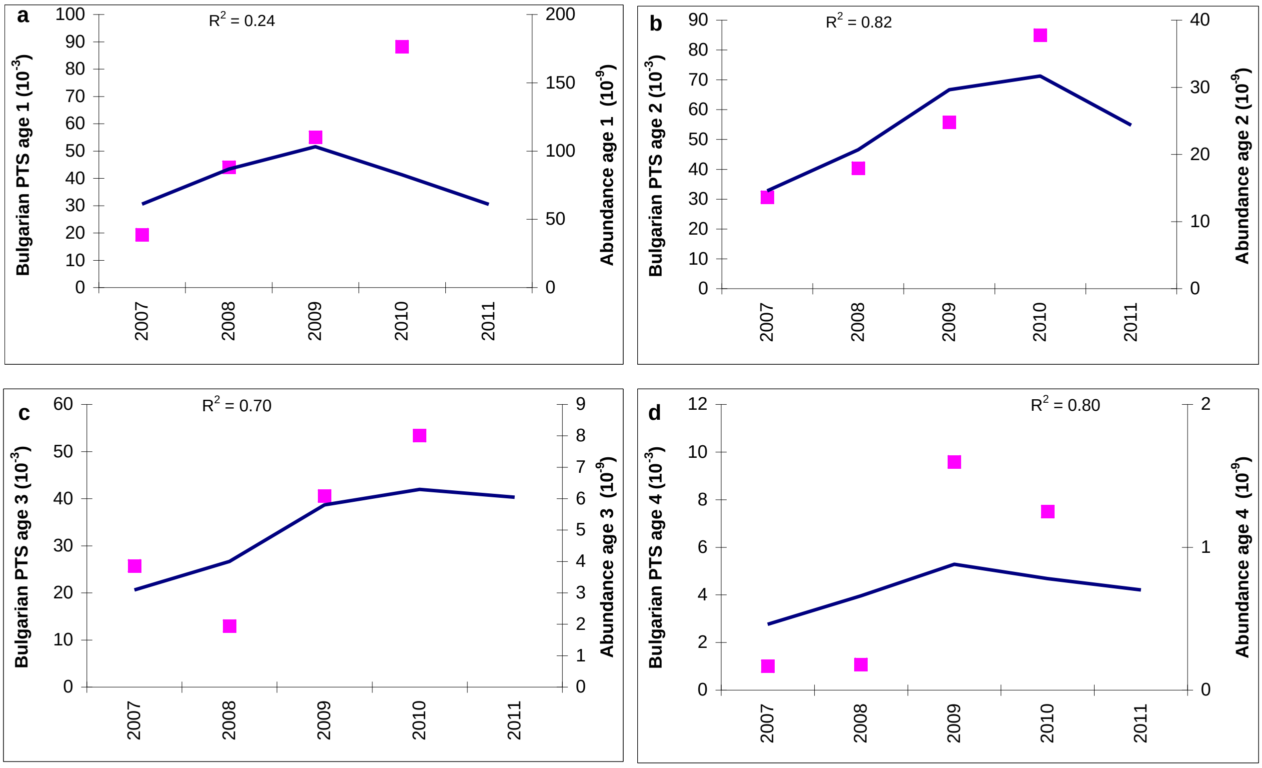


Figure 6.1.4.1.3.5. Adjustment of ICA: time-series of estimated abundance-at-age and age-structured Bulgarian PTS (best fit is given by linear relationships and r^2 are displayed): (a) Age 1, (b) Age 2, (c) Age 3, (d) Age 4.

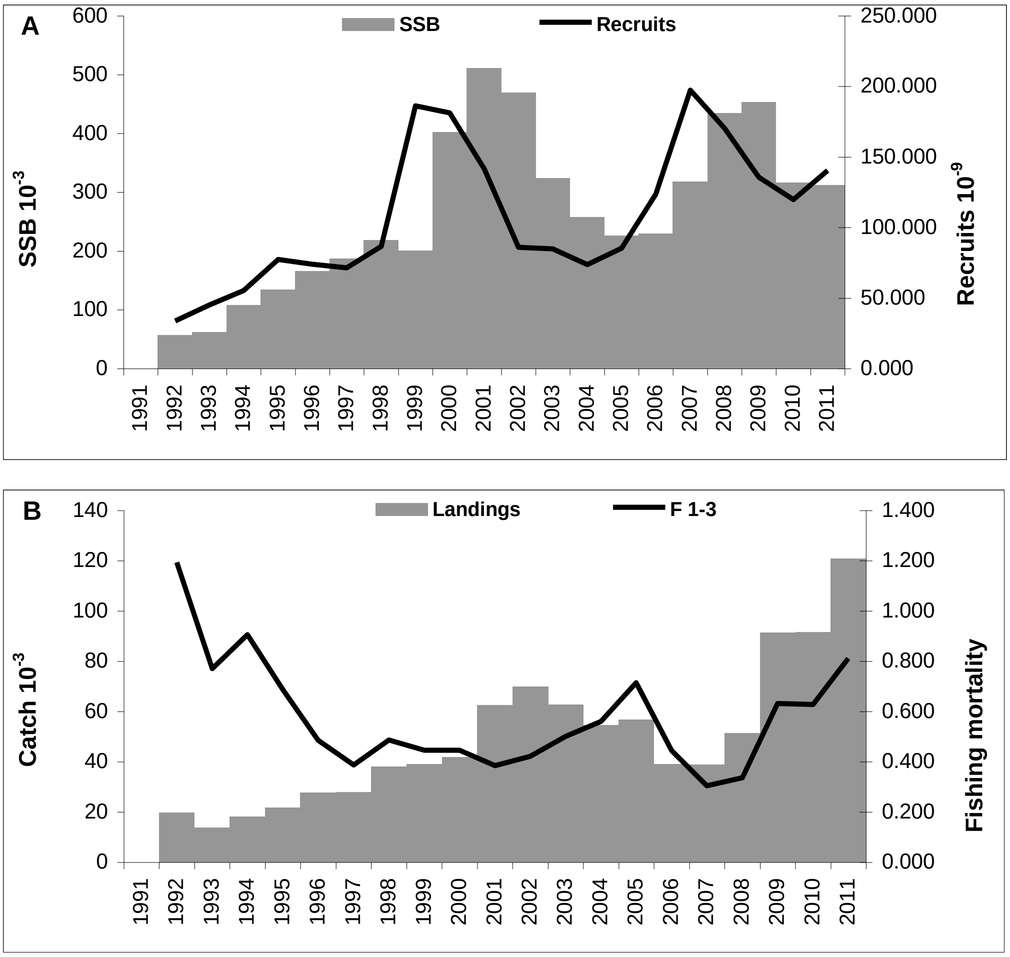


Fig. 6.1.4.1.3.6. Time-series of sprat population estimates: A. recruitment (line) and SSB (grey); B. landings (grey) and average fishing mortality (ages 2–4, line).

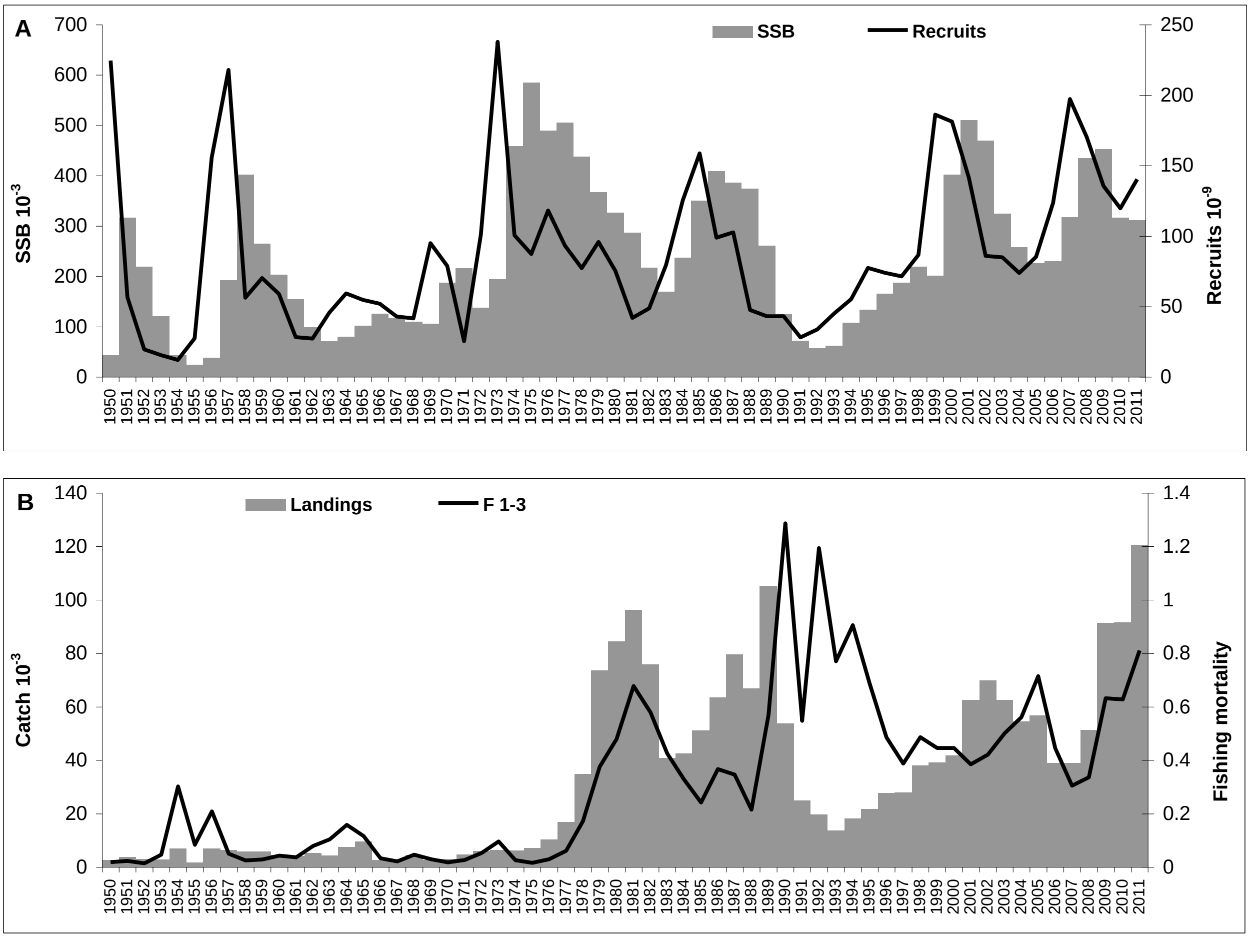


Fig. 6.1.4.1.3.7. Time-series of sprat population estimates – present results combined with historical estimates from Daskalov 1998: A. recruitment (line) and SSB (grey); B. landings (grey) and average fishing mortality (ages 2–4, line).

Table 6.1.4.1.3.1. Sprat in the Black Sea 1990-2009: ICA results and diagnostics.

Fishing Mortality (per year)

AGE	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
0	0.0021	0.0079	0.0030	0.0004	0.0021	0.0054	0.0037	0.0073	0.0032	0.0078	0.0105	0.0144	0.0129	0.0179	0.0129
1	0.3337	0.2668	0.1492	0.1004	0.1020	0.1207	0.1000	0.1383	0.0789	0.1910	0.1456	0.1996	0.1793	0.2483	0.1790
2	1.3666	0.7737	0.9498	0.7659	0.5573	0.3343	0.4079	0.4446	0.3963	0.3337	0.3788	0.5193	0.4667	0.6462	0.4658
3	2.0820	1.4862	1.9033	1.4250	0.9403	0.8334	1.0543	0.8654	0.9052	0.6333	0.6676	0.9153	0.8225	1.1390	0.8210
4	1.1388	0.7704	0.8060	0.6119	0.4521	0.3737	0.4221	0.4318	0.3717	0.3967	0.3788	0.5193	0.4667	0.6462	0.4658
5	1.1388	0.7704	0.8060	0.6119	0.4521	0.3737	0.4221	0.4318	0.3717	0.3967	0.3788	0.5193	0.4667	0.6462	0.4658

Fishing Mortality (per year)

AGE	2007	2008	2009	2010	2011
0	0.0094	0.0090	0.0170	0.0192	0.0339
1	0.1311	0.1246	0.2358	0.2662	0.4701
2	0.3412	0.3243	0.6137	0.6927	1.2233
3	0.6013	0.5715	1.0817	1.2208	2.1561
4	0.3412	0.3243	0.6137	0.6927	1.2233
5	0.3412	0.3243	0.6137	0.6927	1.2233

Population Abundance (1 January)

AGE	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
0	32.92	43.76	52.38	75.04	70.33	70.13	86.70	189.03	172.88	141.08	85.11	81.25	78.79	86.37	111.53
1	14.22	17.32	22.89	27.54	39.55	37.01	36.78	45.55	98.96	90.87	73.81	44.41	42.23	41.01	44.73
2	3.98	3.94	5.13	7.63	9.63	13.81	12.69	12.87	15.34	35.37	29.03	24.68	14.07	13.65	12.37
3	0.81	0.39	0.70	0.77	1.37	2.13	3.82	3.26	3.19	3.99	9.80	7.69	5.68	3.41	2.77
4	0.20	0.04	0.03	0.04	0.07	0.21	0.36	0.52	0.53	0.50	0.82	1.94	1.19	0.96	0.42
5	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

x 10 ^ 9

Population Abundance (1 January)

AGE	2007	2008	2009	2010	2011	2012
0	177.59	207.07	146.62	117.97	104.76	121.84
1	58.06	92.76	108.21	76.01	61.02	53.40
2	14.46	19.69	31.67	33.06	22.53	14.75
3	3.00	3.98	5.51	6.63	6.40	2.56
4	0.47	0.64	0.87	0.72	0.76	0.29
5	0.00	0.00	0.00	0.02	0.03	0.09

x 10 ^ 9

Weighting factors for the catches in number

AGE	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
0	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Predicted Age-Structured Index Values

Bul Predicted

AGE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	26.40	32.54	46.71	43.29	43.47	52.81	118.21	102.63	85.28	49.95	47.98	45.01	50.83	67.56	108.31
2	13.94	22.72	31.85	51.07	45.20	45.03	54.98	130.79	104.97	83.18	48.68	43.18	42.83	53.29	73.17
3	1.82	2.52	5.74	9.42	15.11	14.17	13.59	19.47	46.98	32.57	25.20	12.92	12.29	14.89	20.01
4	0.09	0.12	0.23	0.69	1.17	1.67	1.78	1.65	2.73	6.04	3.80	2.81	1.35	1.60	2.18

x 10 ^ 3

Bul Predicted

AGE	2009	2010	2011
1	119.51	82.68	59.94
2	101.82	102.16	53.39
3	21.47	24.11	14.57
4	2.57	2.06	1.65

x 10 ^ 3

Ukr Predicted

AGE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008

1	62.57	77.13	110.70	102.61	103.03	125.17	280.15	243.23	202.12	118.37	113.71	106.68	120.46	160.13	256.68
2	20.75	33.81	47.41	76.00	67.27	67.01	81.82	194.64	156.21	123.78	72.44	64.26	63.74	79.31	108.89
3	3.19	4.42	10.06	16.52	26.51	24.86	23.84	34.16	82.41	57.13	44.20	22.67	21.55	26.11	35.10
4	0.08	0.11	0.21	0.64	1.07	1.54	1.63	1.51	2.51	5.54	3.49	2.58	1.24	1.47	2.00

x 10 ^ 3

Ukr Predicted

AGE	2009	2010	2011
1	283.23	195.96	142.07
2	151.53	152.04	79.46
3	37.66	42.30	25.56
4	2.36	1.89	1.52

x 10 ^ 3

Bul survey Predicted

AGE	2007	2008	2009	2010
1	33053.	52984.	58465.	40449.
2	32864.	45123.	62790.	63001.
3	21880.	29409.	31554.	35439.
4	1287.	1755.	2072.	1656.

Fitted Selection Pattern

AGE	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
0	0.0015	0.0102	0.0031	0.0005	0.0037	0.0161	0.0090	0.0163	0.0080	0.0234	0.0277	0.0277	0.0277	0.0277	0.0277
1	0.2442	0.3448	0.1571	0.1311	0.1830	0.3610	0.2453	0.3110	0.1992	0.5725	0.3843	0.3843	0.3843	0.3843	0.3843
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.5235	1.9207	2.0038	1.8606	1.6872	2.4931	2.5847	1.9465	2.2843	1.8979	1.7625	1.7625	1.7625	1.7625	1.7625
4	0.8333	0.9956	0.8486	0.7990	0.8112	1.1180	1.0349	0.9713	0.9381	1.1888	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.8333	0.9956	0.8486	0.7990	0.8112	1.1180	1.0349	0.9713	0.9381	1.1888	1.0000	1.0000	1.0000	1.0000	1.0000

Fitted Selection Pattern

AGE	2007	2008	2009	2010	2011
0	0.0277	0.0277	0.0277	0.0277	0.0277
1	0.3843	0.3843	0.3843	0.3843	0.3843
2	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.7625	1.7625	1.7625	1.7625	1.7625
4	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000

STOCK SUMMARY

Year	Recruits Age 0 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 2- 3	SoP (%)
1992	32923440	111096	55126	19700	0.3574	1.7243	100
1993	43756210	134531	60145	13800	0.2294	1.1300	100
1994	52383220	157136	104753	18219	0.1739	1.4266	99
1995	75043180	202634	127591	21746	0.1704	1.0954	100
1996	70332110	229343	159010	27778	0.1747	0.7488	99
1997	70130550	248570	178440	27963	0.1567	0.5838	100
1998	86695340	297520	210824	38117	0.1808	0.7311	99
1999	189034190	386400	197366	39152	0.1984	0.6550	98
2000	172880420	578726	405845	41769	0.1029	0.6507	100
2001	141081620	638834	497752	62587	0.1257	0.4835	100
2002	85113270	547311	462198	69894	0.1512	0.5232	99
2003	81252220	405022	323770	62716	0.1937	0.7173	99
2004	78790330	326922	248132	54574	0.2199	0.6446	100
2005	86368520	324760	238391	56854	0.2385	0.8926	100
2006	111531080	348385	236854	39048	0.1649	0.6434	100
2007	177591160	477075	299484	39008	0.1303	0.4712	99
2008	207072830	604078	397005	51463	0.1296	0.4479	99
2009	146623070	642507	495884	91376	0.1843	0.8477	100
2010	117969360	458932	340963	91594	0.2686	0.9567	99
2011	104761280	414443	309682	120710	0.3898	1.6897	100

No of years for separable analysis : 10
Age range in the analysis : 0 . . . 5
Year range in the analysis : 1992 . . . 2011
Number of indices of SSB : 0
Number of age-structured indices : 3

Parameters to estimate : 39
Number of observations : 210

Conventional single selection vector model to be fitted.

PARAMETER ESTIMATES

Parm. No.		Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
Separable model : F by year								
1	2002	0.3788	23	0.2413	0.5946	0.3009	0.4768	0.3889
2	2003	0.5193	21	0.3436	0.7849	0.4206	0.6411	0.5310
3	2004	0.4667	21	0.3063	0.7112	0.3764	0.5786	0.4776
4	2005	0.6462	20	0.4348	0.9605	0.5279	0.7911	0.6596
5	2006	0.4658	21	0.3043	0.7131	0.3749	0.5789	0.4770
6	2007	0.3412	22	0.2186	0.5325	0.2718	0.4282	0.3501
7	2008	0.3243	22	0.2093	0.5025	0.2594	0.4055	0.3325
8	2009	0.6137	19	0.4161	0.9051	0.5034	0.7482	0.6259
9	2010	0.6927	19	0.4713	1.0180	0.5691	0.8430	0.7062
10	2011	1.2233	29	0.6897	2.1698	0.9132	1.6388	1.2767
Separable Model: Selection (S) by age								
11	0	0.0277	23	0.0173	0.0442	0.0218	0.0352	0.0285
12	1	0.3843	18	0.2691	0.5488	0.3204	0.4609	0.3907
	2	1.0000	Fixed : Reference Age					
13	3	1.7625	14	1.3272	2.3406	1.5250	2.0370	1.7810
	4	1.0000	Fixed : Last true age					
Separable model: Populations in year 2011								
14	0	104761288	67	27731718	395753608	53173931	206396768	131842102
15	1	61023124	32	32381829	114997261	44166178	84313876	64296953
16	2	22526471	23	14200385	35734375	17801304	28505883	23159435
17	3	6395434	22	4155257	9843334	5132430	7969243	6552099
18	4	756457	26	453250	1262498	582494	982375	782733
Separable model: Populations at age								
19	2002	819433	35	404912	1658310	571891	1174123	874184
20	2003	1943485	27	1135260	3327110	1477256	2556858	2017990
21	2004	1190458	26	712172	1989954	915952	1547231	1232068
22	2005	964769	24	597185	1558612	755336	1232271	994096
23	2006	422424	25	254770	700402	326368	546750	436717
24	2007	470745	24	289881	764456	367582	602862	485371
25	2008	636606	23	404977	1000715	505412	801853	653785
26	2009	868494	22	564232	1336831	696949	1082264	889778
27	2010	722057	24	450421	1157506	567550	918626	743293

Age-structured index catchabilities

Bul

Linear model fitted. Slopes at age :

28	1	Q	.1998E-02	19	.1655E-02	.3572E-02	.1998E-02	.2959E-02	.2479E-02
29	2	Q	.7026E-02	19	.5815E-02	.1259E-01	.7026E-02	.1042E-01	.8725E-02
30	3	Q	.1077E-01	20	.8870E-02	.1956E-01	.1077E-01	.1612E-01	.1344E-01
31	4	Q	.6475E-02	21	.5284E-02	.1212E-01	.6475E-02	.9887E-02	.8182E-02

Ukr

Linear model fitted. Slopes at age :

32	1	Q	.4736E-02	19	.3922E-02	.8466E-02	.4736E-02	.7012E-02	.5874E-02
33	2	Q	.1046E-01	19	.8654E-02	.1874E-01	.1046E-01	.1551E-01	.1298E-01
34	3	Q	.1889E-01	20	.1556E-01	.3432E-01	.1889E-01	.2827E-01	.2358E-01
35	4	Q	.5945E-02	21	.4851E-02	.1112E-01	.5945E-02	.9078E-02	.7512E-02

Bul survey

Linear model fitted. Slopes at age :

36	1	Q	.9775E-03	41	.6541E-03	.3373E-02	.9775E-03	.2257E-02	.1621E-02
37	2	Q	.4333E-02	41	.2899E-02	.1497E-01	.4333E-02	.1001E-01	.7190E-02
38	3	Q	.1582E-01	42	.1050E-01	.5604E-01	.1582E-01	.3719E-01	.2657E-01
39	4	Q	.5214E-02	44	.3392E-02	.1963E-01	.5214E-02	.1277E-01	.9021E-02

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
0	-0.4570	0.3382	-0.5191	-0.7620	0.0917	0.9471	-0.0512	-0.1584	0.5719	0.0000
1	0.0450	0.0707	0.4157	0.0148	0.2193	0.1398	0.0928	-0.1977	-0.3881	-0.4185
2	0.2297	-0.2080	0.0196	0.0541	-0.1309	-0.3904	-0.1057	-0.2269	-0.4569	0.1206
3	-0.0479	-0.0530	0.1980	-0.0170	-0.3038	-0.1350	0.1277	0.2522	0.2816	0.6638
4	0.0592	0.2420	-0.0647	0.1775	-0.1397	0.2267	0.3664	0.3146	0.2530	-0.0011

AGE-STRUCTURED INDEX RESIDUALS

Bul

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008

1	-0.993	-0.508	-0.129	0.208	0.186	0.649	-0.203	-0.158	-0.210	0.392	0.521	0.268	0.364	-0.034	-0.335
2	1.417	0.764	0.181	-0.588	0.258	-0.386	0.226	-0.771	-0.463	-0.250	0.116	-0.107	-0.094	-0.348	-0.041
3	2.192	1.072	0.499	-0.416	-1.053	-1.137	-0.772	-1.736	-0.784	-0.557	-0.249	0.012	-0.482	-0.249	0.930
4	0.980	0.667	0.938	-0.131	-0.771	-1.728	-1.075	-2.104	-0.854	-0.592	0.244	-0.762	0.556	0.212	0.838

Bul

Age	2009	2010	2011
1	0.048	-0.016	-0.050
2	0.075	-0.140	0.153
3	0.553	1.040	1.139
4	0.844	1.334	1.407

Ukr

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
1	0.687	0.048	0.004	-0.569	-0.546	-0.251	-0.230	-0.230	-0.244	-0.440	0.098	0.063	0.403	-0.231	0.104
2	1.284	1.121	0.914	-0.411	0.013	0.243	0.581	-0.498	0.138	-0.488	-0.446	0.316	0.082	-1.187	-0.674
3	0.926	0.757	-0.065	-0.451	0.562	0.411	1.025	-0.416	-0.074	-0.184	0.214	0.279	0.135	-0.435	0.067
4	1.795	0.217	1.144	0.128	0.787	-1.016	1.320	0.353	0.617	0.673	0.373	1.139	0.710	-2.686	0.427

Ukr

Age	2009	2010	2011
1	0.169	0.586	0.580
2	-0.056	-0.814	-0.116
3	-0.005	-2.168	-0.576
4	-1.274	-2.054	-2.652

Bul survey

Age	2007	2008	2009	2010
1	-0.535	-0.185	-0.060	0.780
2	-0.069	-0.111	-0.119	0.299
3	0.162	-0.822	0.251	0.409
4	-0.253	-0.485	1.532	-0.793

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 2002 to 2011

Variance	0.1571
Skewness test stat.	1.0592
Kurtosis test statistic	-0.1211
Partial chi-square	0.2508
Significance in fit	0.0000
Degrees of freedom	23

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR Bul

Linear catchability relationship assumed

Age	1	2	3	4
Variance	0.0385	0.0634	0.2532	0.2752
Skewness test stat.	-1.0644	2.0082	0.6447	-0.8029
Kurtosis test statisti	0.4877	1.5405	-0.4384	-0.7606
Partial chi-square	0.0618	0.1054	0.4845	0.6632
Significance in fit	0.0000	0.0000	0.0000	0.0000
Number of observations	18	18	18	18
Degrees of freedom	17	17	17	17
Weight in the analysis	0.2500	0.2500	0.2500	0.2500

DISTRIBUTION STATISTICS FOR Ukr

Linear catchability relationship assumed

Age	1	2	3	4
Variance	0.0363	0.1126	0.1288	0.4582
Skewness test stat.	0.5578	0.5588	-2.2842	-1.5709

Kurtosis test statisti	-0.7322	-0.4886	2.4100	-0.3361
Partial chi-square	0.0528	0.1762	0.2188	1.1402
Significance in fit	0.0000	0.0000	0.0000	0.0000
Number of observations	18	18	18	18
Degrees of freedom	17	17	17	17
Weight in the analysis	0.2500	0.2500	0.2500	0.2500

DISTRIBUTION STATISTICS FOR Bul survey

Linear catchability relationship assumed

Age	1	2	3	4
Variance	0.0777	0.0101	0.0777	0.2729
Skewness test stat.	0.5702	0.9100	-0.8472	0.8166
Kurtosis test statisti	-0.3737	-0.2859	-0.3055	-0.3173
Partial chi-square	0.0221	0.0028	0.0226	0.1081
Significance in fit	0.0009	0.0000	0.0009	0.0092
Number of observations	4	4	4	4
Degrees of freedom	3	3	3	3
Weight in the analysis	0.2500	0.2500	0.2500	0.2500

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	102.9959	210	39	171	0.6023
Catches at age	4.8304	50	27	23	0.2100
Aged Indices					
Bul	42.8647	72	4	68	0.6304
Ukr	50.0404	72	4	68	0.7359
Bul survey	5.2604	16	4	12	0.4384

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	9.7490	210	39	171	0.0570
Catches at age	3.6136	50	27	23	0.1571
Aged Indices					
Bul	2.6790	72	4	68	0.0394
Ukr	3.1275	72	4	68	0.0460
Bul survey	0.3288	16	4	12	0.0274

Conventional VPA with Fishing Mortality Shrinkage

Fs shrunk over 5 years
Minimum CV of the mean taken as 0.20000

Shrinkage Diagnostics

F from model fit		Historic Mean F			Shrunk estimate
Estimate	Variance	Estimate	Variance	Wt for F from Model	
0.034	0.135	0.016	0.060	0.310	0.020
0.470	0.098	0.217	0.060	0.382	0.292
1.223	0.085	0.565	0.060	0.414	0.778
2.156	0.088	0.996	0.060	0.407	1.364
1.223	0.085	0.565	0.060	0.414	0.757
*****	0.385	0.565	0.060	0.136	0.757

Fishing Mortality (per year)

AGE	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
0	0.0021	0.0077	0.0028	0.0004	0.0020	0.0053	0.0037	0.0074	0.0030	0.0078	0.0066	0.0193	0.0082	0.0084	0.0127
1	0.3254	0.2592	0.1442	0.0950	0.0987	0.1143	0.0980	0.1383	0.0801	0.1815	0.1522	0.2125	0.2713	0.2703	0.2282
2	1.3181	0.7419	0.9039	0.7274	0.5173	0.3213	0.3809	0.4332	0.3963	0.3399	0.4658	0.4050	0.4779	0.7464	0.4396
3	1.9378	1.3119	1.6680	1.2393	0.8414	0.7259	0.9797	0.7672	0.8627	0.6333	0.6453	0.8851	0.9335	1.1280	0.6678
4	0.8346	0.6093	0.5819	0.4227	0.3307	0.3054	0.3313	0.3736	0.3010	0.3631	0.3663	0.5397	0.5024	0.5985	0.4682
5	0.8346	0.6093	0.5819	0.4227	0.3307	0.3054	0.3313	0.3736	0.3010	0.3631	0.3663	0.5397	0.5024	0.5985	0.4682

Fishing Mortality (per year)

AGE	2007	2008	2009	2010	2011
0	0.0220	0.0104	0.0157	0.0337	0.0199
1	0.1362	0.1247	0.2357	0.1891	0.2917
2	0.2330	0.2574	0.4130	0.4959	0.7779
3	0.5443	0.6272	1.2471	1.1974	1.3637
4	0.4232	0.3281	0.5750	0.7211	0.7571
5	0.4232	0.3281	0.5750	0.7211	0.7571

Population Abundance (1 January)

AGE	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
0	33.78	45.19	55.27	77.43	74.05	71.51	86.70	186.27	181.22	141.53	85.90	84.90	73.77	85.27	123.69
1	14.54	17.78	23.65	29.06	40.81	38.97	37.51	45.55	97.50	95.27	74.05	45.00	43.91	38.58	44.59
2	4.06	4.06	5.31	7.92	10.22	14.30	13.44	13.15	15.34	34.80	30.73	24.60	14.07	12.95	11.39
3	0.83	0.42	0.75	0.83	1.48	2.36	4.01	3.55	3.30	3.99	9.58	7.46	6.34	3.37	2.37
4	0.25	0.05	0.04	0.05	0.09	0.25	0.44	0.58	0.64	0.54	0.82	1.94	1.19	0.96	0.42
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

x 10 ^ 9

Population Abundance (1 January)

AGE	2007	2008	2009	2010	2011	2012
0	197.28	170.30	135.56	119.69	104.76	121.84
1	64.40	101.75	88.87	70.37	61.02	54.15
2	13.73	21.73	34.74	27.15	22.53	17.63
3	2.84	4.20	6.50	8.89	6.40	4.00
4	0.47	0.64	0.87	0.72	1.04	0.63
5	0.00	0.00	0.00	0.02	0.04	0.20

x 10 ^ 9

STOCK SUMMARY

Year	Recruits Age 0 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 2- 3	SoP (%)
1992	33782600	114191	56761	19700	0.3471	1.6280	100
1993	45188990	138763	61942	13800	0.2228	1.0269	100
1994	55266250	163657	108391	18219	0.1681	1.2859	99
1995	77426390	211675	134249	21746	0.1620	0.9833	100
1996	74050610	239734	165684	27778	0.1677	0.6794	99
1997	71506480	259063	187557	27963	0.1491	0.5236	100
1998	86695340	305338	218643	38117	0.1743	0.6803	99
1999	186274610	387156	200881	39152	0.1949	0.6002	98
2000	181222870	583779	402556	41769	0.1038	0.6295	100
2001	141529580	652465	510936	62587	0.1225	0.4866	100
2002	85901260	555269	469368	69894	0.1489	0.5555	99
2003	84895790	409000	324104	62716	0.1935	0.6450	99
2004	73765070	331602	257837	54574	0.2117	0.7057	100
2005	85273460	311430	226156	56854	0.2514	0.9372	100
2006	123693570	353236	229543	39048	0.1701	0.5537	100
2007	197275040	515066	317791	39008	0.1227	0.3887	99
2008	170296280	605016	434720	51463	0.1184	0.4423	99
2009	135560140	588717	453157	91376	0.2016	0.8300	100
2010	119694830	436044	316350	91594	0.2895	0.8467	99
2011	104761280	416607	311846	120710	0.3871	1.0708	100

6.1.5 Short term prediction of stock biomass and catch

6.1.5.1 Justification

A deterministic short term prediction of stock size and catch was conducted based on ICA results.

6.1.5.2 Input parameters

The input parameters are listed in the Table 6.1.5.2.1 below. They do represent short term averages of the ICA inputs. The exploitation pattern used is the 2011 estimated vector rescaled to the average exploitation patterns estimated for the years 2009-2011. Due to the lack of recruitment index, recruitment was estimated using the geometric mean from 2008-2010.

As the fishery for sprat in the Black Sea is not constrained by an international TAC, the year 2011 was defined as a status quo effort year with unchanged fishing mortality.

Table 6.1.5.2.1. Sprat in the Black Sea. Input to short term prediction.

2012						
age	stock size (000)	M	maturity	weight in stock (kg)	exploitation pattern	weight in catch (kg)
0	140324884	0.6400	0.0000	0.001	0.0271	0.0021
1	72010553	0.9500	1.0000	0.003	0.2807	0.0027
2	24301040	0.9500	1.0000	0.004	0.6608	0.0037
3	6135299	0.9500	1.0000	0.0048	1.4918	0.0046
4	759169	0.9500	1.0000	0.0073	0.8043	0.0087

5	245342	0.9500	1.0000	0.01	0.8043	0.01
2013						
age	stock size (000)	M	maturity	weight in stock (kg)	exploitation pattern	weight in catch (kg)
0	140324883.9	0.6400	0.0000	0.001	0.0271	0.0021
1		0.9500	1.0000	0.003	0.2807	0.0027
2		0.9500	1.0000	0.004	0.6608	0.0037
3		0.9500	1.0000	0.0048	1.4918	0.0046
4		0.9500	1.0000	0.0073	0.8043	0.0087
5		0.9500	1.0000	0.01	0.8043	0.01
2014						
age	stock size (000)	M	maturity	weight in stock (kg)	exploitation pattern	weight in catch (kg)
0	140324883.9	0.6400	0.0000	0.001	0.0271	0.0021
1		0.9500	1.0000	0.003	0.2807	0.0027
2		0.9500	1.0000	0.004	0.6608	0.0037
3		0.9500	1.0000	0.0048	1.4918	0.0046
4		0.9500	1.0000	0.0073	0.8043	0.0087
5		0.9500	1.0000	0.01	0.8043	0.01

6.1.5.3 Results

Table 6.1.5.3.1. Sprat in the Black Sea. Single option (status quo) short term prediction.

2012	F-factor:	1	reference F1-3	0.8111		1 January	
age	absolute F	catch in numbers (000)	catch in weight (t)	stock size (000)	stock biomass (t)	sp. stock size (000)	sp. stock biomass (t)
0	0.0271	2779856	5838	140324883.9	140325	0	0
1	0.2807	11626302	31391	72010552.72	216032	72010553	216032
2	0.6608	7977844	29518	24301040.37	97204	24301040	97204
3	1.4918	3422232	15742	6135299.064	29449	6135299	29449
4	0.8043	287841	2504	759169.2292	5542	759169	5542
5	0.8043	93022	930	245341.9897	2453	245342	2453
		26187097	85923	243776287	491005	103451403	350680
2013	F-factor:	1	reference F1-3	0.8111		1 January	
age	absolute F	catch in numbers (000)	catch in weight (t)	stock size (000)	stock biomass (t)	sp. stock size (000)	sp. stock biomass (t)
0	0.0271	2779856	5838	140324884	140325	0	0
1	0.2807	11626302	31391	72010553	216032	72010553	216032
2	0.6608	6905231	25549	21033789	84135	21033789	84135
3	1.4918	2707334	12454	4853646	23298	4853646	23298
4	0.8043	202384	1761	533781	3897	533781	3897
5	0.8043	49804	498	131355	1314	131355	1314
		24270911	77491	238888008	469001	98563124	328676
2014	F-factor:	1	reference F1-3	0.8111		1 January	
age	absolute F	catch in numbers (000)	catch in weight (t)	stock size (000)	stock biomass (t)	sp. stock size (000)	sp. stock biomass (t)
0	0.0271	2779856	5838	140324884	140325	0	0
1	0.2807	11626302	31391	72010553	216032	72010553	216032
2	0.6608	6905231	25549	21033789	84135	21033789	84135
3	1.4918	2343336	10779	4201078	20165	4201078	20165
4	0.8043	160107	1393	422275	3083	422275	3083
5	0.8043	35017	350	92357	924	92357	924
		23849849	75300	238084936	464664	97760052	324339

The *status quo* fishing in 2012 would result in landings 85 923, and SSB of 350 680 t. Thus the forecasted 2012 SSB is expected to increase by about 12% compared to 2011 (SSB=311 846 t) and total catch to decrease by about 30% from the catch recorded in 2011 - 120 710t. In 2013 and 2014 the status quo model predicts decreasing biomass and catches (Table 6.1.5.3.1.).

Recruitment estimates are rather imprecise due to the lack of survey data. Recruitment however seems to have entered in an increasing trend after 2006. In short-term forecast we used a geometric mean over 2008-2010 equal of 140 324 884 000.

Catches have been very high in the last 3 years due to quickly expending Turkish fishery. Under the status quo F assumption, catches are expected to decrease in 2012 - 2014.

Given that the state of the stock depends greatly on a variable recruitment, the dynamic nature of developing Turkish sprat fishery and the lack of quota constraints on the sprat fisheries, the status quo assumption must be taken with a caution when considered in management advice.

More management options through multiplications of the fishing mortality are given in Table 6.1.5.3.2. The Fmsy level of fishing mortality of 0.64 (corresponding to exploitation rate of 0.4, Patterson 1992, Daskalov et al. 2011) would bring catches of 64 000 -65 000 t that is 47% less of the catch recorded in 2011, and 15 to 25% less the forecasted *status quo* catch in 2012-2014.

At present the sprat stock is in a historically high abundance regime, but the unprecedentedly increasing fishing pressure seems induce a negative trend in the stock biomass and expected catches. The present record catch seems to be sustained by some of the highest historically recorded levels of recruitment (over 2007-2010).

Table 6.1.5.3.2. Sprat in the Black Sea. Management option table (status quo in 2011) providing short term prediction.

		2012					2013			2014		
F-factor	reference F	stock biom	sp. stock bi	catch in we	F-factor	reference F	stock biom	sp. stock b	catch in we	stock biom	sp. stock b	catch
1.0000	0.8111	491005	350680	85923	0.0000	0.0000	469426	329101	0	529185	388860	0
					0.1000	0.0811	469426	329101	9620	520905	380580	12287
					0.2000	0.1622	469426	329101	18729	513152	372827	23013
					0.3000	0.2433	469426	329101	27365	505872	365547	32430
					0.4000	0.3238	469426	329101	35571	499021	358696	40746
					0.5500	0.4452	469426	329101	47151	489470	349145	51523
					0.6000	0.4856	469426	329101	50831	486464	346139	54733
					0.7000	0.5678	469426	329101	57940	480688	340363	60659
					0.8000	0.6489	469426	329101	64739	475210	334885	66011
					0.9000	0.7300	469426	329101	71250	470007	329682	70869
				Fsq	**1.0000**	**0.8111**	**469426**	**329101**	**77491**	**465055**	**324730**	**75300**
					1.1000	0.8922	469426	329101	83483	460334	320009	79361
					1.2000	0.9733	469426	329101	89240	455829	315504	83098
					1.3000	1.0544	469426	329101	94782	451523	311198	86554
					1.4000	1.1355	469426	329101	100116	447399	307074	89760
					1.5000	1.2167	469426	329101	105261	443451	303126	92747
				Fmsy	**0.789**	**0.6400**	**469426**	**329101**	**64006**	**475798**	**335473**	**65448**

6.1.6 Medium term prediction of stock biomass and catch

The EWG did not undertake medium term projections.

6.1.7 Long term predictions

Fmax could not be estimated due to shape to the YpR curve, which has a maximum well outside of the reasonable range. The skewed shape of the YpR curve results from the high natural mortality and the short life span of sprat in the Black Sea. Due to such effects, STECF EWG 11-16 on Black Sea does not consider $F_{0.1}$ as an appropriate management reference point, and proposes a limit reference point of exploitation rate E≤0.4 which implies Fmsy = 0.64. Given that the mean F=0.811 yields an exploitation rate of about E=0.46 (natural mortality M=0.95), the WG considers the stock of sprat in the Black Sea to be exploited above the sustainable level.

6.1.8 Scientific advice

6.1.8.1 Short term considerations

The EWG accepted the current ICA assessment as adequately presenting the state and dynamics of the stock and the development of the fisheries.

State of the spawning stock size: According to the present assessment in recent years the SSB ranges at medium to high levels: in the range of 300 - 400 000 t. Under a constant recruitment scenario and status quo F, SSB is expected to stay at the approximate same level by 2014.

State of recruitment: After a positive trend in 1999-2001 the recruitment has decreased in 2002-2004 and increased again since 2006. Recruitment estimates are rather imprecise due to the lack of survey data. In short-term forecast we used a geometric mean over 2008-2010 average value of 140 324 884 000.

State of exploitation: Over the last few years the fishing mortality has piqued in 2004-2005 and 2009-2011 at a level of 0.6 - 0.8. The current 2011 F=0.811, that equals an exploitation rate of about E=0.46 (natural mortality M=0.95). Proposing a limit reference point of exploitation rate E≤0.4 (as suggested by Patterson 1992 for short living fish), the WG considers the stock of sprat in the Black Sea being at risk of overexploitation. Status quo fishing implies catches in the range of 75 000 to 85 000 t over 2011 - 2013 which are above the recommended catch of 64 000 t at Fmsy.

6.1.8.2 Medium term considerations

Due to the cyclic nature of recruitment and unknown dependence on environmental conditions the WG is not able to provide medium term forecast. After medium-to-high recruitment and relatively strong exploitation the stock is now at a relatively high level. Short term fluctuations, possibly environmentally driven, and unregulated fishing pressure, may cause sudden shifts, as the collapse in 1990.

6.2 Turbot in the Black Sea

6.2.1 Biological features

6.2.1.1 Stock Identification

Turbot (*Scophthalmus maximus*) is demesal species and occurs all over the shelf area of all Black Sea coastal states at depths up to 100 m -140 m, grouped in local shoals. Species inhabits sandy or silt bottoms, mussel beds or mixed types. The spawning process is taking place in spring season – between April and June. Turbot in the Black Sea is represented by several local populations, which migrate and mixing in the adjacent zones. Local populations are independent units of the stock, and have to be covered in order to ensure an accurate assessment of the stock at regional level. Due to existing gaps of information in terms of accurate fisheries statistics and availability of biological data, the present assessment is based on the analysis of the best available information, obtained from combined data of all Black Sea countries.

6.2.1.1. Growth

Turbot is a long living species with a slow growth rate. The parameters reported here by countries are considered appropriate for the description of an average growth performance of the species in GSA 29 – Tab. 6.2.1.2.1.

Table 6.2.1.2.1. Growth parameters of turbot by countries and periods.

COUNTRY	AREA	YEAR_PERIOD	SPECIES	SEX	L_INF	K	t_0	A	B
ROM	29	2003-2005	TUR	C	80.98	0.15	-1.37	0.000018	3.01
ROM	29	2006-2008	TUR	C	72.5	0.212	-1.15	0.00806	3.22
ROM	29	2009-2011	TUR	C	86.3	0.19	-2.1	0.030088	2.87
BGR	29	2007-2008	TUR	C	77.81	0.242	0.152	0.000431	2.21
BGR	29	2008-2009	TUR	C	120.40	0.076	-2.811	0.000011	3.13
BGR	29	2008-2009	TUR	F	129.81	0.065	-3.351	0.000013	3.11
BGR	29	2008-2009	TUR	M	67.38	0.246	-1.217	0.000041	2.78
BGR	29	2007-2008	TUR	M	57.60	0.507	0.458	0.000918	1.96
BGR	29	2007-2008	TUR	F	80.31	0.213	-0.136	0.000424	2.22
BGR	29	2006-2007	TUR	M	77.49	0.158	-1.975	0.000022	2.92
BGR	29	2006-2007	TUR	F	124.27	0.080	-2.136	0.000021	2.94
BGR	29	2006-2007	TUR	C	79.26	0.173	-1.561	0.000008	3.17
UKR (NE)	29	2000 - 2006	TUR	C				0.000216	2.48
UKR (NW)	29	2008 - 2009	TUR	C	74	0.106	-1.73	0.001437	1.94
TR	29	1990 - 1991	TUR	C	82.57	0.17	-0.93	0.0085	3.18
TR	29	1990 - 1996	TUR	C	96.24	0.119	-0.01	0.0112	3.12
TR	29	1998 - 2000	TUR	C	95.9	0.104	-1.55	0.0106	3.14
BGR-RO	29	2010	TUR	C	79.578	0.237	-0.104	0.000242	2.361
TR	29	2010	TUR	C	60.57	0.218	0.25	0.12	3.081
BGR	29	2011	TUR	C	69.98	0.395	1.043	0.0000339	2.837
TR(west)	29	2011	TUR	C	96.376	0.112	-1.304	0.014	3.059
TR(east)	29	2011	TUR	C	101.12	0.11	-1.24	0.01	3.17
ROM	29	2011	TUR	C	86.32	0.242	-1.971	0.06254606	2.660

6.2.1.2. Maturity

The species reaches sexual maturity at ages between 3 and 5. The maturity ogive for 2011 was prepared based on data from Bulgaria, Romania and Turkey, averaged by age groups. In Turkish waters, earlier maturation at age of 2 yers was observed. The proportions of mature individuals by age groups for the period 1970 – 2011 are given in Table 6.2.1.3.1.

Table 6.2.1.3.1. Common maturity ogive of turbot by ages and years.

Year/Age	1	2	3	4	5	6	7	8	9	10+
1970-2006	0	0	0.75	1	1	1	1	1	1	1
2007	0	0	0.38	0.61	1	1	1	1	1	1
2008	0	0	0.51	0.76	1	1	1	1	1	1
2009	0	0	0.41	0.67	1	1	1	1	1	1
2010	0	0	0.22	0.83	1	1	1	1	1	1
2011	0	0.06	0.20	0.86	1	1	1	1	1	1

6.2.2 Fisheries

6.2.2.1 General description

The STECF EWG 12 16 Black Sea noted that turbot (*Scophthalmus maximus*) historically has been fished by all Black Sea countries due to market demand and high prices. Main fishing gear for all coastal states are gillnets, except Turkey, where the bottom trawling is permitted. The turbot is often caught as a by-catch of sprat fishery, long lines and purse seiners fishery. Total annual landings in the Black Sea have decreasing trend during the last 5 years - from 1035 t in 2007 to 486 t in 2011. IUU fisheries on turbot also occur.

6.2.2.2 Management regulations applicable in 2011 and 2012

The quotas allocation of turbot in 2011 to the Member States was introduced regarding to Council Regulations (EC) No 1256/2010. Both for Bulgaria and Romania quotas of 43.2 t in 2011 for each country were permitted. For 2012, Council Regulation (EC) No 5/2012 fixed the same quota.

Prohibition of fishing activity during reproduction period for turbot was in force from 15 April to 15 June in European Community waters of the Black Sea. The minimum legal mesh size for bottom-set nets used to catch turbot should be 400 mm.

In Ukraine Turbot fisheries is conducted with bottom (turbot) gill nets with minimum mesh size 180 - 200 mm. The use of bottom trawls has been prohibited. Turbot exploitation in Ukraine has been regulated by TACs since 1996.

The Regulations of Fisheries in Ukraine determine the following standards regulating the fisheries of the Black Sea turbot:
- minimum commercial fishing size – 35 cm (SL);
- allowable by-catch of its juveniles – during the non-target fisheries not more than 2% of total catch weight, during the target fisheries with nets (with mesh size 180 mm) not more 5% by counting;
- during target long-lining of picked dogfish and Rajiformes by-catch of turbots is allowed, at the amount of not more than 20% of its juveniles by counting;
- turbot by-catch is allowed in trawl catches of sprat not more than 4 individuals a commercial fishing length per one ton of catch;
- in the period of abundant spawning of turbot in the coastal 12-mile zone a temporal prohibition for 15 – 30 days is implemented for harvesting of fish with trawls, net and long-lines (such prohibition may be imposed gradually).
- the fishing effort on turbot is limited to 7 700 gillnets (100 m each).

In Turkey, turbot fisheries is conducted by bottom set gill nets with minimum mesh size of 160 – 200 mm (Tonay, Öztürk, 2003) and by bottom trawls - with minimum mesh size 40 mm. The minimum admissible landing size in Turkey is 40 cm total length. In Turkey, the turbot catches are not regulated by TAC. Seasonal fishing closures in Turkey are, as follows:

- for bottom trawls - from 1st September to 15th April
- for gillnets – from 1th May up to 30th June.

The basic management criteria for turbot fisheries in 2012-2014 announced by Commercial Fishery Advice of General Directorate of Fishery in Turkey are summarized below (Anonim, 2012):

- Area closures: Bottom trawling is prohibited in the areas between 1) Sinop city, İnceburun (42° 05.959' N-34° 56.695'E and Samsun city Çayağzı cape (41° 41.040' N-35° 25.193' E), 2) Ordu city; Ünye, Taşkana cape (41° 08.725' N-37° 17.531' 4) and Georgia border. Furthermore, it is also banned within 2 miles from land between Zonguldak city; Ereğli, Baba cape (41° 17.342' N-31° 23.937'E) and Bartın city; Amasra, Tekke cape (41° 43.485' N-32° 19.258' E) (Fig.6.2.2.2.1). In the rest of the areas, the waters open for trawling are 3 miles from the coast.

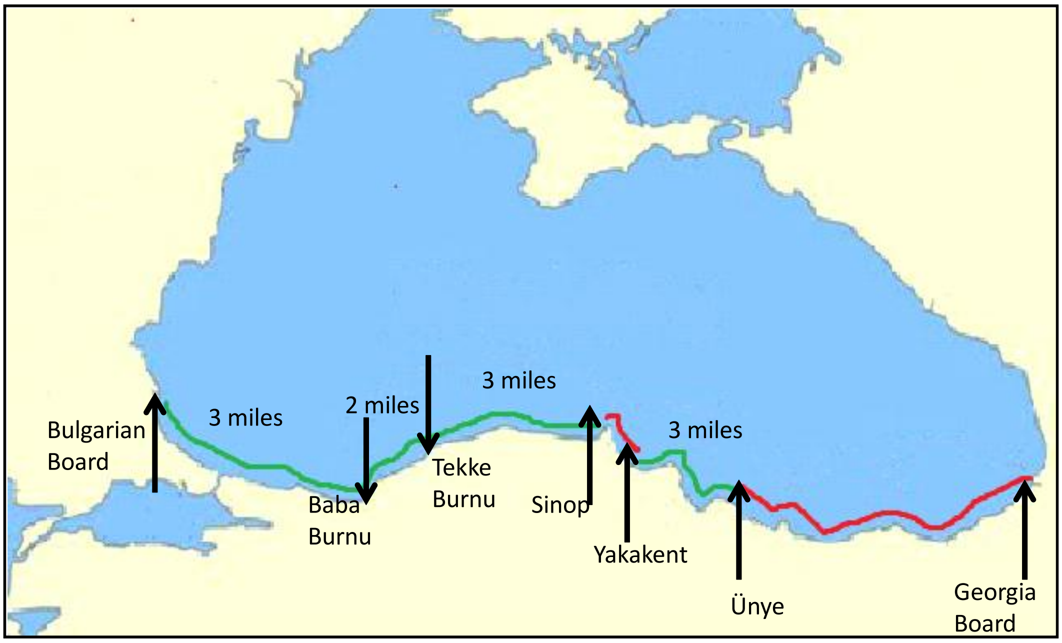


Fig. 6.2.2.2.1. Area closures and distance limitations for bottom trawling along theTurkish coast (Green lines: open areas, red lines: area closures).

- Time closures: In open areas, bottom trawling for turbot is banned between 15 April and 15 September. Turbot fishery by gillnet is allowed except during the period 15 April – 15 June.
- Mesh size limitations: a) Mesh size of the codend should not be lower than 40 mm for bottom trawl nets. b) Mesh size of gillnets should not be lower than 400 mm. c) Long lines and trammel gillnets are forbidden for turbot fishery.
- Minimum legal catch size: Minimum legal size (total length) is determined as 45 cm for all fishing gears.

6.2.2.3 Catches

6.2.2.3.1 Landings

Landings data for Bulgaria and Romania were reported to the STECF EWG 1216 through the EU Data collection program and for the Turkey and Ukraine – according to the official statistics of each country. Since 2002 total annual landings varied between 618 and 1035 tons (Tab. 6.2.2.3.1.1). The data set of landings by countries was compiled for the period 1989 – 2011.

Table 6.2.2.3.1.1 Landings of turbot in the Black Sea during the period 1989 – 2011.

Year	Bulgaria	Romania	Ukraine west	Ukraine east	Turkey west	Turkey east	Russian Federation	Georgia	Black Sea total	Black Sea west
1989	0.9	0	2	0	448	1001	0	8	1459.9	450.9
1990	0	0	9	0	908	475	0	1	1393	917
1991	0	2	17.1	0.9	600	315	0	0	935	619
1992	0	1	18	1	308	110	1	0	439	327
1993	0	6	10	0	400	1185	2	0	1603	416
1994	0	6	18	1	1293	821	5	0	2144	1317
1995	60	4	10	0	2006	844	19	0	2943	2080
1996	62	6	37	2	1414	510	17	0	2048	1519
1997	60	1	40	2	777	134	11	0	1025	878
1998	64	0	40	2	1056	412	14	0	1588	1160
1999	54	2	69	4	1579	225	15	5	1953	1704
2000	55.1	2	76	4	2321	318	4	9	2789.1	2454.1
2001	56.5	13	123	6	2169	154	24	11	2556.5	2361.5
2002	135.5	16.681	99	5.47	193	142	15	11	617.651	444.5
2003	40.8	23.978	118	5.876	126	93	15	1	423.654	308.8
2004	16.2	42.031	126	7.157	118	116	1.7	7	434.088	302.2
2005	12.69	36.53	123	6	273	275	7.5	7	740.72	445.69
2006	14.81	35.108	154	8	266	481	7.6	0	966.518	466.81
2007	66.852	48.064	205	10.58	346	353	5.7	0	1035.396	666
2008	54.621	47.112	239	12.35	224	234	4.7	0	815.786	565
2009	52.47	48.767	247	16	223	119	24.3	0	730.537	571
2010	46.45	48.25	166.00	41.00	218.00	77.00	25	0	621.70	479
2011	37.80	43.25	211.00	25.00	108.10	36.40	24.09	0.00	485.64	400.15

6.2.2.3.2 Discards

No data from discards surveys have been reported to STECF EWG 12-16 Black Sea.

6.2.1.3. Fishing effort

Fishing effort data for Bulgaria and Romania (Table 6.2.2.4.1 and Table 6.2.2.4.2) were reported to EWG 12 16 Black Sea through the Data collection program.

Table 6.2.2.4.1 DCF Fishing effort data (kW days at sea) by gear of Bulgaria during 2008 - 2011.

Country	Year	Vessel length	Gear	Mesh size range	Fishery	Nominal effort	GT Days at sea	No vessels
BUL	2008	VL0006	SB	00D14	MDPSP	86279	7201	45
BUL	2008	VL0612	GNS	400DXX	MDPSP	13360571	1199491	244
BUL	2008	VL0612	FPO	00D14	MDPSP	16388855	155008	192
BUL	2008	VL1218	GNS	400DXX	MDPSP	538247	81346	11
BUL	2008	VL1218	OTM	00D14	SPF	1068620	146035	9
BUL	2008	VL1218	LLD	400DXX	MDPSP	1583816	218369	24
BUL	2008	VL1824	OTM	00D14	SPF	808959	204422	4
BUL	2008	VL1824	GNS	400DXX	MDPSP	514801	111688	9
BUL	2008	VL2440	OTM	20D40	SPF	4251250	2025889	11
BUL	2009	VL0006	GNS	400DXX	MDPSP	4397290	437650	246
BUL	2009	VL0006	SB	00D14	MDPSP	35948	6960	38
BUL	2009	VL0612	GNS	400DXX	MDPSP	31677082	2666531	376
BUL	2009	VL0612	FPO	00D14	MDPSP	12075037	1178437	169
BUL	2009	VL1218	GNS	400DXX	MDPSP	904853	133394	3
BUL	2009	VL1218	LLD	400DXX	MDPSP	2589388	346649	27
BUL	2009	VL1218	OTM	00D14	SPF	2957668	434558	15
BUL	2009	VL1824	OTM	00D14	SPF	1440379	376387	5
BUL	2009	VL1824	GNS	400DXX	MDPSP	663300	170129	11
BUL	2009	VL2440	OTM	20D40	SPF	5520149	2650975	12
BUL	2010	VL0006	GNS	400DXX	MDPSP	6035886	628691	290
BUL	2010	VL0006	SB	00D14	MDPSP	249121	27299	64
BUL	2010	VL0612	GNS	400DXX	MDPSP	48632062	3937369	408
BUL	2010	VL0612	FPO	00D14	MDPSP	18617358	1710535	188
BUL	2010	VL1218	GNS	400DXX	MDPSP	811362	112706	7
BUL	2010	VL1218	OTM	00D14	SPF	3559407	449947	6
BUL	2010	VL1218	LLD	400DXX	MDPSP	6027502	812014	37
BUL	2010	VL1824	OTM	00D14	SPF	1306384	351630	7
BUL	2010	VL1824	GNS	400DXX	MDPSP	632845	178907	10
BUL	2010	VL2440	OTM	20D40	SPF	6995010	3003786	13
BUL	2011	VL0006	GNS	400DXX	MDPSP	9494891	971580	302
BUL	2011	VL0006	SB	00D14	MDPSP	34136	3493	39
BUL	2011	VL0612	GNS	400DXX	MDPSP	83113602	7195983	498
BUL	2011	VL0612	FPO	00D14	MDPSP	740804	64139	87
BUL	2011	VL0612	OTM	00D14	MDPSP	180869	15660	4
BUL	2011	VL1218	GNS	400DXX	MDPSP	1133407	160684	36
BUL	2011	VL1218	OTM	00D14	SPF	5833424	827010	23
BUL	2011	VL1218	LLD	400DXX	MDPSP	679442	96325	1
BUL	2011	VL1824	GNS	400DXX	SPF	147305	42327	6
BUL	2011	VL1824	LLS	400DXX	MDPSP	36536	10498	1
BUL	2011	VL1824	OTM	00D14	MDPSP	856319	246060	5
BUL	2011	VL2440	OTM	20D40	SPF	6172300	2718507	11
BUL	2011	VL2440	GNS	400DXX	MDPSP	541	238	1

Table 6.2.2.4.2. DCF Fishing effort data (kW days at sea) by gear of Romania during 2008 - 2011.

Country	Year	Vessel length	Gear	Mesh size range	Fishery	Nominal effort	GT Days at sea	No vessels
ROM	2008	VL2440	GNS	400DXX	DEMF	63552	26112	4
ROM	2008	VL2440	OTM	14D16	MDPSP	193304	79424	4
ROM	2008	VL1224	GNS	100D400	DEMF	1404	453	2
ROM	2008	VL1824	GNS	400DXX	DEMF	11040	3400	2
ROM	2008	VL1824	OTM	14D16	MDPSP	16560	5100	2
ROM	2008	VL1218	GNS	400DXX	DEMF	11520	1277	4
ROM	2008	VL1218	OTM	14D16	MDPSP	2740	304	4
ROM	2008	VL0612	FPN	14D16	MDPSP	72575	32256	13
ROM	2008	VL0006	GNS	400DXX	DEMF	8031	305	12
ROM	2008	VL0612	GNS	400DXX	DEMF	1728872	146614	68
ROM	2008	VL0006	GNS	100D400	DEMF	8700	332	3
ROM	2008	VL0006	FPN	14D16	MDPSP	3198	410	4
ROM	2009	VL2440	OTM	14D16	SPF	10592	4352	2
ROM	2009	VL2440	GNS	400DXX	DEMF	4965	2040	1
ROM	2009	VL2440	GNS	100D400	DEMF	331	136	1
ROM	2008	VL0612	GNS	100D400	DEMF	1414531	119957	37
ROM	2009	VL1824	GNS	400DXX	DEMF	2429	517	1
ROM	2009	VL1824	GNS	100D400	DEMF	221	47	1
ROM	2009	VL1218	GNS	400DXX	DEMF	7801	866	3
ROM	2009	VL0612	GNS	400DXX	DEMF	3611961	306351	100
ROM	2009	VL0612	GNS	100D400	DEMF	306351	30299	36
ROM	2009	VL0612	FPN	14D16	MDPSP	113342	50377	17
ROM	2009	VL0006	GNS	400DXX	DEMF	6033	225	9
ROM	2009	VL0006	GNS	100D400	DEMF	983	42	3
ROM	2009	VL0006	FPN	14D16	MDPSP	5429	714	7
ROM	2010	VL2440	OTM	14D16	SPF	662	272	1
ROM	2010	VL0612	GNS	400DXX	DEMF	3383293	306344	124
ROM	2010	VL0612	GNS	100D400	DEMF	254657	23059	27
ROM	2010	VL0612	FPN	14D16	MDPSP	102528	45546	14
ROM	2010	VL0612	none	none	DEMSP	810	57	3
ROM	2010	VL0006	GNS	400DXX	DEMF	2519	323	3
ROM	2010	VL0006	FPN	14D16	MDPSP	2624	100	3
ROM	2011	VL2440	GNS	400DXX	DEMF	2208	645	1
ROM	2011	VL2440	OTM	14D16	SPF	27158	8012	2
ROM	2011	VL2440	OTM	14D16	MDPSP	4416	1290	1
ROM	2011	VL1824	GNS	400DXX	DEMF	3641	965	1
ROM	2011	VL1824	GNS	100D400	DEMF	1324	351	1
ROM	2011	VL0612	LLS	none	DEMF	7137	622	4
ROM	2011	VL0612	GNS	400DXX	DEMF	4190670	154361	49
ROM	2011	VL0612	GNS	100D400	DEMF	8429	405	8
ROM	2011	VL0612	none	none	DEMSP	80851	1261	3
ROM	2011	VL0612	FPN	14D16	MDPSP	90236	26371	40
ROM	2011	VL0006	GNS	400DXX	DEMF	14039	558	6
ROM	2011	VL0006	GNS	100D400	DEMF	143	8	1
ROM	2011	VL0006	FPN	14D16	MDPSP	1727	151	8
ROM	2011	VL0006	none	none	DEMSP	777	84	3

No data were available for fishing effort and CPUE from Ukraine.

The number of fishing vessels, operating in Turkish Black Sea area on turbot fisheries are given in Table 6.2.2.4.3.

Table 6.2.2.4.3. Number of Turkish fishing vessels, operating on turbot fisheries in the Black Sea area.

Year	Vessels (in Nbs)
1987	102
1988	89
1989	96
1990	223
1991	94
1992	273
1993	286
1994	204
1995	166
1996	298
1997	266
1998	264
1999	338
2000	340
2001	286
2002	300
2003	133
2004	141
2005	212
2006	231
2007	206
2008	263
2009	237
2010	225
2011	298

6.2.2.4 Commercial CPUE

Table 6.2.2.5.1. CPUE data for Bulgaria (2008 – 2011).

Country	Species	Metier		CPUE			
		Gear	Gear	2008	2009	2010	2011
Bulgaria	TUR	GNS	LOA > 0 < 6	30.4	32.5	21.86	20.22
			LOA => 6<12	58.32	53.91	34.5	43.29
			LOA => 12<18	125.26	71.62	65.48	46.49
			LOA => 18<24	83.05	95.86	102.95	34.47
			LOA => 24<40	-	-	250	110.69
		OTM	LOA => 12<18	139.17	145.1	9.68	-
			LOA => 18<24	45	137.83	--	-
			LOA => 24<40	251.67	95	84.38	-

6.2.3 Scientific Surveys

6.2.3.1 Method 1: International (Bulgarian and Romanian) Bottom Trawl Survey

Based on the DCF, abundance and biomass indices were calculated for the Bulgarian (Panayotova et.al. 2011, 2012) and Romanian waters (Maximov et al, 2011, 2012) in spring and autumn seasons by swept area method using the same fishing vessel and gear. In 2011, demersal survey for estimation of turbot abundance indices by swept area method was carried out in Turkish Black Sea area.The following number of hauls was reported per depth stratum during the year (Tab. 6.2.3.1.1).

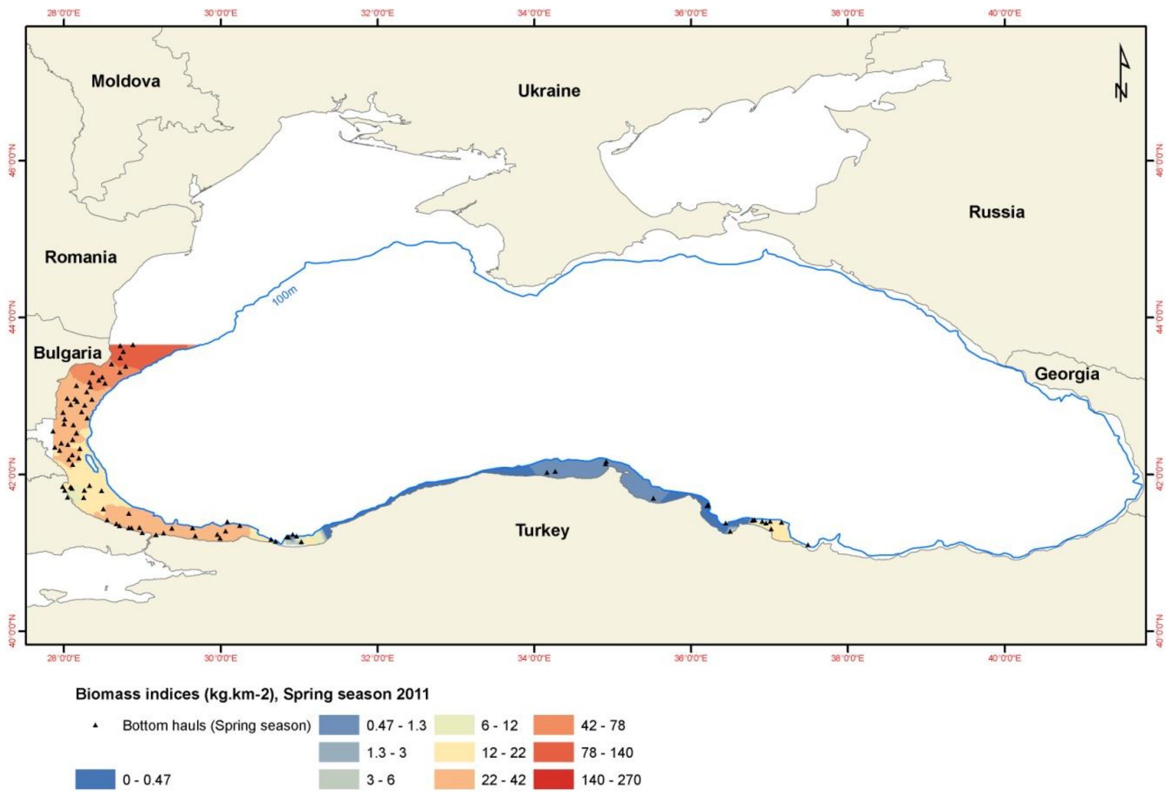
Table 6.2.3.1.1. Number of hauls per depth stratum and country in 2011.

Country	Period	Stratum	Number of hauls
BG	June	15 - 35 m	10
	October - November	35 - 50 m	20
		50 - 75 m	30
		75 - 100 m	17
ROU	May	15 - 35 m	14
	October	35 - 50 m	47
		50 - 75 m	23
TR		15 - 35 m	22
		35 - 50 m	53
		50 - 75 m	67

For estimation of abundance and biomass of turbot stocks in all areas, swept area method and standard methodology for stratified sampling were applied (Sparre, Venema, 1998; Sabatella, Franquesa, 2004).

6.2.3.1.1 Geographical distribution patterns

Distribution of turbot CPUA ($kg.km^{-2}$), merged for the Bulgarian and Turkish waters by seasons is shown in Figures 6.2.3.1.1.1 and 6.2.3.1.1.2.



F
igure 6.2.3.1.1.1. Distribution of turbot CPUA (kg/km^2) from surveys along the Bulgarian and Turkish Black Sea coast in spring season of 2011.

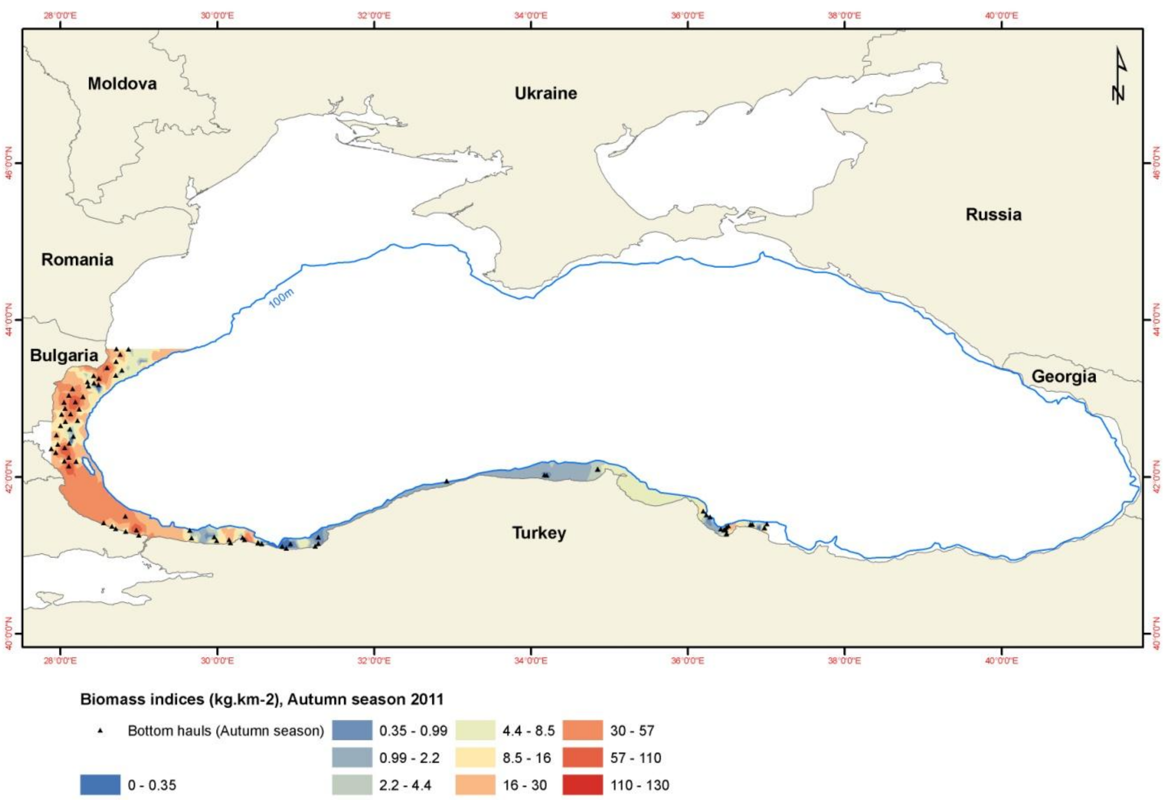


Figure 6.2.3.1.1.2. Distribution of turbot CPUA (kg/km^2) from surveys along the Bulgarian and Turkish Black Sea coast in autumn season of 2011.

Distribution of turbot CPUA (kg.Nm^{-2}) in Romanian waters by seasons (Maximov et.al, 2011, 2012) is shown on Fig. 6.2.3.1.1.3

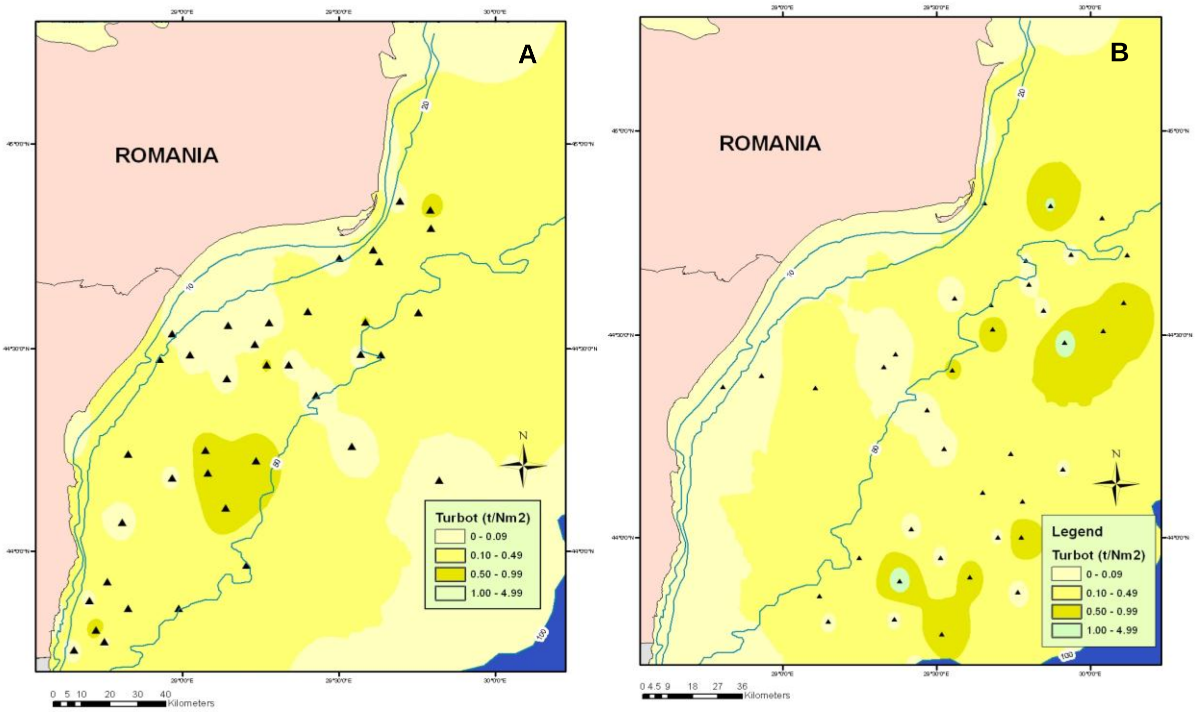


Figure 6.2.3.1.1.3. Distribution of turbot CPUA (kg/Nm^2) from surveys along the Romanian Black Sea coast in spring (A) and autumn (B) seasons of 2011.

Distribution of turbot CPUA (kg.km^{-2}) in Bulgarian waters by seasons (Panayotova et.al, 2011, 2012) is shown on Fig. 6.2.3.1.1.4 and in Turkish area (Zengin, Gumus, 2012) - Fig. 6.2.3.1.1.5.

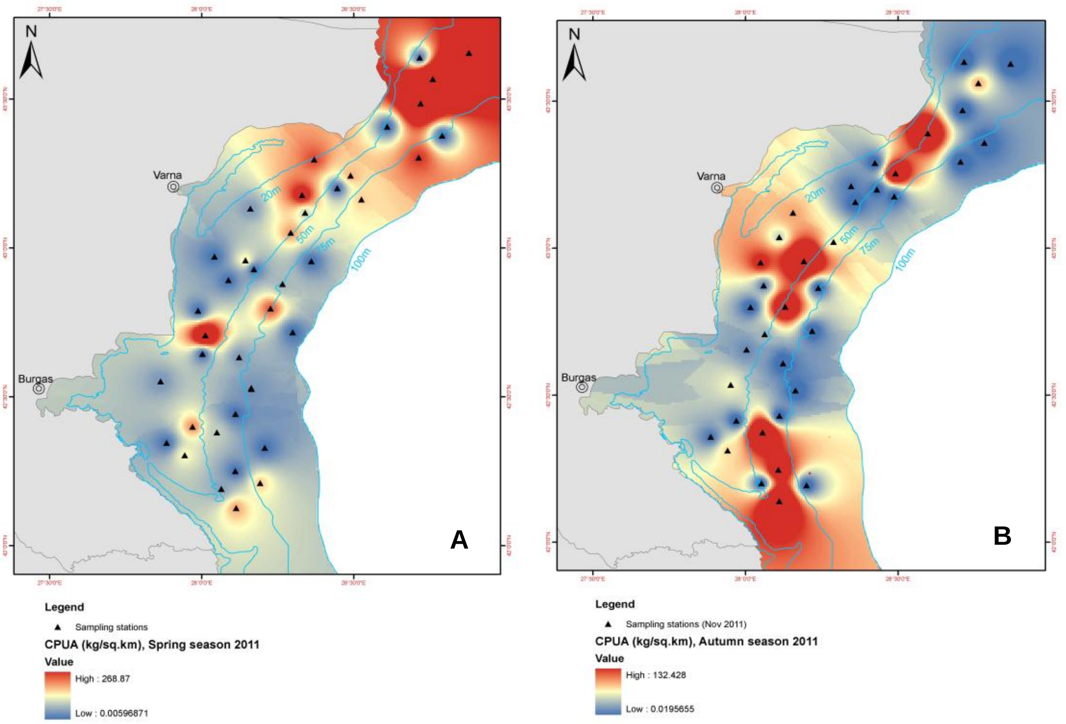


Figure 6.2.3.1.1.4. Distribution of turbot CPUA (kg.km-^{2}) from surveys along the Romanian Black Sea coast in spring (A) and autumn (B) seasons of 2011.

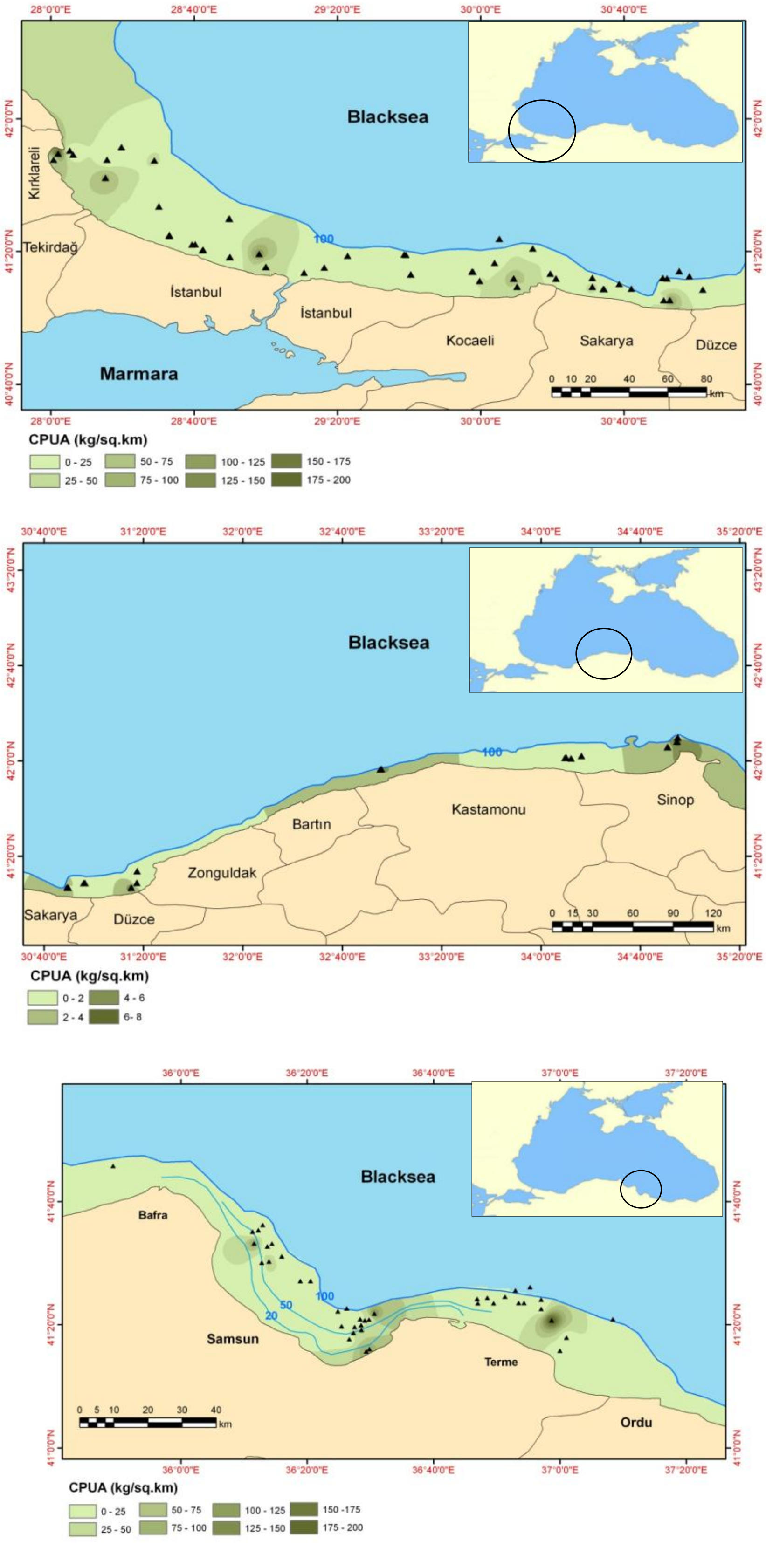


Figure 6.2.3.1.1.5. Distribution of turbot CPUA (kg.km-^{2}) from surveys along the Turkish Black Sea coast in 2011.

6.2.3.1.2 *Trends in abundance and biomass*

Fishery independent information regarding the state of the turbot was derived from the national surveys in Bulgaria (Panayotova et.al., 2006, 2007a, 2007b, 2008a, 2008b, 2009, 2010, 2011a, 2011b, 2012), Romania (Maximov et al, 2009; Maximov et al, 2010a, Maximov et al, 2010b; Radu et al, 2009a; Radu et al, 2009b, Radu et al, 2010a; Radu et al, 2010b, 2011, 2012) and Turkey (Zengun, Gumus, 2012). Fig. 6.2.3.1.2.1 shows the trends in the biomass index in Bulgaria and in Romania. The biomass indices for the Bulgarian waters show decreasing trend since 2008. According to the Romanian surveys, increase was observed in 2011.

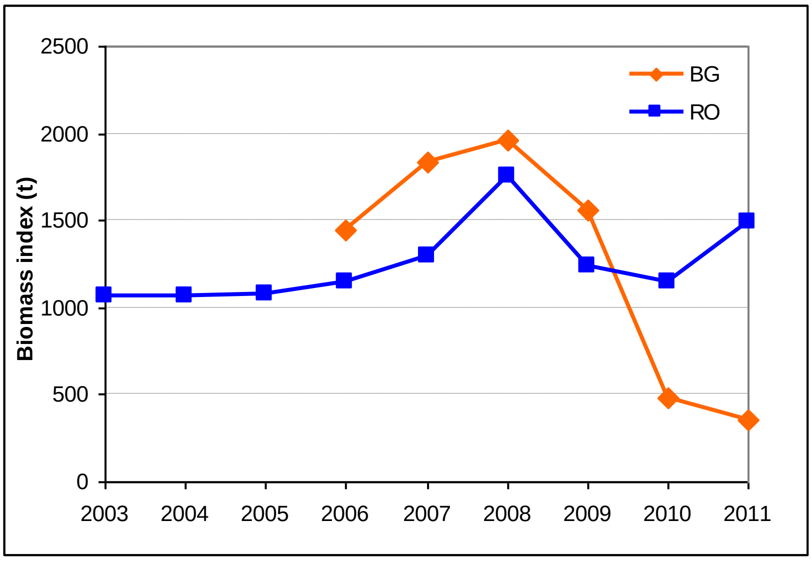


Fig. 6.2.3.1.2.1. Biomass indices derived from national surveys in Bulgaria and Romania) for turbot in the Black Sea in the period 2003 - 2011.

In Turkey, the biomass indices were found to be higher in spring especially in depths lower than 50 m when compared to fall and depths over 50 m – Zengin, Gumus (2012) - Tabl. 6.2.3.1.2.1.

Table 6.2.3.1.2.1. The biomass indices of turbot population for Turkish Black Sea coasts in 2011.

Fishing area	Period	Depth (m)	No of hauls (N)	Mean biomass index (kg/km^2)	Min-Max (kg/km^2)	Standart Deviation (±se)
Samsun Shelf	Spring-2011	0-20	2	0	-	-
		20-50	9	42.1	9.0-206,6	23.6
		50-100	11	21.6	58-5-140,9	13.3
		0-100	22	**28.0**	9.04-206,6	28.0
	Fall-2011	0-20	3	18.1	1.6-108.0	1.0
		20-50	20	14.0	0.5-102.6	6.0
		50-100	14	6.9	0.4-43.2	3.8
		0-100	37	**13.1**	0.4-108,0	4.4
Western Black Sea	Spring-2011	0-20	11	42.1	4.5-199.1	18.4
		20-50	14	7.2	3.9-34.8	3.3
		50-100	18	7.0	10.1-82.1	4.7
		0-100	43	**16.0**	3.9-199.1	5.7
	Fall-2011	0-20	6	24.2	10.8-60.5	9.1
		20-50	9	15.6	6.1-129.6	14.3
		50-100	25	5.5	0.1-121.0	4.8
		0-100	40	**10.6**	0.1129.6	4.6

6.2.3.1.3 Trends in abundance at length or age

The trends in abundance at length and at age during the period 2006 - 2011, according to the survey data along the Bulgarian Black sea area , are presented on Fig. 6.2.3.1.2.1.

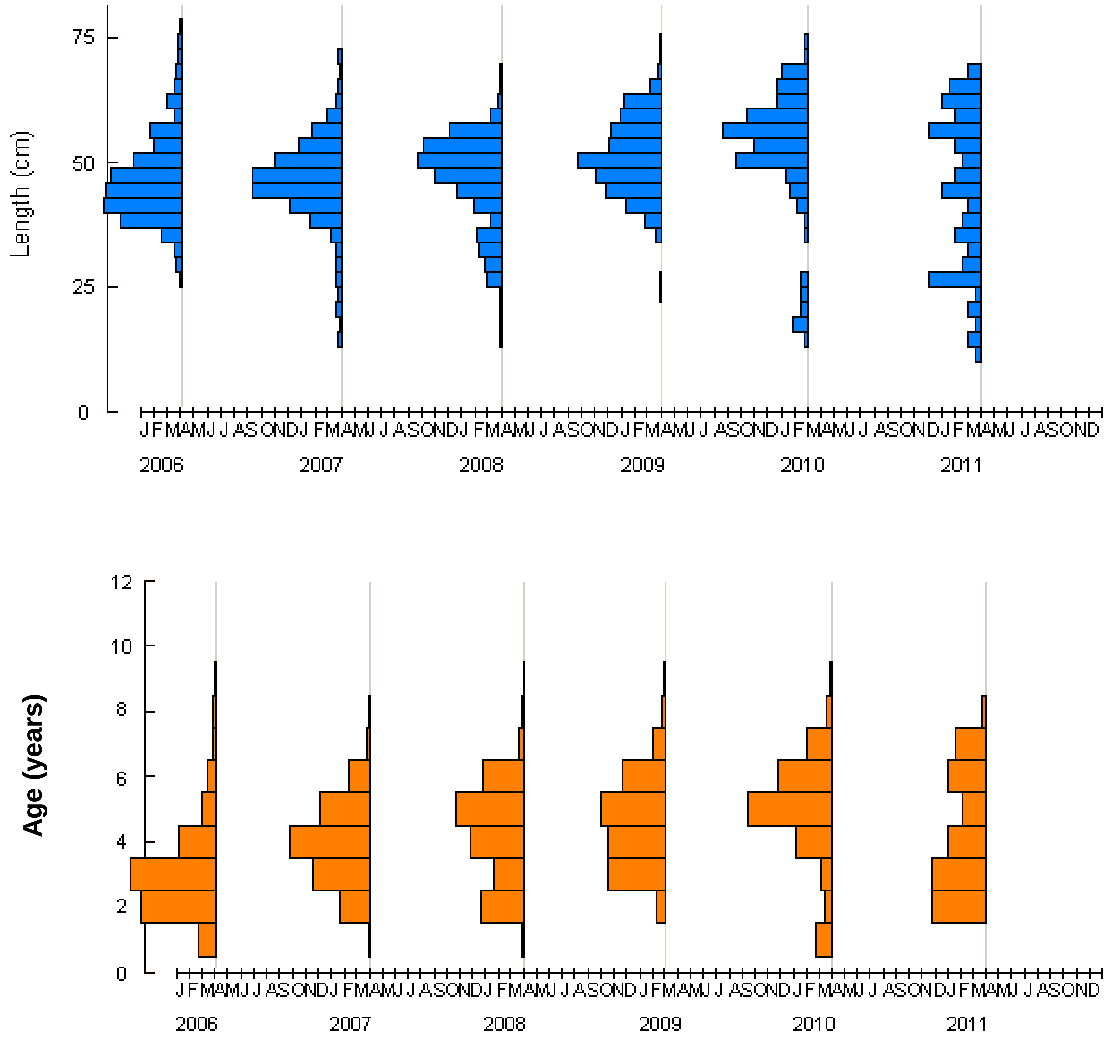


Figure 6.2.3.1.3.1. Length and age frequency data for turbot, obtained during the surveys along the Bulgarian Black Sea coast in the period 2006 – 2011.

The trends in abundance at length during the surveys in Romanian area during the period 2002 – 2010 and 2011 are presented on Fig. 6.2.3.1.3.2.

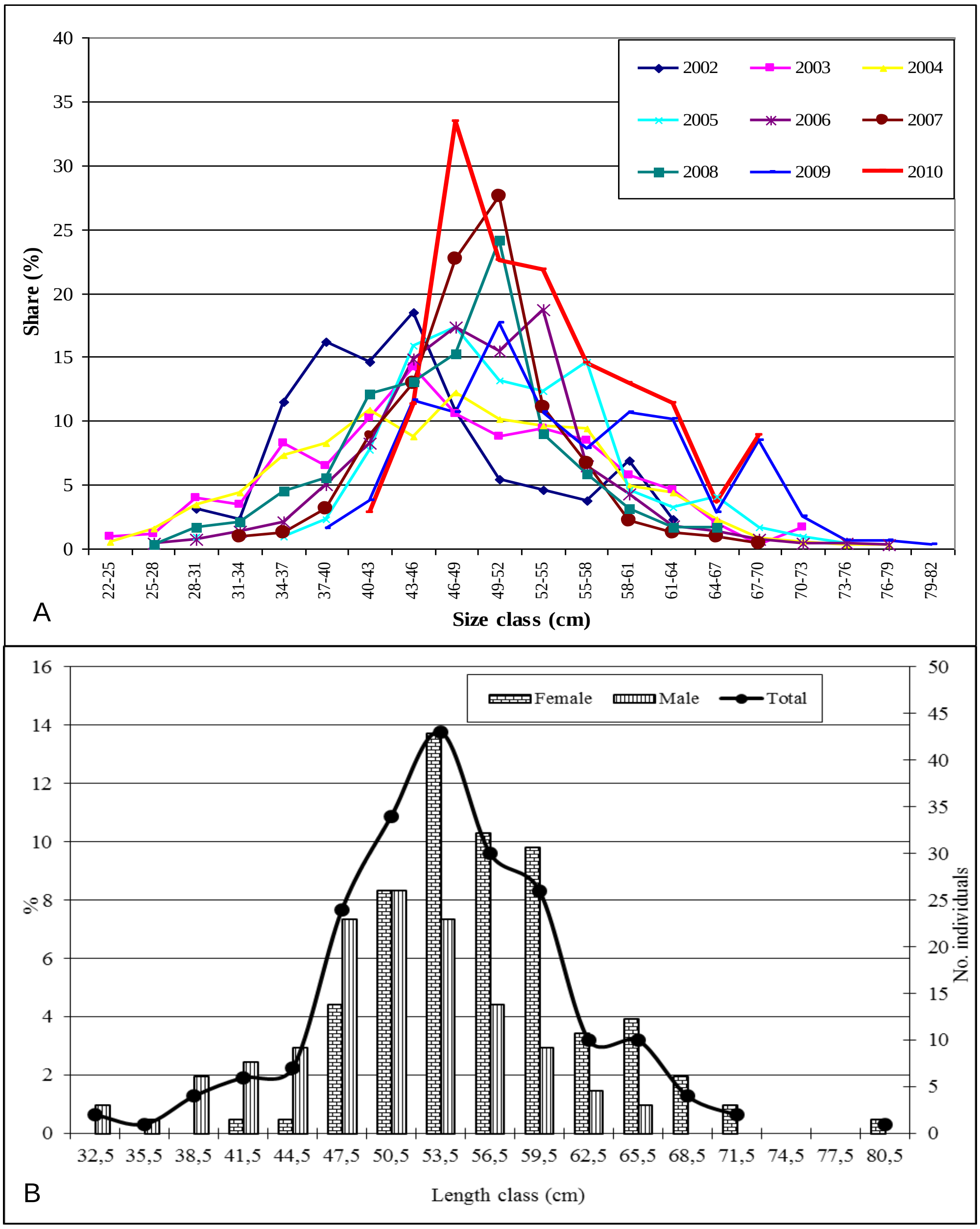
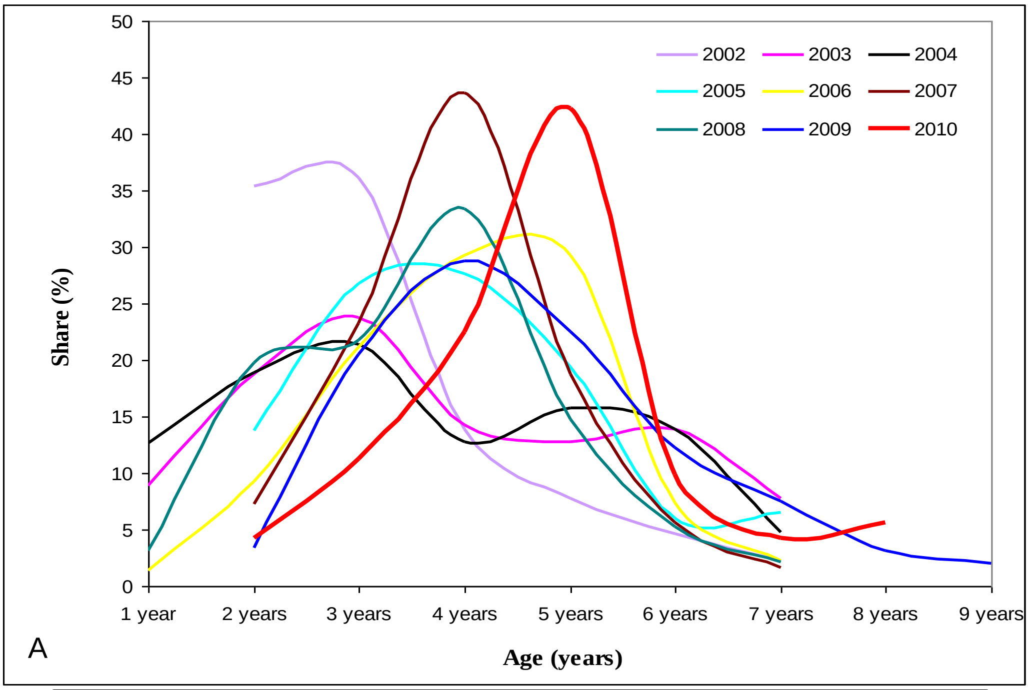


Figure 6.2.3.1.3.2. Length frequency data for turbot, obtained during the surveys along the Romanian Black Sea coast in the period 2002 – 2010 (A) and 2011 (B).

The trends in abundance at age during the surveys in Romanian area in the period 2002 – 2010 and 2011 are presented on Fig. 6.2.3.1.3.3.



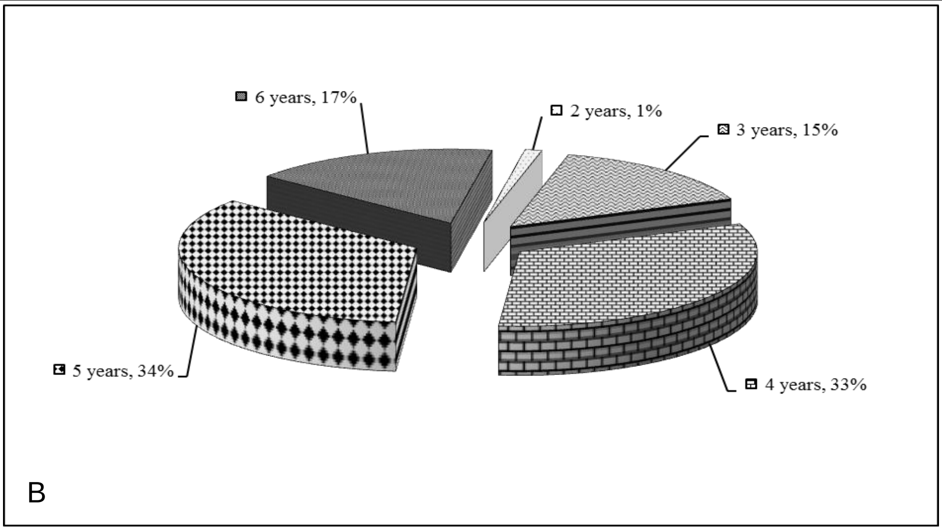


Figure 6.2.3.1.3.3. Length frequency data for turbot, obtained during the surveys along the Romanian Black Sea coast in the period 2002 – 2010 (A) and 2011.

6.2.3.1.4 Trends in growth

No analyses were conducted.

6.2.3.1.5 Trends in maturity

No analyses were conducted.

6.2.4 Assessment of historic parameters

6.2.4.1 Method 1: SAM

6.2.4.1.1 Justification

The data (1950-2011) of total landings, catch at ages, weights and maturity at age are considered appropriate for assesseng the stock using the state-space assessment model (SAM) (Nielsen et al., 2012) in FLR environment. The SAM environment is encapsulated into the Fisheries Library in R (FLR) (Kell et al., 2007) in the form of the package "FLSAM". All assessments are performed with version 0.99-3 of FLSAM, together with version 2.4 of the FLR library (FLCore). Four tuning series (3 surveys and 1 commercial CPUE series were compiled from previous assessments (Daskalov et al., 2011) and recent data.

6.2.4.1.2 Input parameters

Input data types and characteristics are given in Tabl.6.2.4.1.2.1.

Table 6.2.4.1.2.1. Input data, used in SAM.

Name	Type	Year range	Age range	Data Modifications	Variable from year to year?
LA$_{(1)}$	catch in tonnes	1950 - 2011	1 - 10+	See note 1	Yes
CN$_{(2)}$	catch-at-age in numbers	1950 - 2011	1 - 10+	See note 2	Yes
CW$_{(3)}$	Weight-at-age in the commercial catch	1950 - 2011	1 - 10+	See note 3	Yes
SW$_{(3)}$	Weight-at-age of the spawning stock	1950 - 2011	1 - 10+	See note 3	Yes
NM$_{(4)}$	natural mortality	1950 - 2011	1 - 10+	See note 4	Yes
PF	proportion of fishing mortality before spawning	1950 - 2011	1 - 10+		No
MO$_{(5)}$	Proportion mature-at-age	1950 - 2011	1 - 10+	See note 5	Yes
PM	proportion of natural mortality before spawning	1950 - 2011	1 - 10+	No	No
TUN	Ukrainean survey	1989 - 2007	2 – 10+	Yes	Yes
	Romanian survey	2003 - 2011	2 - 7	Yes	yes
	Bulgarian survey	2006 - 2011	2 - 9	Yes	Yes
	Turkish commercial CPUE	1987 - 2011	1 - 10+	Yes	Yes

(1) Assessment and qualitative assumptions about the IUU (Illegal, Unregulated and Unreported) fishing of turbot were made and rates of the Potential Unreported Catch in 2002-2010 were estimated as a proportion between Turkish catch in 1993-2001 and 2009-2010, which then was added to the officially reported catch. The IUU catch in 2011 was estimated as average from proportions in 2002-2009.

(2) Catch-at-age data for 2011 are derived from the raised national landings statistics by countries and added to the historic catch at age data set compiled during the previous meetings from Prodanov et al. (1997) for the period 1970 – 1988. The new data set, covering the period 1950 – 1969 was added according to data from Ivanov, Beverton (1985). The catch-at-age data was corrected to the official landings (SOP corrections). They do represent officially reported landings and do not include any discards and unreported catches.

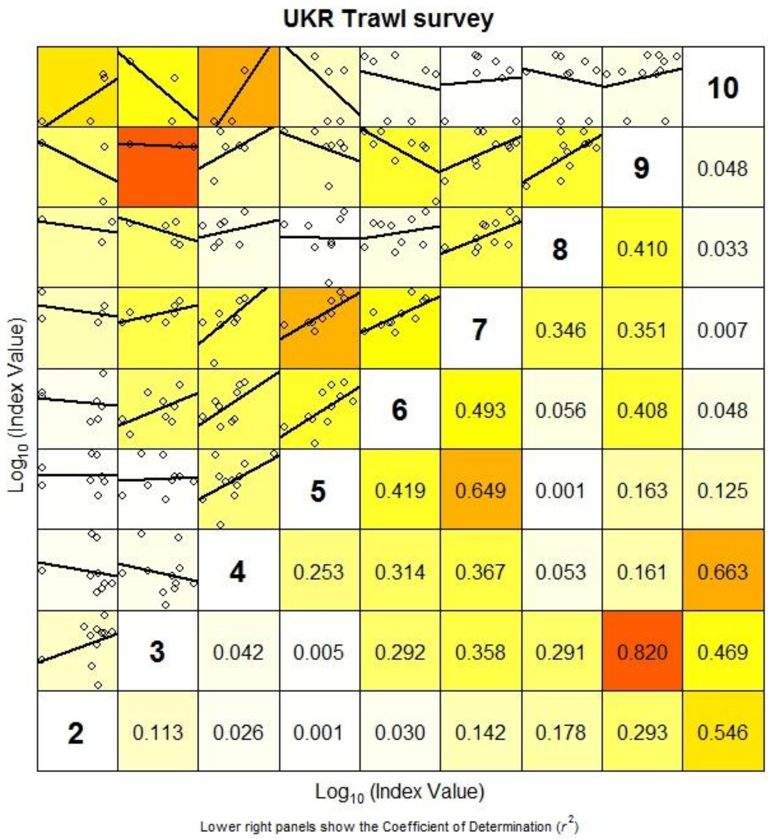
(3) The mean weights at ages in the stock for the period 1989-2011 were assumed equal to the catch weights at age in the landings due to lack of data. The averaged weights-at-age during the period 1989 – 1993 were used to estimate stock biomass in 1950 – 1988.

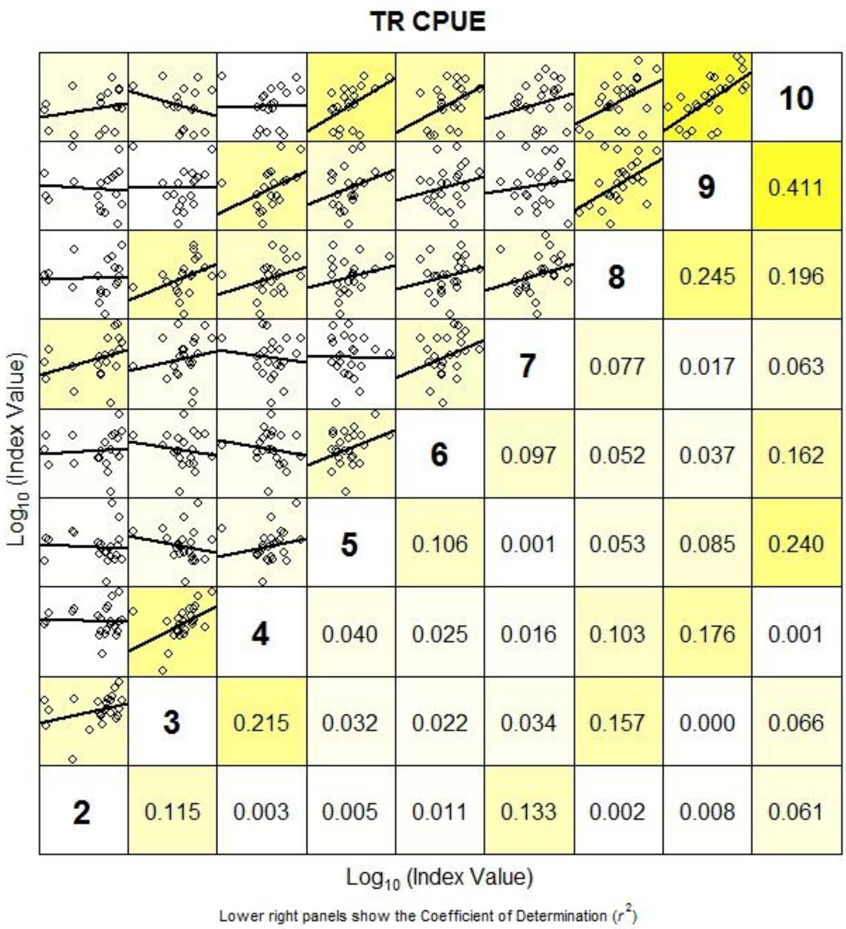
(4) A vector of natural mortality (M) by age groups was estimated by ProdBIOM ver.2009 (Abella et.al, 1997, 1998) using the parameters in VBGF (Tabl. 6.2.1.2.1) and applied for all years.

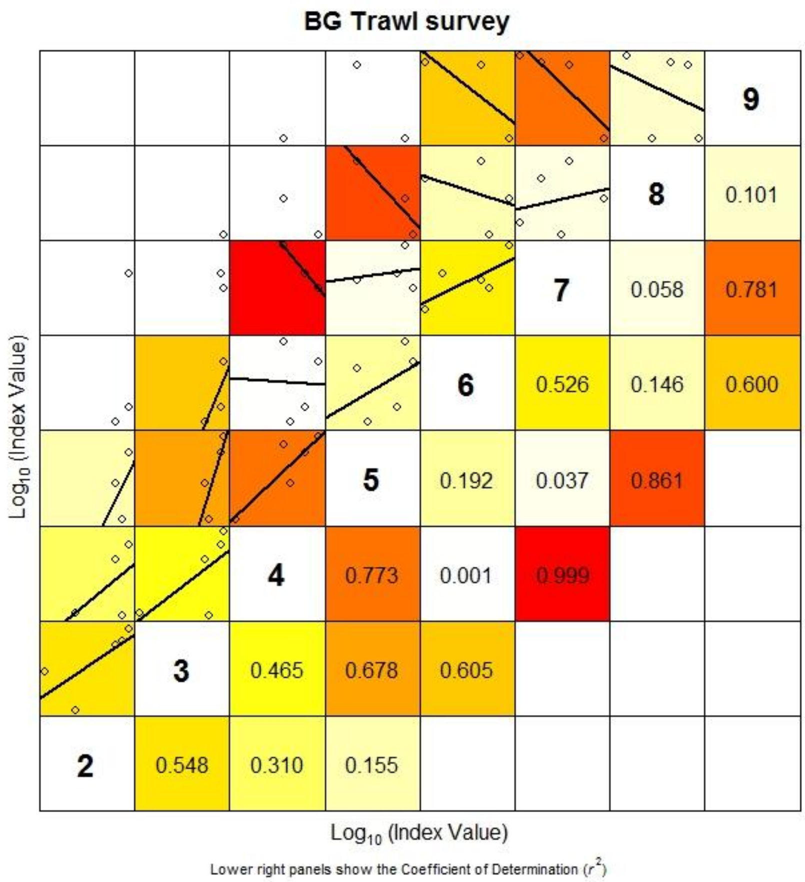
(5) Maturity ogive was calculated as average for the period 2007 – 2009 due to good consistency for these years and applied over the whole period.

Prior to different assessment runs, the exploration analysis of the data was performed and data was assessed as appropriate for stock assessment purposes. The analyses of tuning series is shown on Fig. 6.2.4.1.2.1. The full set of figures of the exploration data analysis are presented in the Annex.

STECF EWG 12 16 considered to use 3 of the 4 series for tuning the SAM model, obtained from Bulgarian and Ukrainean fishery-independent surveys and CPUE of the Turkish fleet, ages 2-10+ over the period 1987-2011. Romanian series was ommited due to low internal consistency and inability to track the cohorts. Turkish tuning series was binded due to similar level of observed variance (Fig. 6.2.4.1.2.2).




TR CPUE
10
9 0.411
8 0.245 0.196
7 0.077 0.017 0.063
6 0.097 0.052 0.037 0.162
5 0.106 0.001 0.053 0.085 0.240
4 0.040 0.025 0.016 0.103 0.176 0.001
3 0.215 0.032 0.022 0.034 0.157 0.000 0.066
2 0.115 0.003 0.005 0.011 0.133 0.002 0.008 0.061
Log10 (Index Value)
Log10 (Index Value)
Lower right panels show the Coefficient of Determination (r2)


BG Trawl survey
9
8 0.101
7 0.058 0.781
6 0.526 0.146 0.600
5 0.192 0.037 0.861
4 0.773 0.001 0.999
3 0.465 0.678 0.605
2 0.548 0.310 0.155
Log10 (Index Value)
Log10 (Index Value)
Lower right panels show the Coefficient of Determination (r2)

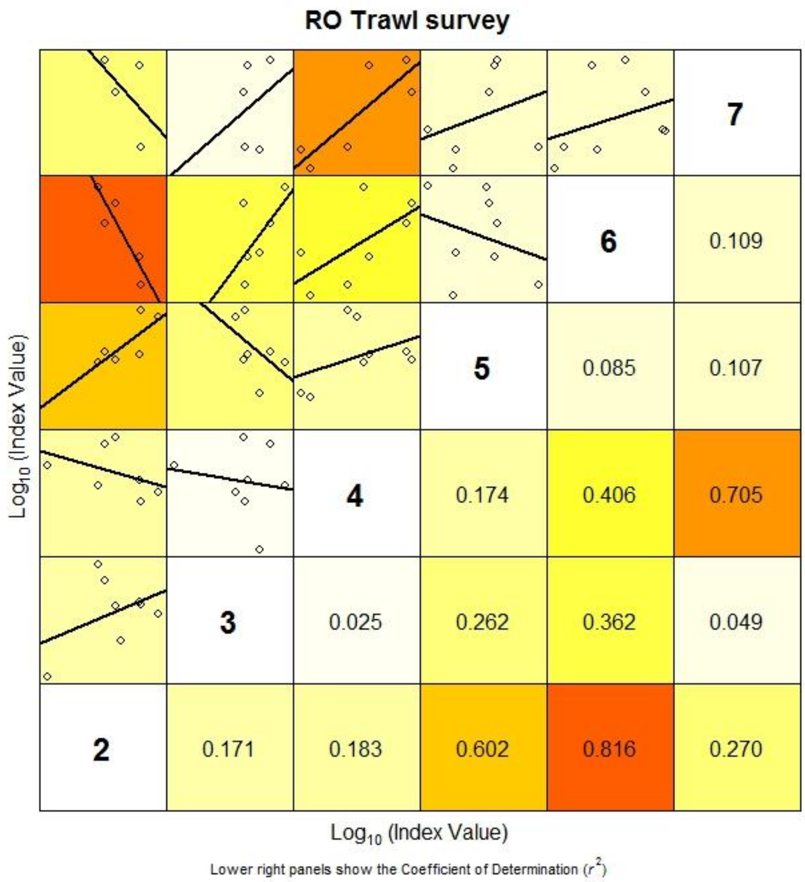


Fig.6.2.4.1.2.1. Fitted linear relationships of cohort trends within the tuning series.

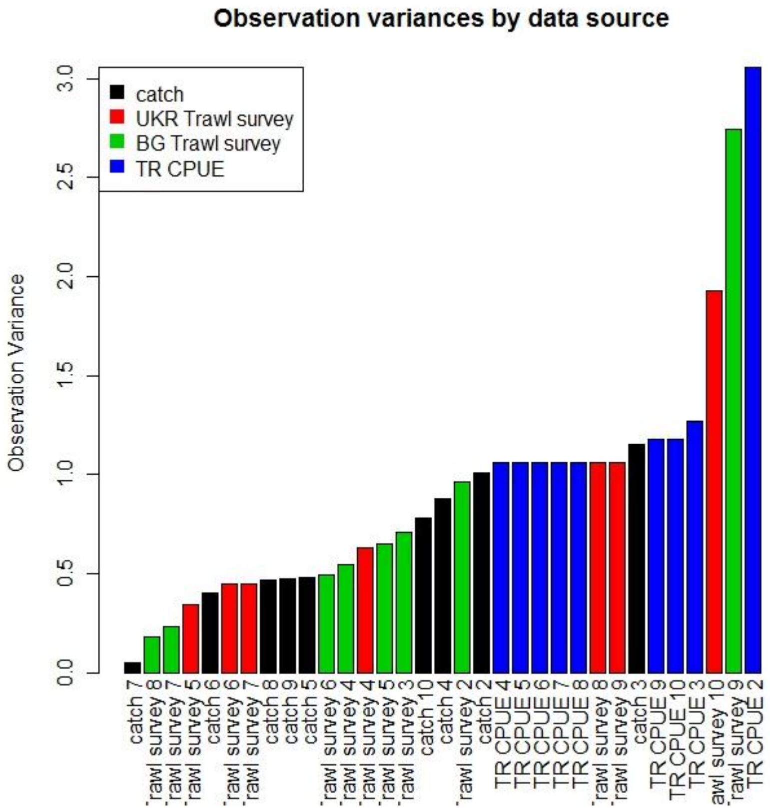


Fig. 6.2.4.1.2.2. Variances of tuning data series.

The input data for SAM includes landings, compiled according to the official landings statistics (Table 6.2.4.1.2.2) with estimated IUU catches (Tabl. 6.2.4.1.2.3 - Tabl. 6.2.4.1.2.8).

Table 6.2.4.1.2.2 Turbot in the Black Sea 1950-2011. SAM input parameters, official landings with IUU catches estimated.

Year	Catch	Year	Catch	Year	Catch
1950	3932	**1971**	3052	**1992**	439
1951	4741	**1972**	3049	**1993**	1603
1952	5217	**1973**	3705	**1994**	2144
1953	4985	**1974**	1696	**1995**	2943
1954	4505	**1975**	1273	**1996**	2048
1955	3678	**1976**	1584	**1997**	1025
1956	3623	**1977**	2012	**1998**	1588
1957	3017	**1978**	2160	**1999**	1953
1958	4289	**1979**	5447	**2000**	2789
1959	4653	**1980**	2843	**2001**	2557
1960	2680	**1981**	3276	**2002**	1412
1961	3058	**1982**	4662	**2003**	943
1962	2904	**1983**	5307	**2004**	989
1963	3812	**1984**	2852	**2005**	2039
1964	3666	**1985**	527	**2006**	2737
1965	3063	**1986**	428	**2007**	2692
1966	3093	**1987**	849	**2008**	1901
1967	2709	**1988**	1116	**2009**	1541
1968	2931	**1989**	1460	**2010**	1321
1969	3076	**1990**	1393	**2011**	887
1970	5273	**1991**	935		

Table 6.2.4.1.2.3. Catch-at-age data (nbs, 10^3)

Units : thousands

year									
age	1950	1951	1952	1953	1954	1955	1956	1957	1958
2	16.397	19.748	23.692	25.119	21.002	18.31	18.04	14.862	21.169
3	112.918	135.972	164.901	176.873	146.621	128.763	126.874	130.048	259.27
4	216.681	260.864	321.152	349.953	286.75	254.327	250.607	293.781	383.447
5	280.36	337.472	420.244	463.324	376.404	336.296	331.387	387.218	486.748
6	226.152	272.659	302.097	291.305	261.462	214.675	211.467	220.132	309.756
7	180.133	217.37	224.295	195.543	189.597	145.942	143.719	77.563	138.655
8	115.062	138.899	138.981	115.318	116.204	86.64	85.307	41.332	57.23
9	41.986	50.659	52.827	46.801	44.818	34.857	34.327	12.084	18.122
10	25.562	30.857	30.872	25.611	25.811	19.242	18.946	6.269	8.541

year									
age	1959	1960	1961	1962	1963	1964	1965	1966	1967
2	33.373	27.762	8.915	14.186	43.495	25.964	11.486	21.708	61.68
3	355.666	138.435	131.955	135.825	235.771	372.001	169.355	132.49	251.327
4	567.8	231.44	278.865	281.284	235.009	312.064	320.28	206.362	235.719
5	402.023	205.908	229.911	172.624	262.933	271.244	265.077	267.176	175.771
6	293.197	182.972	209.673	216.155	290.267	227.835	172.629	236.643	192.666
7	157.728	109.8	112.386	121.817	181.621	136.976	112.799	131.96	93.375
8	64.621	58.186	75.748	72.532	94.435	82.583	69.137	70.776	54.007
9	17.733	13.454	20.071	17.249	15.62	18.076	17.422	13.6	13.28
10	11.175	9.369	11.085	5.081	6.805	6.018	9.17	8.142	7.644

year									
age	1968	1969	1970	1971	1972	1973	1974	1975	1976
2	35.427	30.656	72.647	1.814	1.875	3.4	2.089	0.211	27.663
3	306.856	334.071	353.927	47.933	72.838	47.204	5.576	11.202	86.728
4	319.099	362.644	171.982	434.073	49.816	62.156	8.826	30.674	35.072
5	204.389	262.83	540.574	200.784	202.466	276.994	44.395	145.872	103.805
6	178.719	186.969	310.77	188.526	209.334	237.515	102.688	99.776	93.079
7	113.986	98.328	234.828	142.951	175.418	208.852	101.49	63.921	64.781
8	49.266	40.67	83.85	42.138	72.451	77.682	36.091	19.512	19.124
9	9.798	8.641	38.218	16.895	28.245	34.258	22.168	7.251	12.702
10	4.943	5.437	41.594	15.546	32.019	49.547	39.956	9.98	34.436

year									
age	1977	1978	1979	1980	1981	1982	1983	1984	1985
2	20.331	22.42	3.575	12.814	18.143	0.064	0.067	0.061	0.055
3	47.836	64.459	148.2	75.89	75.342	115.985	158.094	53.836	0.776
4	22.505	50.179	106.001	41.273	24.159	69.497	98.656	49.529	2.251
5	73.658	195.913	406.363	162.346	75.826	201.974	375.707	45.761	4.347
6	93.499	134.19	331.837	193.383	136.36	171.426	212.477	75.37	8.461
7	89.041	99.558	252.491	147.618	166.726	172.368	192.419	80.754	15.215
8	29.572	30.561	77.947	49.345	91.002	76.879	77.62	66.218	7.22
9	24.734	19.218	51.679	25.463	51.087	70.832	70.771	45.761	12.188
10	64.526	32.096	107.789	52.008	83.458	157.448	150.266	121.131	27.169

year										
	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
2	0.056	0.059	0.057	11.804	55.811	70.661	42.675	436.461	122.823	67.184
3	0.056	1.185	0.057	33.052	68.144	120.758	29.139	366.249	283.93	47.037
4	0.224	8.296	0.226	41.147	104.67	87.588	29.625	150.765	224.63	311.408
5	4.938	12.593	19.53	59.359	94.524	60.376	17.215	63.55	204.966	486.222
6	5.78	47.704	29.559	68.128	37.011	47.027	13.473	25.902	62.968	246.691
7	11.783	13.926	24.457	34.739	29.226	36.382	15.199	14.71	44.668	87.013
8	0.225	13.63	38.181	16.863	20.721	8.41	9.901	14.699	39.514	18.741

9	2.581	8.593	8.622	15.852	12.93	6.112	2.271	11.461	33.673	2.444
10	30.806	42.222	55.599	52.614	35.602	6.112	2.453	3.249	10.323	2.444

	year								
age	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
2	38.396	0.01	0.01	0.01	110.151	28.426	80.79	20.717	13.389
3	40.687	62.311	8.951	69.841	98.406	42.512	150.474	33.986	37.052
4	130.189	48.751	25.789	114.285	132.503	133.008	111.603	28.565	46.66
5	168.863	43.585	73.551	76.19	107.75	247.27	130.089	54.114	61.454
6	210.143	50.365	176.184	184.125	78.666	322.937	90.565	77.279	73.88
7	97.104	68.768	97.091	146.031	197.593	103.839	64.237	87.386	58.547
8	42.477	32.285	54.775	25.397	110.854	22.142	5.304	15.985	27.142
9	9.999	13.56	11.2	12.698	56.976	2.584	1.153	0.898	5.232
10	0.011	3.229	0.01	6.349	17.343	7.753	1.384	0.539	0.01

	year						
age	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
2	49.463	76.733	87.238	68.7	34.407	7.077	157.577
3	96.474	141.472	201.205	98.777	102.933	22.693	49.419
4	140.665	319.004	453.814	218.685	127.586	78.873	44.427
5	108.857	232.529	266.855	177.475	112.002	139.599	57.503
6	80.221	131.603	121.593	111.732	76.709	116.846	24.647
7	108.083	97.079	57.347	92.296	118.024	65.605	29.976
8	74.992	16.128	10.977	32.449	24.2	30.597	34.203
9	11.97	20.446	13.169	5.518	3.476	10.253	15.391
10	3.855	0.01	1.411	2.436	0.009	2.524	4.605

Table 6.2.4.1.2.4.Weight-at-age in catch (kg)

	Black	Sea	Turbot.	WEIGHTS	AT	AGE	IN	THE	CATCH		
Units:	kg										
year											
age	**1950**	**1951**	**1952**	**1953**	**1954**	**1955**	**1956**	**1957**	**1958**	**1959**	
2	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	
3	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	
4	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	
5	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	
6	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	
7	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	
8	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	
9	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	
10	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	
year											
age	**1960**	**1961**	**1962**	**1963**	**1964**	**1965**	**1966**	**1967**	**1968**	**1969**	
2	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	
3	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	
4	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	
5	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	
6	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	
7	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	
8	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	
9	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	
10	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	
year											
age	**1970**	**1971**	**1972**	**1973**	**1974**	**1975**	**1976**	**1977**	**1978**	**1979**	
2	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	
3	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	
4	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	
5	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	
6	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	
7	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	
8	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	
9	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	
10	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	
year											
age	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	
2	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	1	
3	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.4	
4	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.8	
5	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.2	
6	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.3	
7	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4	
8	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.3	
9	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	6.6	
10	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	12.117	
year											
age	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
2	0.73	0.777	0.947	0.893	0.76	0.72	1.083	1.083	1.083	1.083	1.083
3	1.247	1.153	1.427	1.1	1.07	0.953	1	1	1.3	1.3	1.227
4	1.777	1.71	1.997	1.543	1.593	1.57	1.6	1.6	1.7	1.7	1.567
5	2.16	2.12	2.647	2.087	2.083	2.22	2.1	2.1	2.2	2.2	2.223
6	3.243	3.03	3.907	2.963	2.597	2.993	2.8	2.8	3.1	3.1	2.87
7	3.9	4.257	5.283	4.443	4.2	4.423	4.3	4.3	4.3	4.3	3.913
8	5.447	5.467	6.3	5.82	5.9	6	6	6	6	6	5.233

9	6.5	6.6	8.8	8.34	8.3	8.5	9.5	9.5	7	7	6.62
10	12.278	9.537	9.537	9.369	9.473	9.5	10	10.5	10.314	9.5	8.321

year											
age	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
2	1.083	0.852	0.793	0.973	0.843	0.999	0.794	0.571	0.66	0.683	0.604
3	1.3	1.283	1.292	1.429	1.321	1.507	1.4	1.356	1.155	1.188	1.129
4	1.7	1.938	1.975	1.953	1.938	2.114	1.891	1.791	1.749	1.726	1.658
5	2.3	2.532	2.4	2.517	2.545	2.68	2.441	2.42	2.423	2.511	2.363
6	3.1	3.197	3.116	3.183	3.436	3.501	3.119	3.001	3.415	2.622	3.192
7	4.1	4.117	4.078	4.238	4.388	4.467	4.706	4.015	4.197	3.846	3.708
8	5.7	5.4	5.4	5.796	5.78	5.828	6.06	4.694	5.192	5.177	4.962
9	9.5	6.6	6.6	6.8	7.5	7.4	7.5	5.697	6.323	5.999	5.627
10	12.667	10.25	10	9.921	9.842	9.421	9	6.643	7.109	7.575	7

Table 6.2.4.1.2.5. Weight-at-age in the stock (kg).

Black Sea Turbot. WEIGHTS AT AGE IN THE STOCK

Units: kg

year												
age		**1950**	**1951**	**1952**	**1953**	**1954**	**1955**	**1956**	**1957**	**1958**	**1959**	
	2	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	
	3	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	
	4	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	
	5	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	
	6	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	
	7	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	
	8	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	
	9	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	
	10	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	
year												
age		**1960**	**1961**	**1962**	**1963**	**1964**	**1965**	**1966**	**1967**	**1968**	**1969**	
	2	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	
	3	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	
	4	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	
	5	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	
	6	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	
	7	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	
	8	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	
	9	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	
	10	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	
year												
age		**1970**	**1971**	**1972**	**1973**	**1974**	**1975**	**1976**	**1977**	**1978**	**1979**	
	2	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	
	3	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	
	4	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	
	5	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	
	6	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	
	7	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	
	8	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	
	9	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	
	10	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	
year												
age		**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	
	2	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	0.869	1	
	3	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.265	1.4	
	4	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.765	1.8	
	5	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.243	2.2	
	6	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.289	3.3	
	7	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4.377	4	
	8	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.667	5.3	
	9	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	7.368	6.6	
	10	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	10.568	12.117	
year												
age		**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
	2	0.73	0.777	0.947	0.893	0.76	0.72	1.083	1.083	1.083	1.083	1.083
	3	1.247	1.153	1.427	1.1	1.07	0.953	1	1	1.3	1.3	1.227
	4	1.777	1.71	1.997	1.543	1.593	1.57	1.6	1.6	1.7	1.7	1.567
	5	2.16	2.12	2.647	2.087	2.083	2.22	2.1	2.1	2.2	2.2	2.223
	6	3.243	3.03	3.907	2.963	2.597	2.993	2.8	2.8	3.1	3.1	2.87
	7	3.9	4.257	5.283	4.443	4.2	4.423	4.3	4.3	4.3	4.3	3.913

	8	5.447	5.467	6.3	5.82	5.9	6	6	6	6	6	5.233
	9	6.5	6.6	8.8	8.34	8.3	8.5	9.5	9.5	7	7	6.62
	10	12.278	9.537	9.537	9.369	9.473	9.5	10	10.5	10.314	9.5	8.321

year age		**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
	2	1.083	0.852	0.793	0.973	0.843	0.999	0.794	0.571	0.66	0.683	0.604
	3	1.3	1.283	1.292	1.429	1.321	1.507	1.4	1.356	1.155	1.188	1.129
	4	1.7	1.938	1.975	1.953	1.938	2.114	1.891	1.791	1.749	1.726	1.658
	5	2.3	2.532	2.4	2.517	2.545	2.68	2.441	2.42	2.423	2.511	2.363
	6	3.1	3.197	3.116	3.183	3.436	3.501	3.119	3.001	3.415	2.622	3.192
	7	4.1	4.117	4.078	4.238	4.388	4.467	4.706	4.015	4.197	3.846	3.708
	8	5.7	5.4	5.4	5.796	5.78	5.828	6.06	4.694	5.192	5.177	4.962
	9	9.5	6.6	6.6	6.8	7.5	7.4	7.5	5.697	6.323	5.999	5.627
	10	12.667	10.25	10	9.921	9.842	9.421	9	6.643	7.109	7.575	7

Table 6.2.4.1.2.6. Maturity ogive

			Black	Sea	Turbot.	PROPORTION	MATURE	
Units	:		NA					
year								
age		**1950**	**1951**	**1952**	**1953**	**1954**	**1955**	**1956**
	2	0	0	0	0	0	0	0
	3	0.4316667	0.431667	0.4316667	0.43167	0.43167	0.4316667	0.4316667
	4	0.6783333	0.678333	0.6783333	0.67833	0.67833	0.6783333	0.6783333
	5	1	1	1	1	1	1	1
	6	1	1	1	1	1	1	1
	7	1	1	1	1	1	1	1
	8	1	1	1	1	1	1	1
	9	1	1	1	1	1	1	1
	10	1	1	1	1	1	1	1
year								
age		**1957**	**1958**	**1959**	**1960**	**1961**	**1962**	**1963**
	2	0	0	0	0	0	0	0
	3	0.4316667	0.431667	0.4316667	0.43167	0.43167	0.4316667	0.4316667
	4	0.6783333	0.678333	0.6783333	0.67833	0.67833	0.6783333	0.6783333
	5	1	1	1	1	1	1	1
	6	1	1	1	1	1	1	1
	7	1	1	1	1	1	1	1
	8	1	1	1	1	1	1	1
	9	1	1	1	1	1	1	1
	10	1	1	1	1	1	1	1
year								
age		**1964**	**1965**	**1966**	**1967**	**1968**	**1969**	**1970**
	2	0	0	0	0	0	0	0
	3	0.4316667	0.431667	0.4316667	0.43167	0.43167	0.4316667	0.4316667
	4	0.6783333	0.678333	0.6783333	0.67833	0.67833	0.6783333	0.6783333
	5	1	1	1	1	1	1	1
	6	1	1	1	1	1	1	1
	7	1	1	1	1	1	1	1
	8	1	1	1	1	1	1	1
	9	1	1	1	1	1	1	1
	10	1	1	1	1	1	1	1
year								
age		**1971**	**1972**	**1973**	**1974**	**1975**	**1976**	**1977**
	2	0	0	0	0	0	0	0
	3	0.4316667	0.431667	0.4316667	0.43167	0.43167	0.4316667	0.4316667
	4	0.6783333	0.678333	0.6783333	0.67833	0.67833	0.6783333	0.6783333
	5	1	1	1	1	1	1	1
	6	1	1	1	1	1	1	1
	7	1	1	1	1	1	1	1
	8	1	1	1	1	1	1	1
	9	1	1	1	1	1	1	1
	10	1	1	1	1	1	1	1
year								
age		**1978**	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**
	2	0	0	0	0	0	0	0
	3	0.4316667	0.431667	0.4316667	0.43167	0.43167	0.4316667	0.4316667
	4	0.6783333	0.678333	0.6783333	0.67833	0.67833	0.6783333	0.6783333
	5	1	1	1	1	1	1	1
	6	1	1	1	1	1	1	1
	7	1	1	1	1	1	1	1
	8	1	1	1	1	1	1	1

	9	1	1	1	1	1	1	1
	10	1	1	1	1	1	1	1
year								
age		**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**
	2	0	0	0	0	0	0	0
	3	0.4316667	0.431667	0.4316667	0.43167	0.43167	0.4316667	0.4316667
	4	0.6783333	0.678333	0.6783333	0.67833	0.67833	0.6783333	0.6783333
	5	1	1	1	1	1	1	1
	6	1	1	1	1	1	1	1
	7	1	1	1	1	1	1	1
	8	1	1	1	1	1	1	1
	9	1	1	1	1	1	1	1
	10	1	1	1	1	1	1	1
year								
age		**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
	2	0	0	0	0	0	0	0
	3	0.4316667	0.431667	0.4316667	0.43167	0.43167	0.4316667	0.4316667
	4	0.6783333	0.678333	0.6783333	0.67833	0.67833	0.6783333	0.6783333
	5	1	1	1	1	1	1	1
	6	1	1	1	1	1	1	1
	7	1	1	1	1	1	1	1
	8	1	1	1	1	1	1	1
	9	1	1	1	1	1	1	1
	10	1	1	1	1	1	1	1
year								
age		**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
	2	0	0	0	0	0	0	0
	3	0.4316667	0.431667	0.4316667	0.43167	0.43167	0.4316667	0.4316667
	4	0.6783333	0.678333	0.6783333	0.67833	0.67833	0.6783333	0.6783333
	5	1	1	1	1	1	1	1
	6	1	1	1	1	1	1	1
	7	1	1	1	1	1	1	1
	8	1	1	1	1	1	1	1
	9	1	1	1	1	1	1	1
	10	1	1	1	1	1	1	1
year								
age		**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	
	2	0	0	0	0	0	0	
	3	0.4316667	0.431667	0.4316667	0.43167	0.43167	0.4316667	
	4	0.6783333	0.678333	0.6783333	0.67833	0.67833	0.6783333	
	5	1	1	1	1	1	1	
	6	1	1	1	1	1	1	
	7	1	1	1	1	1	1	
	8	1	1	1	1	1	1	
	9	1	1	1	1	1	1	
	10	1	1	1	1	1	1	

Table 6.2.4.1.2.7. Natural mortality over ages.

Units	:
age	
2	0.146
3	0.139
4	0.136
5	0.134
6	0.133
7	0.132
8	0.131
9	0.13
10	0.13

Table 6.2.4.1.2.8. Tuning series.

		Black	Sea	Turbot.	SURVEY	INDICES
UKR	**Trawl**	**survey**	**-**	**Configuration**		
BLACK	SEA	TURBOT	Total	2011		
COMBSE X	TUNING	DATA(effort	nos at age)	Imported	from VPA	file.
min	max	plusgroup	minyear	maxyear	startf	endf
4	10	10	1989	2007	0.75	0.83
UKR	Trawl	survey -	Index	Values		
Units:	NA					
year						

age	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
4	24.774	13.117	41.044	37.772	29.367	28.201	NA	NA	NA	19.359
5	35.74	13.833	29.703	33.147	53.371	51.252	NA	NA	NA	55.497
6	41.019	18.126	28.803	38.029	34.729	33.35	NA	NA	NA	122.932
7	20.916	19.676	21.602	28.008	33.197	31.879	NA	NA	NA	70.339
8	10.153	11.686	4.68	6.424	29.367	28.201	NA	NA	NA	37.105
9	9.544	8.705	4.14	5.396	25.026	24.032	NA	NA	NA	10.97
Tabl.10	8.935	5.843	0.9	1.028	5.618	5.395	NA	NA	NA	0.01
year										
age	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	
4	NA	NA	60.944	50.198	23.53	45.968	20.993	176.456	153.739	
5	NA	NA	77.703	89.765	60.505	60.233	45.174	114.858	121.441	
6	NA	NA	22.854	64.962	95.986	89.022	49.18	71.323	56.845	
7	NA	NA	4.571	53.151	139.684	104.555	95.172	50.482	39.619	
8	NA	NA	0.653	6.791	33.24	40.844	70.173	7.873	9.043	
9	NA	NA	0.653	1.476	1.867	12.845	13.611	10.189	12.058	
10	NA	NA	0.653	0.886	1.12	0.01	3.23	0.01	1.292	

BG	**Trawl**	**survey -**	**Configuration**			
BLACK	SEA	TURBOT	Total	2011		
COMBSE X	TUNING	DATA(effort	nos at age)	Imported	from VPA	file.
min	max	plusgroup	minyear	maxyear	startf	endf
2	9	9	2006	2011	0.5	0.5
Index	type:	number				
BG	Trawl	survey -	Index	Values		
Units	:	NA				
year						

age	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
2	222.363	124.125	171.014	19.952	5.104	38.326

3	259.03	233.079	118.966	139.662	7.656	38.326
4	108.816	328.241	215.626	136.593	24.244	26.349
5	41.397	204.116	270.153	155.01	57.419	16.768
6	24.838	86.887	161.1	102.828	37.004	26.349
7	10.645	13.792	19.828	30.695	17.864	21.558
8	7.097	2.758	4.957	6.139	3.828	2.395
9	2.366	0.01	2.478	1.535	1.276	0.01

TR	**CPUE**	**-**	**Configuration**				
BLACK	SEA	TURBOT	Total	2011			
COMBSEX	TUNING	DATA(effort	nos at age)	Imported	from VPA	file.	
min	max	plusgroup	minyear	maxyear	startf	endf	
2	10	10	1987	2011	0.45	0.55	
Index	type	:	number				
TR	CPUE	-	Index	Values			
Units:	NA						
year							
age	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**
2	0.915633	1.13377	138.2309	342.495	649.47341	223.12971	648.3129
3	18.5324	1.13377	387.0465	418.174	1109.943	152.35355	544.0213
4	129.6994	4.535079	481.8334	642.325	805.0635	154.89598	223.9446
5	196.8702	391.071175	695.1039	580.063	554.94177	90.00912	94.39636
6	745.7736	591.895798	797.7897	227.123	432.24211	70.44667	38.47431
7	217.71	489.731812	406.7938	179.347	334.40361	79.47077	21.84975
8	213.0769	764.534907	197.4727	127.157	77.2992	51.76986	21.83342
9	134.3325	172.639109	185.6243	79.3476	56.17857	11.87382	17.02413
10	660.0704	1113.30514	616.1148	218.478	56.17857	12.82373	4.825617
year							
age	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	
2	922.426	516.78177	78.02475	0.02269	0.0342739	0.01935724	
3	2132.378	361.80751	82.68144	139.883	30.407508	133.807842	
4	1687.02	2395.36651	264.5584	109.442	87.610353	218.958287	
5	1539.339	3740.03875	343.1492	97.8456	249.86535	145.972191	
6	472.9016	1897.55847	427.0336	113.066	598.52794	352.766129	
7	335.4657	669.31029	197.3262	154.379	329.83643	279.780033	
8	296.7581	144.15651	86.31718	72.4783	186.08104	48.6573971	
9	252.8895	18.80302	20.31825	30.4409	38.046784	24.3286986	
10	77.52771	18.80302	0.022353	7.24783	0.0342739	12.1643493	
year							
age	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	
2	383.2108	38.597884	50.25898	45.0084	34.726372	95.162511	
3	342.3498	57.72415	97.46137	78.4587	88.407077	285.550643	
4	460.9727	180.602388	73.80968	73.1362	108.8577	292.425092	
5	374.857	335.751419	86.92831	122.406	133.97118	203.785325	
6	273.6741	438.495662	60.59916	173.125	148.38654	97.916848	
7	687.4163	140.996776	43.05592	185.598	101.34481	80.789124	
8	385.6561	30.065102	3.561103	31.0393	54.850708	53.535629	
9	198.2156	3.508899	0.774153	1.74378	6.1560028	4.658359	
10	60.33373	10.526696	0.928984	1.04627	0.0479141	1.500149	
year							
age	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	
2	192.5133	174.813649	96.97577	60.9437	10.736045	64.225503	
3	257.4648	328.306808	104.7111	162.82	34.424781	20.142193	
4	348.8415	623.198113	234.6736	182.621	119.64996	18.107823	
5	257.3886	299.917506	148.3487	118.267	211.77228	23.437167	
6	157.2577	153.739726	99.48387	68.3016	177.25541	10.045734	

7	134.7729	55.1230086	52.2118	85.1865	99.523768	12.217777
8	25.72314	7.2408713	18.04928	13.9688	46.416182	13.940363
9	33.37222	7.0552266	2.998105	2.00653	15.553313	6.273258
10	0.037443	0.7559171	1.146048	0.02138	3.828934	1.876907

6.2.4.1.3 Results

The Black Sea Turbot stock was assessed using the XSA (Extended survirors analysis) for the period 1970 – 2010 by STECF EWG 12 16 Black Sea, but exploration analysis of input data was not completed. STECF EWG 12 16 evaluated the "state-space" modelling approach for Black Sea Turbot. This modelling framework is more robust and has a number of highly desirable characteristics, such as the stochastic treatment of all observations, a full statistical framework for evaluating model results, open source and cross platform source code, and an extremely high degree of flexibility allowing ready customisation to the peculiarities of the stock. Both models were applied on the same data set to explore the effect on SSB, recruitment and fishing mortality (Fig. 6.2.4.1.3.1).

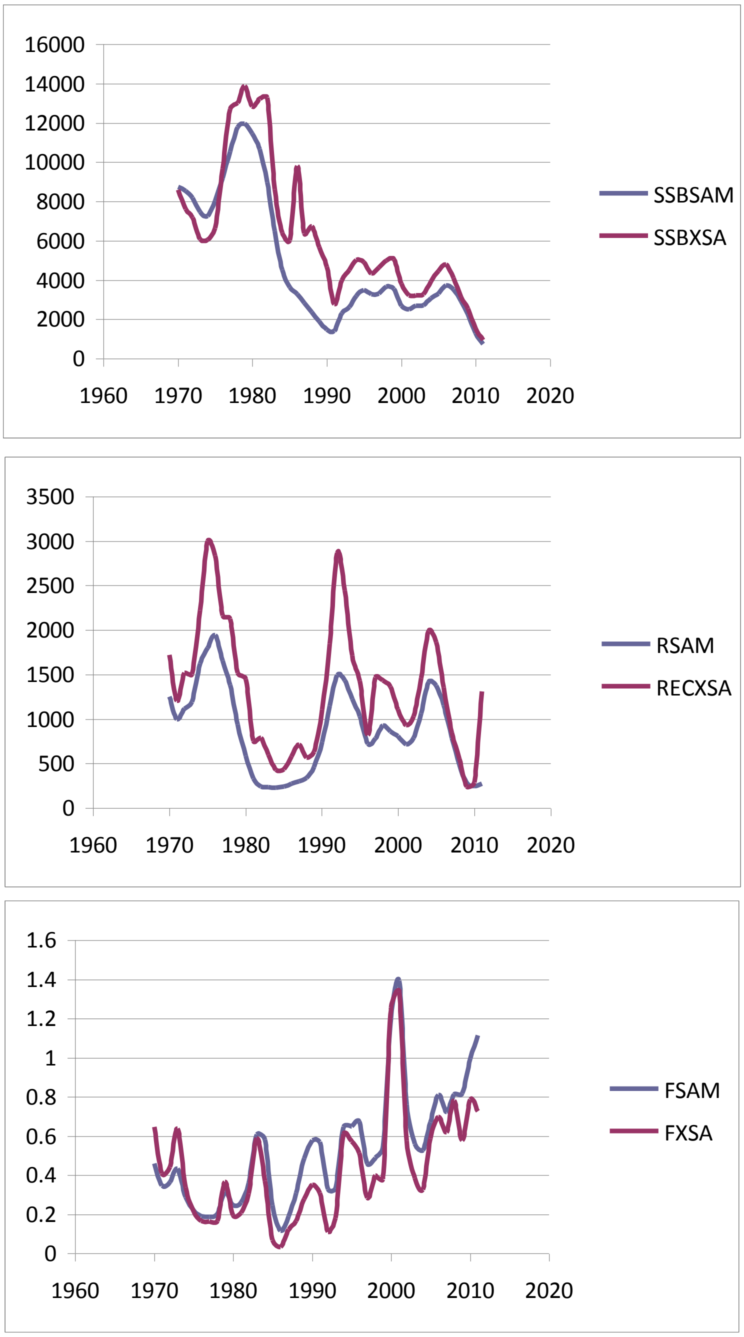


Fig. 6.2.4.1.3.1. Trends in SSB, recruitment anf fishing mortality according to SAM model and XSA.

Similar trends were observed in assessment parameters (Fig. 6.2.4.1.3.1), obtained from SAM and XSA and the STECF EWG 12-16 Black Sea chose the SAM model as more advanced and robust.

The Black Sea Turbot assessment model is based on the state-space assessment model (SAM) (Nielsen et al., 2012). Version details and model configuration are listed below.

Black Sea Turbot. STOCK OBJECT CONFIGURATION

min	max	plusgroup	minyear	maxyear	minfbar	maxfbar
2	10	10	1950	2011	4	8

Black Sea Turbot. sam CONFIGURATION SETTINGS

```
        name          : Final Assessment
]       desc          :
        range         :     min     max plusgroup   minyear   maxyear   minfbar   maxfbar
]       range         :       2      10        10      1950      2011         4         8
        fleets        :          catch UKR Trawl survey  BG Trawl survey        TR CPUE
        fleets        :              0                2                2              2
]       plus.group    : TRUE
        states        :                age
        states        : fleet            2  3  4  5  6  7  8  9 10
        states        :   catch           1  2  3  4  5  6  7  8  8
        states        :   UKR Trawl survey NA NA NA NA NA NA NA NA NA
        states        :   BG Trawl survey  NA NA NA NA NA NA NA NA NA
        states        :   TR CPUE         NA NA NA NA NA NA NA NA NA
        logN.vars     : 1 2 2 2 2 2 2 2 2
        catchabilities :               age
        catchabilities : fleet            2  3  4  5  6  7  8  9 10
        catchabilities :   catch           NA NA NA NA NA NA NA NA NA
        catchabilities :   UKR Trawl survey NA NA  1  2  3  4  5  6  6
        catchabilities :   BG Trawl survey   7  8  9 10 11 12 12 12 NA
        catchabilities :   TR CPUE         13 14 15 16 17 18 19 20 20
        power.law.exps :               age
        power.law.exps : fleet            2  3  4  5  6  7  8  9 10
        power.law.exps :   catch           NA NA NA NA NA NA NA NA NA
        power.law.exps :   UKR Trawl survey NA NA NA NA NA NA NA NA NA
        power.law.exps :   BG Trawl survey  NA NA NA NA NA NA NA NA NA
        power.law.exps :   TR CPUE         NA NA NA NA NA NA NA NA NA
        f.vars        :                age
        f.vars        : fleet            2  3  4  5  6  7  8  9 10
        f.vars        :   catch           1  2  2  2  2  2  2  2  2
        f.vars        :   UKR Trawl survey NA NA NA NA NA NA NA NA NA
        f.vars        :   BG Trawl survey  NA NA NA NA NA NA NA NA NA
        f.vars        :   TR CPUE         NA NA NA NA NA NA NA NA NA
        obs.vars      :                age
        obs.vars      : fleet            2  3  4  5  6  7  8  9 10
        obs.vars      :   catch           1  2  3  4  4  5  6  7  8
        obs.vars      :   UKR Trawl survey NA NA  9 10 11 11 12 12 13
        obs.vars      :   BG Trawl survey  14 15 15 15 16 17 17 18 NA
        [673]    obs.vars      :   TR CPUE         19 20 21 21 21 21 21 22 22
        srr           : 0
        cor.F         : FALSE
        nohess        : FALSE
        timeout       : 3600

Black Sea Turbot. FLR, R SOFTWARE VERSIONS
        FLSAM.version                  0.99-3
        FLCore.version                 2.4
        R.version      R version 2.13.2 (2011-09-30)
        platform                 i386-pc-mingw32
]       run.date              2012-10-10 10:01:38
```

Fig. 6.2.4.1.3.2 illustrates the retrospective behaviour of the fishing mortality (average over ages 4-8), SSB and recruitment. The retrospective runs consistently underestimate recruitment and SSB and overestimate fishing mortality.

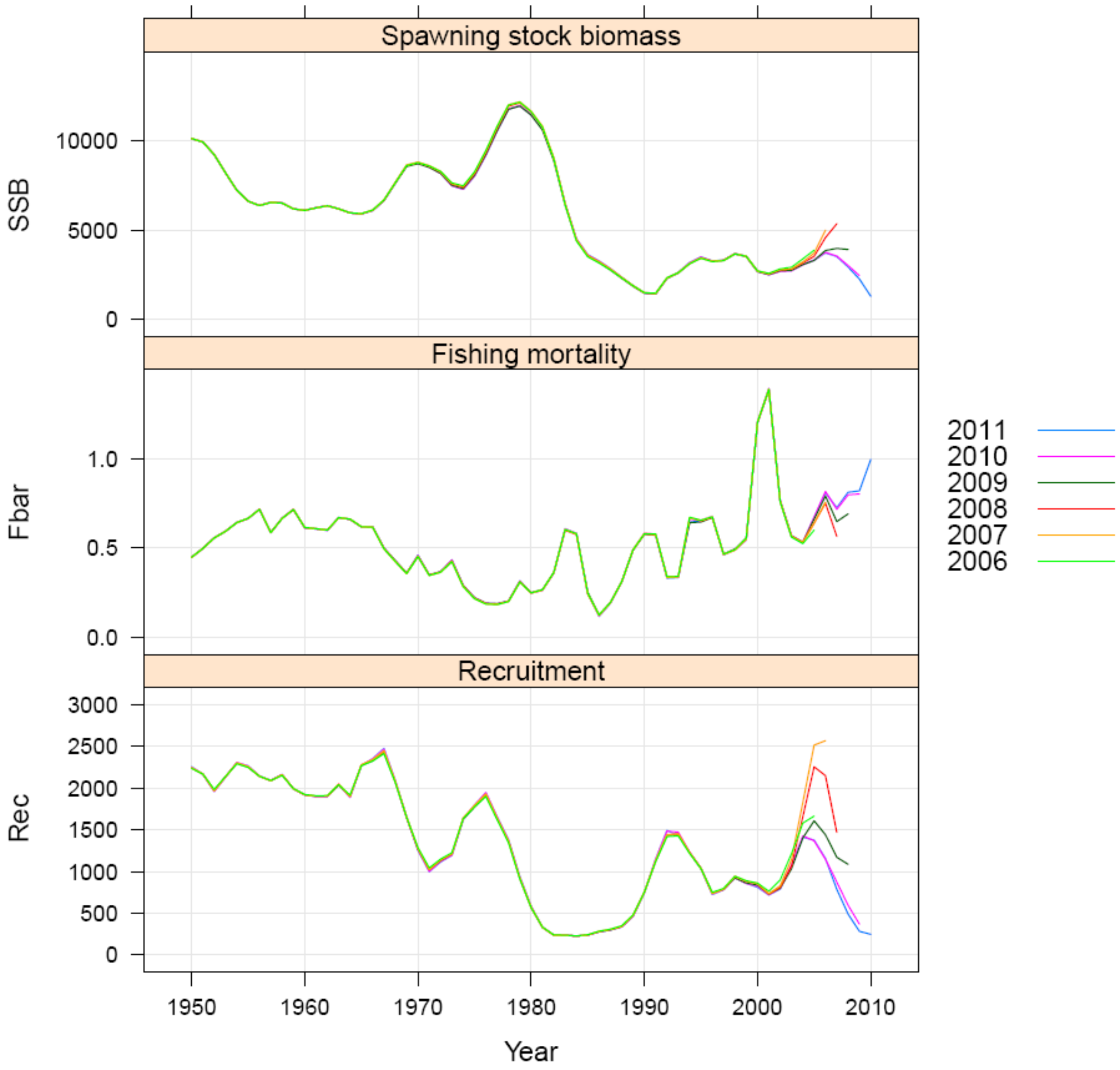


Fig. 6.2.4.1.3.2. Turbot in the Black Sea. Retrospective trends of the assessment parameters fishing mortality (average over ages 4-8), SSB and recruitment.

SAM outputs and diagnostics are listed in the Table 6.2.4.1.3.1.

Table 6.2.4.1.3.1. Turbot in the Black Sea. SAM results and diagnostics.

Black Sea			Turbot.	STOCK	SUMM	ARY								
Year	Recruitment	Low	High	TSB	Low	High	SSB	Low	High	Fbar	Low	High	Landings	Landings
Age	2	(Ages	4-8)	SOP										
f	f	f	tonnes											
1950	2258	1565	3258	17685	15115	20693	10109	8541	11965	0.445	0.3238	0.6116	3932	1
1951	2168	1548	3035	17580	15118	20443	9931	8426	11705	0.4961	0.3798	0.6481	4741	1.0001
1952	1961	1385	2777	16667	14298	19429	9230	7834	10874	0.556	0.4318	0.7161	5217	1
1953	2133	1533	2967	15412	13188	18012	8198	6958	9660	0.5926	0.4636	0.7575	4985	1.0001
1954	2307	1663	3200	14340	12265	16766	7213	6127	8491	0.6423	0.5046	0.8177	4505	1.0001
1955	2268	1615	3185	13532	11532	15879	6600	5609	7766	0.6627	0.5234	0.8392	3678	1

1956	2147	1524	3024	13086	11091	15440	6370	5394	7522	0.7169	0.5613	0.9156	3623	1
1957	2094	1487	2948	12836	10827	15217	6558	5552	7747	0.5838	0.4546	0.7497	3017	1.0002
1958	2165	1563	2999	13079	11086	15432	6519	5534	7678	0.6669	0.5297	0.8398	4289	0.9999
1959	1991	1427	2776	12587	10708	14795	6180	5262	7257	0.7158	0.5638	0.9088	4653	0.9999
1960	1919	1370	2687	11916	10149	13989	6096	5192	7158	0.6097	0.473	0.7859	2680	0.9999
1961	1900	1361	2652	11954	10202	14006	6245	5320	7330	0.6054	0.4684	0.7824	3058	1.0001
1962	1903	1348	2687	12067	10301	14136	6368	5422	7479	0.597	0.4589	0.7767	2904	0.9999
1963	2041	1458	2857	12285	10478	14402	6186	5243	7298	0.6697	0.5245	0.8551	3812	1.0001
1964	1891	1350	2648	11835	10038	13954	5956	5016	7072	0.6596	0.5082	0.8561	3666	1
1965	2271	1660	3106	11868	10052	14013	5896	4908	7085	0.6167	0.4625	0.8223	3063	0.9999
1966	2355	1699	3264	12349	10427	14624	6080	4995	7400	0.6183	0.4535	0.8428	3093	1.0001
1967	2477	1790	3429	13031	10924	15545	6641	5394	8175	0.498	0.3497	0.7092	2709	1
1968	2092	1527	2866	13840	11534	16607	7628	6133	9487	0.4271	0.2984	0.6114	2931	1
1969	1656	1187	2311	14373	11877	17394	8601	6829	10832	0.3574	0.2549	0.501	3076	0.9999
1970	1254	895	1757	14418	11751	17689	8746	6730	11367	0.4591	0.3284	0.6417	5273	1
1971	999	707	1410	12982	10240	16457	8526	6317	11508	0.3469	0.2425	0.4962	3052	1
1972	1115	801	1552	12501	9576	16320	8177	5766	11596	0.3656	0.2522	0.5299	3049	1.0001
1973	1194	865	1648	11881	8783	16072	7478	4915	11378	0.4317	0.285	0.6538	3705	1.0001
1974	1623	1216	2167	11405	8183	15896	7274	4584	11543	0.2883	0.1768	0.4702	1696	1.0001
1975	1798	1330	2429	12417	8990	17150	8018	5129	12536	0.2198	0.1391	0.3472	1273	1.0001
1976	1945	1447	2615	14145	10513	19030	9184	6107	13811	0.1891	0.1233	0.2899	1584	1
1977	1654	1244	2198	15711	11957	20643	10551	7346	15155	0.186	0.1245	0.2779	2012	1.0001
1978	1382	1044	1829	16887	13110	21751	11771	8509	16283	0.2016	0.143	0.2841	2160	1.0001
1979	941	680	1301	17295	13552	22073	11957	8784	16278	0.3151	0.2319	0.4281	5447	1.0001
1980	584	396	861	15590	12119	20056	11463	8465	15523	0.2472	0.1828	0.3341	2843	1.0001
1981	332	234	470	14253	10987	18489	10663	7870	14447	0.2621	0.1961	0.3504	3276	1
1982	238	171	332	12360	9404	16245	8975	6528	12339	0.3586	0.2777	0.4631	4662	1
1983	237	178	316	9590	7124	12910	6492	4509	9346	0.6067	0.4686	0.7855	5307	1
1984	225	173	295	6450	4528	9187	4504	2921	6945	0.58	0.4205	0.8	2852	1
1985	238	178	318	4755	3214	7033	3617	2292	5707	0.2459	0.159	0.3802	527	1
1986	276	212	359	4291	2974	6192	3262	2130	4994	0.1159	0.0756	0.1777	428	1.0001
1987	298	223	399	4067	2953	5600	2838	1961	4107	0.1888	0.138	0.2584	849	1.0001
1988	337	248	457	3662	2826	4745	2351	1734	3187	0.3086	0.2325	0.4096	1116	1.0001
1989	461	343	621	3538	2855	4384	1879	1475	2394	0.4869	0.3801	0.6237	1460	0.9987
1990	745	563	986	3100	2638	3643	1468	1248	1726	0.5779	0.4527	0.7377	1393	0.9935
1991	1149	852	1550	3385	2922	3922	1419	1237	1628	0.5698	0.434	0.7481	935	0.9774
1992	1493	1069	2084	5277	4480	6216	2296	1998	2638	0.3293	0.2431	0.4461	439	0.9691
1993	1435	1029	2000	5658	4775	6705	2626	2260	3051	0.3328	0.2535	0.4369	1603	0.943
1994	1227	913	1648	6263	5334	7353	3180	2705	3738	0.6451	0.474	0.8779	2144	0.9998
1995	1032	793	1343	6559	5655	7608	3489	2984	4079	0.6481	0.5172	0.8121	2943	0.9994
1996	723	540	968	6236	5464	7117	3270	2837	3768	0.6739	0.5254	0.8643	2048	0.9771
1997	783	569	1076	5852	5154	6644	3309	2879	3803	0.4595	0.3464	0.6095	1025	1
1998	926	692	1241	6608	5818	7507	3672	3213	4197	0.4898	0.3799	0.6314	1588	1.0001
1999	859	644	1146	6689	5881	7608	3532	3060	4076	0.543	0.4261	0.6918	1953	1
2000	811	616	1067	6024	5272	6884	2681	2297	3128	1.2016	0.9952	1.4507	2789	0.9995
2001	719	542	953	5389	4694	6187	2497	2165	2879	1.3913	1.1765	1.6453	2557	0.9999
2002	791	586	1067	4978	4354	5691	2695	2350	3090	0.7616	0.6068	0.9558	1412	1
2003	1065	791	1435	5143	4509	5866	2727	2384	3119	0.5608	0.4416	0.7122	943	0.9983
2004	1412	1034	1929	6361	5508	7347	3064	2686	3495	0.526	0.3902	0.709	989	0.999
2005	1377	970	1954	7127	6123	8295	3308	2879	3800	0.6703	0.5475	0.8205	2039	0.9955
2006	1156	799	1672	8018	6735	9547	3718	3178	4350	0.8075	0.6735	0.9681	2737	0.9964
2007	787	526	1176	6794	5637	8189	3510	2988	4123	0.7239	0.5796	0.904	2692	0.9984
2008	489	310	771	5411	4481	6534	2925	2479	3450	0.8108	0.657	1.0007	1901	0.9995
2009	282	157	508	4128	3433	4964	2250	1883	2689	0.8186	0.6632	1.0106	1541	1.0001
2010	246	128	473	2580	2089	3187	1288	1033	1607	0.9946	0.775	1.2765	1321	0.9963
2011	274	126	596	1612	1200	2165	749	515	1088	1.1126	0.8001	1.5472	887	0.9458

TABLE		Black Sea	Turbot	ESTIMATED	FISHING	MORTALITY
Units	:	f				
year						
age	**1950**	**1951**	**1952**	**1953**	**1954**	**1955**
2	0.00823057	0.0099002	0.012455	0.01212725	0.009973736	0.008950911
3	0.0770963	0.0815858	0.088019	0.09425985	0.091419178	0.08893051
4	0.17999972	0.19264619	0.215952	0.23868753	0.257637943	0.235463351
5	0.30011186	0.34704529	0.419211	0.50091443	0.508327172	0.559008836
6	0.37896933	0.42719273	0.498411	0.54766034	0.611543005	0.608468582
7	0.53994392	0.62707445	0.701033	0.70697498	0.783832445	0.824003913
8	0.82619042	0.88648595	0.945631	0.96874777	1.050172042	1.086641775
9	0.851803	0.92593059	0.999937	1.03210768	1.113947486	1.151931386
10	0.851803	0.92593059	0.999937	1.03210768	1.113947486	1.151931386
year						
age	**1956**	**1957**	**1958**	**1959**	**1960**	**1961**
2	0.008942858	0.00841617	0.010801	0.01573921	0.01347526	0.006715748
3	0.092328722	0.10145905	0.115822	0.1212986	0.11816185	0.118197302
4	0.224338322	0.24472993	0.284905	0.31154858	0.26521884	0.269523418
5	0.475275806	0.46094341	0.527561	0.49818689	0.3581154	0.302159577
6	0.741040499	0.62317369	0.648379	0.70167145	0.59484168	0.552954256
7	0.889958897	0.61090733	0.848224	0.89360628	0.68003569	0.676860556
8	1.253788791	0.97929731	1.025545	1.17420345	1.15036582	1.225366521
9	1.223970399	0.92259309	0.924106	0.98274952	1.00277645	1.176413026
10	1.223970399	0.92259309	0.924106	0.98274952	1.00277645	1.176413026
year						
age	**1962**	**1963**	**1964**	**1965**	**1966**	**1967**
2	0.008996677	0.01741715	0.013767	0.007247491	0.01075914	0.02082294
3	0.122578946	0.13451225	0.138332	0.13341376	0.11797294	0.12071776
4	0.267696876	0.25960345	0.270874	0.254717549	0.24294991	0.20390522
5	0.294551918	0.36564221	0.389543	0.402053546	0.353384	0.30352236
6	0.501912238	0.62135047	0.627043	0.548789684	0.63577535	0.50314343
7	0.649612011	0.85212675	0.78629	0.699625561	0.78977278	0.59773367
8	1.271261863	1.24993306	1.224227	1.17828501	1.0694623	0.8815884
9	1.064219855	0.99359907	0.892133	0.822217763	0.68771553	0.53959846
10	1.064219855	0.99359907	0.892133	0.822217763	0.68771553	0.53959846
year						
age	**1968**	**1969**	**1970**	**1971**	**1972**	**1973**
2	0.01914909	0.02139282	0.030875	0.003306384	0.002130071	0.002435995
3	0.11933746	0.11863544	0.107593	0.081855482	0.066383948	0.047472722
4	0.20096993	0.1834891	0.163491	0.154385895	0.099629198	0.071747663
5	0.25709747	0.30857202	0.384681	0.297958817	0.3266389	0.343180065
6	0.47088094	0.3643647	0.462167	0.397345142	0.413102307	0.515808349
7	0.5332153	0.45698258	0.771244	0.496108811	0.589117279	0.835855105
8	0.67354532	0.4733501	0.513754	0.388675684	0.39935681	0.391758383
9	0.36287386	0.2937577	0.408902	0.302673685	0.30657281	0.293963403
10	0.36287386	0.2937577	0.408902	0.302673685	0.30657281	0.293963403
year						
age	**1974**	**1975**	**1976**	**1977**	**1978**	**1979**
2	0.001222326	0.00040106	0.00747	0.01198499	0.01347391	0.006657575
3	0.033420025	0.03181874	0.039502	0.04586743	0.0587244	0.077552512
4	0.043252511	0.03989916	0.036389	0.03570373	0.04371343	0.056994529
5	0.179999717	0.19602756	0.16454	0.12463074	0.18550007	0.260461558
6	0.396103396	0.31723895	0.249799	0.23274776	0.22279572	0.339154338
7	0.518637551	0.33645193	0.313329	0.33567898	0.34534892	0.626103241
8	0.303370636	0.20917167	0.181427	0.20143269	0.21045151	0.29276062

9	0.211041602	0.12744123	0.160205	0.21906211	0.21983017	0.30550168	
10	0.211041602	0.12744123	0.160205	0.21906211	0.21983017	0.30550168	
year							
age	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	
2	0.01843323	0.022073	0.000658	0.000347481	0.000292777	0.000252348	
3	0.09536916	0.11964814	0.142873	0.116659015	0.0585602	0.021831531	
4	0.06180321	0.07511763	0.114418	0.145090151	0.097998804	0.038422963	
5	0.21729487	0.19610599	0.428939	0.932175665	0.402230489	0.097422314	
6	0.31008774	0.29945234	0.374232	0.723438312	0.924156361	0.261924234	
7	0.37688695	0.42604939	0.543204	0.857152011	1.100119709	0.625114779	
8	0.26971215	0.31401956	0.332339	0.375603956	0.375326112	0.206449386	
9	0.26775042	0.33420523	0.422245	0.447862058	0.380347489	0.231332317	
10	0.26775042	0.33420523	0.422245	0.447862058	0.380347489	0.231332317	
year							
age	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	
2	0.000228929	0.00024489	0.00043	0.01507526	0.05629216	0.05697743	
3	0.010973193	0.01084122	0.012268	0.02919961	0.05220902	0.06967595	
4	0.020568387	0.02591846	0.026495	0.07598647	0.17075935	0.22277344	
5	0.067468126	0.09928111	0.158516	0.27253179	0.44153853	0.45874536	
6	0.163098658	0.31317285	0.363746	0.60080792	0.410233	0.41560084	
7	0.239668155	0.23112421	0.428626	0.74664906	0.88469706	0.7702193	
8	0.088602075	0.27455601	0.565605	0.73845878	0.98216889	0.98191258	
9	0.214896234	0.41745438	0.558372	0.99915338	1.48778733	1.44100387	
10	0.214896234	0.41745438	0.558372	0.99915338	1.48778733	1.44100387	
year							
age	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	
2	0.04361736	0.17827999	0.108143	0.05594423	0.0170791	5.41E-05	
3	0.07347574	0.09258761	0.098974	0.0841041	0.07703465	7.86E-02	
4	0.18270179	0.18975908	0.210346	0.2418349	0.18751433	1.41E-01	
5	0.2279566	0.25648118	0.363564	0.51615922	0.37117189	1.66E-01	
6	0.31546738	0.28513287	0.351797	0.55997676	0.65103622	3.76E-01	
7	0.3183194	0.30727874	0.643727	0.9310838	0.89771736	5.80E-01	
8	0.60207696	0.62528358	1.656074	0.99125149	1.26193972	1.03E+00	
9	1.09145427	1.12749685	1.86265	5.22628134	2.33466871	5.70E+00	
10	1.09145427	1.12749685	1.86265	5.22628134	2.33466871	5.70E+00	
year							
age	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	
2	2.05E-05	5.61E-05	0.028984	0.04913911	0.08504285	0.02537477	
3	6.54E-02	7.46E-02	0.087966	0.09794002	0.11359679	0.10228421	
4	1.43E-01	1.54E-01	0.161767	0.1770895	0.17978385	0.16358869	
5	1.75E-01	2.55E-01	0.298197	0.39158605	0.32654092	0.23052407	
6	4.11E-01	4.20E-01	0.60541	0.85763215	0.50073413	0.4303872	
7	7.34E-01	1.03E+00	2.119309	2.83034893	1.09237475	0.88877604	
8	9.86E-01	8.57E-01	2.823	2.69980622	1.70842177	1.09091304	
9	1.76E+00	1.25E+00	1.692353	2.19930192	1.99982565	3.03466185	
10	1.76E+00	1.25E+00	1.692353	2.19930192	1.99982565	3.03466185	
year							
age	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
2	0.01460487	0.03463121	0.064069	0.1122081	0.1736871	0.3655691	0.08464409
3	0.09518813	0.10353972	0.128838	0.1648862	0.2035996	0.2594996	0.27756504
4	0.1786369	0.2109783	0.265166	0.3886018	0.4512291	0.5387089	0.70763985
5	0.26158395	0.37240623	0.437429	0.4888449	0.6081462	0.5806541	0.94361315
6	0.37904513	0.47876759	0.646857	0.5677921	0.5365422	0.6164735	0.66676341
7	0.52033107	1.17358128	1.71484	0.9775391	1.1304095	1.2049885	0.92643073
8	1.29041	1.11551926	0.973104	1.1966069	1.3277423	1.1523807	1.72864869
9	1.86419626	5.11409268	3.03618	2.6037429	5.4216489	1.9651528	1.88794701
10	1.86419626	5.11409268	3.03618	2.6037429	5.4216489	1.9651528	1.88794701
year							

age	2011
2	0.385332
3	0.2827195
4	0.691785
5	1.0402926
6	0.5713576
7	0.4710411
8	2.7884894
9	3.2307038
10	3.2307038

TABLE		Black Sea	Turbot	ESTIMATED	POPULATION	ABUNDANCE	
Units	:	NA					
year							
age	**1950**	**1951**	**1952**	**1953**	**1954**	**1955**	
2	2257.69577	2167.86914	1961.177	2132.8193	2306.99248	2268.10509	
3	2180.69737	1937.78336	1858.268	1664.36675	1820.9252	1979.69882	
4	1703.77218	1757.76782	1556.352	1483.26349	1310.02303	1446.20766	
5	1269.78135	1242.89672	1266.611	1095.7562	1020.75722	878.31035	
6	824.02428	823.61237	768.8532	728.7276	580.33179	537.69958	
7	458.70165	494.32836	470.8785	408.91201	369.11196	275.31062	
8	225.67592	234.53387	231.4584	204.67022	176.84966	147.68771	
9	79.83803	86.69533	84.81734	78.85415	68.16969	54.27154	
10	49.68982	48.55514	47.06361	42.60621	38.00433	30.6	
year							
age	**1956**	**1957**	**1958**	**1959**	**1960**	**1961**	
2	2146.94247	2093.51552	2164.836	1990.61716	1918.69395	1899.7926	
3	1944.96644	1837.02005	1791.306	1857.33882	1690.19638	1633.85903	
4	1581.29593	1545.80486	1443.751	1385.33879	1435.25814	1305.18491	
5	997.94683	1107.10082	1058.28	946.90616	882.18343	964.29764	
6	436.76706	543.32083	612.9602	545.93504	501.84936	538.61445	
7	256.72359	181.29037	255.6476	281.23764	236.4886	242.18454	
8	105.79466	92.19446	86.45292	95.8419	100.7256	105.0882	
9	43.7285	26.42736	30.40783	27.23492	25.95333	27.96909	
10	23.55646	17.34319	15.28084	15.9379	14.19798	12.94358	
year							
age	**1962**	**1963**	**1964**	**1965**	**1966**	**1967**	
2	1903.2153	2041.00987	1891.074	2270.82845	2355.0094	2477.23922	
3	1631.41008	1627.17392	1739.756	1598.94609	1958.43311	2012.8361	
4	1262.3117	1257.02111	1235.091	1321.73428	1208.09498	1523.70477	
5	868.96252	842.43794	847.5078	820.16046	896.143	821.06313	
6	625.78071	566.79631	510.1986	502.4017	478.37742	551.14614	
7	270.9949	333.25235	266.3204	238.1022	254.70347	220.78735	
8	107.78085	124.25054	124.5117	106.25055	103.7309	101.15965	
9	27.072	26.50677	31.24627	32.10462	28.6714	31.21816	
10	11.06514	11.55132	12.36661	15.69591	18.43406	20.77188	
year							
age	**1968**	**1969**	**1970**	**1971**	**1972**	**1973**	**1974**
2	2092.05057	1656.06569	1254.259	998.74551	1115.1007	1194.162	1623.1111
3	2108.8541	1777.38773	1402.904	1047.22596	852.7786	963.1412	1021.3699
4	1551.6901	1637.45748	1374.988	1095.86578	837.5659	687.9389	800.4708
5	1091.49108	1106.5474	1194.64	1020.45104	816.5597	660.8983	553.0785
6	527.21055	744.11828	710.451	710.37997	665.2082	513.577	407.3204
7	292.36412	286.80427	456.9619	390.45003	418.3423	386.9131	266.9069
8	106.30369	150.46041	159.5089	184.76782	208.9093	203.7716	146.423
9	36.70819	47.48909	82.54966	83.588	110.0022	123.1004	120.7232

10	26.55983	38.62115	56.55423	81.12572	107.0076	140.4287	172.397
year							
age	**1975**	**1976**	**1977**	**1978**	**1979**	**1980**	**1981**
2	1797.58612	1945.35547	1653.584	1381.8798	940.5831	583.8243	332.0548
3	1409.09087	1558.68844	1677.4	1412.3355	1184.6469	810.7016	496.26
4	855.76859	1197.63014	1307.929	1402.7642	1159.5648	958.1458	643.872
5	672.9022	714.51215	1016.886	1107.2115	1179.5638	954.7982	790.29
6	403.18681	484.83082	527.5797	796.2395	807.3845	795.2846	671.7592
7	238.96091	256.62093	331.6897	364.6726	566.513	502.653	511.0155
8	138.82304	149.59027	164.3996	208.1794	226.7844	265.4695	303.4145
9	94.47167	98.76072	109.7056	117.8367	148.5914	148.1611	178.1988
10	207.88811	234.06527	249.3855	253.3571	262.3554	266.1606	279.0804
year							
age	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**
2	238.4835	236.962	225.4955	237.79287	275.61363	298.3896	336.63525
3	277.9941	204.4043	205.039	194.20222	204.87499	238.6266	257.75255
4	383.6766	207.2032	156.5069	168.05646	165.35588	177.0443	206.47927
5	524.3713	298.4791	153.9149	121.94864	141.40102	142.5938	150.70134
6	575.1898	299.7354	101.6769	88.63262	96.38012	116.65257	113.76103
7	436.7671	350.5839	127.1541	34.83073	59.41222	72.18267	74.5746
8	292.8908	222.9617	130.8825	36.89219	16.16583	41.14079	50.72911
9	194.8636	184.5647	134.4645	78.6966	26.15133	13.09984	27.37417
10	288.4437	278.8572	260.2129	236.51225	219.75208	174.47823	108.91851
year							
age	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	
2	461.46213	745.16077	1149.061	1492.637547	1434.827626	1226.843635	
3	289.94754	390.02077	608.5627	941.712475	1246.880361	1038.4661	
4	224.52791	243.03367	318.3336	491.125649	765.937061	995.156489	
5	179.37884	182.4726	176.3728	217.761407	356.273965	558.525346	
6	112.37034	120.42173	103.4822	95.382965	150.610947	241.918284	
7	69.56767	53.05876	70.85957	59.733918	59.805642	99.365006	
8	42.40643	28.94218	19.01066	28.823759	38.470819	38.451588	
9	25.25186	17.74848	9.483942	6.203415	13.954472	18.316458	
10	68.60051	30.38655	9.53434	3.950333	2.999963	4.858355	
year							
age	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	
2	1032.150739	723.065635	782.583	926.4869867	858.854908	811.025909	
3	951.176843	846.914716	604.1364	678.239181	809.324541	746.279355	
4	814.846702	760.594223	686.4957	477.6126269	557.409412	660.70008	
5	709.528028	552.359996	550.21	525.5261756	358.238871	420.187063	
6	344.226544	368.779904	329.5407	411.825617	394.374119	240.856182	
7	150.550714	172.552235	167.0679	197.947135	239.894682	230.926621	
8	45.814471	51.9717343	61.52232	82.08046117	83.529511	75.406992	
9	6.361728	14.9797607	12.8713	19.22862396	26.84018	31.465761	
10	3.162934	0.04461434	1.28787	0.04131622	2.938502	7.551151	
year							
age	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	
2	718.812108	790.527149	1064.968	1.41E+03	1376.638587	1155.51337	
3	678.646247	587.690236	623.0956	8.98E+02	1214.879289	1153.781399	
4	596.751035	534.910798	453.0489	4.87E+02	713.084552	963.2374937	
5	494.723985	436.723381	389.6309	3.36E+02	354.107309	508.4159949	
6	274.348721	292.510335	274.239	2.72E+02	225.924303	213.1081962	
7	114.548693	102.217204	156.1629	1.55E+02	163.989106	122.8912724	
8	24.273859	5.9334154	30.12634	5.58E+01	81.280001	44.1812283	
9	3.905946	1.4319254	0.941441	8.91E+00	13.40865	23.4132008	
10	6.315456	0.9974759	0.289964	5.16E-02	1.229392	0.0764514	
year							
age	**2007**	**2008**	**2009**	**2010**	**2011**		

2	786.7417109	488.72502	282.0262	246.2629826	274.266428
3	940.3950002	608.380191	354.5679	167.4525454	195.527298
4	885.0994398	694.505443	432.2914	236.1577467	110.299567
5	650.0179644	518.842309	385.7926	219.9719416	101.179888
6	287.6372104	348.242822	244.7409	189.3126725	74.537325
7	97.4851443	143.165313	178.0741	114.8813665	85.268065
8	19.3076232	32.381912	40.65411	46.3351105	39.701938
9	14.6758018	5.112047	7.499977	11.312406	7.268137
10	0.9918404	1.022651	0.023688	0.9314563	1.634489

TABLE		Black Sea	Turbot	PREDICTED	CATCH	NUMBERS	AT AGE
Units	:	NA					
year							
age	**1950**	**1951**	**1952**	**1953**	**1954**	**1955**	**1956**
2	17.22015	19.87236	22.58983	23.92347	21.3056	18.80796	17.78704
3	151.19796	141.87409	146.3338	139.91988	148.67906	157.43143	160.30849
4	262.94109	288.63127	283.3152	295.26994	279.01066	284.43934	297.87085
5	309.1356	342.40355	407.8094	406.32771	382.86023	354.18168	355.16767
6	244.39115	269.38727	284.1352	289.49557	250.27993	231.02363	215.79956
7	180.34109	217.20682	224.0054	195.674	189.48503	146.06913	143.10377
8	119.99499	130.46696	134.0201	120.26408	108.97189	92.79289	71.80399
9	43.31721	49.57467	50.81339	48.12395	43.44779	35.23606	29.32382
10	26.95908	27.76483	28.19515	26.00321	24.22294	19.8668	15.79558
year							
age	**1957**	**1958**	**1959**	**1960**	**1961**	**1962**	
2	16.326017	21.642955	28.92829	23.897647	11.832382	15.862852	
3	165.665385	183.138006	198.3712	176.111972	170.270781	175.960581	
4	314.61825	335.737633	347.9435	313.581721	289.206221	278.046954	
5	384.629295	408.433863	349.6456	249.502766	236.145939	208.189766	
6	237.555196	275.801113	259.7501	212.068641	215.521355	232.525524	
7	78.160156	138.217703	157.1797	110.118824	112.400681	122.150025	
8	54.528309	52.547105	62.84806	65.320766	70.482186	73.673267	
9	15.078652	17.367662	16.14822	15.574267	18.366714	16.817332	
10	9.895598	8.727509	9.449388	8.519605	8.499013	6.873201	
year							
age	**1963**	**1964**	**1965**	**1966**	**1967**	**1968**	
2	32.796441	24.059502	15.25916	23.450926	47.506664	36.929105	
3	191.490845	210.164383	186.7274	203.730899	213.990153	221.785345	
4	269.516604	274.875976	278.6761	244.312954	263.377931	264.737826	
5	242.426846	257.003576	255.2568	250.650616	201.838929	232.255951	
6	247.279679	224.077058	199.8806	212.223508	205.174328	186.356219	
7	180.700326	137.006723	113.1077	131.414967	93.676748	113.852073	
8	84.198744	83.473565	69.79902	64.58938	56.078921	49.187523	
9	15.818972	17.458908	17.02478	13.469125	12.278503	10.516337	
10	6.893783	6.909726	8.32306	8.659266	8.170009	7.609291	
year							
age	**1969**	**1970**	**1971**	**1972**	**1973**	**1974**	
2	32.621775	35.49139	3.067767	2.207525	2.703418	1.844773	
3	185.874181	133.76439	76.9157	51.173919	41.712882	31.355196	
4	257.183542	194.25661	146.8409	74.345266	44.566391	31.697886	
5	275.894901	358.55426	246.9115	213.744206	180.369946	85.438772	
6	213.633088	247.45036	219.061	211.748659	194.887019	125.291121	
7	99.044575	232.04701	143.8369	175.589696	207.199065	101.757242	
8	53.45018	60.39764	56.00775	64.751055	62.167354	36.032813	
9	11.371043	26.09412	20.53724	27.324671	29.495273	21.586756	
10	9.247562	17.87727	19.93267	26.582152	33.646532	30.828204	

year							
age	**1975**	**1976**	**1977**	**1978**	**1979**	**1980**	**1981**
2	0.6706895	13.47155	18.3324	17.21154	5.807325	9.924138	6.747081
3	41.2144944	56.39159	70.24717	75.25031	82.608287	68.927829	52.318498
4	31.3085117	40.03123	42.90593	56.12212	60.101212	53.729382	43.598816
5	112.3422483	101.64029	111.6691	175.80053	253.86941	174.949962	132.002386
6	102.9887748	100.62291	102.8447	149.27049	218.260652	199.222044	163.300163
7	64.1953	64.88782	88.92915	100.14008	248.645951	148.475506	166.849132
8	24.6136213	23.30761	28.17091	37.11755	54.118171	58.991301	76.901086
9	10.6153387	13.73284	20.28618	21.85785	36.801183	32.730259	47.646063
10	23.3587115	32.54716	46.116	46.99776	64.978731	58.795775	74.617868

year						
age	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**
2	0.1460436	0.07659297	0.061418	0.05582631	0.05869739	0.06798352
3	34.6112924	21.0413595	10.89463	3.91646711	2.08748084	2.40242826
4	38.8337611	26.2078766	13.67515	5.92546995	3.14813433	4.23642605
5	171.9854706	171.110578	47.91842	10.60610735	8.6404961	12.6262755
6	168.8279248	145.672361	58.00099	19.17926984	13.60544391	29.46991758
7	172.5091019	190.81989	80.41655	15.26999818	11.89323796	13.98926151
8	77.9003153	65.7026987	38.5436	6.46452799	1.2859619	9.28574102
9	63.2237486	62.7839834	40.05606	15.27901014	4.75339928	4.21175742
10	93.5887328	94.8569531	77.51411	45.91904708	39.93846921	56.09069869

year							
age	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**
2	0.1345324	6.4256	37.97735	59.25262	59.305971	218.470283	117.163454
3	2.9346259	7.792331	18.53573	38.268994	62.337926	103.047495	91.46716
4	5.0489485	15.374188	35.73784	59.58477	76.834211	124.035771	176.918646
5	20.7106902	40.171991	61.2614	61.038817	41.64911	75.649437	159.972192
6	32.6126418	47.833202	38.1147	33.099891	24.2479	35.093643	67.440114
7	24.4678497	34.564599	29.4655	35.952909	15.309752	14.87274	44.496476
8	20.6651767	20.919464	17.14694	11.261389	12.299886	16.876633	29.665656
9	11.0490008	15.120025	13.08478	6.891646	3.908877	8.953549	14.788354
10	43.9674681	41.090214	22.41342	6.93111	2.490026	1.924673	3.922464

year						
age	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
2	52.283456	11.3955166	0.03936	0.01763358	0.04483079	21.564318
3	71.699946	58.6741937	42.6595	40.09373148	54.35627161	58.730548
4	164.097375	121.851123	84.75036	59.44907121	74.33188513	92.430776
5	269.263378	160.954224	79.09819	79.18524651	75.73496933	101.734858
6	139.062017	166.417551	97.18146	130.5987963	127.1744798	103.104187
7	86.311254	96.7103085	69.33987	97.16397352	146.0296963	194.509305
8	27.291901	35.3917945	37.55062	48.75072163	45.48488168	68.307529
9	6.179207	12.9845475	12.54698	15.18821807	18.18305288	24.498209
10	3.073909	0.03868165	1.256064	0.03265001	1.99082276	5.879078

year						
age	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
2	32.088253	60.028533	24.83441	19.04967422	43.618876	66.7717442
3	59.179192	58.9989708	56.62553	76.21360576	111.6959	130.4095653
4	90.727454	82.4638487	64.0459	74.63130073	127.11218	210.408315
5	150.678737	114.278677	75.2631	72.4929996	103.471892	169.4063048
6	149.319753	108.484792	90.23433	80.74612715	80.912636	95.7183476
7	103.785887	64.3881751	86.98103	59.30478535	107.461216	96.10871513
8	21.786053	4.6349713	18.97135	38.44466751	51.82849	26.0320898
9	3.328527	1.1845465	0.864589	7.19337167	13.00573	21.5046674
10	5.38313	0.8250816	0.266269	0.04163517	1.192499	0.07020611

year					
age	**2007**	**2008**	**2009**	**2010**	**2011**
2	77.8030007	72.6599254	80.70254	18.6165319	81.982844

3	133.7229336	104.869844	75.88963	38.0119278	45.103507		
4	267.6419286	237.028408	169.3724	112.8805297	51.895911		
5	236.5169794	222.738848	160.057	127.0562625	61.935901		
6	117.4132778	136.200764	106.172	86.8958261	30.569415		
7	57.5710594	91.9228833	118.341	65.6606624	30.161009		
8	12.7890585	22.6219348	26.38934	36.3636628	35.8739		
9	13.0694834	4.972735	6.168588	9.1761709	6.744585		
10	0.8829665	0.9947552	0.01948	0.7553402	1.516536		

TABLE		Black Sea	Turbot	CATCH	AT AGE	RESIDUALS	
Units	:	NA					
year							
age	**1950**	**1951**	**1952**	**1953**	**1954**	**1955**	
2	-0.0511906	-0.0065655	0.049784	0.0509633	-0.0149949	-0.0280396	
3	-0.253964	-0.0369654	0.103925	0.203886	-0.0121261	-0.174881	
4	-0.220669	-0.115349	0.142952	0.193758	0.0311972	-0.127609	
5	-0.22274	-0.0330719	0.068465	0.299228	-0.0387616	-0.118123	
6	-0.176809	0.0275082	0.139736	0.0142077	0.0996324	-0.167304	
7	-0.0232417	0.0149911	0.025986	-0.0134333	0.0118194	-0.0174058	
8	-0.0900839	0.13439	0.077997	-0.09012	0.137888	-0.147238	
9	-0.0660188	0.0457478	0.082189	-0.0589419	0.065663	-0.0228709	
10	-0.0679988	0.134931	0.115898	-0.0194246	0.0811416	-0.0408308	
year							
age	**1956**	**1957**	**1958**	**1959**	**1960**	**1961**	**1962**
2	0.0147582	-0.0981933	-0.023145	0.149376	0.156655	-0.295877	-0.116765
3	-0.203486	-0.210592	0.302422	0.507927	-0.209419	-0.221778	-0.225228
4	-0.197028	-0.0781474	0.151524	0.558482	-0.346379	-0.0415226	0.0131995
5	-0.157993	0.0152811	0.399875	0.318206	-0.437765	-0.0609879	-0.427044
6	-0.0462245	-0.173653	0.264665	0.276119	-0.336408	-0.0627035	-0.166416
7	0.0861425	-0.154055	0.063505	0.0698794	-0.058336	-0.0025621	-0.0549278
8	0.369785	-0.594607	0.183199	0.0597039	-0.248208	0.154629	-0.0335076
9	0.333146	-0.468198	0.089904	0.197973	-0.309476	0.187654	0.0535904
10	0.232387	-0.583287	-0.027603	0.214323	0.12144	0.339443	-0.386057
year							
age	**1963**	**1964**	**1965**	**1966**	**1967**	**1968**	
2	0.295068	0.0796198	-0.296869	-0.0807149	0.272868	-0.0434045	
3	0.180967	0.496755	-0.084951	-0.374335	0.139909	0.282449	
4	-0.156239	0.144703	0.158679	-0.19252	-0.126523	0.212977	
5	0.185092	0.122928	0.086059	0.145558	-0.315242	-0.291378	
6	0.365385	0.0379173	-0.334128	0.24827	-0.143396	-0.0953865	
7	0.102072	-0.0045947	-0.054856	0.0831532	-0.06474	0.0236255	
8	0.246219	-0.0230115	-0.020456	0.196292	-0.0807873	0.00342659	
9	-0.0267716	0.0734616	0.048775	0.0204451	0.165812	-0.149613	
10	-0.0165698	-0.176565	0.123834	-0.0787048	-0.0850389	-0.551249	
year							
age	**1969**	**1970**	**1971**	**1972**	**1973**	**1974**	**1975**
2	-0.064951	0.74865	-0.549125	-0.17063	0.239604	0.12994	-1.20863
3	0.510042	0.846485	-0.411413	0.307104	0.107587	-1.50235	-1.13329
4	0.391875	-0.13889	1.23602	-0.456594	0.379365	-1.45804	-0.0233448
5	-0.110582	0.935895	-0.471426	-0.123574	0.977912	-1.49239	0.595383
6	-0.303919	0.519402	-0.34221	-0.0261341	0.450938	-0.453507	-0.0722548
7	-0.145832	0.239261	-0.124044	-0.0197053	0.159674	-0.0529003	-0.0860204
8	-0.586408	0.704056	-0.61061	0.241122	0.478113	0.00345231	-0.498442
9	-0.580603	0.806974	-0.412855	0.0700464	0.316558	0.0561878	-0.806051
10	-0.678697	1.07902	-0.317609	0.237785	0.494535	0.331398	-1.08664
year							

age	**1976**	**1977**	**1978**	**1979**	**1980**	**1981**	**1982**
2	0.751981	0.108147	0.276305	-0.507052	0.267102	1.03382	-0.862252
3	0.374479	-0.33428	-0.134663	0.508453	0.0837161	0.317264	1.05203
4	-0.150822	-0.735857	-0.127648	0.647075	-0.300774	-0.673251	0.663694
5	0.0480336	-0.948569	0.24694	1.07239	-0.170449	-1.26378	0.366396
6	-0.17766	-0.217169	-0.24279	0.955056	-0.0678225	-0.410997	0.0348042
7	-0.0330293	0.0253411	-0.117107	0.308131	-0.116311	-0.0147309	-0.0164751
8	-0.424547	0.104155	-0.417094	0.782984	-0.383166	0.3613	-0.0283246
9	-0.165013	0.419227	-0.272187	0.718002	-0.530956	0.147465	0.240306
10	0.0720796	0.429223	-0.487324	0.646724	-0.156756	0.143069	0.664702
year							
age	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	
2	-0.13985	-0.0071383	-0.015586	-0.0491641	-0.148125	-0.89751	
3	1.75446	1.38991	-1.40829	-3.14784	-0.614836	-3.42877	
4	1.51167	1.46764	-1.10376	-3.01394	0.766395	-3.54249	
5	1.79291	-0.105013	-2.03328	-1.27543	-0.00602641	-0.133816	
6	0.860497	0.597144	-1.86554	-1.9515	1.09796	-0.224114	
7	0.167542	0.0841461	-0.07246	-0.18701	-0.090977	-0.00892811	
8	0.357706	1.16132	0.237189	-3.74077	0.823617	1.31739	
9	0.253232	0.28159	-0.477984	-1.29144	1.50796	-0.524506	
10	0.587846	0.570439	-0.6706	-0.331761	-0.362932	0.299917	
year							
age	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**
2	0.635589	0.402358	0.184029	-0.343952	0.723283	0.0493083	0.262074
3	1.25704	1.13262	0.999718	-0.661599	1.10322	0.985449	-0.366738
4	1.12267	1.22546	0.439327	-1.08682	0.222549	0.27228	0.730577
5	0.890035	0.988664	-0.024887	-2.01402	-0.39729	0.564982	1.34719
6	0.806215	-0.0669968	0.800574	-1.3396	-0.692325	-0.156411	1.3067
7	0.101168	-0.163846	0.238367	-0.145743	-0.220998	0.0772717	0.162693
8	-0.462574	0.4063	-0.626526	-0.465579	-0.296476	0.615176	-0.806613
9	0.0999799	-0.0251651	-0.253892	-1.14837	0.522134	1.74014	-1.96154
10	0.315888	0.591295	-0.160705	-0.0191436	0.669054	1.23649	-0.29302
year							
age	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	
2	1.26955	-1.43199	-0.59282	-1.56801	1.7044	-0.126653	
3	-0.318483	0.329618	-1.30447	0.218069	0.449027	-0.287769	
4	0.0754823	-0.630617	-0.952418	0.490544	0.410709	0.436255	
5	0.109357	-1.35859	-0.16827	0.0136578	0.13094	1.12916	
6	0.531812	-1.49834	0.682504	0.843576	-0.616691	1.75841	
7	0.0815791	-0.166277	-0.015099	0.000192196	0.31602	0.0102647	
8	0.391605	-0.324219	0.25003	-1.25056	1.03907	0.0347727	
9	-0.55254	0.164193	-0.644175	-0.759287	1.78491	-0.53543	
10	-1.60682	1.2065	-1.512	1.48195	1.38233	0.466159	
year							
age	2002	2003	2004	2005	2006	2007	
2	0.310435	-0.189453	-0.368529	0.131404	0.145328	0.119625	
3	0.81452	-0.444123	-0.627428	-0.127451	0.0708349	0.35543	
4	0.345064	-0.92076	-0.535602	0.115532	0.474578	0.602164	
5	0.29538	-0.752039	-0.37659	0.115662	0.721982	0.275107	
6	-0.411572	-0.353303	-0.202589	-0.0195627	0.725776	0.0797338	
7	-0.0473077	0.0933607	-0.258353	0.115936	0.201728	-0.0782923	
8	0.289348	-0.367551	-0.747081	0.792801	-1.02742	-0.327878	
9	-0.0570827	0.0801831	-0.673266	-0.175502	-0.106754	0.0160332	
10	0.660952	0.901125	-1.82263	1.49929	-2.49028	0.598998	
year							
age	**2008**	**2009**	**2010**	**2011**			
2	-0.0585673	-0.890984	-1.01084	0.682892			
3	-0.0520727	0.26516	-0.448761	0.0794919			

4	-0.0918503	-0.32308	-0.408813	-0.177212
5	-0.517859	-0.813859	0.21462	-0.169284
6	-0.451423	-0.740956	0.675093	-0.490905
7	0.0814608	-0.0539432	-0.017032	-0.123573
8	0.774147	-0.185851	-0.370549	-0.102346
9	0.220031	-1.213	0.23466	1.74475
10	1.14443	-0.986702	1.5416	1.41929

TABLE		Black Sea	Turbot	PREDICTED	INDEX AT AGE	TR	CPUE
Units	:	NA					
year							
age	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**
2	13.07314	14.747	20.06807	31.74483	48.93241	63.99404	57.50777
3	52.76985	56.95947	63.5324	84.48635	130.66673	201.82278	264.6743
4	83.09795	96.88745	102.784	106.10297	135.40767	213.13164	331.22238
5	115.77053	118.78201	133.5572	124.85462	119.63435	165.79134	267.37977
6	122.3236	116.31244	102.0477	120.29656	103.09903	99.91402	160.16588
7	126.49971	118.3966	94.21411	67.05546	94.83609	100.21321	100.88992
8	96.90489	103.29407	79.19633	47.84803	31.43054	57.62808	76.03623
9	68.62727	133.62936	98.88129	54.43025	29.77264	23.18881	51.24305
10	913.94464	531.7588	268.72	93.23564	29.94313	14.7718	11.01535
year							
age	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	
2	50.92836	43.976702	31.41326	34.2888422	40.5952068	37.63144	
3	219.74988	202.769527	181.1871	129.1507078	145.9479425	173.3478	
4	425.95768	343.315552	329.2871	304.1618618	211.4735645	245.45411	
5	397.32715	467.654605	391.4469	431.9716668	410.7644764	269.02384	
6	248.82504	319.079408	326.6143	334.8457574	411.2042296	392.09337	
7	141.67278	185.907642	216.6667	245.8692769	269.8213302	282.07698	
8	45.38992	75.405484	74.70821	99.1644913	135.4103774	147.0055	
9	46.58926	3.01	30.08811	4.8069366	51.5560724	92.75949	
10	12.35734	1.497352	0.089634	0.4812155	0.1108298	10.15605	
year							
age	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	
2	35.02388	30.731556	33.19668	46.0726731	61.4129055	59.2846251	
3	158.78165	143.683074	123.4554	131.6253988	190.394836	256.4875178	
4	289.73885	259.703345	232.4767	198.5081188	211.7486589	305.11538	
5	308.86368	347.046925	316.4768	296.234094	251.1951181	250.7985432	
6	218.23228	219.135443	279.2758	271.2063581	276.1902666	218.0991989	
7	157.433	54.726607	116.4439	196.9756269	235.2973421	179.3896041	
8	49.65405	17.000793	6.821777	47.1686747	79.0973996	125.7128075	
9	87.11944	8.389828	3.39869	1.3320046	22.6287224	6.7058481	
10	20.90671	13.568623	2.367319	0.4102207	0.1309748	0.6148604	
year							
age	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	
2	49.0318457	32.591776	19.63355	10.29254658	10.343724	9.911344	
3	240.5312455	192.545021	122.1708	69.24078032	32.404911	37.742999	
4	401.1598595	346.547537	263.5492	157.0242104	78.828137	37.112357	
5	348.5633525	434.3584	326.6045	246.213735	117.095519	51.317406	
6	189.127237	265.578376	326.5947	220.5424074	166.350998	68.699368	
7	102.5571291	117.624812	160.0298	191.7591198	142.196514	132.527477	
8	73.3754932	28.673691	45.03861	61.7244423	52.739252	26.6005	
9	33.0972435	25.757865	2.192315	18.11100926	28.395765	9.321467	
10	0.1080523	1.740177	0.438555	0.05719436	2.337416	2.095952	

TABLE		Black Sea	Turbot	INDEX AT AGE	RESIDUALS	TR	CPUE
Units	:	NA					
year							
age	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**
2	-0.869637	-0.83915	0.63122	0.777995	0.845768	0.408524	0.792363
3	-0.822867	-3.08001	1.42095	1.25763	1.68235	-0.221115	0.566565
4	0.419302	-2.8836	1.4551	1.69593	1.67893	-0.300587	-0.368623
5	0.500048	1.12228	1.55357	1.44663	1.44516	-0.575289	-0.980594
6	1.70259	1.5324	1.93678	0.598559	1.34992	-0.329128	-1.34325
7	0.51134	1.33722	1.37764	0.926571	1.18688	-0.218423	-1.44084
8	0.742089	1.88524	0.86052	0.920532	0.847557	-0.10097	-1.17518
9	0.571909	0.218101	0.536292	0.320956	0.540667	-0.569953	-0.938333
10	-0.277107	0.629189	0.706557	0.725115	0.535807	-0.120422	-0.702802
year							
age	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
2	0.947451	0.805943	0.297588	-2.39449	-2.31483	-2.47691	0.782585
3	1.78701	0.455334	-0.616925	0.0627765	-1.23346	-0.203583	0.604168
4	1.29631	1.82963	-0.206132	-0.962698	-0.82994	-0.107584	0.437345
5	1.27556	1.95817	-0.124025	-1.39858	-0.46818	-0.575814	0.182382
6	0.604779	1.67916	0.25249	-1.02254	0.353549	-0.0995495	0.213212
7	0.811856	1.20648	-0.088066	-0.43832	0.18915	-0.00770306	1.38819
8	1.7684	0.610324	0.136035	-0.295256	0.29938	-1.04135	1.93062
9	1.44042	1.56006	-0.334317	1.57167	-0.258736	-1.13964	0.700016
10	1.56372	2.15462	-1.18256	2.30945	-0.999352	0.153644	0.902458
year							
age	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	
2	0.0745482	0.135657	-0.007645	-0.186482	0.154791	0.44736	
3	-0.717111	-0.185915	-0.406855	-0.603257	0.0844044	0.0535021	
4	-0.342107	-1.08056	-0.940422	-0.626651	-0.040012	-0.13161	
5	-0.0311631	-1.21699	-0.832397	-0.592038	-0.195508	-0.285596	
6	0.653305	-1.43903	-0.422756	-0.58513	-0.754241	-0.173798	
7	0.891334	-0.937035	-0.056038	-0.793323	-0.751315	0.257278	
8	0.536939	-0.612231	-0.394132	-0.344771	-0.803996	-0.987221	
9	-0.742283	-1.25972	0.229375	-1.1085	-0.310225	0.00704924	
10	-0.216156	-0.796532	0.797271	-0.856288	0.759493	-0.902438	
year							
age	**2007**	**2008**	**2009**	**2010**	**2011**		
2	0.549404	0.522438	0.581742	0.0121766	0.611242		
3	0.41962	-0.121265	0.67238	0.0475466	-0.493822		
4	0.552704	-0.109294	0.14223	0.393025	-0.675857		
5	-0.348818	-0.743275	-0.690591	0.558053	-0.73812		
6	-0.514852	-1.11957	-1.10396	0.0597952	-1.81075		
7	-0.713838	-1.05489	-0.764196	-0.336052	-2.24522		
8	-1.29618	-0.861222	-1.39942	-0.120278	-0.608549		
9	-1.10269	0.266545	-1.87344	-0.512587	-0.337226		
10	-0.710007	0.817962	-0.837774	0.42026	-0.0939931		

TABLE		Black Sea	Turbot	PREDICTED	INDEX AT AGE	UKR	Trawl survey
Units	:	NA					
year							
age	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1998**
4	17.78437	17.86101	22.45291	35.753566	55.450459	70.885791	35.8904054
5	27.99679	24.92098	23.75992	35.206474	56.310443	81.119226	88.5723737
6	23.92682	29.80839	25.50718	25.447818	41.153954	62.710569	101.863125

7	31.10598	21.27005	31.09789	37.462484	37.835961	48.191854	89.423186
8	23.41882	13.18342	8.660306	17.728438	23.234773	10.286476	37.2637126
9	38.69382	18.48482	10.24879	8.833842	19.319404	14.194151	16.1967402
10	105.15443	31.66367	10.30748	5.627301	4.152954	3.764857	0.03481803
year							
age	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	
4	43.6372	39.0319289	33.48575	35.56350601	50.76666813	65.70598387	
5	70.280192	65.3096627	62.85937	52.82423069	51.07269449	69.65608069	
6	47.692302	67.4090984	66.81048	69.05960691	52.97923265	43.75605486	
7	9.873851	34.7774782	62.40716	82.95514168	52.3300094	25.57128392	
8	2.846329	1.5225796	12.59261	19.92927986	33.32307167	20.26975756	
9	2.317776	0.9949122	0.288832	6.88992362	0.79552421	7.1730432	
10	3.748478	0.6929946	0.088952	0.03987882	0.07294132	0.02341777	
year							
age	**2007**						
4	54.7654763						
5	85.5157013						
6	62.868799						
7	36.3196893						
8	7.4239406						
9	6.3287959						
10	0.4275671						

TABLE		Black Sea	Turbot	INDEX AT AGE	RESIDUALS	UKR	Trawl survey
Units	:	NA					
year							
age	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1998**
4	0.521625	-0.485798	0.949266	0.0864181	-1.00024	-1.45045	-0.971438
5	0.716758	-1.72789	0.655316	-0.176928	-0.157368	-1.34781	-1.37223
6	1.18884	-1.0971	0.268	0.885989	-0.37438	-1.3927	0.414625
7	-0.875317	-0.171801	-0.803583	-0.641464	-0.288488	-0.911403	-0.529432
8	-0.786036	-0.113391	-0.578831	-0.954725	0.220288	0.948515	-0.00401848
9	-1.31648	-0.708247	-0.852525	-0.463598	0.243405	0.495226	-0.366458
10	-1.27668	-0.875089	-1.26258	-0.880316	0.156466	0.186295	-0.646015
year							
age	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
4	0.525666	0.395923	-0.555252	0.403835	-1.38961	1.55458	1.62432
5	0.294706	0.93359	-0.112055	0.385267	-0.36025	1.46806	1.0295
6	-1.62246	-0.0815483	0.799131	0.560014	-0.164117	1.07758	-0.222142
7	-1.69857	0.935494	1.77696	0.510368	1.31913	1.50006	0.191769
8	-1.38461	1.40622	0.912892	0.674874	0.700399	-0.889423	0.185546
9	-1.19141	0.370966	1.7552	0.585828	2.67067	0.330099	0.606263
10	-0.90492	0.127228	1.31165	-0.716291	1.96287	-0.440625	0.572632

TABLE		Black Sea	Turbot	PREDICTED	INDEX AT AGE	BG Trawl	survey
Units	:	NA					
year							
age	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	
2	132.524827	88.089206	53.06566	27.8190211	27.957346	26.7886958	
3	216.946331	173.66532	110.1915	62.4521086	29.227791	34.0425087	
4	232.091108	200.495139	152.4764	90.8463847	45.606033	21.471361	
5	139.925481	174.366604	131.1104	98.8377879	47.006223	20.6005958	
6	57.689778	81.010599	99.62269	67.2723967	50.742813	20.9556856	
7	13.153265	15.08559	20.52431	24.5936923	18.236954	16.9970534	

8	6.85556	2.679017	4.208011	5.7669884	4.927442	2.4852966
9	1.295355	1.008111	0.085803	0.7088311	1.111355	0.3648241

TABLE		Black Sea	Turbot	INDEX AT AGE	RESIDUALS	BG Trawl	survey
Units	:	NA					
year							
age	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	
2	0.54185	0.359044	1.22518	-0.348002	-1.78053	0.374973	
3	0.275037	0.456466	0.118857	1.24854	-2.07818	0.183867	
4	-1.17507	0.764729	0.537584	0.632686	-0.980228	0.317574	
5	-1.88935	0.24438	1.12152	0.698103	0.310417	-0.319335	
6	-1.73408	0.14411	0.989038	0.873125	-0.649714	0.471277	
7	-1.01404	-0.429688	-0.1654	1.06215	-0.0990335	1.13929	
8	0.165907	0.139259	0.785114	0.299604	-1.21008	-0.177377	
9	0.214177	-1.64015	1.19571	0.274708	0.0491166	-1.27879	

TABLE		Black Sea	Turbot	FIT	PARAMETERS
name	value	std.dev			
1	logFpar	-2.3682	1.77E-01		
2	logFpar	-1.5363	1.02E-01		
3	logFpar	-0.96705	1.27E-01		
4	logFpar	-0.11084	1.41E-01		
5	logFpar	0.093057	3.00E-01		
6	logFpar	1.3186	3.01E-01		
7	logFpar	-2.0604	4.48E-01		
8	logFpar	-1.5373	3.06E-01		
9	logFpar	-1.2226	2.88E-01		
10	logFpar	-1.0045	2.87E-01		
11	logFpar	-0.91675	2.18E-01		
12	logFpar	-1.3112	1.20E-01		
13	logFpar	-3.0547	6.15E-01		
14	logFpar	-1.4341	2.60E-01		
15	logFpar	-0.67539	2.17E-01		
16	logFpar	-0.091751	2.17E-01		
17	logFpar	0.27059	2.15E-01		
18	logFpar	0.74254	2.19E-01		
19	logFpar	1.0593	2.23E-01		
20	logFpar	1.9294	2.19E-01		
21	logSdLogFsta	0.58102	1.72E-01		
22	logSdLogFsta	-0.70017	9.12E-02		
23	logSdLogN	-1.248	1.24E-01		
24	logSdLogN	-3	4.06E-07		
25	logSdLogObs	-0.044137	2.32E-01		
26	logSdLogObs	0.1393	1.29E-01		
27	logSdLogObs	-0.13136	1.29E-01		
28	logSdLogObs	-0.824	1.48E-01		
29	logSdLogObs	-3	2.67E-06		
30	logSdLogObs	-0.76359	1.94E-01		
31	logSdLogObs	-0.74894	1.82E-01		
32	logSdLogObs	-0.24515	1.90E-01		
33	logSdLogObs	-0.4534	2.00E-01		
34	logSdLogObs	-1.0768	2.18E-01		
35	logSdLogObs	-0.79095	1.57E-01		

36	logSdLogObs	0.061347	1.64E-01
37	logSdLogObs	0.65811	2.09E-01
38	logSdLogObs	-0.045901	3.09E-01
39	logSdLogObs	-0.4391	1.75E-01
40	logSdLogObs	-0.72162	3.10E-01
41	logSdLogObs	-1.5671	3.78E-01
42	logSdLogObs	1.0341	2.95E-01
43	logSdLogObs	1.1175	1.42E-01
44	logSdLogObs	0.24034	1.44E-01
45	logSdLogObs	0.059935	6.70E-02
46	logSdLogObs	0.16167	1.10E-01

TABLE		Black Sea	Turbot	NEGATIVE	LOG-LIKELIHOOD
1337.19					

The SAM estimated recruitment has four peaks in 1965 – 1968, 1974 – 1977,1991 – 1994 and 2003 – 2006 and three lows in 1982-85, 1996 – 1997 and 2001. Correspondingly, SSB attained higher values up to 12,000 t in 1977 – 1981 and very low values after 1989. For the recent period however the STECF EWG 12 16 Black Sea is aware of misreporting of actual catches which could have contributed to the underestimation of stock abundance. Fishing mortality F_{4-8} has a peak of F~1.4 in 2000-2001 and keeps as high as F = 0.6 - 0.8 thereafter (Fig. 6.2.4.1.3.3).

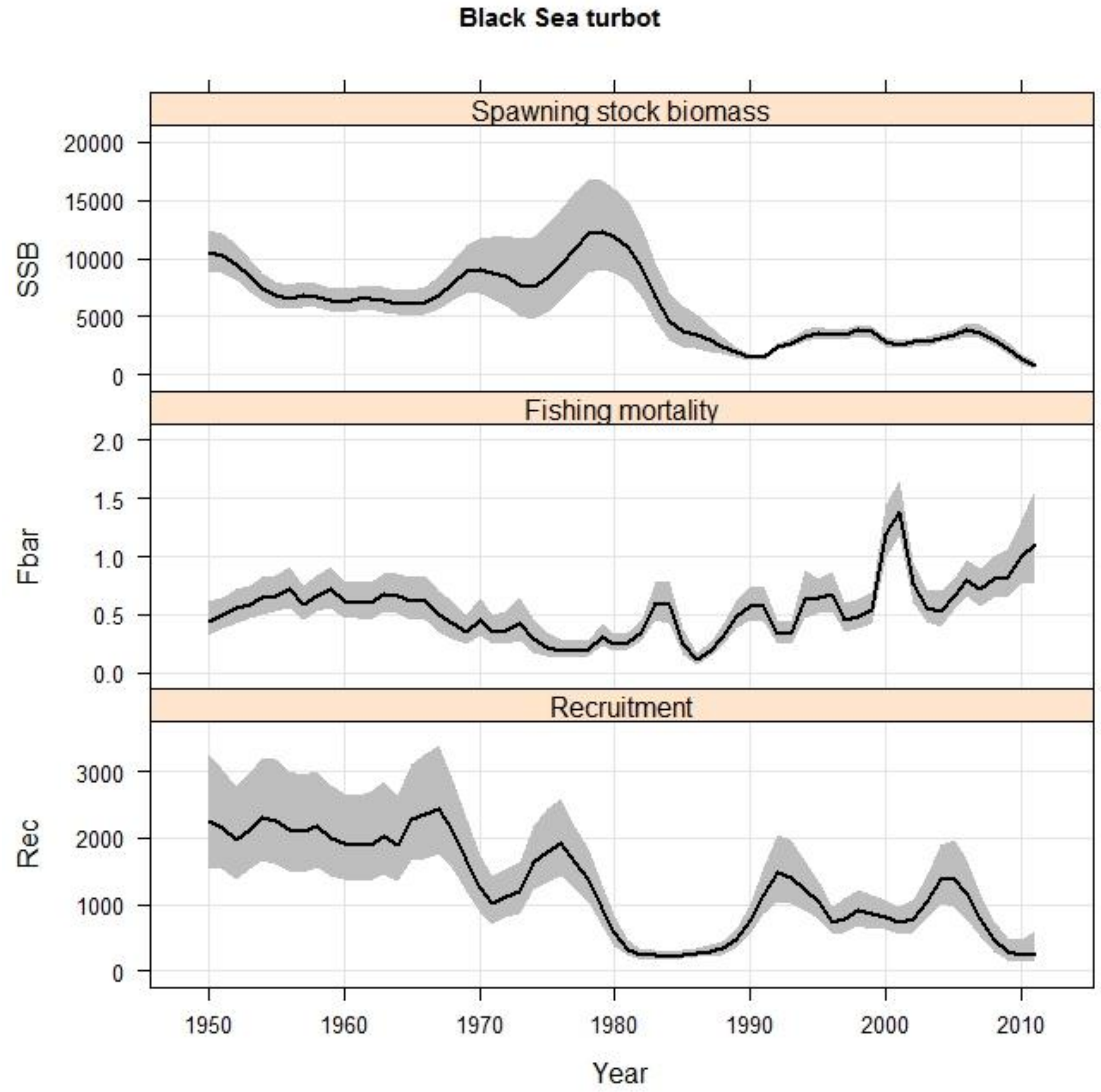


Fig. 6.2.4.1.3.3. Time-series of turbot population estimates of total stock in the Black Sea (SAM model) including estimated IUU catches: recruitment, SSB and average fishing mortality (ages 4–8) with estimate of uncertainty.

The uncertainty of estimates of SSB, recruitment and fishing mortality are at acceptable levels (Fig. 6.2.4.1.3.4)

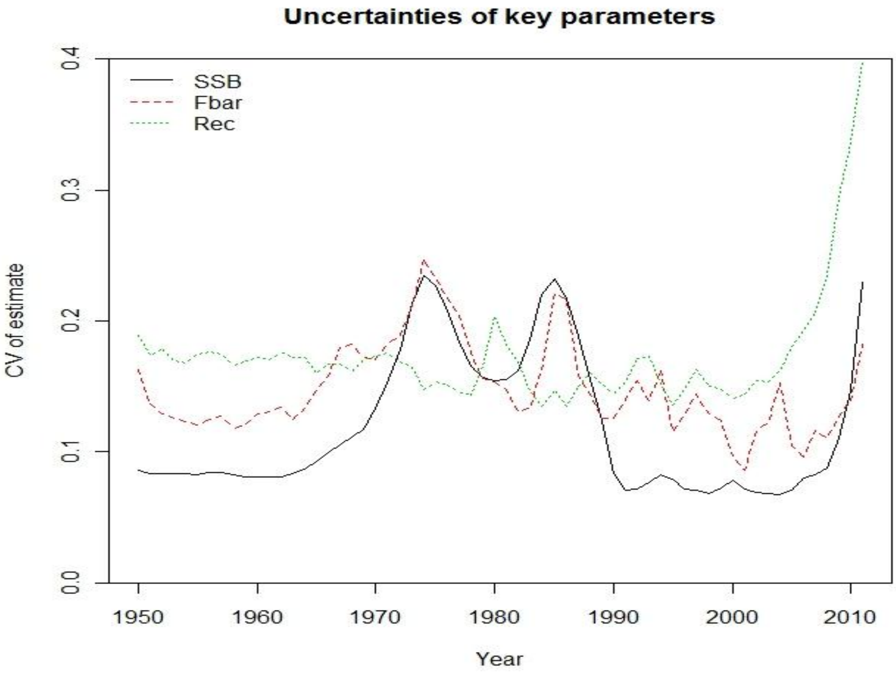


Fig. 6.2.4.1.3.4. Uncertainties of key parameters.

The STECF EWG Black Sea 12 16 made qualitative assumptions about the IUU (Illegal, Unregulated and Unreported) fishing of turbot and estimated the Potential Unreported Catch in 2011.

Because of uncertainties about actual catch the STECF EWG Black Sea 12 16 interprets the assessment only in relative terms – i.e. they are considered indicative of trends only.

6.2.5 Short term prediction of stock biomass and catch

Given the uncertainties of actual catches the STECF EWG 12-16 Black Sea did not undertake short term projections.

6.2.6 Medium term prediction of stock biomass and catch

Given the uncertainties of actual catches the EWG 12-16 Black Sea did not undertake medium term projections.

6.2.7 Long term predictions

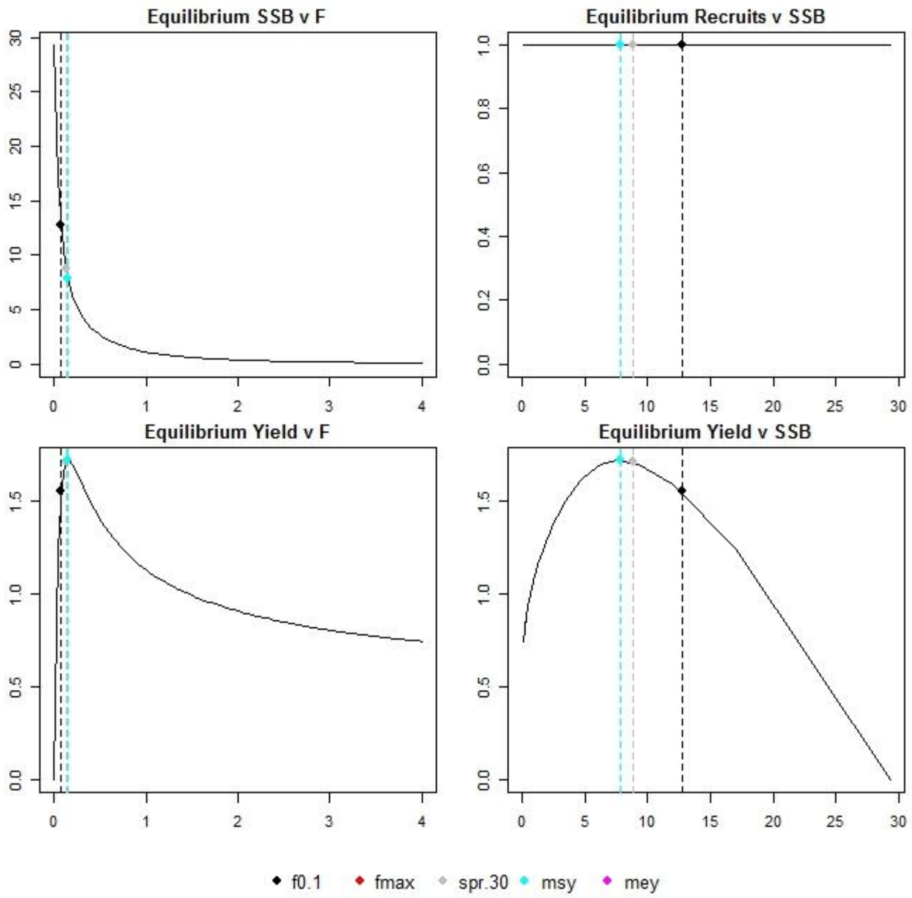
6.2.7.1 Method 1: Yield per Recruit

6.2.7.1.1 Input parameters

Input parameters for YPR are derived from long term means of the SAM input data and averaged for the last 3 years with IUU catch included.

6.2.7.1.2 Results

Fmax was estimated as 0.151 from YpR curves based on exploitation paterns from the SAM assessment with IUU catch included (Fig. 6.2.7.1.2.1). $F_{0.1}$ was estimated at 0.07 (Table 6.2.7.1.2.1).



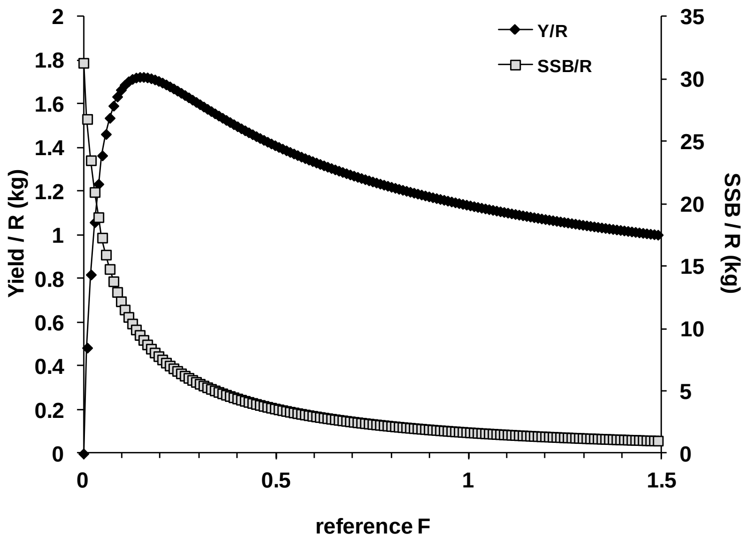


Fig. 6.2.7.1.2.1 Turbot in the Black Sea. SSBvR, RvSSB, YvF and Yv SSB from landings with IUU catch included (average of ages 4-8 y). Fmax= 0.151.

Table 6.2.7.1.2.1. Turbot in the Black Sea. Reference points based on equilibrium models with inputs of official landings with IUU estimates included.

Ref.points	Harvest	Yield	Recruitment	SSB	Biomass	Revenue	Cost	Harvest
$f_{0.1}$	0.071602	1.553254	1	12.748071	14.221435	NA	NA	0.071602
fmax	0.151476	1.720645	1	7.811845	9.235398	NA	NA	0.151476
spr.30	0.128485	1.712404	1	8.798949	10.236581	NA	NA	0.128485
msy	0.151476	1.720645	1	7.811845	9.235398			0.151476

6.2.8 Data quality

The available data from both fisheries dependent and fisheries independent sources is considered good enough in order to perform a reliable assessment of the stock. However, the unknown share of unreported landings make the analysis very sensitive to different options.

6.2.9 Scientific advice

6.2.9.1 Short term considerations

State of the spawning stock size: Uncertainties regarding the actual landings constrains the EWG 12-16 to interpret the SAM assessment results only in relative terms, i.e. they are considered indicative of trends only. In the absence of a biomass precautionary reference points the EWG is unable to fully evaluate the stock size in respect to this. However, survey indices and the SAM analyses indicate that the stock size is at a historic low and it is less than 10% of the SSB estimated in the end of the 1970s.

State of recruitment: Recruitment has increased since 2003 but this has not yet materialized in a significant increase in SSB. However, the last years classes (xxxx-xxxx) are among the lowest observed in the time series,

State of exploitation: The STECF EWG 12-16 propose Fmsy to between =0.07-0.15 as limit reference point consistent with high long term yiels. F is at the historical high level around 1.00, almost 6 times Fmax.The EWG classifies the stock of turbot in the Black Sea as being exploited unsustainably and at the risk of collapse. The EWG notes that despite the recently low TACs the fishing mortality remains at a level with no signal of reduction. STECF advises on the basis of precautionary considerations that there should be no directed fisheries and bycatch should be minimised.

6.3 Whiting in the Black Sea

6.3.1 Biological features

6.3.1.1 *Stock Identification*

In the Black Sea, the whiting is one of the most abundant species among the demersal fishes. It does not undertake distant migrations, spawning mainly in the cold season within the whole habitat area – Figure 6.3.1.1.1. The whiting produces pelagic juveniles, which inhabit the upper 10-meter water layer for about a year. The adult whiting is cold-living, preferring temperatures 6-10º C. Fishes at the age less than 6 years are predominant in the whiting populations, the older year classes are found in catches individually. It occurs all along the shelf, dense commercial concentrations are formed by 1-3 year old fishes in the water down to 150 m depth, most often at 60-120 m depths (Shlyakhov, 1983; Özdamar *et al*, 1996). Such concentrations on the shelf of Bulgaria, Georgia, Romania, the Russian Federation and Ukraine not do from every year, appearing at periods of 4-6 years - in the years of appearance of highly productive year classes. In these countries, whiting is very rarely the target species for fisheries and yielded as by-catch during trawl fisheries for other fish species or while non-selective fisheries with fixed nets in the coastal sea areas (Shlyakhov and Daskalov, 2008).

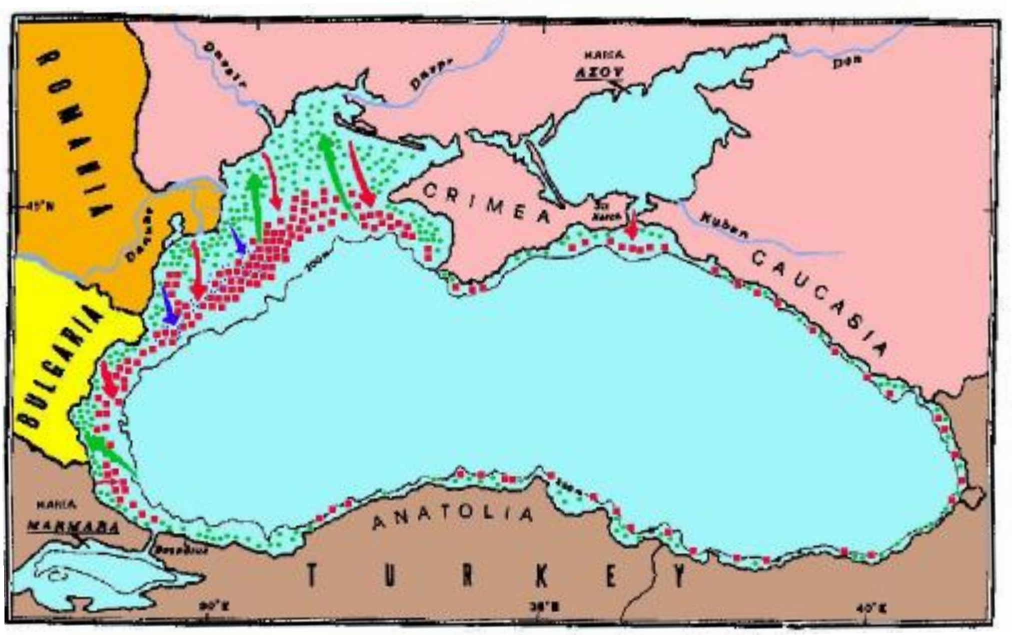


Fig. 6.3.1.1.1. Map of distribution of whiting in the Black Sea.

In the vicinity of the southern coast of the Black Sea whiting concentrations are more stable. Turkey is the only country in the region, where the annual target trawling fisheries for this fish is conducted. There are two methods of whiting fishery in Turkish Black Sea coasts. The first is gillnets and give 15% of total catch. There is no limitation in mesh size for gill net fishery of whiting but the fishermen generally use the gears with 32 mm mesh size. But by the decrease in mean individual size in recent years, they also started to use nets with 28 mm mesh size. Until 2000, whiting nets were produced with mono filament fishing strings (transparent). The remaining percent of 85 is obtained from bottom trawls (Zengin vd, 1998). Bottom trawl fishery intensifies along Yesilirmak and Kizilirmak estuaries; Samsun shelf area (Middle Black Sea) and in Sakarya shelf area along western Black Sea (Fig. 6.3.1.1.2). In 2011, 64% of the total catch landed from Samsun and 36% from western Black Sea (TUIK, 2011).

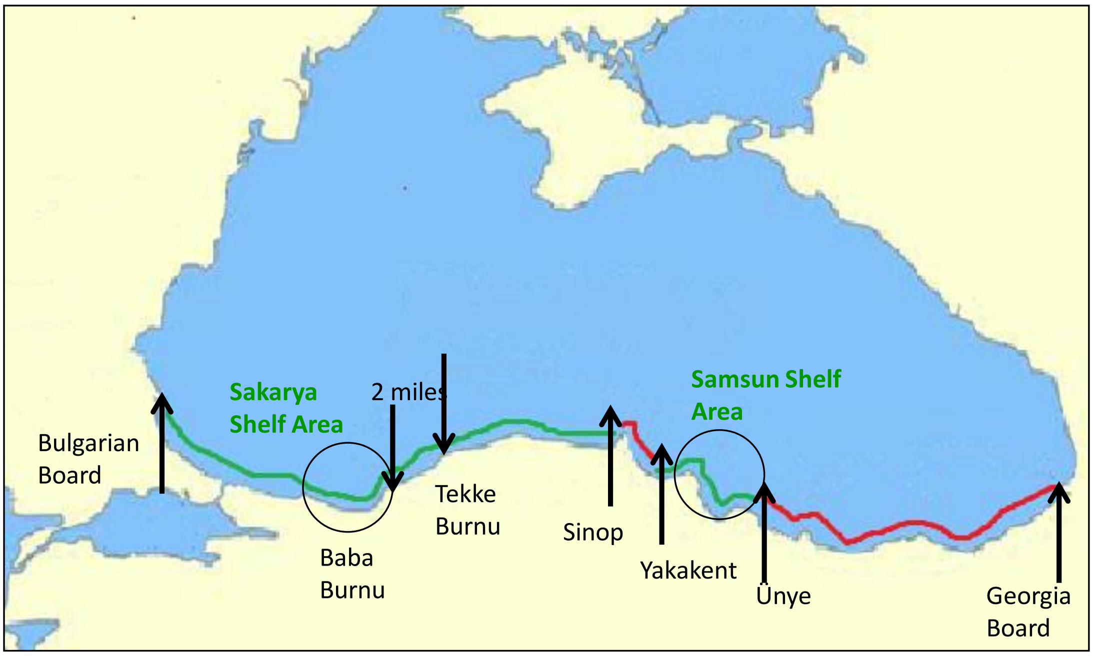


Fig. 6.3.1.1.2. Area closures and limitations for distance from land for bottom trawling along Turkish coasts (Green lines: open areas, red lines: area closures)

The problem of units for whiting stocks in the Black Sea has not been settled yet. Fisheries experts from the Black Sea Commission specify the stock as shared that is although this fish does not make long migrations; its whole stock (or two different stocks – Eastern and Western) is exploited by each Black Sea country in their waters and for its adequate assessment the analysis of the regional data is required.

With the exception of last year's estimates of the Black Sea STECF EWG, for last 15 years only one regional research was undertaken (Prodanov *et al*., 1997) that made possible to produce assessments of abundance and biomass of whiting in the Black Sea by VPA method for the period of 1971 – 1993 on the basis of analysis of regional biological and fishing data.

According to Bulgarian scientists (Prodanov and Bradova, 2003), whiting biomass in the western part of the Black Sea excluding the western Turkish coastal waters in 1997 was assessed by VPA as 121 thousand tons, which was comparable with the long-term mean after decline in 1990 – 1991. / Prodanov K, Bradova, N. (2003) Stock Assessment of the Whiting (Merlangius merlangus) in the Western Part of the Black Sea During 1971-1997.

Along Georgian coasts after the disintegration of the USSR whiting biomass assessments were not made, but on the basis of monitoring the scientists from this country make conclusion that in the period from the early 1990s until the mid-2000s the whiting abundance as well as of other bottom fishes increase (Komakhidze, Diasamidze, Guchmanidze, 2003).

In Romanian waters in 1996 – 2010 whiting remained the most abundant among bottom fishes although its mean annual catch reduced as much as four times as compared with 1989 – 1995. Partially it was caused by reduction of fishing efforts as compared with previous period (Nicolaev *et al*., 2003). The stock biomass was assessed at 5500-9000 tons by swept area method (bottom trawl surveys).

In the Russian sector of the Black Sea trawl survey show that stocks of whiting and other *Gadidae* (*Gaidrosparus mediterraneus*) are estimated about 7.6 – 8 thousand tons and the annual TAC for whiting averages 2 thousand tons (Volovik, Agapov, 2003).

Along the Turkish coasts the total trawlable biomass of whiting in local areas were estimated by A. İşmen (2003). In 1992 the highest biomass between Sinop and Sarp (eastern Black Sea), which is an area, closed to trawl fishing – 30 thousand tons. In 1990 the biomass of whiting between Sinop and İğneada (western Black Sea) was estimated within the range of 1.1 – 1.7 thousand tons. Even if for the period of 1996 – 2005 similar direct assessments of whiting biomass were made, they were not published.

In 1992 – 1995 in the waters of Ukraine whiting biomass changed from 43 up to 70 thousand tons, on average 54 thousand tons, and for the subsequent decade – from 40 up to 68 thousand tons, on average 52 thousand tons (Shlyakhov, Charova, 2006). These data testify rather high inter-annual fluctuations but rather stable average level of whiting biomass in the specified areas where whiting specialized fisheries is almost absent and trawling fisheries are not conducted on the grounds with the densest whiting distribution.

By this reason the most realistic assessments of the stock abundance seem to be estimates according to the data of trawl surveys or surveys produced on the basis of analysis of fisheries with obligatory correction for unregistered catch. In order to make rough assessment of the present state of whiting stock and the extent of its exploitation by fisheries (underexploitation – exploitation at the target level – overfishing), let address to the assessments of allowable catch assessments in the various parts of the habitat area of this species.

As regards the levels of the reference points of whiting (Raykov *et al.*, 2008), in western part of the Black Sea the lowest level of F_{max} was established in Romanian waters: 0.52 and the middle level were established in Bulgarian waters: 0.61 and the highest - 0.68 was detected in Ukrainian waters. If to consider the value of this coefficient of natural mortality as constant and equal M = 0.70 (Prodanov *et al.*, 1997), and F_{max} = 0.60, so with favorable state of whiting population the highest level of annual capture makes up 33.6% of its initial stock.

6.3.1.2 *Growth and mortality*

The determination of the biologic parameters represents an important objective for the establishment of the demographic structure, the growth parameters, as well as other parameters required for the study of recruitment, mortality, effective and biomass, divided into age classes.

In the Black Sea for the grounds with relatively slight fished off whiting population was characteristic of predominance of larger-sized fishes than in the grounds with wide shelf (Shlyakhov, 1983). In 1996 – 2005 in the grounds of intensive Turkish trawl fisheries one can observe tendency to reduction of mean length of fishes which became equal or even less than in Ukrainian waters. It is not quite typical and in our opinion it is the evidence of excessive intensity of fishery. Turkish scientists came to the same conclusion. Thus, according to materials of 2000 Genç *et al.* (2002) applying methods of LCA and Thompson and Bell found that modern whiting fisheries in the waters of Turkey is conducted with excessive MSY due to trawls with mesh size less than 22 mm. İşmen (1995, 2006) estimates existing fishing intensity as F=1.24 and considers possible to achieve optimal exploitation of whiting by means of decrease in fishing intensity or enforcement of a minimum allowable total length. Thus, whiting stock in the waters of Turkey may be characterized as excessively exploited.

In front the Bulgarian coast whiting catch length composition ranged between 50 and 230 mm and individual weight between 3.08–86.2 g. The highest percent belongs to the 115-120 mm group, followed by 135-140 mm and 155-160 mm. The length group 85-90 mm, accounts around 6% of the whiting bycatch. The rest of the length groups are very weakly presented in the landings (Maximov et al., 2009, in press). The analysis performed by (Raykov et al., 2008), show that highest value for L asymptotic of the whiting was calculated in Ukranian waters (39 cm) with the lowest growth rate (k = 0.106), accordingly. In Bulgarian and Romanian marine area the values are very similar and lower, as regards the asymptotic length (Table 6.3.1.2.1).

Table 6.3.1.2.1. Length growth of whiting in the North-Western part of the Black Sea (Raykov *et al*., 2008).

Merlangius merlangus euxinus(Nordm)

$L_t = L\infty\ (1-e^{-k\,(t-t_0)})$	Age					
	1	2	3	4	5	6
Bulgaria						
$L_t = 29.83\ (1-e^{-0.157(t+2.49)})$	12.6	15.09	17.2	19.06	20.6	22.0
Romania						
$L_t = 26.3\ (1-e^{-0.16\,(t+2.19)})$	10.5	12.8	14.8	16.6	18.0	19.2
Ukraine						
$L_t = 39\ (1-e^{-0.106\,(t+1.324)})$	8.5	11.6	14.3	16.8	19.0	21.0

Overall, between 2004 and 2008, the whiting population on the Romanian littoral was homogenous, the length ranging between 40 and 230 mm/2.03–82.92 g, the dominant classes being those of 90-145 mm/5.50–23.84 g. The average body length was 107.45 mm, and the average weight 10.58g (Maximov *et al*., 2009).

The analysis of age components during the entire Bulgarian fishing season emphasized the presence of individuals aged between $0;0^+$ to $5;5^+$ years, with a domination of individuals aged between $2;2^+$ years and $3;3^+$ years.

The analysis of age components during the entire Romanian fishing season emphasized the presence of individuals aged between $0;0^+$ to $4;4^+$ years, with a domination of individuals aged between$1;1^+$ years and 2;2+ years. The variation between sexes indicates a clear domination of the females (57.53%) (Maximov et al., 2009).

In previous studies (Prodanov et al. 1997, Daskalov 1998) an estimate of M = 0.7 has been applied over all age groups and year in VPA/XSA analyses. See also notes on M in the anchovy section.

Natural mortality of the Black Sea whiting for the period of total absence of it fisheries in the waters of the former Soviet Union (1975-1977) was determined by three methods: Beverton-Holt $M = Z = k\ (L\ \infty - l')\ /\ (l'-l_1) = 0.72$; Robson-Chapman M = Z = ln (1 + t'-1 / n) - ln t '= 0.74 and Gulland $M = Z = -\ (\ln N_{t+1} - \ln N_t) = 0.73$ (Shlyakhov, 1983).

6.3.1.3 *Maturity*

The maturity information used is presented in the analytical assessment described in the following sections.

6.3.2 Fisheries

6.3.2.1 *General description*

6.3.2.2 *Management regulations applicable in 2010 and 2011*

Not considering in details the similarity and differences of various measures of Black Sea whiting fisheries in various countries it should be noted that fishing in Turkey is conducted without limitation of annual catch or the fishing efforts. The mesh size of bottom trawls is designed to catch whiting 40 mm and minimum commercial size 13.0 cm (TL). By the ruling of General Directorate of Fisheries in 2010, the use of monofilament strings was prohibited.

“Regulations of the Commercial Fisheries in the Black Sea Basin” currently in force in Ukraine have determined the following requirements: minimum commercial size of whiting – 12 cm (SL); the allowable by-catch of its juveniles – not more than 20% of total biomass of catch during non-target trawl fisheries and not more 30% by counting during the target fisheries with trawls (with mesh size not less than 12 mm). The annual regulation of whiting fisheries includes determination of the limits for whiting’s harvesting on the basis of its stock value and TAC. It should be noted, that even taking into account the by-catch in sprat fisheries total yield of whiting in the Ukrainian waters does not exceed 30% of TAC.

6.3.2.3 *Catches*

6.3.2.3.1 Landings

The following table lists the whiting landings 1970-2011 (Table 6.3.2.3.1.1).

Table 6.3.2.3.1.1. Whiting landings (tons) by countries (FAO Fisheries Statistics, GFCM Capture Production 1970 - 2008, 2009 – 2011 from National Fisheries Statistics of countries

Year	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine	Un. Sov. Soc. Rep.
1970	-	.	115	.	4312	.	.
1971	-	.	442	.	5855	.	.
1972	-	.	416	.	5284	.	.
1973	-	.	329	.	2476	.	.
1974	-	.	1305	.	2844	.	.
1975	454	.	346	.	3913	.	.
1976	347	.	541	.	4213	.	.
1977	218	.	1495	.	5726	.	.
1978	407	.	1345	.	21265	.	531
1979	71	.	1205	.	20778	.	11377
1980	30	.	618	.	6838	.	2690
1981	1	.	894	.	4669	.	2238
1982	4	.	800	.	4264	.	1513
1983	-	.	1080	.	11696	.	2381
1984	-	.	1192	.	11595	.	4738
1985	-	.	3138	.	16036	.	2655
1986	-	.	1949	.	17738	.	2652
1987	-	.	615	.	27103	.	2764
1988	-	5	1009	736	28263	1482	.
1989	-	5	2738	7	19283	579	.
1990	-	-	2653	235	16259	87	.
1991	-	-	59	-	18956	24	.
1992	-	70	1357	-	17923	.	.
1993	-	172	599	16	17844	5	-
1994	-	187	432	125	15084	64	-
1995	-	146	327	91	17562	17	-
1996	-	223	372	11	20326	3	-
1997	-	58	441	10	12725	29	-
1998	-	53	640	119	11863	55	-
1999	-	41	272	184	12459	18	-
2000	9	37*	275	341	15343	20	-
2001	8	32	306	642	7781	18	-
2002	16	37	85	656	7775	9	-
2003	13	45	113	93	7062	21	-
2004	2	29	118	55	7243	43	-
2005	3	30	92	78	6637	30	-
2006	2	37	113	60	7797	15	-
2007	16	41	118	22	11232	64	-
2008	0	15	92	96	10986	9	-
2009	2	15*	40	52	8979	17	-
2010	15	15*	24	23	11894	17	-
2011	1	42	0	21	8122	36	-

* - expert estimation

6.3.2.3.2 Discards

Discards, in particular of early life stages, are believed to be substantial and to be highly variable. However, no discard quantifications are available to the EWG except Romania (for 2011 – 27 tons).

6.3.2.4 *Fishing effort*

Not provided.

6.3.2.5 *Commercial CPUE*

Not provided.

6.3.3 Scientific Surveys

The following section provides results obtained in 2010-2011 from various regional and internationally coordinated scientific programmes of trawl and Hydroacoustic surveys which can be taken as fishery independent information.

6.3.3.1 Method 1: Scientific Trawl Surveys

6.3.3.1.1 Geographical distribution patterns

Geographical distribution patterns of whiting in Romanian and Turkish waters of the Black Sea in 2010-2011 are given in figures 6.3.3.1.1.1 to 6.3.3.1.1.5.

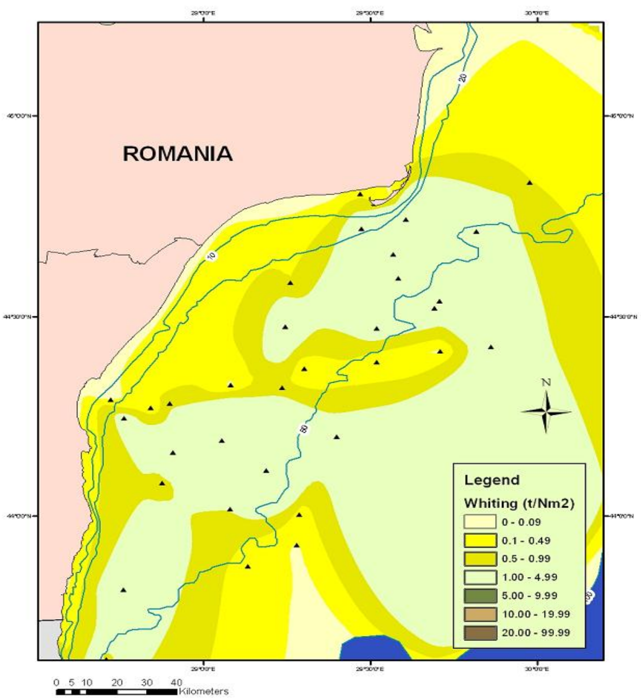


Fig. 6.3.3.1.1.1. Distribution of the whiting agglomerations at Romanian littoral in May 2010.

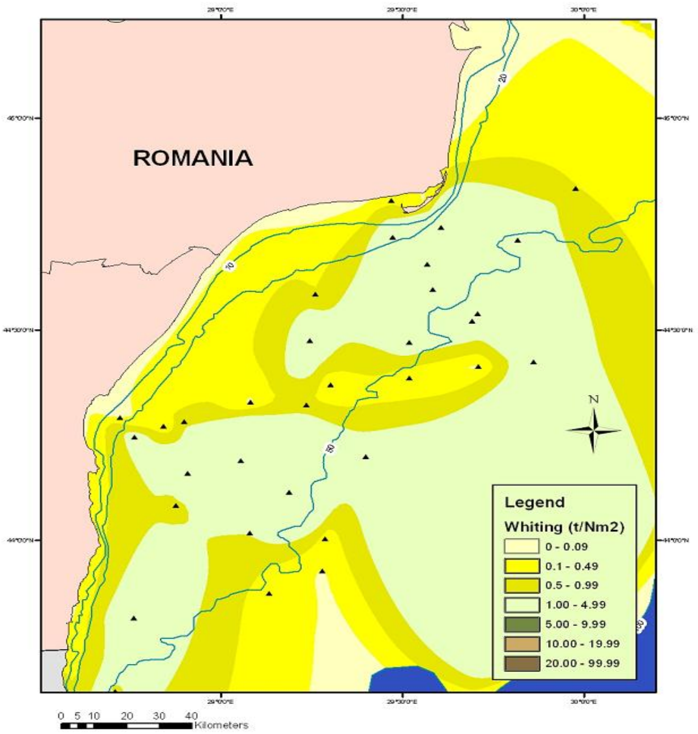


Fig. 6.3.3.1.1.2. Distribution of the whiting agglomerations at Romanian littoral in November 2010.

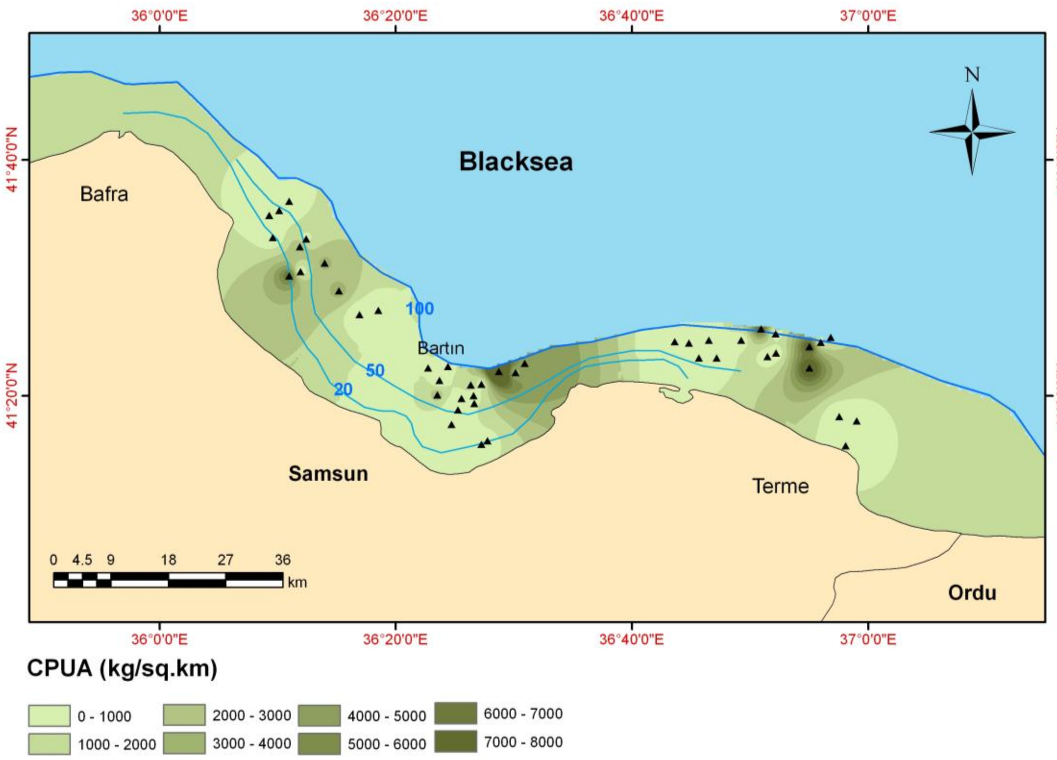


Fig. 6.3.3.1.1.3. Distribution of the whiting agglomerations along Eastern Black Sea coasts of Turkey in 2011.

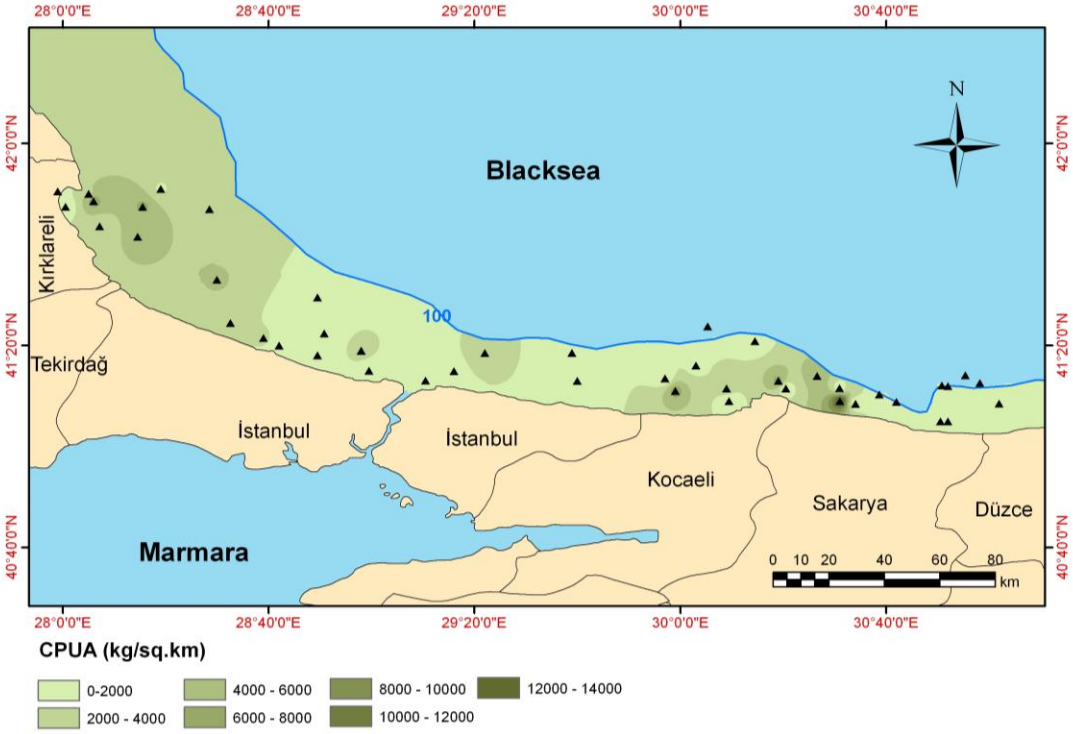


Fig. 6.3.3.1.1.4. Distribution of the whiting agglomerations along Western Black Sea coasts of Turkey in 2011.

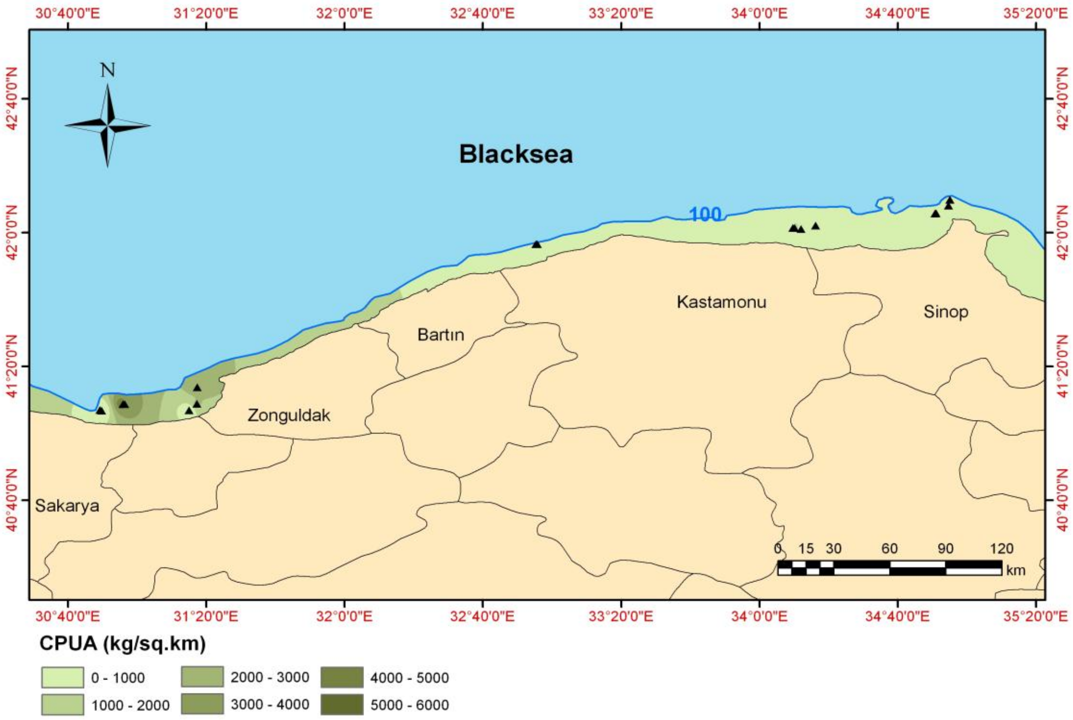


Fig. 6.3.3.1.1.5. Distribution of the whiting agglomerations along Central Black Sea coast of Turkey in 2011.

6.3.3.1.2 Abundance and biomass

In Romanian waters the swept area method was applied for stock assessment of whiting. Results for estimated whiting biomasses in May and November of 2010 in Romanian waters are given in Tables 6.3.3.1.2.1 and 6.3.3.1.2.2. In May 2010 the biomass of whiting was evaluated at 7,410 tons for the shelf till 50 Nm from the shore. In the autumn period the biomass agglomeration increased at 20,948 tons (2010).

Table 6.3.3.1.2.1 Assessment of whiting agglomeration in the Romanian area in the period May – June 2010, sampling gear demersal trawl.

No. polygon	Polygon area (Nm^2)	Range (t/Nm^2)	Average (t/Nm^2)	Total tons in polygon (t)	Total on the shelf (t)
1	209	0.08-0.24	0.17	35.53	Extrapolated at **7,410 tons** for the shelf till 50 Nm from shore (about 5000 Nm2), including the new area (near Snake Island)
2	950	0.055.22	1.97	1871.12	
3	265.25	0.00	0.0	0.0	
4	1145.75	0.36-3.17	1.66	1902	
Total	**2570**			**3809**	

Table 6.3.3.1.2.2 Assessment of whiting agglomeration in the Romanian area in the period October - November 2010, sampling gear demersal trawl.

No. polygon	Polygon area (Nm^2)	Range (t/Nm^2)	Average (t/Nm^2)	Total tons in polygon (t)	Total on the shelf (t)
1	931.8	0.11-0.54	0.23	223.6	Extrapolated at **20,948 tons** for the shelf till 50 Nm from shore (about 5000 Nm^2), including the new area near (Snake Island)
2	450	0.55-1.1	0.73	328.5	
3	1303.1	0.55-8.88	3.29	4287.2	
4	299.6	10.1-27.41	21.03	6300.6	
5	66.4	24.67	24.67	1638.1	
TOTAL	**3050**			**12778**	

Overall, in 2010 and 2011, the whiting population at the Romanian coast was homogeneous, length range between 45-235 mm, the dominant classes being 90-135 mm.

Analysis of the age composition of the entire fishing season revealed the occurrence of 0;0+ to 5;5 years, with a dominance of individuals of 1;1+ years (2010 – 58.21%, 2011 – 50.27%), 2; 2 + years (2010 –21.69%, 2011 – 30.96%) and 0; 0 + years (2010 – 16.53%, 2011 – 12.1%).

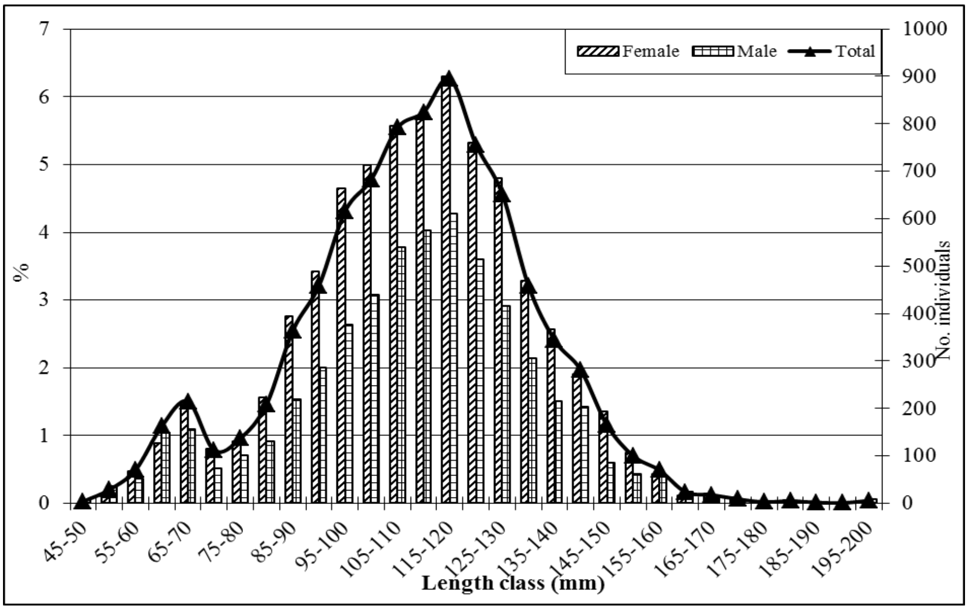


Fig. 6.3.3.1.2.1 Length compositions of whiting in 2011, trawl, Romania.

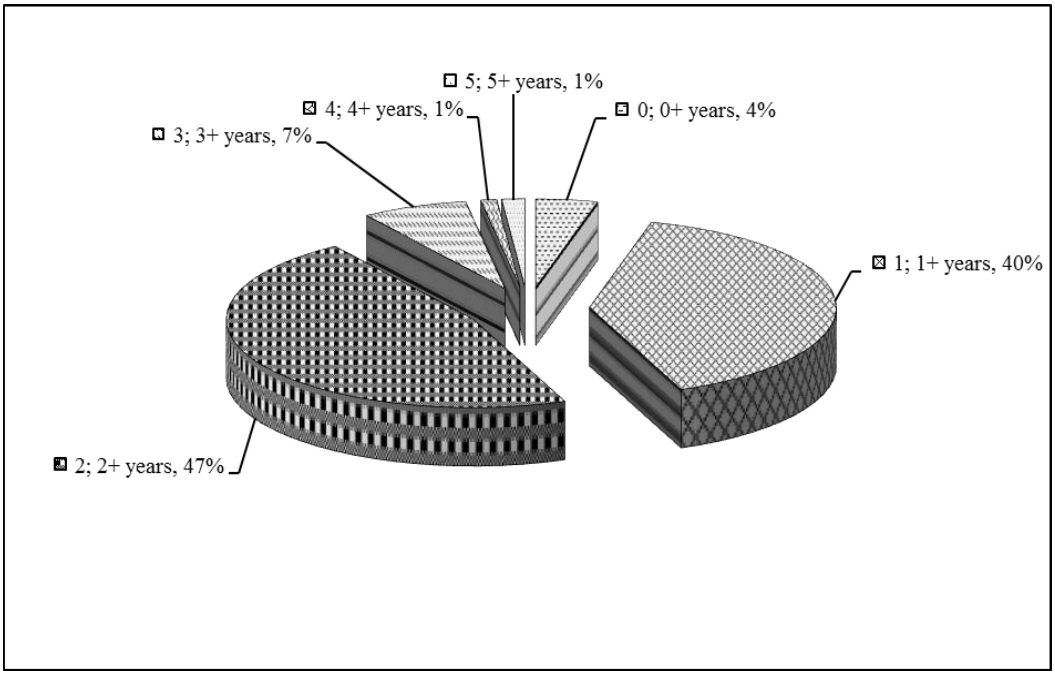


Fig. 6.3.3.1.2.2 Age compositions of whiting in 2011, trawl, Romania

6.3.3.2 Method 2: Scientific Acoustic Survey

A pilot acoustic survey of whiting was conducted in front of the Bulgarian and Romanian Black Sea coasts, over the continental shelf between 42º50´ N and 43°50´ N and 28°00´ E and 29°30´ E in December 2010. Acoustic data were collected by using of EK 60 system (SIMRAD), operating at 38, 120 and 200 kHz simultaneously with hull-mounted split-beam transducers on the R/V "Akademik", Institute of Oceanology, Varna - Bulgarian Academy of Sciences. In November – December 2011 acoustic survey of whiting was conducted as well.

6.3.3.2.1 Abundance indices

Abundance indices of whiting were estimated from acoustic survey in November – December 2011. The survey covers shelf are up to 100 m depth. The total acoustically investigated area covers 2332.67 nm^2, distributed between 3 polygons covering the coastal and offshore strata in front of Bulgaria.

Whiting was found very scare spreaded over the Bulgarian survey area. Schools were acoustically registered only in front of Varna Bay, cape Emine and cape Maslen nos. In the rest of the area of whiting distributions was not registered – in figure 6.3.3.2.1.1.

The estimated whiting biomass by age group is given on Tabl. Xx. Estimated relative whiting biomass is 591.72 t, from which biomass of mature fish amounts of 167.92 t.

Table 6.3.3.2.1.1Estimated biomass (tonnes) of whiting by age groups and polygons, November-December 2011.

Polygon	**Total (t)**	**Age**					
		0	1	2	3	4	5
1	337.93	6.92	121.88	139.88	51.24	16.62	1.38
3	253.79	4.19	54.53	96.48	86.00	12.58	
Total	591.72	11.12	176.41	236.36	137.24	29.20	1.38

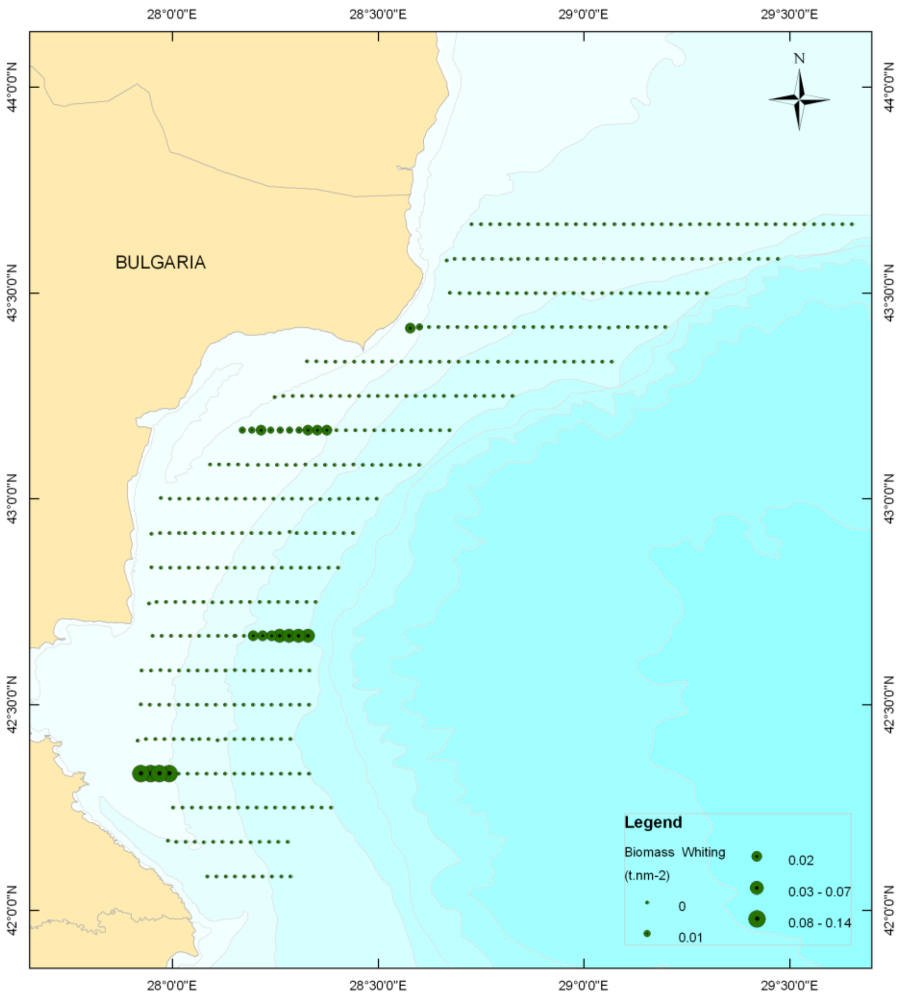


Fig. 6.3.3.2.1.1 Distribution map of whiting relative biomass values, obtained during the acoustic survey of R/V "Akademik" in November - December 2011

6.3.3.2.2 Trends in growth

No data presented.

6.3.3.2.3 Trends in maturity

No data presented.

6.3.4 Assessment of historic parameters

6.3.4.1 *Method 1: XSA*

6.3.4.1.1 Justification

An XSA formulation has been accomplished as being documented in the previous sections.

6.3.4.1.2 Input parameters

Input parameters have changed from EWG 12-16. A first step taken before the XSA was to correct the catch at age data to the official landings (SOP corrections) since there where clear discrepancies (Fig. 6.3.4.1.2.1). This implies that results from the EWG can't be entirely compared with these ones since the input data slightly changed.

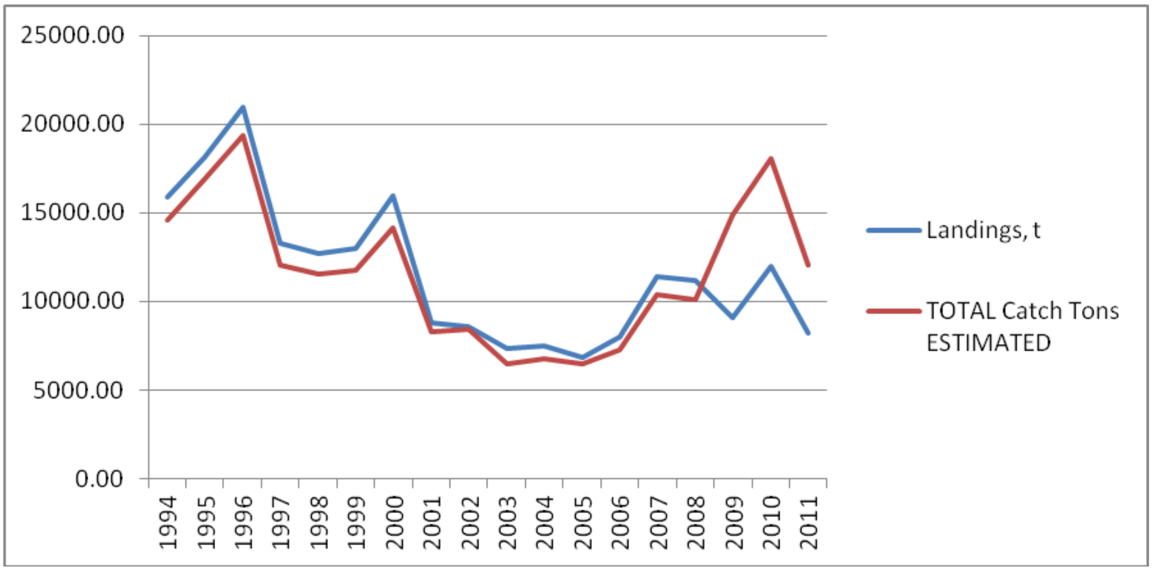


Fig. 6.3.4.1.2.1Total landings in tons compared with Catch weights, a discrepancy is visible in particular in the past 3 years

Additionally the Catch Weight matrix in 2010 assessment used weights at age that had been derived across countries using a weighted average with weighting based on landings. This is now changed and an arithmetic mean is calculated across countries to derive mean weight at age.

Mean weight at age are available all years for age classes 1-5 but in several cases values are missing for age class 6 and thus a mean calculated in all years was used to replace missing values.

New maturity ogives were defined.

The survey tuning fleet, lacking data in 2011 was replaced by the last two year mean values.

```
 An object of class "FLStock"
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An object of class "FLQuant"
, , unit = unique, season = all, area = unique

    year
```

```
age   1994    1995    1996    1997    1998    1999    2000    2001    2002    2003    2004    2005    2006
  all 15892.1 18143.0 20952.0 13263.1 12730.0 12974.4 15979.0  8779.0  8562.0  7334.4  7487.6  6868.3  8005.7
     year
age   2007    2008    2009    2010    2011
  all 11369.7 11181.3  9084.2 12043.6  8215.9

units:  NA NA

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  1 5.1811e+05 7.6604e+05 7.8213e+05 2.5994e+05 3.5781e+05 4.4155e+05 5.7774e+05 2.8128e+05 5.9000e+04
  2 1.1689e+05 5.0538e+04 3.0974e+05 2.4555e+05 2.1880e+05 2.0307e+05 2.0218e+05 9.8358e+04 7.3816e+04
  3 1.1323e+05 8.6894e+04 6.1503e+04 5.3087e+04 4.9765e+04 4.5307e+04 4.4041e+04 2.9537e+04 3.9516e+04
  4 2.0879e+04 1.7297e+04 1.7221e+04 1.2436e+03 2.5335e+04 2.3357e+04 2.3062e+04 6.4225e+03 3.6405e+04
  5 3.2896e+02 9.7427e+03 1.7618e+03 7.9210e+00 2.8378e+03 3.4129e+03 4.3795e+03 2.8137e+03 1.7444e+04
  6 1.0000e+00 1.8239e+03 9.2056e+02 1.0000e+00 6.4425e+01 6.5246e+01 3.4727e+03 1.2054e+03 5.5934e+03
   year
age 2003       2004       2005       2006       2007       2008       2009       2010       2011
  0 7.0259e+04 3.2850e+05 3.8791e+05 9.8841e+04 1.3924e+05 8.1753e+04 4.4415e+05 6.2912e+03 1.0605e+04
  1 8.6395e+04 8.0039e+04 3.1897e+05 2.7600e+05 3.4181e+05 3.2979e+05 1.0299e+05 2.0015e+05 1.0132e+05
  2 8.4294e+04 1.4431e+05 1.6311e+04 1.5403e+05 1.8770e+05 1.8995e+05 1.9239e+05 3.0194e+05 2.5964e+05
  3 3.2412e+04 4.4886e+04 3.8405e+04 1.7603e+04 3.6843e+04 3.6900e+04 6.0228e+04 9.6182e+04 7.3522e+04
  4 2.5979e+04 1.0357e+04 6.0930e+03 1.0509e+04 1.4681e+04 2.6712e+04 1.3818e+04 2.0688e+04 1.1935e+04
  5 1.7819e+04 1.1980e+03 1.5233e+03 6.0844e+03 1.0988e+04 8.0135e+03 1.6256e+03 3.7801e+03 6.3283e+03
  6 2.2693e+03 8.8309e-02 2.5850e+02 3.0078e+02 2.9651e+03 7.8123e+02 1.0000e+00 1.0000e+00 1.0000e+00

units:  NA

Slot "catch.wt":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1994      1995      1996      1997      1998      1999      2000      2001      2002      2003
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  1 0.0092784 0.0092784 0.0092784 0.0092784 0.0092784 0.0092784 0.0104910 0.0099225 0.0117063 0.0099623
  2 0.0203818 0.0203818 0.0203818 0.0203818 0.0203818 0.0203818 0.0218754 0.0205824 0.0232155 0.0209708
  3 0.0373918 0.0373918 0.0373918 0.0373918 0.0373918 0.0373918 0.0394396 0.0370321 0.0385409 0.0381709
  4 0.0692155 0.0692155 0.0692155 0.0692155 0.0692155 0.0692155 0.0681027 0.0651002 0.0610750 0.0561559
  5 0.0896458 0.0896458 0.0896458 0.0896458 0.0896458 0.0896458 0.0864281 0.0819525 0.0839375 0.0819525
  6 0.1235760 0.1422000 0.1422000 0.1235760 0.1422000 0.1422000 0.1221433 0.1221433 0.1422000 0.1221433
   year
age 2004      2005      2006      2007      2008      2009      2010      2011
  0 0.0037380 0.0037364 0.0037999 0.0042094 0.0040218 0.0035013 0.0033326 0.0029223
  1 0.0100004 0.0097829 0.0097197 0.0100000 0.0100000 0.0090000 0.0090000 0.0070000
  2 0.0210962 0.0198329 0.0204000 0.0203432 0.0204303 0.0190568 0.0186033 0.0164689
  3 0.0387281 0.0383296 0.0368348 0.0382176 0.0355741 0.0336695 0.0328159 0.0302149
  4 0.0558321 0.0574356 0.0591492 0.0580689 0.0604256 0.0564348 0.0553102 0.0461411
  5 0.0819525 0.0801344 0.0819525 0.0823900 0.0817069 0.0787481 0.0803225 0.0675341
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units:  NA

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```

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units:  NA

Slot "discards.wt":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011
  0 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  1 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  2 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  3 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  4 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  5 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
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units:  NA

Slot "landings":
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     year
age   1994    1995    1996    1997    1998    1999    2000    2001    2002    2003    2004    2005    2006
  all 15892.0 18143.0 20952.0 13263.0 12730.0 12974.4 15979.0  8779.0  8562.0  7334.4  7487.6  6868.3  8005.7
     year
age   2007    2008    2009    2010    2011
  all 11376.1 11161.2  9087.5 11957.6  8249.0

units:  NA

Slot "landings.n":
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, , unit = unique, season = all, area = unique

   year
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  1 5.1811e+05 7.6604e+05 7.8213e+05 2.5994e+05 3.5781e+05 4.4155e+05 5.7774e+05 2.8128e+05 5.9000e+04
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   year
age 2003       2004       2005       2006       2007       2008       2009       2010       2011
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  1 8.6395e+04 8.0039e+04 3.1897e+05 2.7600e+05 3.4181e+05 3.2979e+05 1.0299e+05 2.0015e+05 1.0132e+05
  2 8.4294e+04 1.4431e+05 1.6311e+04 1.5403e+05 1.8770e+05 1.8995e+05 1.9239e+05 3.0194e+05 2.5964e+05
  3 3.2412e+04 4.4886e+04 3.8405e+04 1.7603e+04 3.6843e+04 3.6900e+04 6.0228e+04 9.6182e+04 7.3522e+04
  4 2.5979e+04 1.0357e+04 6.0930e+03 1.0509e+04 1.4681e+04 2.6712e+04 1.3818e+04 2.0688e+04 1.1935e+04
  5 1.7819e+04 1.1980e+03 1.5233e+03 6.0844e+03 1.0988e+04 8.0135e+03 1.6256e+03 3.7801e+03 6.3283e+03
  6 2.2693e+03 8.8309e-02 2.5850e+02 3.0078e+02 2.9651e+03 7.8123e+02 1.0000e+00 1.0000e+00 1.0000e+00

units:  NA

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, , unit = unique, season = all, area = unique

   year
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  0 0.0037820 0.0037820 0.0037820 0.0037820 0.0037820 0.0037820 0.0041684 0.0038499 0.0047689 0.0038778
  1 0.0092784 0.0092784 0.0092784 0.0092784 0.0092784 0.0092784 0.0104910 0.0099225 0.0117063 0.0099623
  2 0.0203818 0.0203818 0.0203818 0.0203818 0.0203818 0.0203818 0.0218754 0.0205824 0.0232155 0.0209708
  3 0.0373918 0.0373918 0.0373918 0.0373918 0.0373918 0.0373918 0.0394396 0.0370321 0.0385409 0.0381709
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  5 0.0896458 0.0896458 0.0896458 0.0896458 0.0896458 0.0896458 0.0864281 0.0819525 0.0839375 0.0819525
  6 0.1235760 0.1422000 0.1422000 0.1235760 0.1422000 0.1422000 0.1221433 0.1221433 0.1422000 0.1221433
   year
age 2004      2005      2006      2007      2008      2009      2010      2011
  0 0.0037380 0.0037364 0.0037999 0.0042094 0.0040218 0.0035013 0.0033326 0.0029223
  1 0.0100004 0.0097829 0.0097197 0.0100000 0.0100000 0.0090000 0.0090000 0.0070000
  2 0.0210962 0.0198329 0.0204000 0.0203432 0.0204303 0.0190568 0.0186033 0.0164689
  3 0.0387281 0.0383296 0.0368348 0.0382176 0.0355741 0.0336695 0.0328159 0.0302149
  4 0.0558321 0.0574356 0.0591492 0.0580689 0.0604256 0.0564348 0.0553102 0.0461411
```

```
  5 0.0819525 0.0801344 0.0819525 0.0823900 0.0817069 0.0787481 0.0803225 0.0675341
  6 0.0820300 0.1197333 0.1221433 0.1285333 0.1181633 0.0820300 0.1235760 0.1235760

units:  NA

Slot "stock":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

     year
age   1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011
  all 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0

units:  NA * NA

Slot "stock.n":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1994       1995       1996       1997       1998       1999       2000       2001       2002
  0 7.9500e+06 8.2994e+06 6.1685e+06 6.8465e+06 5.9158e+06 4.5664e+06 3.1090e+06 3.7406e+06 3.3391e+06
  1 1.3266e+06 2.6685e+06 2.5686e+06 1.8571e+06 2.0984e+06 2.1785e+06 1.6341e+06 1.0292e+06 1.1506e+06
  2 4.6550e+05 2.7965e+05 7.5420e+05 6.9490e+05 7.1450e+05 7.6285e+05 7.4332e+05 3.8642e+05 3.0074e+05
  3 2.0437e+05 1.6057e+05 1.1076e+05 1.7277e+05 1.8811e+05 2.1787e+05 2.5479e+05 2.4514e+05 1.3233e+05
  4 5.7081e+04 2.7579e+04 2.3196e+04 1.4845e+04 5.4744e+04 6.5527e+04 8.4982e+04 1.0598e+05 1.1142e+05
  5 6.6746e+02 1.6097e+04 2.4097e+03 3.6932e+01 7.3033e+03 1.1483e+04 1.8933e+04 2.9938e+04 5.3964e+04
  6 1.9034e+00 2.7583e+03 1.0758e+03 4.5243e+00 1.5795e+02 2.1134e+02 1.4546e+04 1.2566e+04 1.6611e+04
   year
age 2003       2004       2005       2006       2007       2008       2009       2010       2011
  0 1.6091e+06 4.0605e+06 4.0498e+06 4.5754e+06 4.5935e+06 4.5034e+06 5.2418e+06 2.4935e+06 1.5786e+06
  1 1.3106e+06 5.9690e+05 1.4108e+06 1.3691e+06 1.7610e+06 1.7427e+06 1.7431e+06 1.8086e+06 9.8973e+05
  2 5.1354e+05 5.7162e+05 2.3209e+05 4.5846e+05 4.6816e+05 6.1136e+05 6.1088e+05 7.6850e+05 7.3263e+05
  3 1.0498e+05 2.0958e+05 1.9662e+05 1.1053e+05 1.2990e+05 1.1056e+05 1.8443e+05 1.8241e+05 1.8597e+05
  4 4.2774e+04 3.3147e+04 8.0787e+04 7.8524e+04 4.7083e+04 4.3423e+04 3.2872e+04 5.5815e+04 2.8212e+04
  5 3.4659e+04 4.3688e+03 1.0663e+04 4.0246e+04 3.5703e+04 1.5169e+04 4.1829e+03 7.9341e+03 1.5537e+04
  6 4.1247e+03 3.1075e-01 1.7664e+03 1.9409e+03 9.2647e+03 1.3782e+03 2.4512e+00 1.9743e+00 2.3332e+00

units:  NA

Slot "stock.wt":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1994      1995      1996      1997      1998      1999      2000      2001      2002      2003
  0 0.0037820 0.0037820 0.0037820 0.0037820 0.0037820 0.0037820 0.0041684 0.0038499 0.0047689 0.0038778
  1 0.0092784 0.0092784 0.0092784 0.0092784 0.0092784 0.0092784 0.0104910 0.0099225 0.0117063 0.0099623
  2 0.0203818 0.0203818 0.0203818 0.0203818 0.0203818 0.0203818 0.0218754 0.0205824 0.0232155 0.0209708
  3 0.0373918 0.0373918 0.0373918 0.0373918 0.0373918 0.0373918 0.0394396 0.0370321 0.0385409 0.0381709
  4 0.0692155 0.0692155 0.0692155 0.0692155 0.0692155 0.0692155 0.0681027 0.0651002 0.0610750 0.0561559
  5 0.0896458 0.0896458 0.0896458 0.0896458 0.0896458 0.0896458 0.0864281 0.0819525 0.0839375 0.0819525
  6 0.1235760 0.1422000 0.1422000 0.1235760 0.1422000 0.1422000 0.1221433 0.1221433 0.1422000 0.1221433
   year
age 2004      2005      2006      2007      2008      2009      2010      2011
  0 0.0037380 0.0037364 0.0037999 0.0042094 0.0040218 0.0035013 0.0033326 0.0029223
  1 0.0100004 0.0097829 0.0097197 0.0100000 0.0100000 0.0090000 0.0090000 0.0070000
  2 0.0210962 0.0198329 0.0204000 0.0203432 0.0204303 0.0190568 0.0186033 0.0164689
  3 0.0387281 0.0383296 0.0368348 0.0382176 0.0355741 0.0336695 0.0328159 0.0302149
  4 0.0558321 0.0574356 0.0591492 0.0580689 0.0604256 0.0564348 0.0553102 0.0461411
  5 0.0819525 0.0801344 0.0819525 0.0823900 0.0817069 0.0787481 0.0803225 0.0675341
  6 0.0820300 0.1197333 0.1221433 0.1285333 0.1181633 0.0820300 0.1235760 0.1235760

units:  NA

Slot "m":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011
  0 0.92 0.92 0.92 0.92 0.92 0.92 0.92 0.92 0.92 0.92 0.92 0.92 0.92 0.92 0.92 0.92 0.92 0.92
  1 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73
  2 0.64 0.64 0.64 0.64 0.64 0.64 0.64 0.64 0.64 0.64 0.64 0.64 0.64 0.64 0.64 0.64 0.64 0.64
  3 0.61 0.61 0.61 0.61 0.61 0.61 0.61 0.61 0.61 0.61 0.61 0.61 0.61 0.61 0.61 0.61 0.61 0.61
  4 0.59 0.59 0.59 0.59 0.59 0.59 0.59 0.59 0.59 0.59 0.59 0.59 0.59 0.59 0.59 0.59 0.59 0.59
  5 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58
  6 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58 0.58
```

units: NA

Slot "mat":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

year

age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

units: NA

Slot "harvest":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

year

age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
0	0.1716442	0.2528026	0.2804457	0.2625579	0.0789831	0.1076457	0.1854701	0.2589248	0.0151989	0.0716751
1	0.8268704	0.5336198	0.5773608	0.2251822	0.2818718	0.3452660	0.7119300	0.5003395	0.0767344	0.0997734
2	0.4243624	0.2861797	0.8336972	0.6667447	0.5476904	0.4566317	0.4693179	0.4316031	0.4125101	0.2562436
3	1.3928976	1.3247590	1.3996630	0.5393043	0.4445619	0.3314466	0.2672191	0.1784854	0.5193752	0.5427694
4	0.6758512	1.8475493	5.8526741	0.1193627	0.9717588	0.6515374	0.4533205	0.0849018	0.5777546	1.6914458
5	1.0748644	1.6548768	3.7759589	0.3377578	0.7324936	0.5061575	0.3698011	0.1342200	0.5656533	1.1618376
6	1.0748644	1.6548768	3.7759589	0.3377578	0.7324936	0.5061575	0.3698011	0.1342200	0.5656533	1.1618376

year

age	2004	2005	2006	2007	2008	2009	2010	2011
0	0.1371386	0.1645552	0.0348193	0.0492079	0.0291784	0.1441262	0.0040047	0.0106987
1	0.2146289	0.3940493	0.3430633	0.3279562	0.3182892	0.0889579	0.1736592	0.1595358
2	0.4272115	0.1017950	0.6211219	0.8032585	0.5584039	0.5686627	0.7788360	0.6695318
3	0.3432698	0.3078625	0.2434118	0.4857658	0.6029227	0.5852277	1.2564904	0.7685563
4	0.5441716	0.1068045	0.1981592	0.5426807	1.7499793	0.8314642	0.6887961	0.8398153
5	0.4564408	0.2118533	0.2256964	0.5298409	1.2242331	0.7326835	1.0126226	0.7859585
6	0.4564408	0.2118533	0.2256964	0.5298409	1.2242331	0.7326835	1.0126226	0.7859585

units: f

Slot "harvest.spwn":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

year

age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

units: NA

Slot "m.spwn":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

year

age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

units: NA

Slot "name":
[1] "BLACK SEA WHITING,2011,COMBSEX,PLUSGROUP,INDEX FILE"

Slot "desc":

[1] "Imported from a VPA file. (BSW_94_2011IND.DAT). Fri Oct 12 12:23:34 2012 + FLAssess: + FLAssess: "

Slot "range":

min	max	plusgroup	minyear	maxyear	minfbar	maxfbar
0	6	6	1994	2011	1	4

The control of XSA are reported below in R code:

```
FLXSA.control.bsw <- FLXSA.control(x=NULL, tol=1e-09, maxit=30, min.nse=0.3, fse=0.5,
rage=1, qage=3, shk.n=TRUE, shk.f=TRUE, shk.yrs=5, shk.ages=2,
window=100, tsrange=20, tspower=3, vpa=FALSE)

###Final settings
FLXSA.control.bsw1 <- FLXSA.control(x=NULL, tol=1e-09, maxit=30, min.nse=0.3, fse=1.0,
rage=1, qage=3, shk.n=TRUE, shk.f=TRUE, shk.yrs=5, shk.ages=2,
window=100, tsrange=20, tspower=3, vpa=FALSE)

FLXSA.control.bsw2 <- FLXSA.control(x=NULL, tol=1e-09, maxit=30, min.nse=0.3, fse=2.0,
rage=1, qage=3, shk.n=TRUE, shk.f=TRUE, shk.yrs=5, shk.ages=2,
window=100, tsrange=20, tspower=3, vpa=FALSE)
```

6.3.4.1.3 Diagnostics and results

After several tries the EWG choose a very light shrinkage in order to downweigth the trends in catchability residuals for the recruiting year class caused by very high tuning indices in the survey.

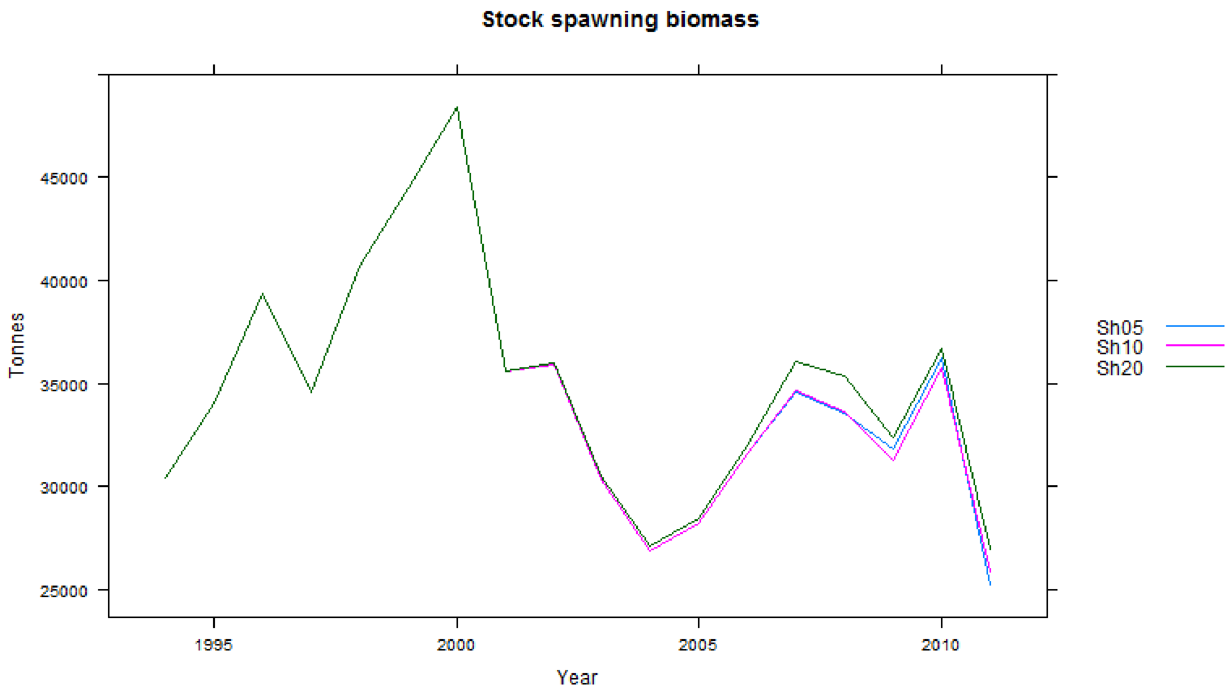


Fig. 6.3.4.1.3.1 Sensitivity analysis on Spawning Stock Biomass for different levels of shrinkage.

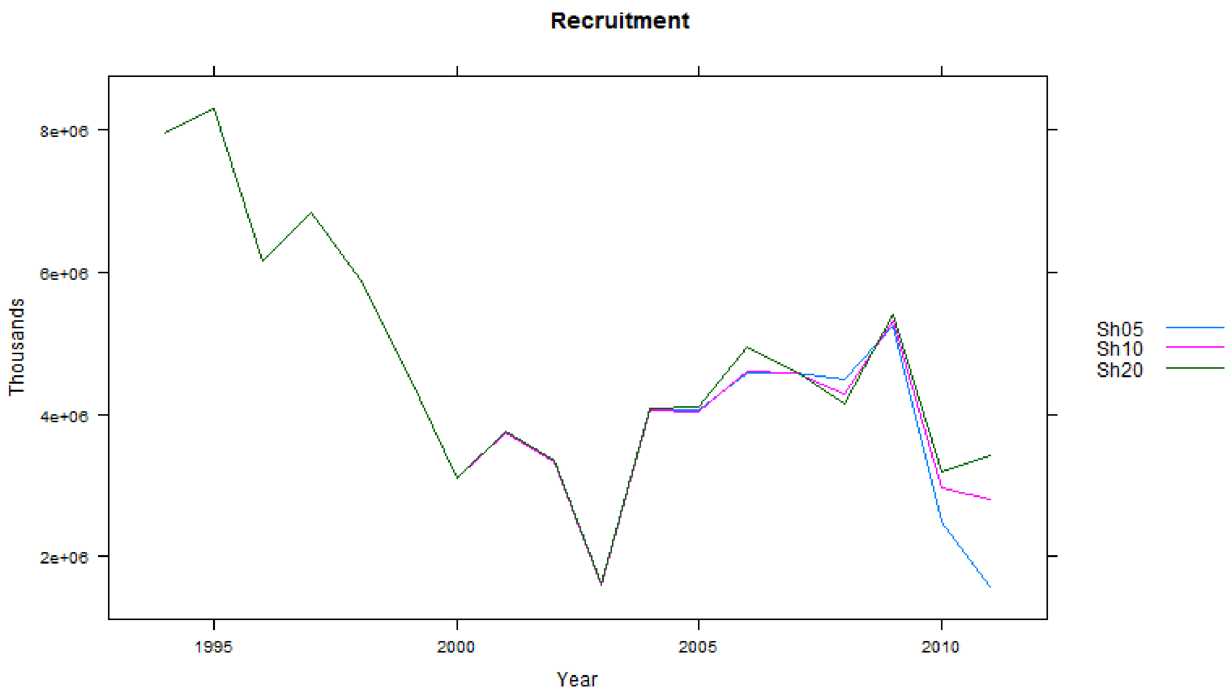


Fig. 6.3.4.1.3.2 Sensitivity analysis on Recruitment for different levels of shrinkage.

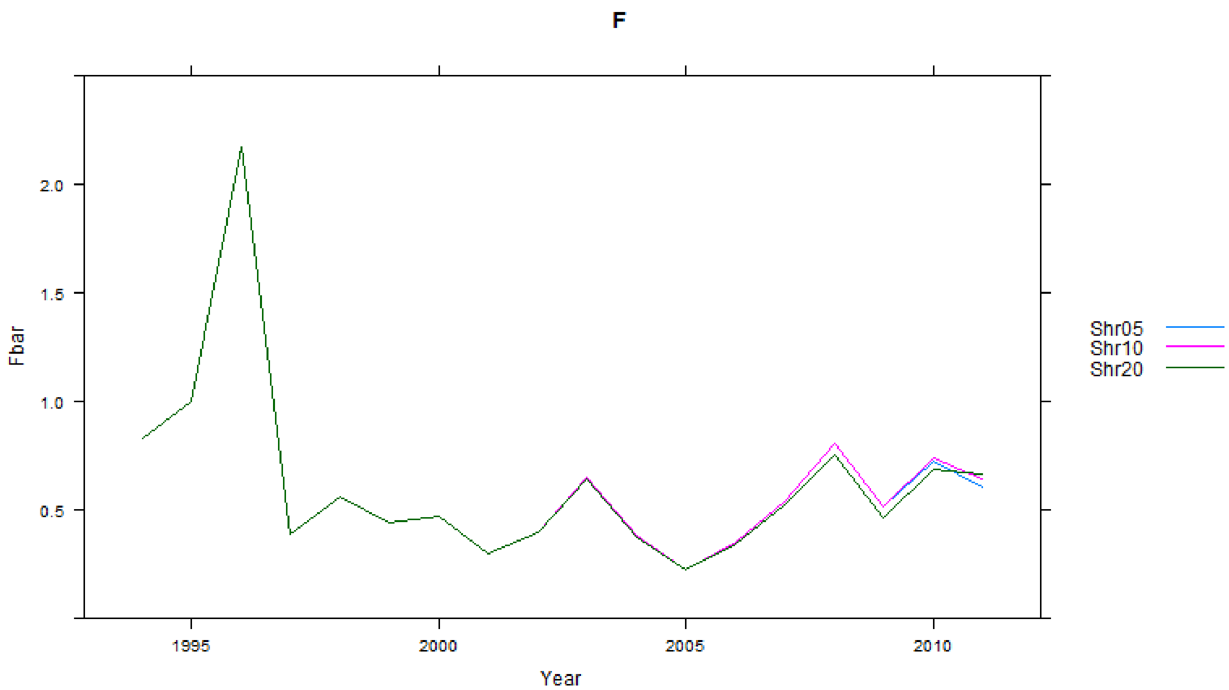


Fig. 6.3.4.1.3.3 Sensitivity analysis on Fbar(4-8) for different levels of shrinkage.

```
FLR XSA Diagnostics 2012-10-18 19:05:42

CPUE data from indices

Catch data for 18 years 1994 to 2011. Ages 0 to 6.

           fleet first age last age first year last year alpha beta
1 RO Trawl fleet         0        3       2008      2010  <NA> <NA>
```

Time series weights :

Tapered time weighting applied
Power = 3 over 20 years

Catchability analysis :

Catchability independent of size for ages > 1

Catchability independent of age for ages > 3

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 5 years or the 2 oldest ages.

S.E. of the mean to which the estimates are shrunk = 2

Minimum standard error for population
estimates derived from each fleet = 0.3

prior weighting not applied

Regression weights

age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
all	0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

age	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
0	0.015	0.071	0.137	0.163	0.032	0.049	0.032	0.139	0.003	0.005
1	0.076	0.099	0.212	0.392	0.338	0.298	0.317	0.097	0.167	0.122
2	0.411	0.254	0.424	0.100	0.615	0.780	0.481	0.566	0.899	0.631
3	0.519	0.540	0.340	0.304	0.240	0.477	0.569	0.456	1.240	1.088
4	0.577	1.685	0.540	0.105	0.195	0.530	1.651	0.741	0.449	0.810
5	0.565	1.157	0.452	0.209	0.222	0.519	1.154	0.617	0.776	0.373
6	0.565	1.157	0.452	0.209	0.222	0.519	1.154	0.617	0.776	0.373

XSA population number (Thousand)

year	0	1	2	3	4	5	6
2002	3358272	1158090	301481	132442	111557	54021	16630
2003	1624668	1318263	517137	105367	42834	34734	4135

```
  2004 4078118  603108 575308 211472  33360  4402      0
  2005 4096657 1417834 235080 198562  81817 10781   1786
  2006 4957094 1387715 461841 112111  79580 40817   1969
  2007 4605636 1913100 477154 131680  47940 36289   9422
  2008 4152169 1747535 684655 115302  44391 15644   1426
  2009 5403775 1603109 613212 223081  35449  4719      3
  2010 3195348 1873124 701055 183637  76816  9363      2
  2011 3420469 1269436 763732 150409  28881 27179      4


 Estimated population abundance at 1st Jan  2012
      age
year              0       1       2       3      4     5      6
  2012 7.040128e+164 1356230 541319 214157 27489 7094 10437


 Fleet:  RO Trawl fleet
```

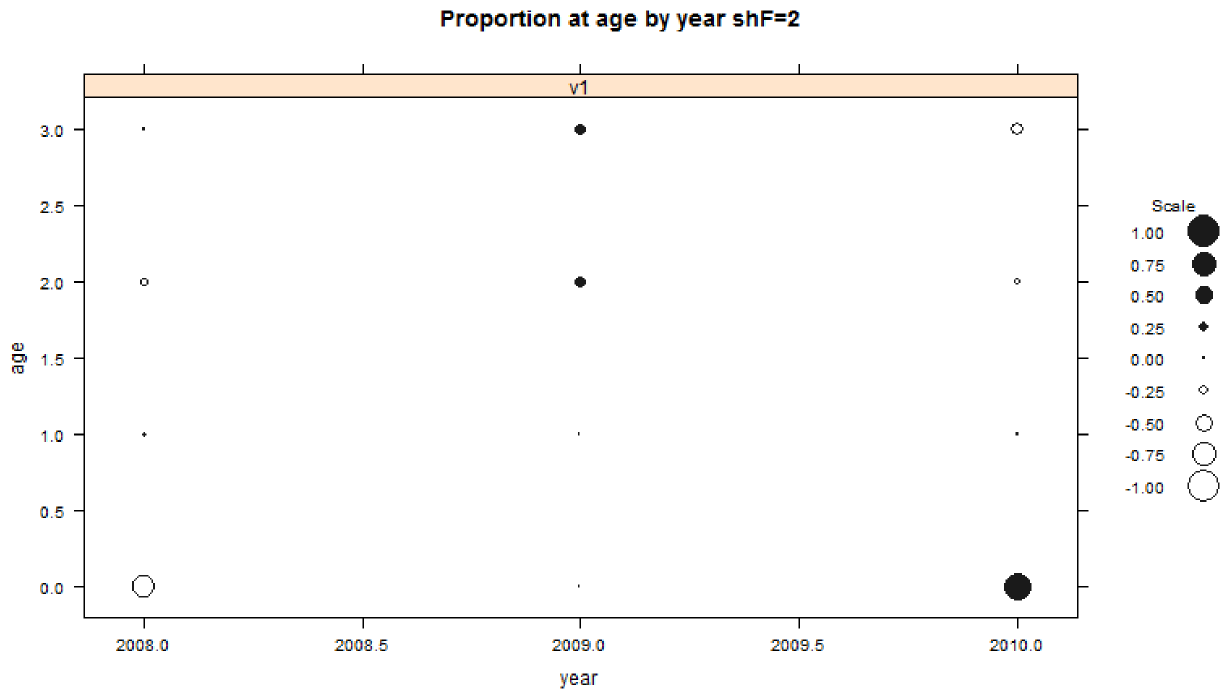


Fig. 6.3.4.1.3.4 Residuals of log transformed catchability applying a very low shrinkage of 2.0.

Table 6.3.4.1.3.1 Summary table of stock parameters. Fbar is estimated over ages 1-4.

Year	ssb	fbar	rec	catch	landings
1994	30372.54	0.829991	7950154	15892.12	15892
1995	34018.41	0.998019	8299835	18143	18143
1996	39364.8	2.165761	6169492	20952	20952
1997	34583.43	0.387584	6848388	13263.12	13263
1998	40676.86	0.561293	5918233	12730	12730

1999	44469.73	0.445975	4567526	12974.4	12974.4
2000	48394.71	0.475132	3112847	15979	15979
2001	35613.99	0.298446	3759276	8779	8779
2002	35983.66	0.395772	3358272	8562.015	8562.02
2003	30473.43	0.644684	1624668	7334.425	7334.43
2004	27073.57	0.378787	4078118	7487.613	7487.61
2005	28453.05	0.225456	4096657	6868.31	6868.31
2006	31959.88	0.346805	4957094	8005.737	8005.74
2007	36072.22	0.521271	4605636	11369.65	11376.15
2008	35324.97	0.75487	4152169	11181.31	11161.2
2009	32390.28	0.465093	5403775	9084.162	9087.51
2010	36712.77	0.688781	3195348	12043.65	11957.6
2011	26955.57	0.662854	3420469	8215.864	8249.03

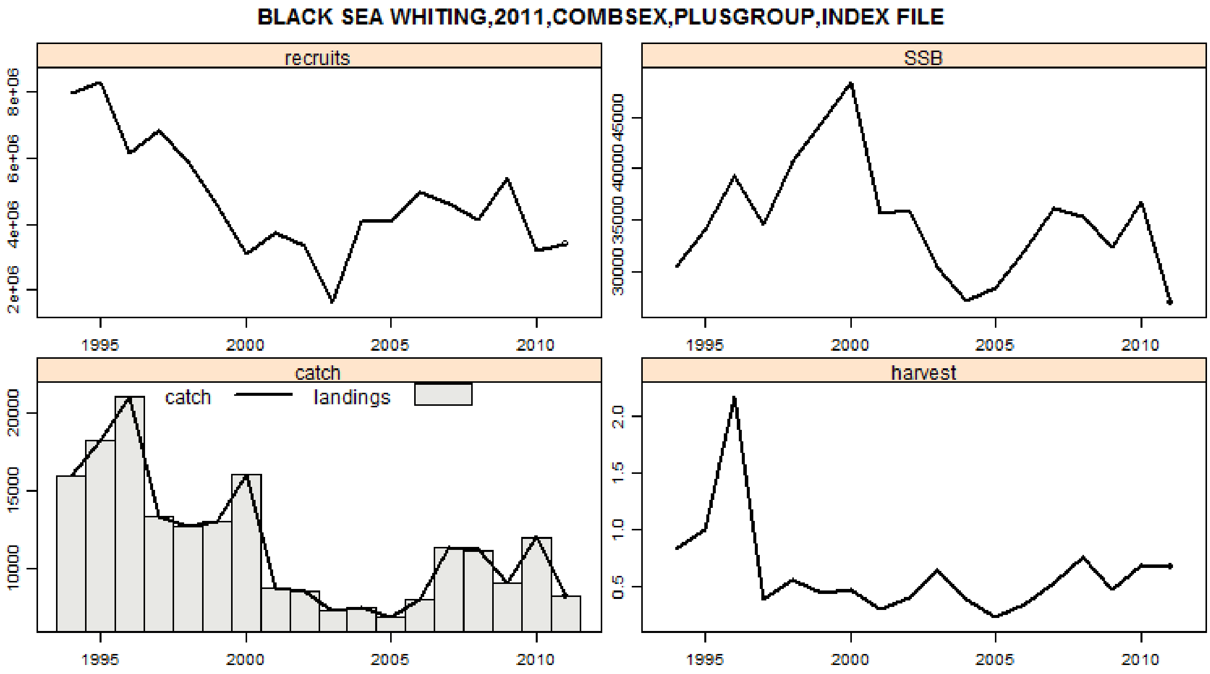


Fig. 6.3.4.1.3.5 Summary of trends in stock parameters as estimated by the XSA with low shrinkage (2.0). F is averaged over ages 1-4.

6.3.5 Short term prediction of stock biomass and catch

6.3.5.1 *Justification*

A deterministic short term projection of stock size and catch for 2011-13 under varying management options has been conducted. A status quo fishing has been assumed for 2011.

6.3.5.2 *Input parameters*

The input parameters are those obtained from the XSA with a short term geometric mean as recruitment estimates of 2011, 2012 and 2013.

6.3.5.3 *Results*

Table 6.3.5.3.1 Management option table for whiting in the Black Sea. Landins and SSB are given in tons.

Fscenario	Fmult	Catch_2012	Catch_2013	Catch_2014	SSB_2012	SSB_2013
0.4	0.656	7514	4219	4971	21013	18680
0	0	7514	0	0	21013	18680
0.061	0.1	7514	752	1112	21013	18680
0.122	0.2	7514	1461	2068	21013	18680
0.183	0.3	7514	2128	2888	21013	18680
0.244	0.4	7514	2759	3592	21013	18680
0.305	0.5	7514	3353	4195	21013	18680
0.366	0.6	7514	3915	4713	21013	18680
0.427	0.7	7514	4447	5156	21013	18680
0.487	0.8	7514	4949	5536	21013	18680
0.548	0.9	7514	5425	5861	21013	18680
0.609	1	7514	5875	6138	21013	18680
0.67	1.1	7514	6302	6375	21013	18680
0.731	1.2	7514	6708	6577	21013	18680
0.792	1.3	7514	7093	6749	21013	18680
0.853	1.4	7514	7458	6896	21013	18680
0.914	1.5	7514	7806	7020	21013	18680
0.975	1.6	7514	8137	7125	21013	18680
1.036	1.7	7514	8452	7214	21013	18680
1.097	1.8	7514	8752	7289	21013	18680
1.158	1.9	7514	9039	7352	21013	18680
1.219	2	7514	9313	7405	21013	18680

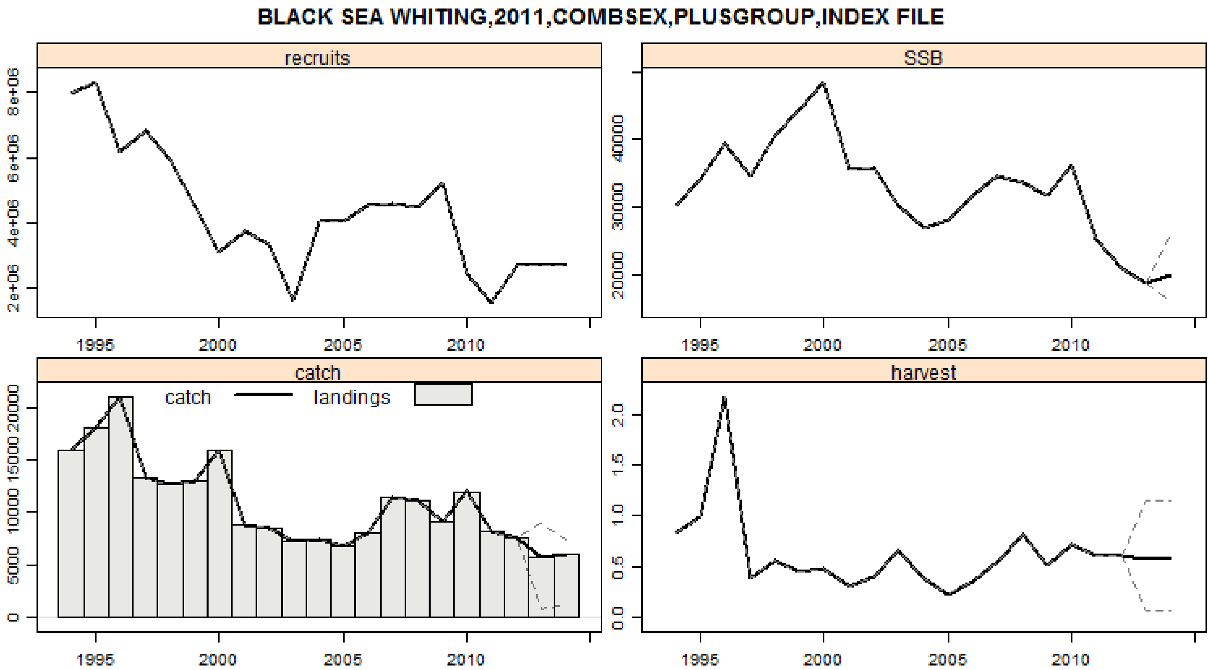


Fig. 6.3.5.3.1 Historic trends and short term prediction (status quo) of relevant stock parameters.

6.3.6 Medium term prediction of stock biomass and catch

The EWG 12-16 did not undertake medium term projections.

6.3.7 Long term predictions

6.3.7.1 *Justification*

A yield per recruit YpR analysis was conducted.

6.3.7.2 *Input parameters*

The input parameters are those averaged over the whole time series as obtained from the XSA based and where recalculated in EWG 12-16 since the input data changed from the last EWG 11-16 meeting.

6.3.7.3 *Results*

An object of class "refpts":

refpt	harvest	yield	rec	ssb	biomass
f0.1	0.408677	0.002232	1	0.008888	0.012936
fmax	1.891135	0.002597	1	0.004166	0.0081
spr.30	1.043999	0.002559	1	0.005603	0.0096
msy	1.891135	0.002597	1	0.004166	0.0081

The EWG proposes F 0.1=0.4 as approximation of the Fmsy reference point consistent with high long term yields, which is the same as in the meeting of the EWG 11-16.

6.3.8 Scientific advice

6.3.8.1 *Short term considerations*

State of the spawning stock size:

Since 1994 the SSB has varied without a trend. In the absence of a biomass biological reference points the EWG 12-16 is unable to fully evaluate the stock status in respect to it.

State of recruitment: Since 1994 the recruitment has varied without a trend. There is no fishery independent recruitment index (survey) available as none of the surveys cover the entire stock area.

State of exploitation:

The EWG 12-16 proposes Fmsy (1-4)≤0.4 as limit reference point consistent with high long term yields and low risk of fisheries collapse. As the estimated F(1-4)= 0.66 exceeds Fmsy the EWG 12-16 classifies the stock of whiting in the Black Sea as being exploited unsustainably. If the stock is fished at Fmsy (1-4) = 0.4 the status quo catch for 2013/2014 would be 4218 and 4971 t respectively. The EWG 12-16 therefore recommends a total catch not larger than 4971 t corresponding to catches at Fmsy. The EWG 12-16 notes the geographically uneven pattern in the catches of this stock. Given that this is not a highly migratory species we may conclude that the resident population is more exploited in the southern part (Turkish waters) than in the rest of the Black Sea - an effect that has been demonstrated by Prodanov et al. (1997) who performed separate VPA analyses of the western/northern and eastern/southern components of the whiting stock.

6.3.8.2 *Medium term considerations*

Due to the lack of discard information in the catch statistics, which might bias the assessment, no medium term analyses have been conducted.

6.4 Horse mackerel in the Black Sea

6.4.1 Biological features

6.4.1.1 Stock Identification

The Black sea horse mackerel is a subspecies of the Mediterranean horse mackerel *Trachurus mediterraneus.* Although in the past the Black sea horse mackerel has been attributed to various subpopulations, in a more recent study Prodanov *et al.* (1997) brought evidence that the horse mackerel rather exists as a single population in the Black sea, and thus all Black sea horse mackerel fished across the region should be treated as a unit stock.

The horse mackerel is a migratory species distributed in the whole Black Sea (Ivanov and Beverton, 1985; Figure 6.4.1.1.1). In the spring it migrates to the north for reproduction and feeding. In summer the horse mackerel is distributed preferably in the shelf waters above the seasonal thermocline. In the autumn it migrates towards the withering grounds along the Anatolian and Caucasian coasts migration (Ivanov and Beverton, 1985). The horse mackerel population in the Black Sea mainly winters along the Crimean, Caucasian and Anatolian coasts and warm sections of the Marmara Sea. They winter at a depth ranging between 20 and 90 meters off Crimea and between 20 and 60 meters off the Caucasian coasts. The horse mackerel population continuously remains in the eastern Black Sea winters in an area north-east of Trabzon. The population migrating between Marmara and the eastern Black Sea spend the winter in the Bosphorus area and off the Marmara Sea at optimal depths ranging between 30 and 50 meters. Depending on water temperature, feeding migration starts in mid-April or towards the end of that month (Demir, 1958). Horse mackerel groups migrate from the Bosphorus to the Bulgarian and Romanian coasts in the north. They are also believed to migrate from Crimea to the north-west and from the Caucasian and north-eastern Anatolian coasts to the Crimean coasts. Autumn migration starts in September and reaches a peak in October and November (Ivanov and Beverton, 1985).

The family Carangidae is represented by two species in the Black Sea: *Trachurus trachurus* and *T. mediterraneus* (Drenski, 1948, 1951; Aleev, 1956; Georgiev and Kolarov, 1959, 1962; Stoyanov *et al.,* 1963; Svetovidov, 1964; Valkanov *et al.,* 1978; Sivkov, 2004; Zhivkov *et al.*, 2005; Kapapetkova and Zhivkov, 2006; Raykov and Yankova, 2008; Yankova *et al.,* 2010a). The systematic position of the Black Sea horse mackerel was examined by Nümann (1956) and Aleev (1952, 1957). These authors stated that in the Black Sea the species is represented by four local subpopulations: a south western (Bosporic), a northern (Crimean), an eastern (Caucasian) and a southern (Anatolian). Each subpopulation has its own biological characteristics such as wintering grounds, fat content, spawning patterns, age composition, growth rate, feeding patterns.

According to some authors (Aleev, 1956; Georgiev and Kolarov, 1959, 1962; Stoyanov *et al.*, 1963; Kapapetkova and Zhivkov, 2006) the Black Sea horse mackerel is represented into two size-forms: ”large” and “small”. The presence of the large form has been reported for a first time in 1913 by S. A. Zernov (Aleev, 1956). However, after that time this form disappeared, but it is registered again in the territorial waters of Georgia in 1947 and is being intensively fished for 10 years. Draughts of the large form for the eastern part of the Black Sea reached up to 8601,7 t in 1954 (Tikhonov *et al.,* 1955). Since 1958, only single specimens are found in the nets (Dobrovolov, 2000). There are several hypotheses about the presence of the large horse mackerel in the Black Sea: a) it is a new immigrant from the Mediterranean (Aleev, 1956); b) it is the same small horse mackerel with accelerated growth under extremely favorable conditions (Tikhonov *et al.*, 1955; Shaverdov, 1964); c) it is an ecological breed that hibernates in the warmest areas (Aleev, 1957), or it is an ecotype (Shaverdov, 1964); d) it belongs to another species present in the Mediterranean or even in the Atlantic Ocean and in case of extremely high species numbers some shoals enter the Black Sea enlarging their nutritive territory (Altukhov and Salmenkova, 1981); e) it is a polyploid form of the small horse mackerel originating in the Black Sea (Georgiev and Kolarov, 1962); f) it is a "giant" horse mackerel as a new species *Trachurus gigas*, n.sp (Banarescu and Nalbant, 1979).

According to Shaverdov (1964), the "large" and "small" forms of the Black Sea horse mackerel belongs to one and the same subspecies as described by Aleev (1957). After the study of Golovko (1964) about the electrophoretic spectra of serum proteins from these two forms, Shulman and Kulikova (1966) reconsidered their own earlier assumption about the belonging of both forms to a taxonomically close but different species. Tkacheva (1957) performs crosses between small and large horse mackerel under field conditions on board a research motor boat, which showed the possibility to obtain hybrids. Until now, there does not exist any information confirming the polyploidity of the large form of horse mackerel. On the other hand, the existence of two different subspecies of *T. mediterraneus* in the Black Sea: *T. m.* ssp. *ponticus* and *T. m.* ssp. *mediterraneus* is described by Altukhov and Apekin (1963) based on serological analyses and also by Altukhov and Michalev

(1964) by means of the characteristics of the cellular thermal (Prodanov *et al.,* 1997). According to (Dobrovolov & Dobrovolova 1983; Dobrovolov and Manolov 1983; Dobrovolov, 1988) no difference at species level can be found between *T. mediterraneus* ssp. *ponticus* and *T. mediterraneus* ssp. *mediterraneus* by electrophoretical method. Dobrovolov (1986) revealed that the occurrence of large form can be explained as a result of heterosis effect between the above-mentioned subspecies.

Turan (2004) analysed the population structure of *T. mediterraneus* in Turkish coastal waters using morphometric and meristic traits and reported on population structuring in three areas: the Black Sea, Marmara Sea and the north-east Mediterranean Sea. The samples from the Black Sea were similar to each other for both morphometric and meristic charactrers. Biometric indices were insufficient to distinguish two horse mackerel subpopulations in the Bulgarian and Turkish Black Sea waters (Yankova and Raykov, 2006a). The same authors concluded that all of the morphological differences are possible due to variability of the habitat and sample size of the study. Acording to Prodanov *et al.,* (1997) the Black Sea horse mackerel represent a single population, as the environmental conditions are almost one and the same in the whole area inhabited, and there exists no positive evidence for the occurrence of two distinct subpopulations differing substantially in their biological parameters. The present mtDNA analysis also indicated that there were no subspecies of *T. mediterraneus* from the Turkish Black Sea waters (Bektas and Belduz, 2008).

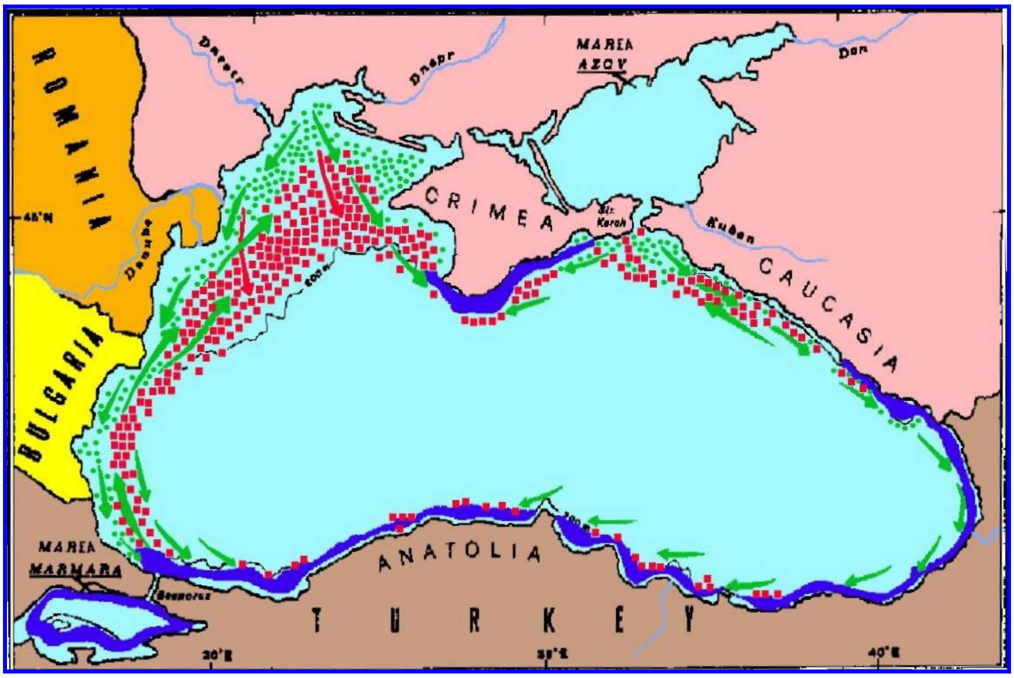


Fig.6.4.1.1.1 Distribution and migration routes of horse mackerel in the Black Sea.

6.4.1.2 Growth

Horse mackerel growth parameters from VBGF and length-weight relationship, provided by different countries are presented in Table 6.4.1.2.1.

The exponent *b* ranged between 3.3029 for females and 3.3123 for males, exhibiting positive allometric growth (Yankova *et al.,* 2010). There was not a significant difference when the length-weight relationships of the sexes were compared using covariance ($P > 0.05$). The slope (*b* value) of the length-weight relationship was similar for males (3.3123) and females (3.3029), indicating that weight increased allometrically with length (Yankova *et al.,* 2010).

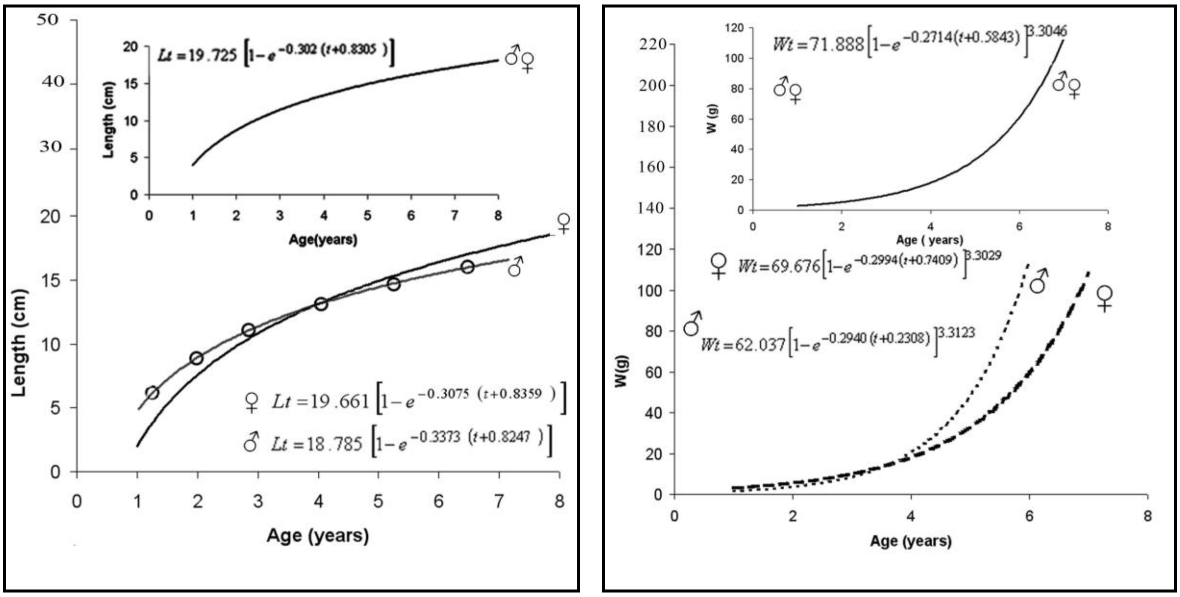


Fig. 6.4.1.2.1. Length Weight growth curves of horse mackerel males, females and both sexes combined from Bulgarian Black Sea waters (after Yankova *et al.,* 2010).

Comparison of the growth parameters of horse mackerel in Bulgarian Black Sea waters (Yankova *et al.,* 2010) showed that there were no differences (ANOVA, $F = 1.40$, $P > 0.05$). During the first 3 years of life females and males differ in length (Fig. 6.4.1.2.1). Males are characterized by higher growth rates than females (Yankova *et al.*, 2010).

Table 6.4.1.2.1. VBGF parameters calculated in the Black Sea.

COUNTRY	YEAR_PERIOD	SPECIES	SEX	L_INF	K	t_0	a	b
Bulgaria	2007-2008	HMM	C	19.75	0.3020	-0.8305	0.0035	3.3046
Bulgaria	2007-2008	HMM	M	18.785	-0.3373	-0.8247	0.0034	3.3123
Bulgaria	2007-2008	HMM	F	19.661	-0.3075	-0.8359	0.0038	3.3029
Romania	2000	HMM	C	18.6	0.224	-1.43	0.0380	2.3552
Romania	2001	HMM	C	18.95	0.268	-0.63	0.0470	2.3501
Romania	2009	HMM	C	18.42	0.42	-0.41	0.0450	2.3469
Romania	2010	HMM	C	20.03	0.302	-0.467	0.0111	2.9065
Romania	2011	HMM	C	17.37	0.371	-0.445	0.0101	2.9101
Turkey	1991 – 1992	HMM	M	19.9	0.396	-1.02	0.0110	3.18
Turkey	1991 – 1992	HMM	F	20.6	0.356	-1.11	0.0080	2.993
Turkey *	2005	HMM	C	20.237	0.3181	-1.603	0.0081	2.9983
Turkey *	2006	HMM	C	22.394	0.241	-1.932	0.0064	3.0986
Turkey *	2007	HMM	C	22.232	0.2554	-1.828	0.0085	2.984
Turkey *	2008	HMM	C	22.244	0.2538	-1.8	0.0069	3.1018
Turkey *	2009	HMM	C	24.023	0.2082	-2.075	0.0062	3.1024
Turkey *	2010	HMM	C	25.002	0.187	-2.11	0.0052	3.1654

Turkey *	2011	HMM	C	24.44	0.235	-1.767	0.0056	3.1402
Ukraine	2008	HMM	C	18.5	0.343	-0.66	_	_

**data according "Purse seine fisheries monitoring project by Trabzon Central Fisheries Institute"*

6.4.1.3 Maturity

The horse mackerel matures at age of 1-2 years during the summer, which is also the main feeding and growth season. It spawns in the upper layers, mainly in the open part of the sea as well as near the coast (Arkhipov, 1993). Eggs and larvae are often found in areas with a low productivity and higher salinity (Arkhipov, 1993). Daskalov (1999) has found that horse mackerel recruitment is related to divergence and increased productivity of the sea. Peak spawning in the Bulgarian Black Sea Coast falls between June-August (Georgiev *et al.,* 1961; Georgiev and Kolarov, 1962; Georgiev *et al.,* 1962; Stoyanov *et al.,* 1963, Karapetkova and Zhivkov, 2006; Yankova and Raykov, 2009; Yankova, 2011). Spawning has been reported to occur 20 miles off the coast (Georgiev *et al.,* 1962). The pelagic eggs are 0.73-1.00 mm (Georgiev *et al.,* 1961; Georgiev *et al.,* 1962; Stoyanov *et al.,* 1963) and hatch after four days (Radu and Radu, 2008) at local temperatures 16-26 °C and salinity is 15.5-19‰ (Georgiev *et al.,* 1961; Georgiev *et al.,* 1962; Stoyanov *et al.,* 1963). The eggs of horse mackerel are pelagic, spherical, with a drop of fat (Karapetkova and Zhivkov, 2006).

The horse mackerel reproduction start at age of 1 year during the summer in Southern Black Sea (peak July), reproduction temperature is between 18-25 °C , salinity salinity is 16-18 ‰ (Genç *et al.*, 1999).

6.4.2 Fisheries

6.4.2.1 General description

The horse mackerel (*Trachurus mediterraneus*) fishery operates mainly on the wintering grounds in the southern Black Sea using purse seine and mid-water trawls. The horse mackerel of age 1-3 years generally prevails in the commercial catches, but strong year classes (for example, the 1969-year class) may enter into exploitation at age of 0.5 year and may prevail up to age 5-6 years. Over the last 40 years, highest horse mackerel catches were reported in the years preceding *M. leidyi* outbreak (1988-1990). (Prodanov *et al*., 1997; FAO, 2007). The maximum catch of 141 thousand tons was recorded in 1985, from which ~100 thousand tons were caught by Turkey (Prodanov *et al*., 1997). In the next four years catches remained at the level of 97-105 thousand tons. In the period 1971-1989, the stock increased, although years of high abundance alternated with years of low abundance due to year class's fluctuations, typical of this fish. VPA estimates showed that the stock was highest in 1984-1988 (Prodanov *et al*., 1997). Scientists (Chashchin, 1998) believed that the intensive fishing in Turkish waters in 1985-1989 has led to overfishing of horse mackerel population and reduction of the stock and catches in the next years. A drastic decline in stock abundance occurred after 1990 when the stock diminished by 56%. In 1991 the horse mackerel stock dropped to a minimum of 75 thousand tons and the catch dropped to 4.7 thousand tons that is a twenty fold reduction compared to the average annual catch in 1985-1989.

The horse mackerel recruitment has been highly variable with the stock biomass supported by sporadic strong year-classes (e.g. 1969, 1983, 1987) followed by weak-ones. Thus, the influence of a strong year-class can be traced through the subsequent few years of biomass increase. No evidence of reliable stock-recruitment relationship has been found (Daskalov, 1999). The relationship with selected environmental variables has been explored by Daskalov (1999, 2003). A strong negative correlation was with surface temperature (SST) has been found. It may appear surprising for a warm-water summer spawning species to correlate negatively with SST. Such relationships have been also found however in other studies (Simonov et al., 1992). The effect of the wind stress was significant and generally positive. These results indicate that horse mackerel recruitment has been more abundant in years with increased physical forcing and enrichment, probably related to the spawning distribution wide spread over areas of low productivity.

During 1985-1993, only in 1988 a relatively successful recruitment was recorded. Despite of its coincidence with the first year of *M. leidyi* outbreak, the juveniles from this cohort were sufficiently well supplied with food. As the first burst of *M. leidyi* occurred in the autumn of 1988, the summer zooplankton maximum production did not suffer much from the devastating effect of *M. leidyi*. The copepods *Oithona nana* and *Oithona similis*, constituting the main food of larval horse mackerel (Revina, 1964), were especially abundant. However, the favorable trophic conditions for larvae in summer 1988 failed to ensure the formation of numerically strong year-class because further in the year juveniles were faced with strong feeding competition with *M. leidyi*. Sharp decline in *Oithona* under the predation pressure of *M. leidyi* in the subsequent years (Vinogradov *et al*., 1993 ;) affected the survival of horse mackerel. Dietary studies of juvenile and adult horse mackerel (Revina, 1964) have shown that both the habitat diet of juvenile horse mackerel and *M. leidyi* overlap, therefore the strong feeding pressure by *M. leidyi* on zooplankton directly affected larval and juvenile horse mackerel. Food in relation to fish size shows that the most important for the diet of horse mackerel groups are *Mysidacea* and *Pisces.* The contribution of the rest of groups was relatively low (Yankova & Raykov, 2010). The same authors reveal that main prey of the Black Sea horse mackerel is fish and zooplankton. This group represents over 55% of the total IRI and was the main food for this species. Besides having the largest number of zooplankton, it had a high impact on populations of commercial fish such as sprat and anchovy.

Over the last 40 years, highest horse mackerel catches were reported in the years preceding *M. leidyi* outbreak (1988-1990). Quantitative stock assessments showed that the stock was highest in 1984-1988, although years of high abundance alternated with years of low abundance due to year classes' fluctuations, typical of this species. Scientists believed that the intensive fishing in Turkish waters in 1985-1989 has led to over fishing of horse mackerel population and reduction of the stock and catches in the next years. A drastic decline in the stock abundance occurred after 1990 when the stock diminished by 56%. In 1991 the horse mackerel stock dropped to a minimum of 75 thousand tons and the catch dropped to 4.7 thousand tons, hat is a twenty fold reduction compared to the average annual catch in 1985-1989. In contrast to anchovy and sprat, the horse mackerel stock still remains in a depressed state. The total catch (taken predominantly by Turkey) in 2000-2005, remains ~10 th. t, similar to the pre-industrial period 1950-1975.

The catches of Black sea horse mackerel were realized by active (bathypelagic trawls and surrounding nets) and passive fishing gears (gill netting, trawl net, trap nets) (Prodanov *et al.*, 1997; Yankova *et al.*, 2010a). The Bulgarian and Romanian catches are taken primarily by passive, while the Turkish and former USSR entities by active gears (Prodanov *et al.,* 1997). The horse mackerel of age 1-3 years generally prevails in the commercial catches (Grishin *et al.,* 2007; Yankova and Raykov, 2009; Yankova *et al.,* 2010a), but strong year classes (for example, the 1969 year class) may enter into exploitation at age of 0.5 year and may prevail up to age 5-6 years (Grishin et al., 2007). The accuracy of the stock assessments depends exclusively on the fishery statistical data (Prodanov *et al.,* 1997). There are lack of information on horse mackerel catches or its underestimation by Russia, Ukraine and Georgia, Romania and Bulgaria enhances the risk of an incorrect assessment of biomasses. Over the last 40 years, highest horse mackerel catches were reported in the years preceding *Mnemiopsis leidyi* outbreak (1988-1990) (Prodanov *et al.*, 1997). The improvements of fishing gears and the application of modern echo-acoustics further contribute to a more effective fishery (Prodanov *et al.*, 1997). The same authors reported that when the level of the horse mackerel stock was low, even small catches caused higher fishing mortality, and vice verse. All this stresses the necessity of annual assessments of stock size, of TAC`s, as well as of clarifying the causes (natural and anthropogenic) determining flictuations in year class strength.

6.4.2.1.1 State of the fisheries in Turkey

Horse mackerel stock was a subject of overfishing, resulting in a fisheries collapse in the beginning of 1990's (Ozekinei et al., 2001). The ratios of undersized individuals for horse mackerel were 89% and 92% for autumn and winter seasons, respectively. The corresponding ratios for the horse mackerel for the same seasons were 70 and 67%, respectively. Minimum allowable sizes for horse mackerel and bluefish are 13 and 20cm, respectively. The 50% cumulative values obtained trawling trials are close to those figures. But the ratios of the undersize fish of horse mackerel (< 13 cm) for the seasons of spring, autumn and winter were calculated as 93.7, 75.8 and 30.7%, respectively (Dincer *et al*., 2007).

Production of the horse mackerel, which is the second most important pelagic catch along Turkey's Black Sea coasts after the European anchovy, steadily increased until the mid-1980s and reached its maximum level of approximately 100,000 tons in 1985. The total amount of catch, however, constantly declined due to uncontrolled fishing activities and over-fishing in the 1990s and declined to 80,000 tons. Research into commercial fish stocks on Turkey's Black Sea coasts conducted during the second half of the 1980s indicated that the horse mackerel population suffered the greatest fall in terms of quantity after the sea-perch among the pelagic stocks in the past 15 years (Bingel *et a*l., 1995; Zengin *et al*., 1998a; Zengin, 2001). The breakdown of horse mackerel caught by commercial fishermen between 1991 and 1993, when the amount of horse mackerel catch started to decrease along Turkish coasts, by length confirms this conclusion. The average lengths of horse mackerel caught by large purse-seine nets and trawlers during those years were 11.1 cm, 10.9 cm and 10.6 cm, respectively (Zengin, 1998). Average operating ratio (E) calculated for the same period was 0.78 (Genç *et al*., 1999), which clearly demonstrates the over-fishing of the horse mackerel stock. This sharp fall in the horse mackerel catch steadily increased until the end of the 1990s. The share of horse mackerel below optimal catch length ($L_{opt.}$= 13 cm) in the total catch caught by coastal surrounding nets in the eastern Black Sea early in the 1990s (1990-1993) was 52.2%, rose towards the end of 1990s (66.7 %) (Zengin *et al*., 1998a, Zengin *et al*., 2002) – Table 6.5.2.1.1.1. The length of the horse mackerel population off the southern Black Sea coast after they reach initial reproductive maturity is 11.7 cm (Genç *et al*., 1999). A large part of immature and young individuals below the optimal catch length (*discards catch*) are taken by coastal fishermen from stock and sold on the market under the counter or destroyed on the sea. In order to eliminate this trend, which is an indicator of growth over-fishing, new fishing methods and management planning are also considered necessary for horse mackerel populations.

After the beginning of the 2000s the landings started to increased again. Total Turkish Black sea catch was up to 26.000 tons (2006 official statistics) and the average length also increased 13.7 cm. (Genç *et al*, 2006).

Horse mackerel stocks in the Black Sea are usually caught by Turkish fishermen by using active (bottom trawler, pelagic trawler and large bag-shaped nets) and passive (extension and longline) nets Table 6.4.2.1.1.1. Almost the whole horse mackerel catch (98.2%) is caught by large bag-shaped nets. CPUE of fishing boats using that type of net for catching horse mackerel is 3837.5 (600-10,000) kg/boat/day (Zengin *et al*., 2003). The remaining part of the catch is caught by bottom trawler, pelagic trawler, extension net and long lines. A large part of the catch (80%) is caught in the autumn and the first part of winter (September-December) (Zengin *et al.*, 1998a) (Fig. 6.4.2.1.1.1).

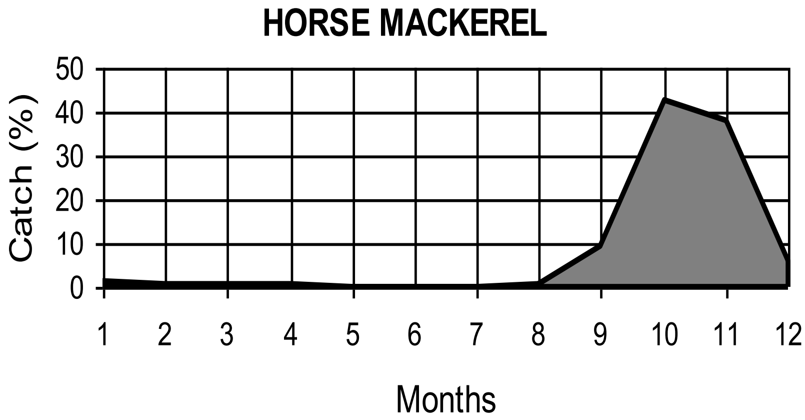


Fig. 6.4.2.1.1.1 Catch distribution of the Horse mackerel in the south Black Sea by monthly.

Table 6.4.2.1.1.1. Distribution of average length (cm) and catches below the optimum catch length (L_{opt}) in the southern Black Sea in the period between 1990 and 2011.

Fishing season	**Landings (tons)**	**Optimum catch length (cm)**	**Mean weight(g)**
1990	75882	11.1	
1991	25679	10.9	
1992	20989	10.1	
1993	23945	-	
1994	25275	-	
1995	15809	-	
1996	16093	-	
1997	11097	-	
1998	8246	-	
1999	8331	-	
2000	16181	12.4	
2001	16750	-	
2002	8903	-	

2003	9213	-	
2004	9113	13.1	
2005	17003	11.6	15.70
2006	25927	12.7	17.69
2007	17429	12.6	16.71
2008	20124	13.2	20.57
2009	15905	12.6	17.09
2010	12929	12.1	17.00
2011	17746	11.92	15.52

Table 6.4.2.1.1.2 % catch and catch per unit effort according to type of net in the south Black Sea in the period of between 1990 and 2000.

Fish species	Parameters	Purse seine	Trawl	Pelagic trawl	Gill-nets	Set-net	Long-line
Horse mackerel	%Catch CPUE (kg/boat/day)	98.2 3837.5 (600-10000)	0.3 -	0.4 2038.7 (95.9-79.20)	0.9 -	-	0.2 -

6.4.2.1.2 State of the fisheries in Ukraine

After a long absence, since the end of 2002 was renewed fishing of horse mackerel in the waters under the jurisdiction of Ukraine. Horse mackerel forms aggregations during the wintering and to a lesser extent, in the autumn on migration routes. The Ukrainian waters near the Southern coast of Crimea from November to March it occur wintering ground of horse mackerel. In the formation of wintering aggregations of horse mackerel it possible for fishing by lifting cone-shaped nets with electric light attraction, and purse seines. In the warm season in small quantities horse mackerel harvested with pound nets, including the Sea of Azov. In recent years the number of horse mackerel midwater trawl is produced as by-catch in fisheries sprat. Generally, the share of Ukrainian total catch in the catch of mackerel in the Black Sea is very low.

Upon a characterization of commercial use of the Horse mackerel stock in Ukraine, two periods clearly stand out: 1992-2001 years and since 2003 up to the present. During the first of mentioned periods Horse mackerel was practically absent as an object for Ukrainian fishing. Absence of commercial catches in the waters of the Black Sea under Ukrainian jurisdiction during 1992-2001 has an explanation in the considerable decrease of its stock number, which, in V. A. Shlyakhov and A. N. Grishin’s opinion (2009), was conditioned by the negative influence of Ctenophora *Mnemiopsis*. As these authors points, the introduction of Ctenophora Beroe, that had led to decrease of negative influence of Mnemiopsis, has influenced well on the Horse mackerel stock state. Since 2003 it regains its commercial significance, and its Ukrainian catches vary on the level of several thousand tons.

Horse mackerel forms aggregations during wintering and, to lesser extent, in the autumn on migration routes. It winters in Ukrainian waters near the Southern coast of Crimea from November to March, and some years can be found from c. Takil to c. Lucull. Upon forming wintering aggregations the possibility of specialized fishing of Horse mackerel with lifting cone-shaped nets with electric light attraction appears, and, to lesser extent, of fishing with purse seines. But the aggregations of commercial character form not every year, thus the specialized fishing of Horse mackerel is carried out occasionally and only in certain years. As a rule, the most part of Horse mackerel is caught with midwater trawls as by-catch at sprat fishing. During warm seasons Horse mackerel is caught with pound nets in small amounts. Under mentioned peculiarities of distribution, the prevalent part of the Horse mackerel year catch falls on I and IV quarters. The age structure of Horse mackerel catches (Shlyakhov *et al.*, 2012) differentiates significantly in different years, herewith the prevalence of individuals of one-two generations is characteristic in catches (Table 6.4.2.1.2.1).

Table 6.4.2.1.2.1 Age structure of horse mackerel commercial catches in the waters of the Black Sea under the jurisdiction of Ukraine during 2003-2011.

Year	Average weight (g)	Age composition (%)					
		0+	1-1+	2-2+	3-3+	4-4+	5-5+
2003	**18.1**	**-**	**1**	**97**	**2**	**-**	**-**
2004	**29.4**	**1**	**2**	**6**	**91**	**0**	**-**
2005	**23.3**	**-**	**30**	**50**	**15**	**5**	**-**
2006	**17.4**	**-**	**67.7**	**13.1**	**18.9**	**0.3**	**-**
2007	**18.2**	**-**	**51.1**	**20.4**	**27.7**	**0.8**	**-**
2008	**17.9**	**0.9**	**24.8**	**63.3**	**10.3**	**0.5**	**0.2**
2009	**23.2**	**-**	**-**	**16.9**	**55.8**	**24.0**	**3.3**
2010	**12.8**	**46.4**	**52.8**	**0.8**	**-**	**-**	**-**
2011	**17.5**	**9.1**	**80.4**	**4.5**	**3.8**	**2.2**	**-**

Table 6.4.2.1.2.2 Horse mackerel fishing mortality (F) by Jones method (Ukrainian waters).

	Year							
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
FL, mm								
146-150	0.243	1.340	1.826	0.532	1.194	0.499	1.299	1.370
151-155	0.280	1.049	2.099	0.624	0.638	0.373	1.199	3.841
156-160	0.342	1.177	0.843	0.637	0.547	0.357	0.720	0.342
161-165	0.463	0.479	0.463	0.742	0.903	0.186	0.463	0.463
L145-165	0.332	1.011	1.308	0.634	0.820	0,354	0,920	1.504

6.4.2.2 Management regulations applicable in 2010 and 2011

The EWG 12-16 did not provide a full description of national and international regulations regulating the horse mackerel fisheries during its next meeting in 2012.

6.4.2.3 Catches

6.4.2.3.1 Landings

The data of Bulgarian catches show considerable fluctuations, they could be distinguished in two stages(Yankova *et al.*,2009). In the first stage from 2000 to 2003 years, relatively high amounts of catches are evident. In 1992 was realized catch of 165 t. Last relatively high catch amount of 141.6 t was reported in 2003. Upon 1993 the amounts of catches suddenly dropped particularly in 1994-1999 period, when the landings fluctuated from 30 t in 1999 to 80 t in 1994. The last investigated years are characterized by a trend of considerable increase of horse mackerel catches. Comparison with 2007 substantially increase (round about 55%) was reported in catches of horse mackerel, which is the amount was 179.8 t for 2008 (data source -official statistics of the National Agency of Fisheries and Aquaculture). The data set of landings was compiled for the period 1992 – 2011 (Table 6.4.2.3.1.1).

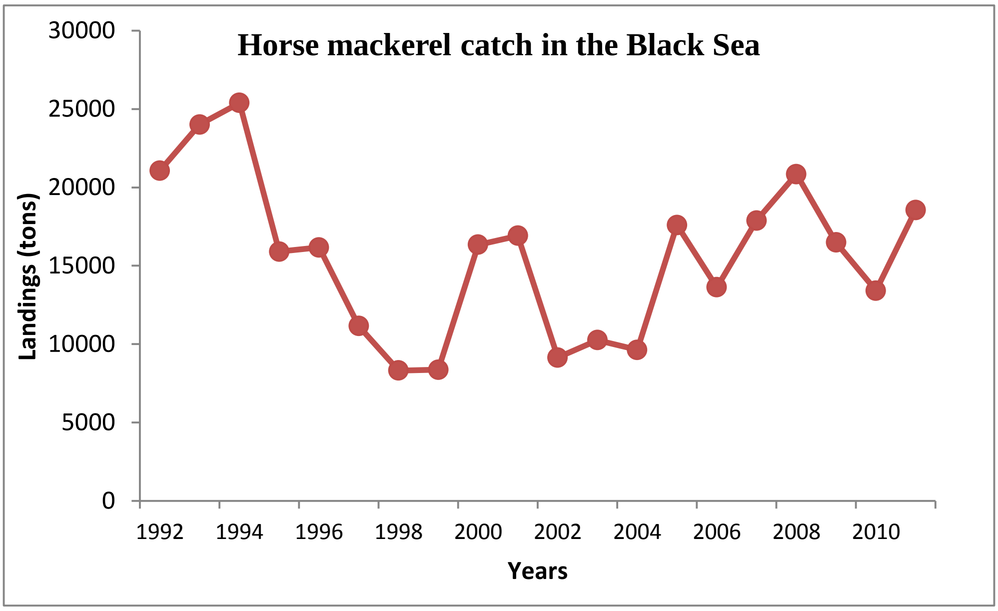
Table 6.4.2.3.1.1. Horse mackerel landings by countries (FAO Fisheries Statistics, GFCM Capture Production 1992 – 2006, 2007 – 2011 from National Fisheries Statistics of countries).

Year	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine	Total
1992	54	0	22	0	20989	0	21065.00
1993	31	0	30	0	23945	0	24006.00
1994	80	0	35	1	25275	1	25392.00
1995	70	0	24	1	15809	2	15906.00

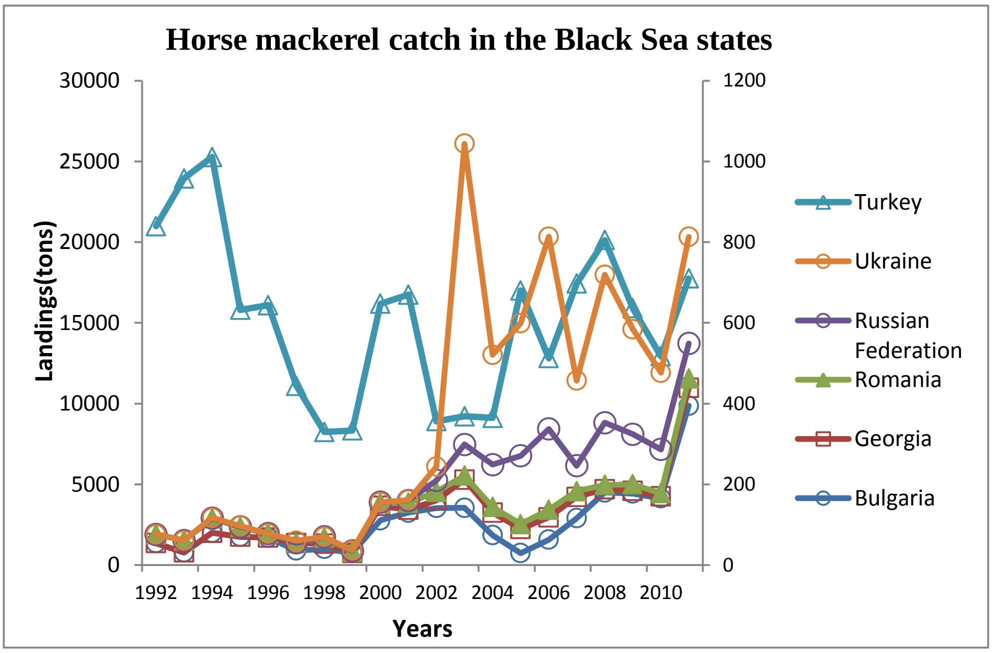
1996	68	0	10	0	16093	0	16171.00
1997	36	18	1	0	11097	5	11157.00
1998	40	13	15	2	8246	0	8316.00
1999	30	0	3	2	8331	1	8367.20
2000	111	35	8	2	16181	0	16336.80
2001	130	7	17	6	16750	1	16911.00
2002	141.5	19	21	28	8903	34	9146.50
2003	141.6	70	10	77	9213	745	10256.60
2004	73.9	56	14	105	9113	272	9633.90
2005	29.4	60	12	169	17003	329	17602.40
2006	62.834	55	19	200.5	12812	476	13625.33
2007	115.88	53	14	63.2	17429	211	17886.08
2008	179.607	8	11	154.24	20124	366	20842.85
2009	176.91	6*	17	124.04	15905	260	16489.06
2010	165.27	5*	7	108.86	12929	190	13405.50
2011	394.84	44	22.820	87.21	17746	264	18558.87

* expert assessments

In 1992 was achieved a catch of 21065 t. Upon 1994 the amounts of catches decreased especially in 1998-1999 period. In 2008 considerably increase in catches of horse mackerel was reported, at the level of 20842.85 t (Figure 6.4.2.3.1.1A).



A.



B.

Figure 6.4.2.3.1.1 Trend in total (A) and by countries (B) horse mackerel landings in the Black Sea.

6.4.2.3.2 Discards

No discards have been reported for the horse mackerel fishery.

6.4.2.4 Fishing effort

No information has been tabled during the EWG 12-16 meeting

6.4.2.5 Commercial CPUE

Table 6.4.2.5.1. CPUE kg/h of horse mackerel by fishing gears in Bulgaria, 2008-2011.

Mediterranean horse mackerel HMM			**2008**	**2009**	**2010**	**2011**
	FPO	LOA>0<6	344.98	101.56	51.22	123.92
		LOA=>6<12	130.4	97.62	77.67	40.96
		LOA=>12<18	209.73	43.33	-	-
	OTM	LOA=>6<12	149.8	95.54	105.28	50.28
		LOA=>12<18	273.78	112.44	202.42	240.01
		LOA=>18<24	456.47	294.84	321.25	272.91
		LOA=>24<40	268.4	279.61	293.23	1121.39

Legend: FPO –Pound nets/Pots; OTM – Midwater otter trawl; LOA – Length overall of the fishing vessels.

Table 6.4.2.5.2. Average CPUE $kg*h^{-1}$ of horse mackerel in Bulgaria, 2008-2009.

Fleet Segment	LOA>0<6		LOA=>6<12		LOA=>12<18		LOA=>18<24		LOA=>24<40	
Average CPUE	**2008**	**2009**	**2008**	**2009**	**2008**	**2009**	**2008**	**2009**	**2008**	**2009**
Mediterranean horse mackerel HMM	94.74	36.98	92.99	49.12	258.88	65.02	458.73	308.69	262.79	282.17

6.4.3 Scientific Surveys

No specific fisheries independent scientific surveys have been conducted.

6.4.4 Assessment of historic parameters

6.4.4.1 Input parameters

Table 6.4.4.1.1. Data availability by countries.

Type of data	Turkey	Romania	Bulgaria	Ukraine	Comment
Catch (monthly, quarterly, yearly)	yes	yes, monthly, 2006-2008	the end year 2008	the end year 2010	
IUU catches	only can be estimated	no	the end year 2008	no	expert est.: low level (not more then 10-15%)
Fishing gears	yes	yes	the end year 2008	yes	trawls (by-catch), lift cone-shaped nets with electric light attraction, pound nets
Fishing seasons	yes	yes	the end year 2008	yes	trawls: November-March; Lift cone-shaped nets: December-February; Pound nets: June-September
Fishing areas	yes	yes	the end year 2008	yes	trawls & lift cone-shaped nets: Crimean waters; pound nets: Crimean & NW of Black Sea coastal waters, Crimean of Azov Sea coastal waters
Fishing and natural mortality estimations	yes	yes	no	2004-2009	
Mean individual weights	yes	yes	the end year 2008	2011	2003-2008
Catch-at-age	yes	yes		2004-2011	
Length and weight at age	yes	yes	yes	2011	
CPUE from commercial yield and surveys	indirectly		no	no	
Migration routes (spawning,fattening, wintering grounds)	indirectly	yes	yes	yes	
Existing fishery regulations in country	yes	yes	yes	yes	
Existing analyses for 1950-2009	some years; 1990-1993	yes	yes	yes	in Turkey they are some poulation parametrs diffrent yeras, diffrent area and institution

Catch at age

Table 6.4.4.1.2. Aggregated catch at age in number 10^{-3} of Bulgaria, Georgia, Romania, Russia, Turkey and Ukraine.

Age Year	0	1	2	3	4	5	6
2004	4004	8496.3	23719.55	348640.9	486.8653	170.3481	20.41601
2005	24623.8	442576.7	504480.7	115439.6	15402.4	2078.61	54.25074
2006	7149.718	274253.2	378853.8	64652.91	19545.35	2295.039	554.5081
2007	596.9276	631119.2	363755.2	59751.05	5692.716	2740.416	0
2008	6601,745	187904.2	551534.8	231373.6	27245.18	2556.786	26.64733
2009	3910.733	395249.7	420001.4	88190.1	35478.36	5780.068	998.3546
2010	28037.68	300250.7	334447.1	129098	57226.42	18832.02	6057.423
2011	29325.4	715934	272265	134564	23781.8	7464.85	3072.33

Weight at age in the catch

Table 6.4.4.1.3 Weight at age in the catch (in g).

Age Year	0	1	2	3	4	5	6	Mean
2004	8.61	12.51	14.15	25.86	30.58	39.46	43.41	24.99
2005	4.24	13.23	20.62	29.72	38.62	45.84	43.56	15.93
2006	4.94	14.28	21.30	31.79	42.23	51.82	57.20	18.23
2007	9.66	14.70	20.10	29.19	36.97	42.72		16.82
2008	4.79	12.66	23.07	30.28	39.00	50.90	41.25	20.69
2009	5.19	13.01	20.69	30.22	42.54	50.12	67.44	17.36
2010	4.37	10.05	21.85	28.46	31.43	36.81	63.36	15.34
2011	5.42	13.01	24.79	37.88	51.42	65.63	73.17	15.64

Table 6.4.4.1.4 Horse mackerel maturity at age.

Age Year	0	1	2	3	4	5	6
2004	0	0.8	1	1	1	1	1
2005	0	0.8	1	1	1	1	1
2006	0	0.8	1	1	1	1	1
2007	0	0.8	1	1	1	1	1
2008	0	0.8	1	1	1	1	1
2009	0	0.8	1	1	1	1	1
2010	0	0.8	1	1	1	1	1
2011	0	0.8	1	1	1	1	1

A new tuning series from a commercial CPUE from Bulgaria (Table 6.4.4.1.5), was made available for this meeting and has been used to tune an XSA model.

Table 6.4.4.1.5 Tuning fleet data from Bulgarian commercial CPUE.

Age Year	0	1	2	3	4	5
2009	394.332	3656.533	4463.121	3082.959	2599.006	824.5124
2010	1018.096	2923.245	1790.908	2513.319	2452.838	1118.897
2011	979.2468	4194.011	5527.591	2570.523	1597.719	141.7331

Table 6.4.4.1.6 Natural Mortality matrix for Horse Mackrel in Black Sea.

Age Year	0	1	2	3	4	5	6
2004	0.4	0.4	0.4	0.4	0.4	0.4	0.4
2005	0.4	0.4	0.4	0.4	0.4	0.4	0.4
2006	0.4	0.4	0.4	0.4	0.4	0.4	0.4
2007	0.4	0.4	0.4	0.4	0.4	0.4	0.4
2008	0.4	0.4	0.4	0.4	0.4	0.4	0.4
2009	0.4	0.4	0.4	0.4	0.4	0.4	0.4
2010	0.4	0.4	0.4	0.4	0.4	0.4	0.4
2011	0.4	0.4	0.4	0.4	0.4	0.4	0.4

6.4.4.2 Method 1: XSA

6.4.4.2.1 Justification

The EWG 12-16 was able to only conduct a separable VPA. Given the availability of a new tuning fleet of commercial CPUE from Bulgaria for years 2008-2011 an XSA (in FLR) was attempted.

6.4.4.2.2 Input data

Input data have been described in previous sections and are the same for the XSA and separable VPA. A first step taken before the XSA was to correct the catch at age data to the official landings (SOP corrections) since there where clear discrepancies. This imlies that results from EWG 11-16 can’t be entirely compared with these ones since the input data slightly changed.

An average natural mortality (M) of 0.4 is applied in all ages and years.

The XSA was tuned with the series of CPUE from Bulgaria, ages 1-6+ over the period 2004-2011.

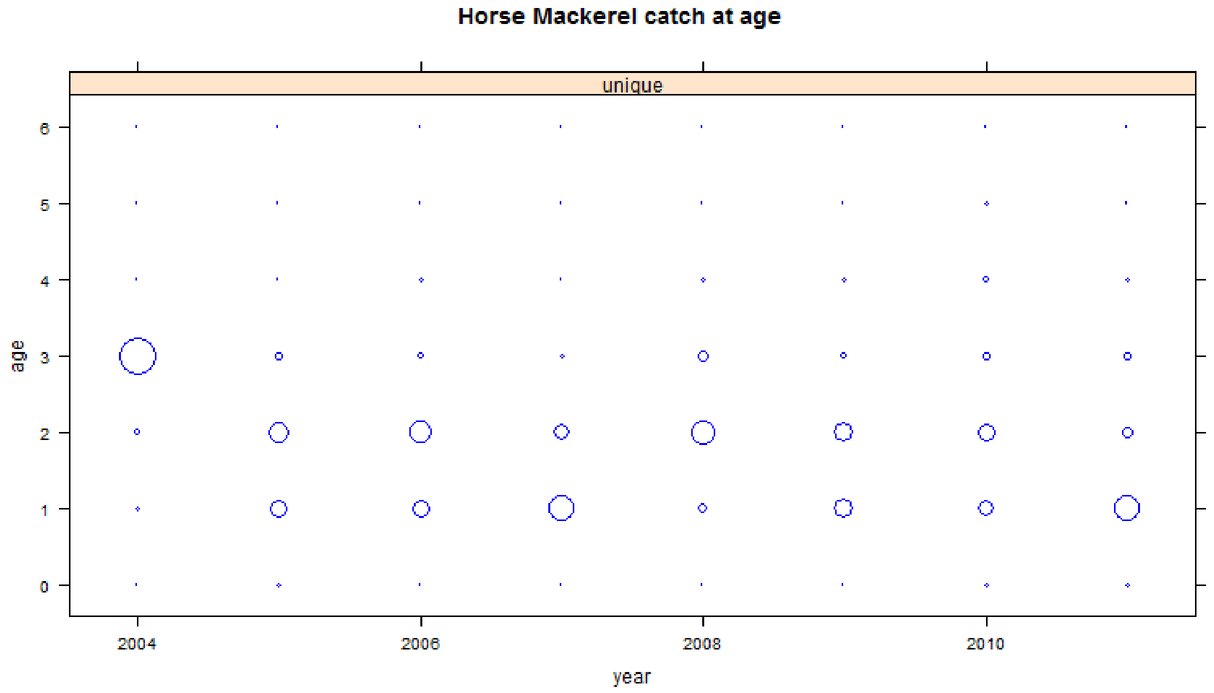


Fig. 6.4.4.2.2.1 Horse mackerel catch at age in the Black Sea.

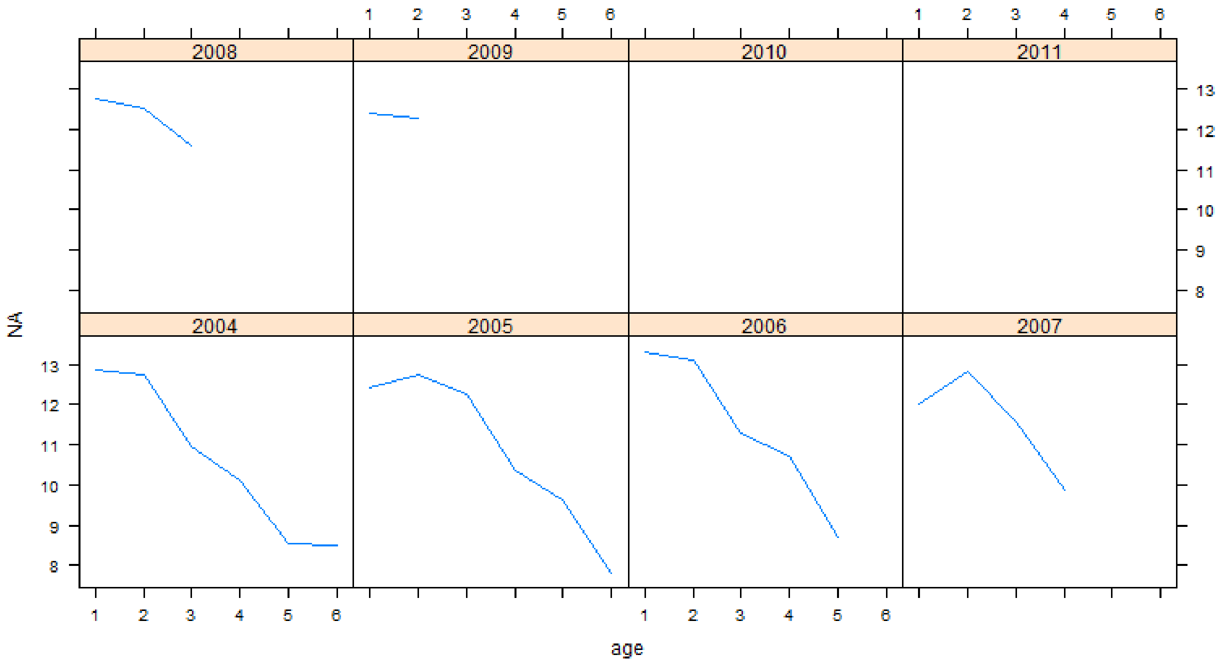


Fig. 6.4.4.2.2.2 Cohorts for age 1-6 by year from catch numbers at age.

6.4.4.2.3 Results

3 different XSA where run with varying settings for the shrinkage in the fishing mortality standard error for 2 years and age 2 as follows in R code:

```
FLXSA.control.hke <- FLXSA.control(x=NULL, tol=1e-09, maxit=30, min.nse=0.3, fse=0.5, rage=1, qage=6, shk.n=TRUE, shk.f=TRUE, shk.yrs=2, shk.ages=2, window=100, tsrange=20, tspower=3, vpa=FALSE)
```

```
FLXSA.control.hke1 <- FLXSA.control(x=NULL, tol=1e-09, maxit=30, min.nse=0.3, fse=1.0, rage=1, qage=6, shk.n=TRUE, shk.f=TRUE, shk.yrs=2, shk.ages=2,window=100, tsrange=20, tspower=3, vpa=FALSE)

FLXSA.control.hke2 <- FLXSA.control(x=NULL, tol=1e-09, maxit=30, min.nse=0.3, fse=2.0, rage=1, qage=6, shk.n=TRUE, shk.f=TRUE, shk.yrs=2, shk.ages=2, window=100, tsrange=20, tspower=3, vpa=FALSE)
```

The EWG 12-16 accomplished analysis of residuals of Bulgarian tuning series for different shrinkage settings Fig. 6.4.4.2.3.1-6.4.4.2.3.3. The residuals with intermediate shrinkage seem the best ones Fig. 6.4.4.2.3.2.

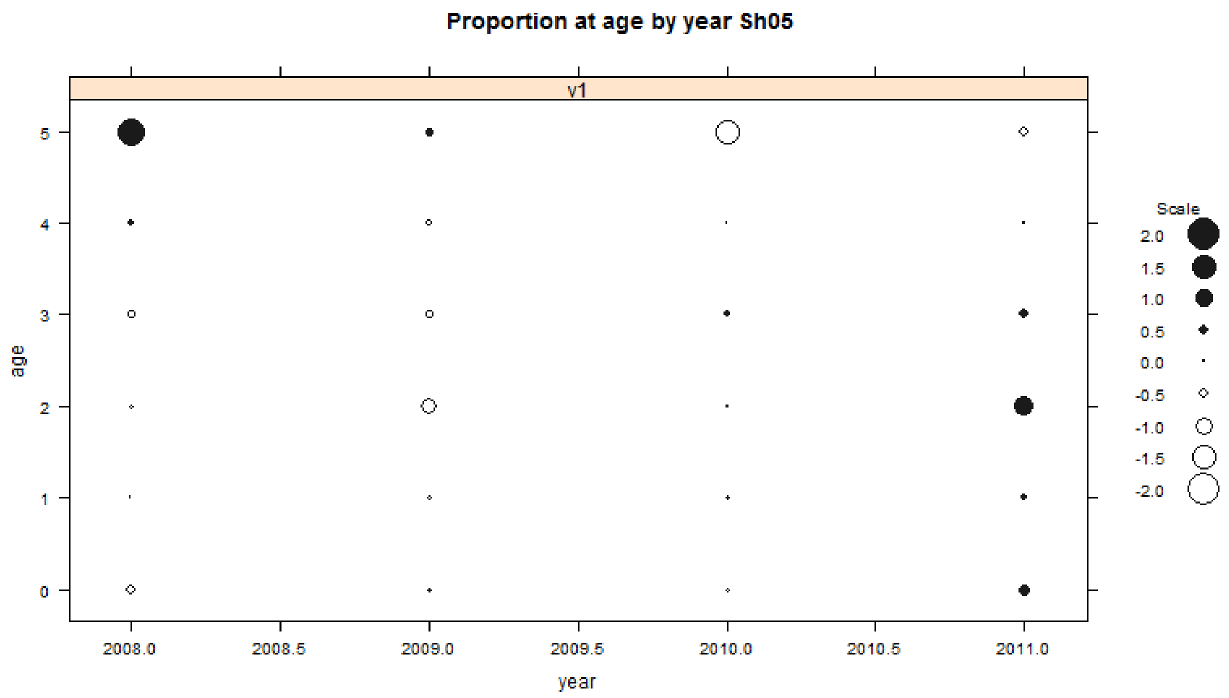


Fig. 6.4.4.2.3.1 Residuals of tuning series applying a shrinkage of 0.5.

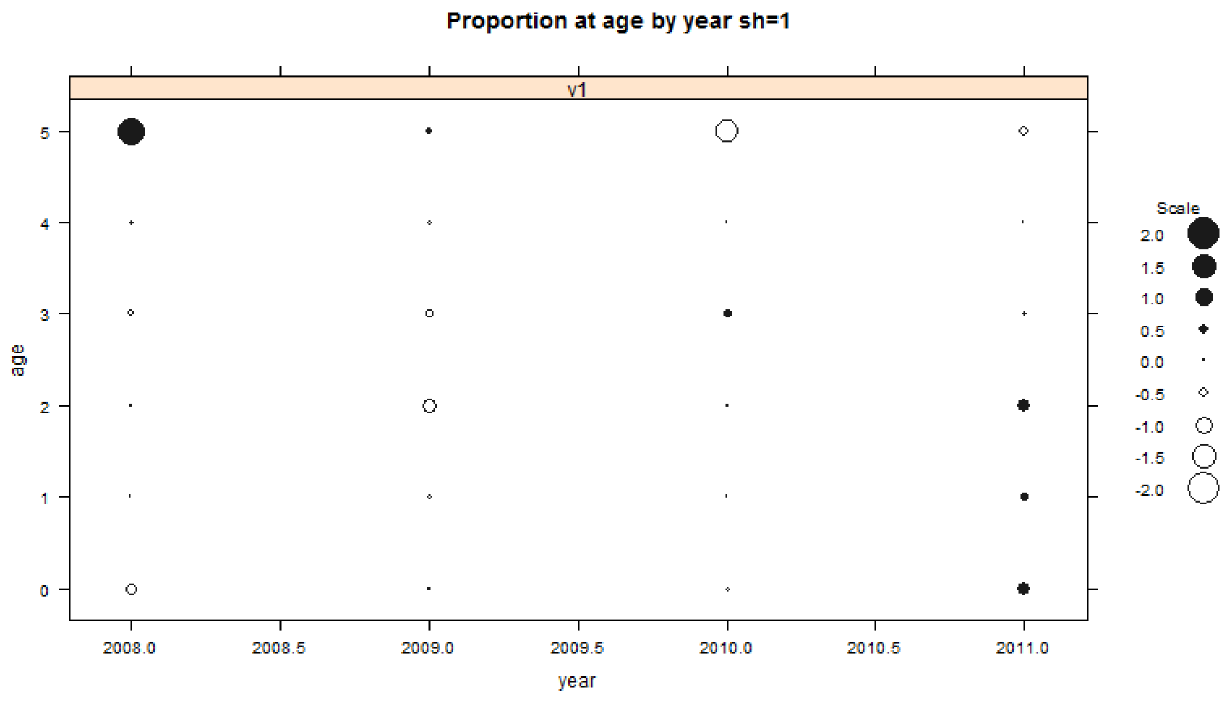


Fig. 6.4.4.2.3.2 Residuals of tuning series applying a shrinkage of 1.0.

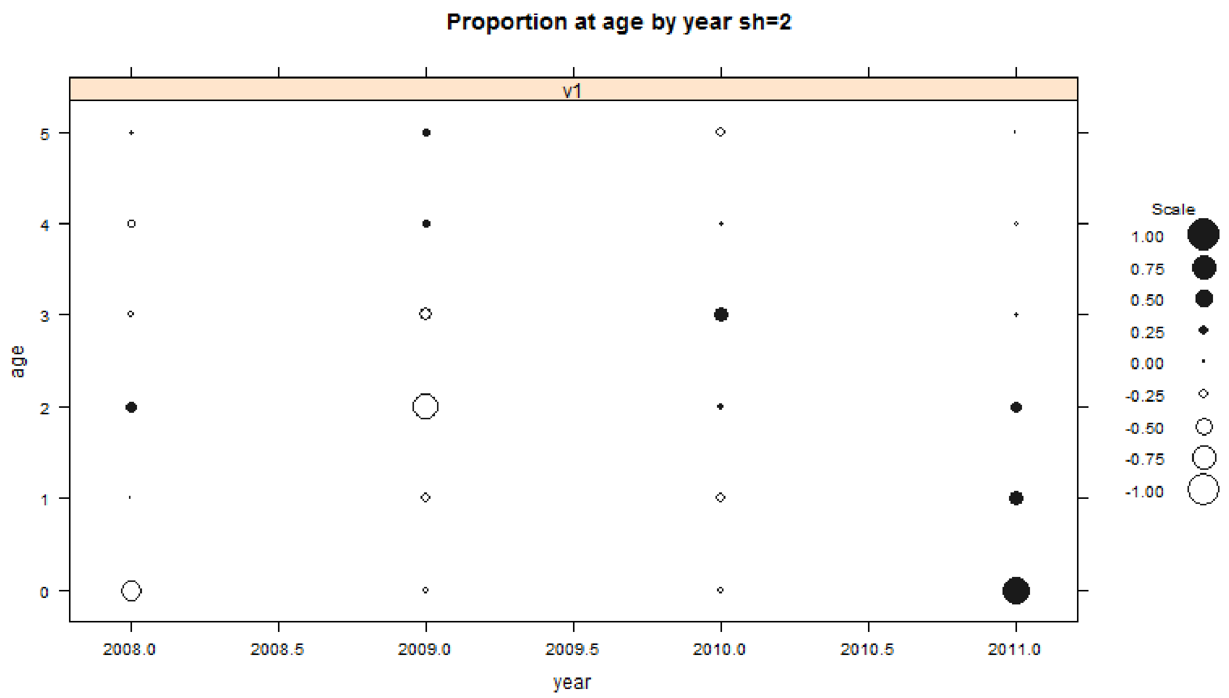


Fig. 6.4.4.2.3.3. Residuals of tuning series applying a shrinkage of 2.0.

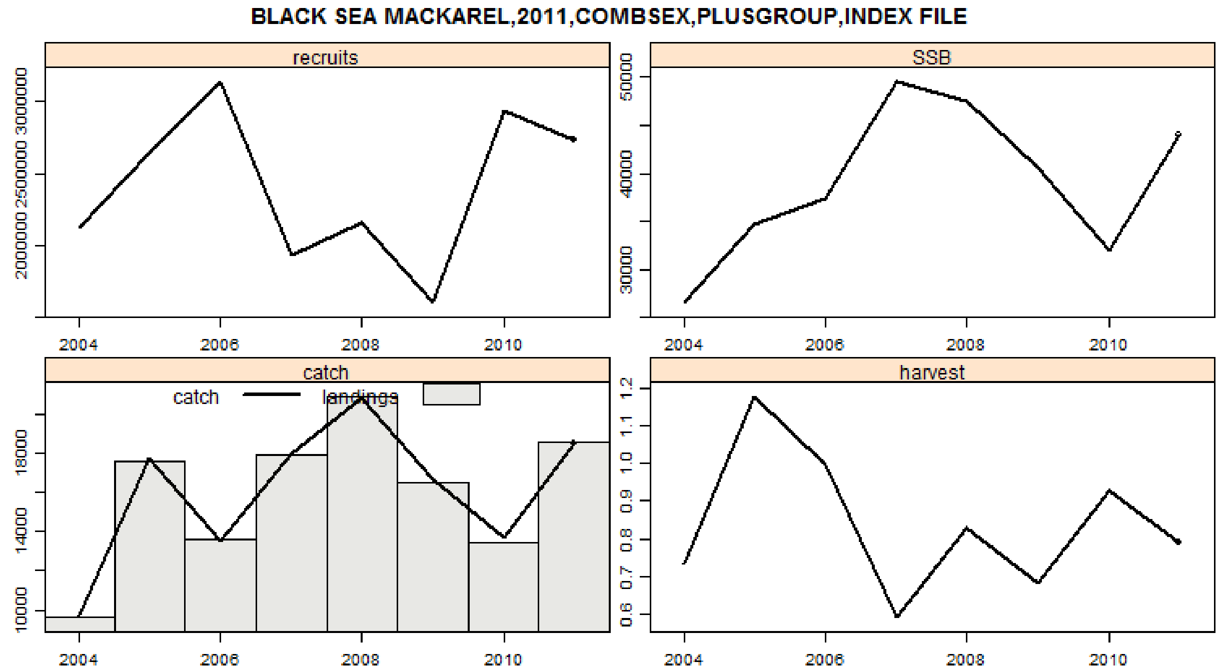


Fig. 6.4.4.2.3.4 Summary of trends in stock parameters of Horse mackerel in the Black Sea with a shrinkage of 0.5.

EWG 12-16 performed a sensitivity analysis for different shrinkage settings, results are presented in figures 6.4.4.2.3.5-6.4.4.2.3.7. Low shrinkage returns lower estimates of spawning biomass and higher Fbar when to bring into comparison of different XSAs.

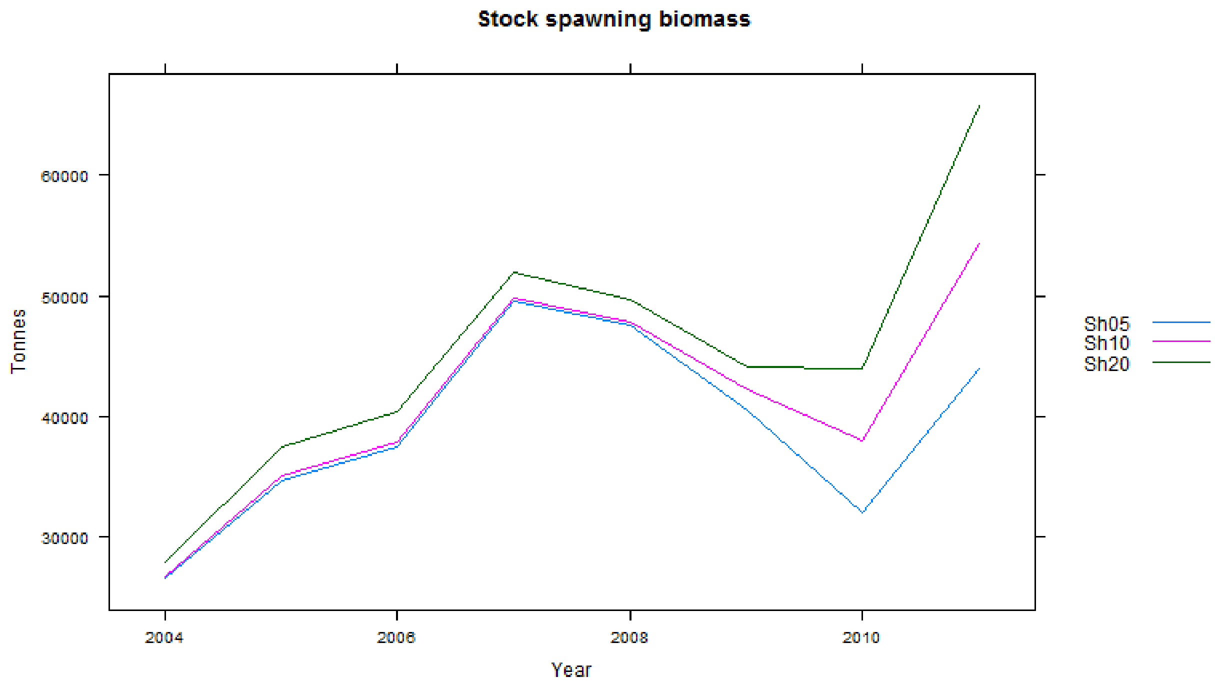


Fig. 6.4.4.2.3.5 Sensitivity analysis on Stock spawning biomass for different levels of shrinkage.

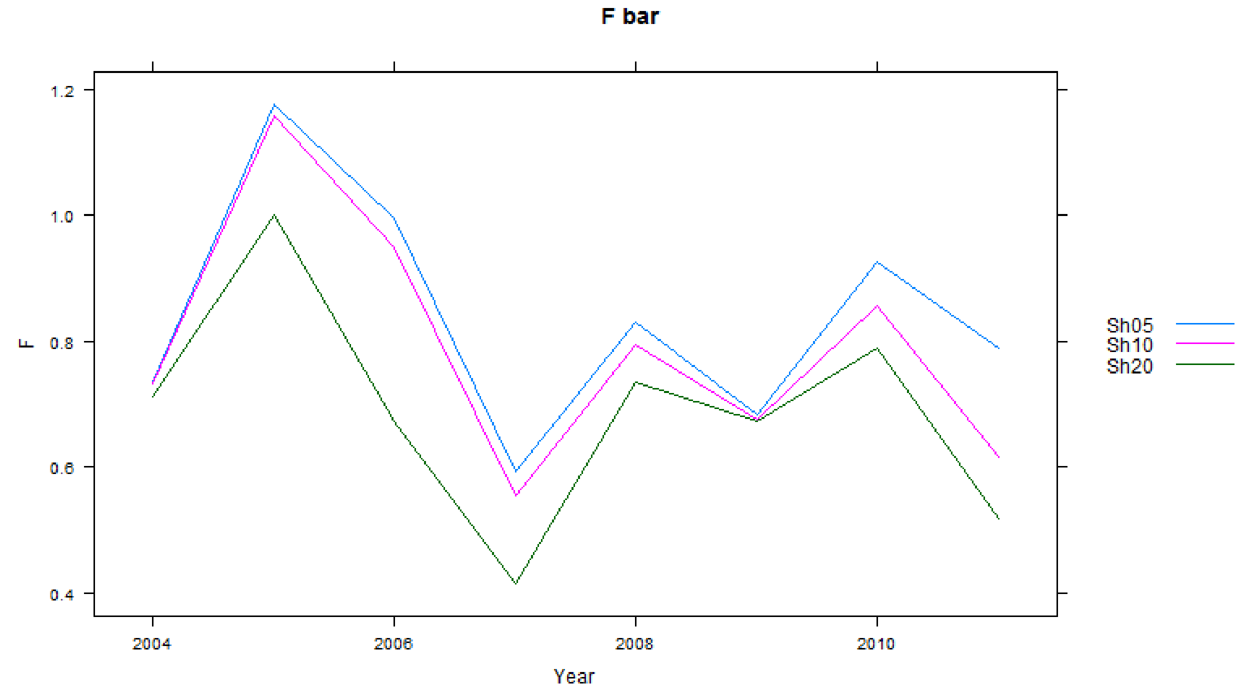


Fig. 6.4.4.2.3.6 Sensitivity analysis on Fbar (Ages 1-3) for different levels of shrinkage.

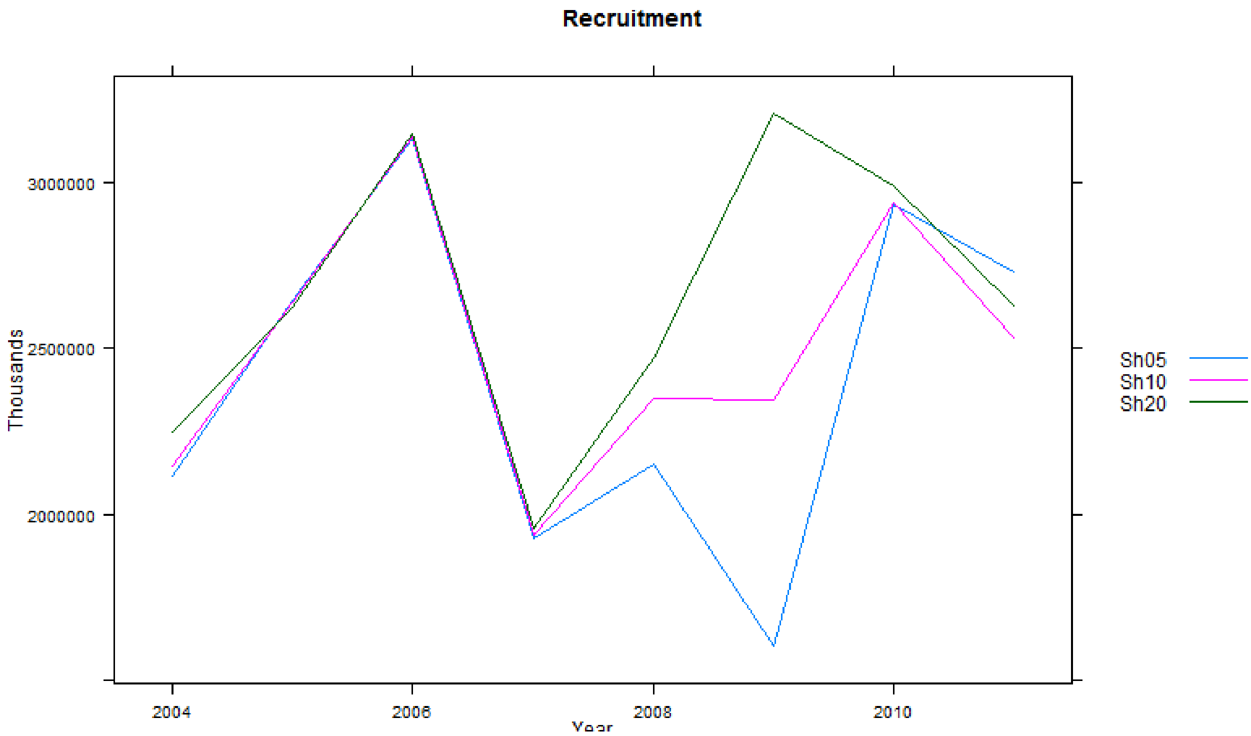


Fig. 6.4.4.2.3.7 Sensitivity analysis on Recruitment for different levels of shrinkage.

Retrospective Analysis

The STECF EWG 12-16 applied the Extended Survivors Analysis (XSA) under FLR and the technique "shrinkage to the mean" for assessing the stock of Horse mackerel over the period 2004-2011. The tuning of XSA is defined according to the default settings of the program.

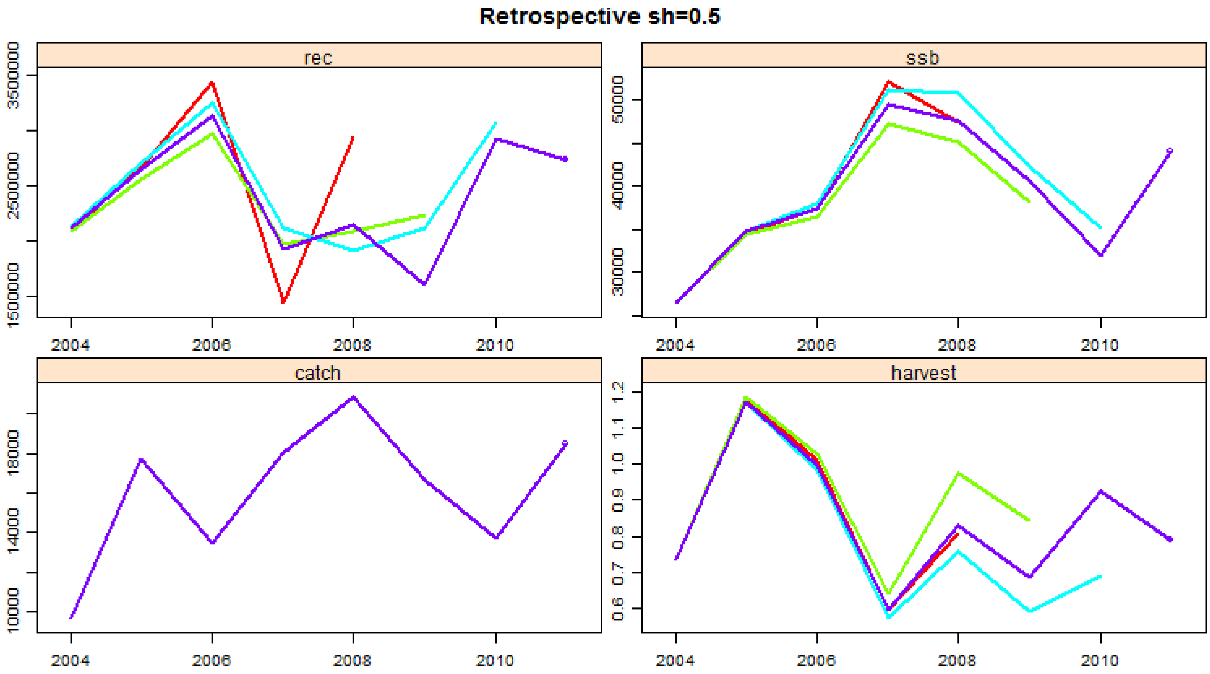


Figure 6.4.4.2.3.8 Retrospective trends of the assessment parameters (average over ages 1-3), recruitment, SSB, catch and harvest for shrinkage 0.5.

Fig. 6.4.4.2.3.9 Retrospective trends of the assessment parameters (average over ages 1-3), recruitment, SSB, catch and harvest for shrinkage=1.

Fig. 6.4.4.2.3.10 Retrospective trends of the assessment parameters (average over ages 1-3), recruitment, SSB, catch and harvest for shrinkage=2.

EWG 12-16 deemed the result of XSA not reliable because of retrospective patterns been unsatisfactory and residual patterns and mainly because the tuning fleet from commercial CPUE from Bulgaria is not considered reliable and is inappropriate for tuning the bulck of the catches coming from the Turkish series. The XSA analysis is therefore not retained by EW12-16 and a recommendation for the future is the avaialability of an appropriate tuning fleet from scientific survey.

6.4.4.3 Method 2: Separable VPA with varying terminal Fs (0.4, 0.8 and 1.2)

6.4.4.3.1 Justification

The EWG 112-16 found out that data available in different national databases would allow performing a quantitative assessment of this stock. Data from the Turkish fisheries (~95% of the catch) will be very important but horse mackerel fisheries are quite important for rest of the Black Sea countries especially when the stock is high that assures a regular strong migration in the northern Black Sea. Fisheries and biological (age and individual size and growth) and survey data (acoustics, juveniles, and egg-production) from all countries need to be thoroughly compiled.

At the first stage data must be carefully screened and organised into age structured matrices. Age structured assessment methods such as VPA (XSA) and ICA than can be applied similar to sprat and turbot.

The lack of any reliable tuning series to estimate terminal fishing mortalies in 2011, the EWG 12-16 (similarly to EWG 11-16) decided to run 3 versions of separable VPAs with F=0.4, F=0.8 and F=1.2 as arbitrary inputs, respectively. This range has been chosen after a review of the results obtained from the Jones method (Table 6.4.4.3.1.1).

All the input parameters used for the separable VPA are the same, with the exception of the tuning fleet, to those used for the XSA and described above.

6.4.4.3.2 Results

The following results are derived from the separable VPA based on a terminal F=0.4.

Separable VPA

ctrl <- FLSepVPA.control(sep.nyr=7,sep.age=3,sep.sel=1)

hma.stk.svpa <- SepVPA(hma.stk,ctrl,fit.plusgroup=TRUE, ref.harvest=0.4)

hma.stk.svpa1 <- SepVPA(hma.stk,ctrl,fit.plusgroup=TRUE, ref.harvest=0.8)

hma.stk.svpa2 <- SepVPA(hma.stk,ctrl,fit.plusgroup=TRUE, ref.harvest=1.2)

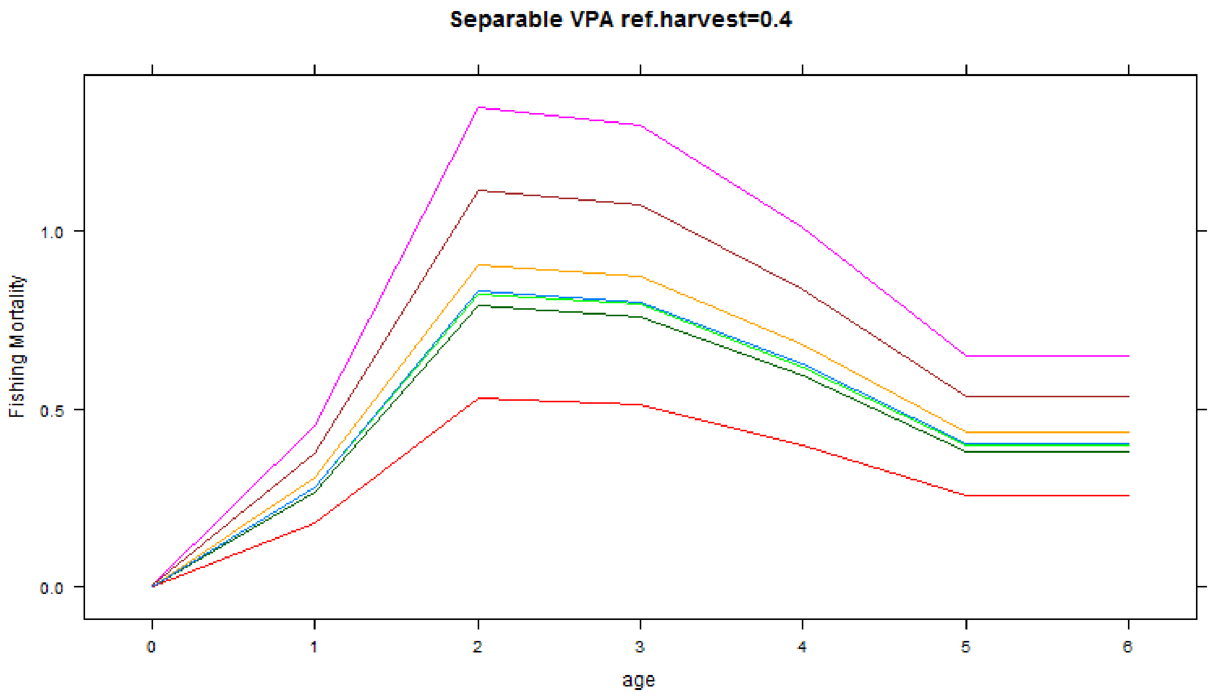


Fig. 6.4.4.3.2.1 Selection patterns as derived from the separable VPA with F terminal of 0.4.

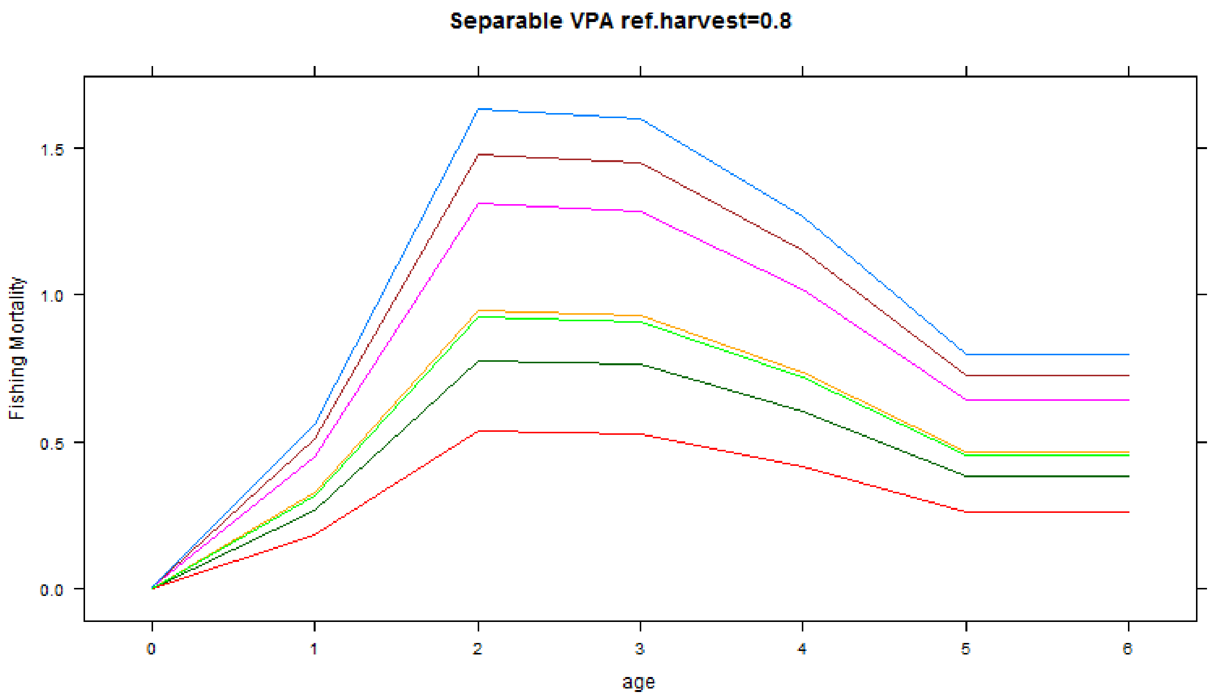


Fig. 6.4.4.3.2.2 Selection patterns as derived from the separable VPA with F terminal of 0.8.

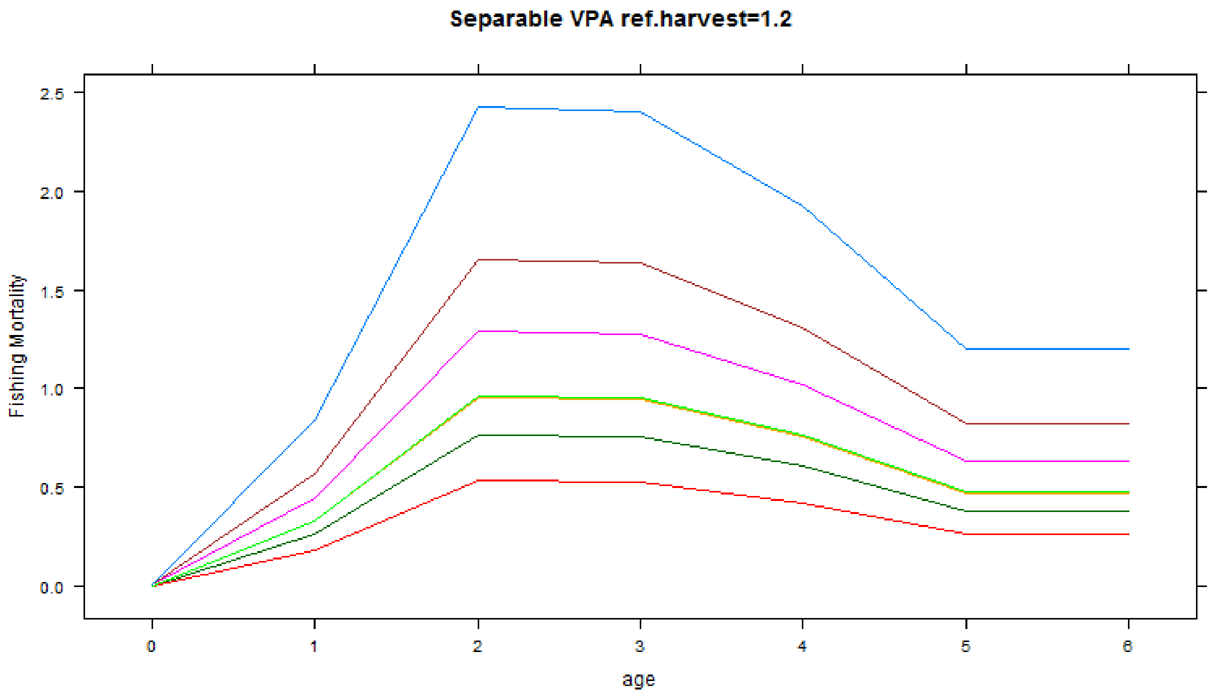


Fig. 6.4.4.3.2.3 Selection patterns as derived from the separable VPA with F terminal of 1.2.

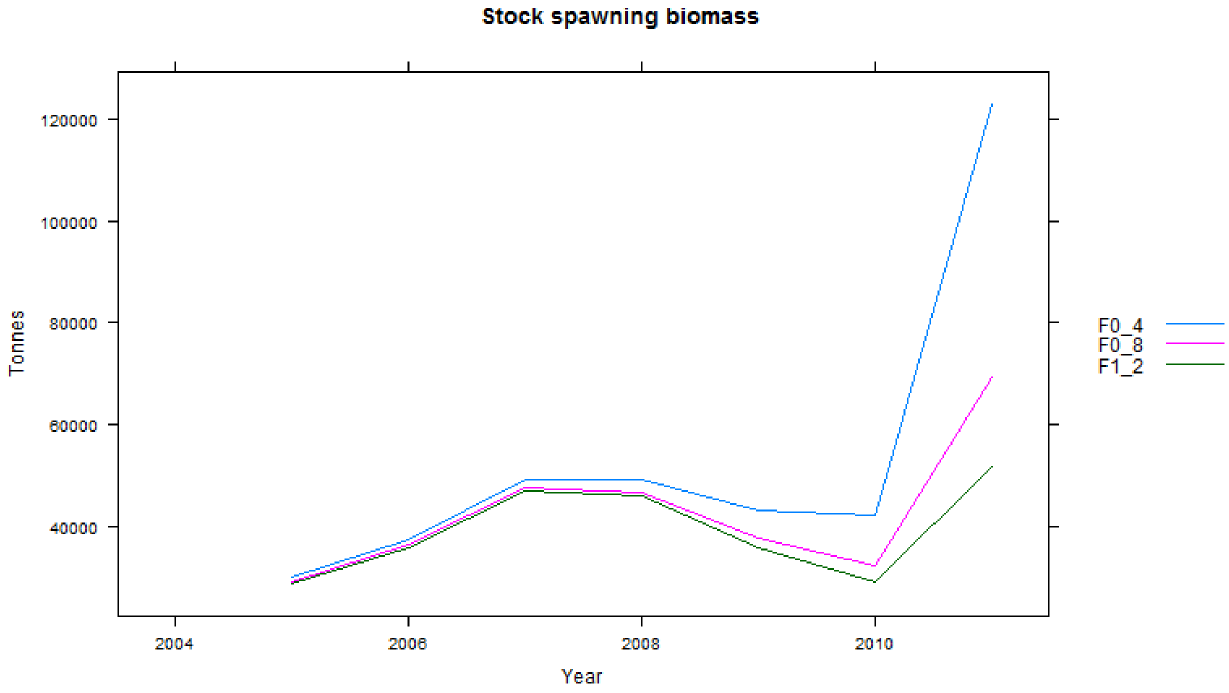


Fig. 6.4.4.3.2.4 Sensitivity analisys of the effect of tunning series over SSB with 3 levels of F terminal.

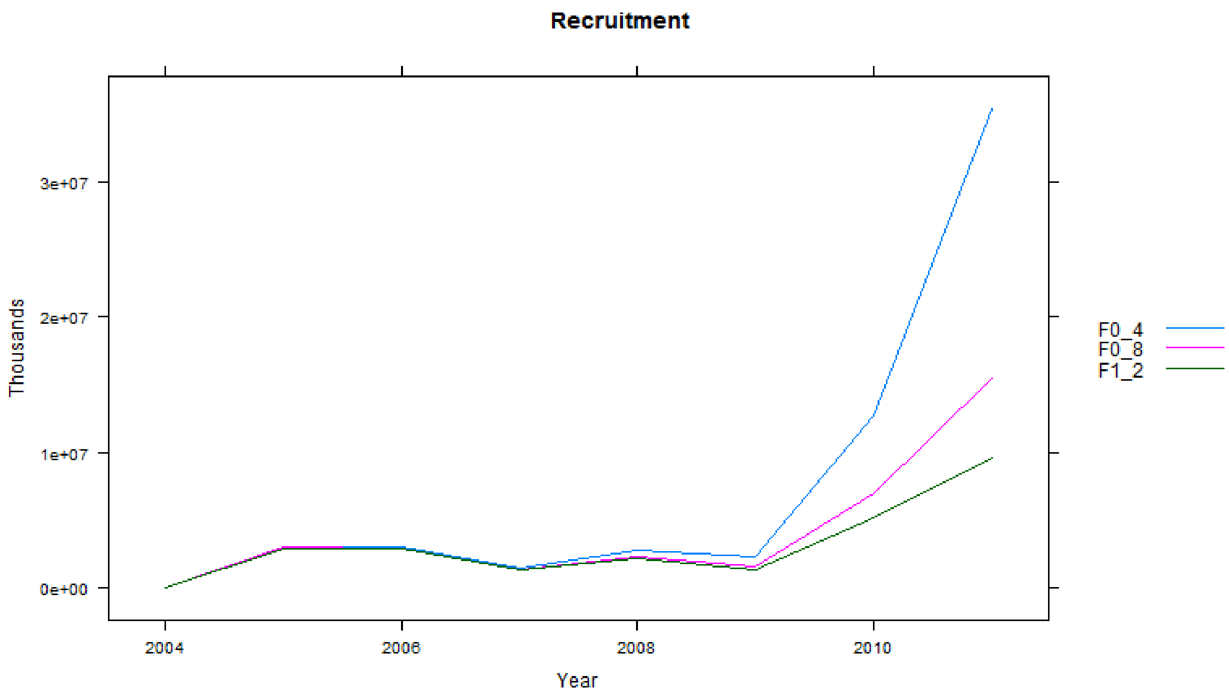


Fig. 6.4.4.3.2.5 Sensitivity analisys of the effect of tunning series over recruitment with 3 levels of F terminal.

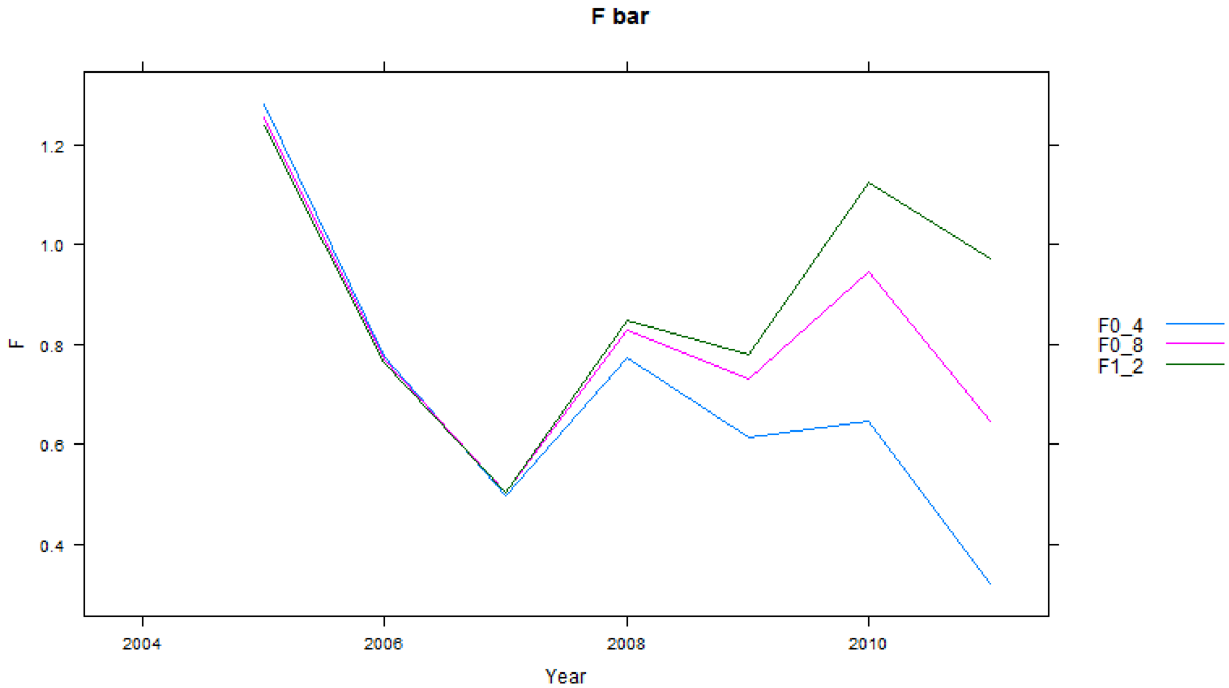


Fig. 6.4.4.3.2.6 Sensitivity analisys of the effect of tunning series over F with 3 levels of F terminal.

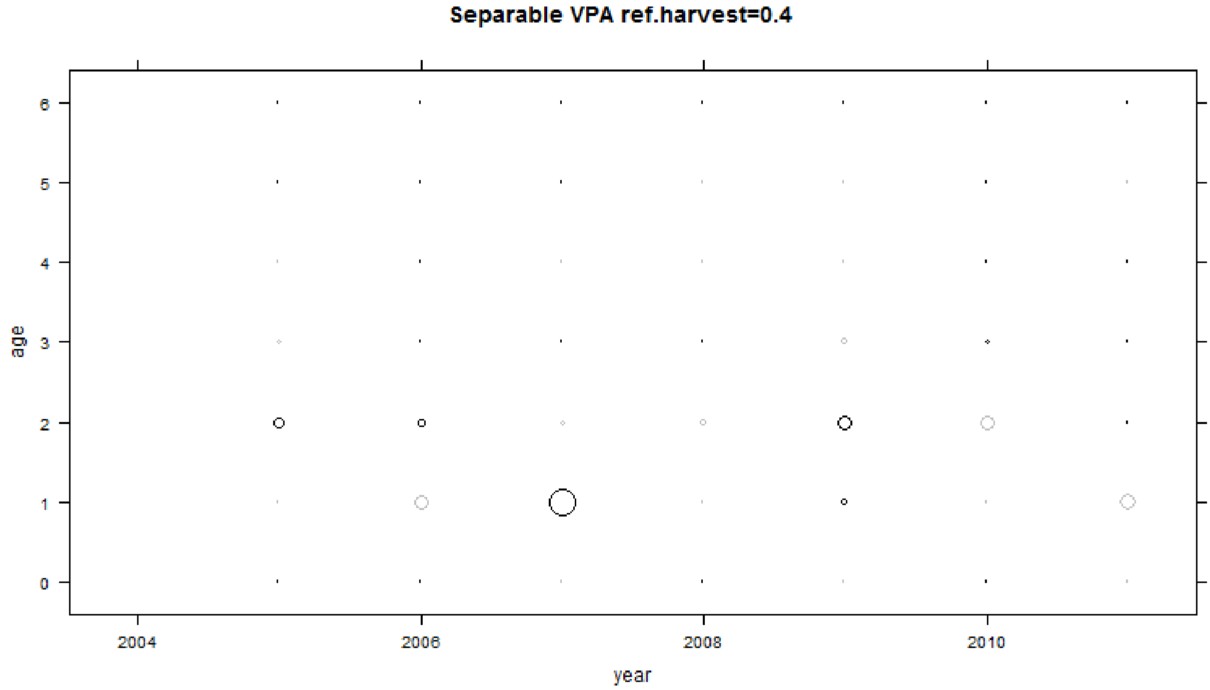


Fig. 6.4.4.3.2.7 Residuals in estimated fishing mortalies with F terminal of 0.4.

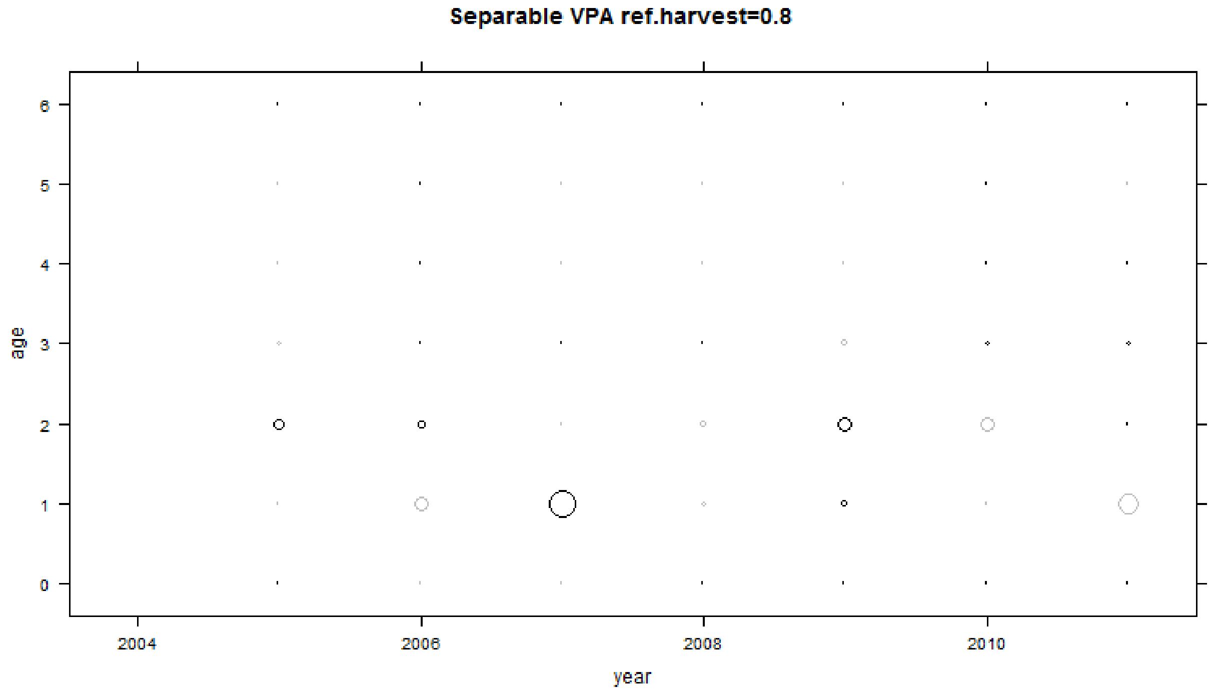


Fig. 6.4.4.3.2.8 Residuals in estimated fishing mortalies with F terminal of 0.8.

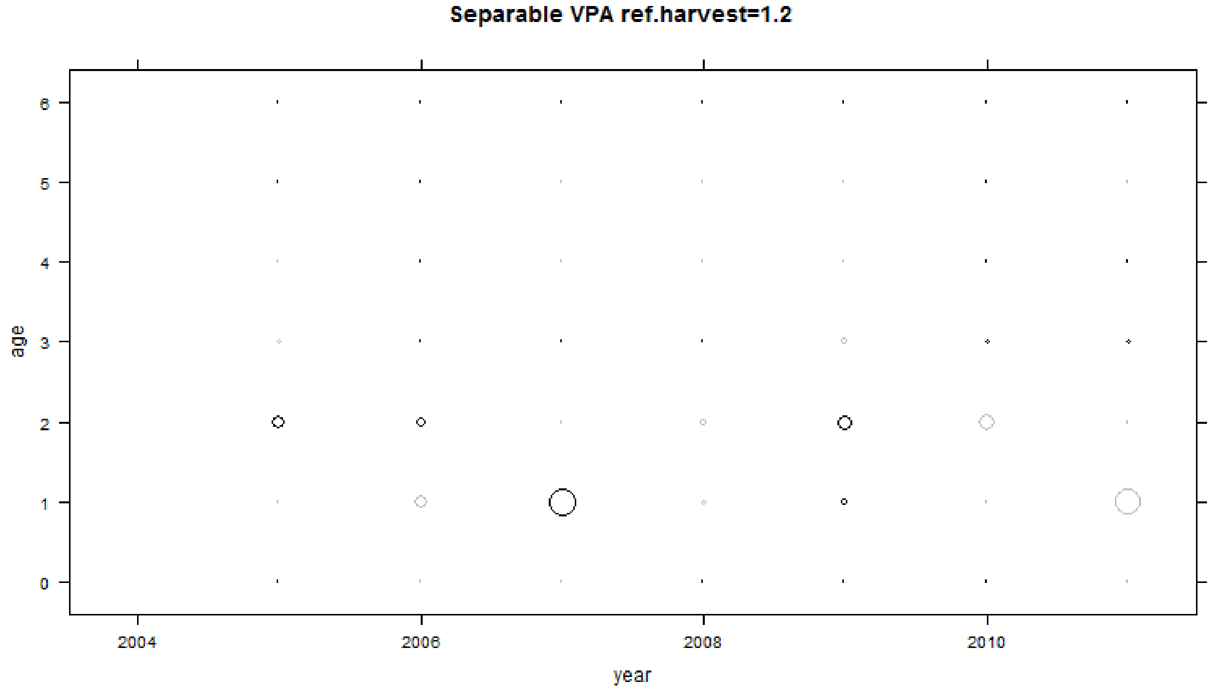


Fig. 6.4.4.3.2.9 Residuals in estimated fishing mortalies with F terminal of 1.2.

6.4.5 Short term prediction of stock biomass and catch

The current state of the assessment does not allow any reliable formulation of a short term prediction of stock size and biomass under various management scenarios.

6.4.6 *Medium term prediction of stock biomass and catch*

The current state of the assessment does not allow any reliable formulation of a medium term prediction of stock size and biomass under various management scenarios.

6.4.7 *Long term predictions*

The current state of the assessment does not allow any reliable formulation of a long term prediction of stock size and biomass to conclude on biological reference points consistent with high long term yields.

6.4.8 *Scientific advice*

The lack of a fishery independent scientific survey to monitor horse mackerel all over the Black Sea to indicate trends in total mortality and recruitment appears the major data deficiency in the assessment. EWG 12-16 recommends such survey to be established.

6.4.8.1 Short term considerations

State of the spawning stock size:

The assessment is considered only indicative of relative stock trends. All three assessment formulations indicate that the SSB in 2011 is increasing from previous year. In the absence of total stock size estimates and biological reference points, EWG 12-16 is unable to fully evaluate the stock size with regard to the precautionary approach.

State of recruitment:

Recruitment is indicated to have varied but the levels in the last years are the highest in the short series available.

State of exploitation:

Given the current state of the assessment of horse mackerel in the Black Sea, EWG 12-16 is unable to provide a biological reference point consistent with high long term yield nor to quantify the expoitation rate. Based on the assessment results the exploitation rate appears to have varied since 2004 without a clear trend. In the absence of a biological reference points, EWG 12-16 is unable to fully evaluate the exploitation state with regard to the precautionary approach.

6.4.8.2 Medium term considerations

Given the current state of the assessment of horse mackerel in the Black Sea, EWG 12-16 is unable to provide advice for the medium term future.

6.5 Anchovy in the Black Sea

6.5.1 Biological features

6.5.1.1 Stock Identification

Achovy *Engraulis encrasicolus* populations has been represented by two 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.

The Black Sea stock has higher ecological and commercial importance and the information bellow concerns only this stock which will be further called Black sea anchovy.

Black sea anchovy is distributed in the whole Black Sea – Fig. 6.5.1.1.1. In October-November it migrates to the wintering grounds along the Anatolian and Caucasian coasts in southern Black Sea. In these areas it forms dense wintering concentrations in November-March which are subject to intensive commercial fishery. In the rest of the year it occupies its usual spawning and feeding habitats across the sea with some preference to the shelf areas and the northwestern part of the sea– characterized by the largest shelf area and high productivity due to abundant river run-off (Faschuk *et al*. 1995, Daskalov, 1999). But according to the studies carried out in the southern Black Sea (Turkey's EEZ) anchovy has also spawn in that area (Fig. 6.5.1.1.2) (Niermann et al. 1994). It also may be affected from the climatic changes and other ecological impacts in the last 3 decades.

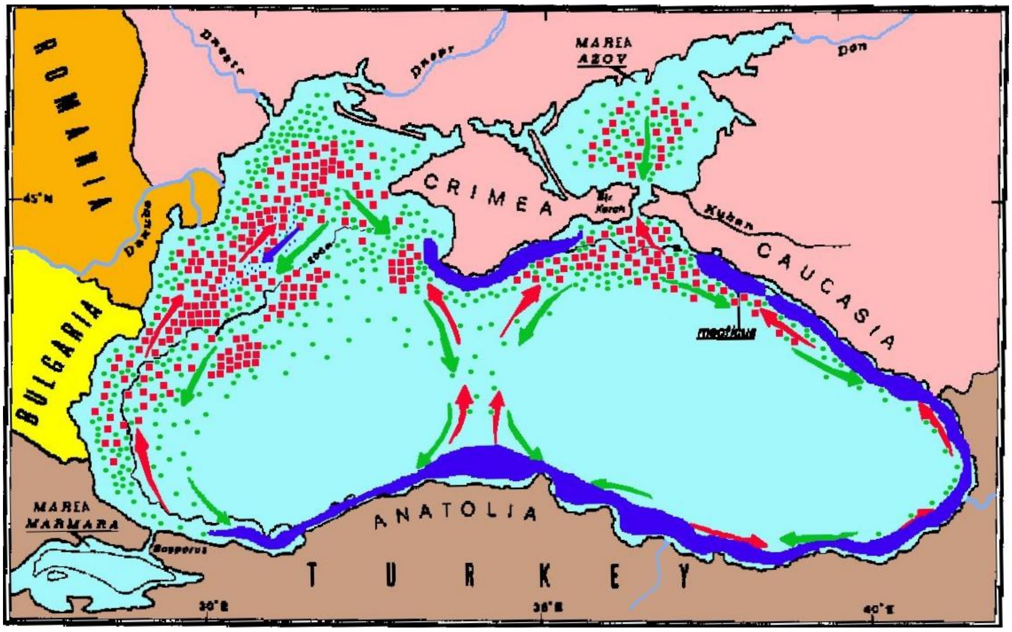


Fig. 6.5.1.1.1 Distribution of the anchovy at the Romanian littoral and in the whole Black Sea.

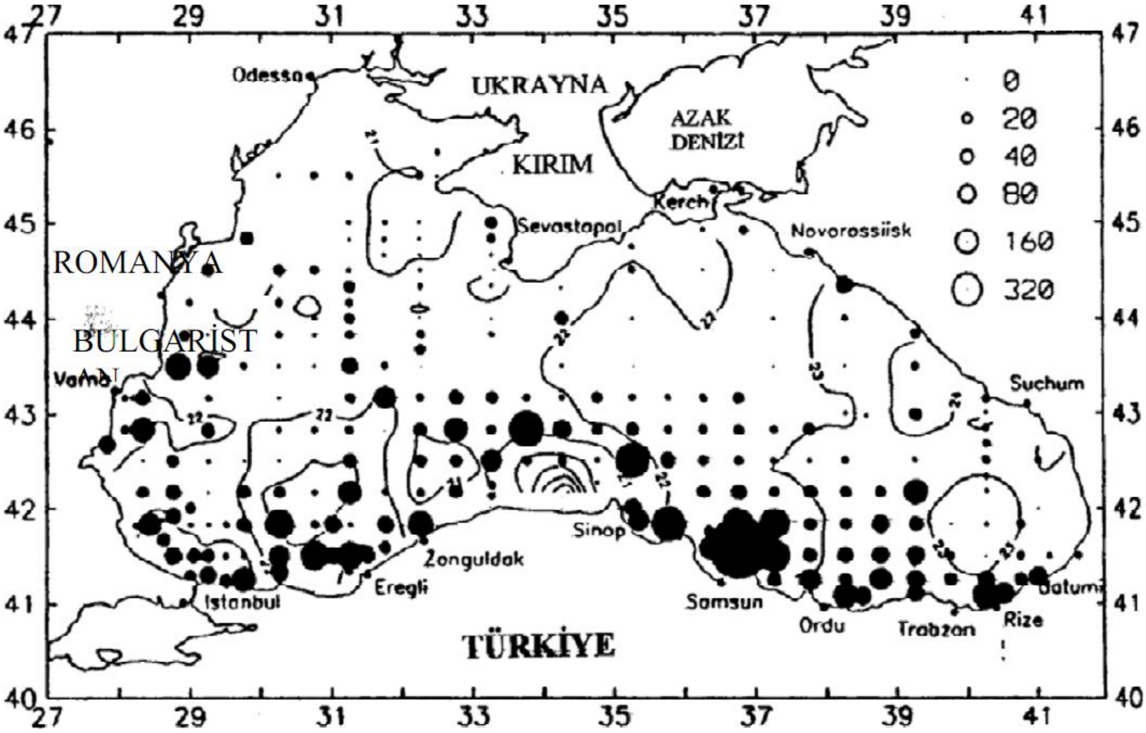


Fig. 6.5.1.1.2 Egg distribution of anchovy during 1991-1992 (Niermann et al. 1994).

6.5.1.2 *Growth and mortality*

During the last 10 year, the ages in the catch have been represented as 0 to 4, which older ages were observed not in the wintering areas.

At the first stage data must be carefully screened and organised into age structured matrices. Age structured assessment methods such as ICA and VPA (XSA) than can be applied similar to sprat.

L_∞: 14.61 cm

t_o: -1.6591

In the last years, the anchovy individuals presented a total length which ranged between 106.14 mm and 115.88mm and the average weight of 6.79 -9.56g. The age of individuals oscillated between $0;0^+$ - $3;3^+$, dominant being the groups 1; 1^+ - 2; 2^+, as a consequence of the high fishing pressure in the wintering area (Maximov et. al, 2008).

The estimated parameters in VBGF by countries and mortality rates are presented on Tab. 6.5.1.2.1 and Tab. 6.5.1.2.2.

Table 6.5.1.2.1 VBGF parameters calculated in the Black Sea

	L_∞	**K**	**t_0**	**a**	**b**
Bulgaria	14.65	0.497	-1.676		
Romania	15.20	0.403	-0.194	0.0758	2.846
Ukraine	14.97	0.426	-1.881		
Turkey	14.61	0.503	-1.659	0.0072	2.949

Table 6.5.1.2.2. Mortality rates for 2011.

	Z	**F**	**M**
Bulgaria	2.2723[1]	1.4213	**0.851[3]**
Romania	1.3016[1]	0.5666	0.735[3]
Ukraine	2.20[1]	1.435	**0.765[3]**
Turkey	1.9104[2]	1.0514	0.859[3]

[1]Age-length frequency, [2] Length-frequency, [3] Pauly

Natural mortality (M) is probably the most important parameter in models of population dynamics, especially in short lived species, and is the one proved to be the most difficult to estimate. In nature natural mortality may vary among years and ages/sizes.

6.5.1.3 *Maturity*

First maturity age is year 1 for anchovy. It spawns during the summer, which is also the main feeding and growth season. The main feature characterizing the summer habitat is the strong stratification of the water due to the seasonal thermocline and reinforced in coastal and shelf waters by the river plumes. Anchovy was found to spawn mainly in the surface layer of these warm and stratified areas (Arkhipov, 1993; Fashchuk et al. 1995). Eggs and larvae are retained in the coastal layer stabilized in depth by the thermocline and protected from the offshore by thermo-haline fronts. A large convergence zone is formed on the northwestern and the western shelf (the main anchovy spawning area) due to the river Danube inflow, which favors fish offspring retention (Radu and Maximov 2006-2008).

6.5.2 Fisheries

6.5.2.1 *General description*

Anchovy is an object of both artisanal (with coastal trap nets and beach seines mainly in Bulgaria, Romania and Ukraine), and commercial purse-seines fishery on the wintering grounds mainly in Turkey. Majority of the production has obtained by Turkey by purse seine vessels. In recent years midwater trawling has also been started in anchovy fisheries.

The catch of the Black Sea countries increased until 1985-1986 after which a sharp decline occurred. For instance, the Turkish catch of anchovy in 1990-1991 fell to 13-15% of the 1985-1986 level.

Heavy fishing on small pelagic fish predominantly by the Soviet Union, and later also by Turkey, was carried out in a competitive framework without any agreement between the countries on limits to fishing. Depletion of the small pelagic stock appears to have led to increased opportunities for population explosion of planktonic predators (jelly fish and ctenophores) which have competed for food with fish, and preyed on their eggs and larvae.

The total anchovy catch was progressively increasing since 1980 to 1988 when maximum yield was obtained (606,401t) then decreasing up to a minimum of 102,904 t in 1990 (except 1988), 90% from this quantity being obtained by Turkey.

In spite of improving the fishing effort by the continuous increase of fishing vessels number, at the end of the 1980’s when the outbreak of the alien jellyfish occurred, catches dramatically declined up to three times.

The state of the anchovy stock has improved after the collapse in 1990s, and in 2000-2005 the catches reached levels of about 300 th. tons.

However in 2006 the anchovy catches dropped to 119 thousand t in Turkey (TUIK, 2007) showing that the stock is not in a good condition. This year, bonito catches reached the maximum amount of the last 50 years (70797 tons) and most of the purse seiners preferred to catch bonito considering the high market value of that fish. On the other hand, the possible causes of the drop ranges may be attributed to the climate effects (raised water temperature may cause a dispersal of fish schools making them less accessible to the fishing gears), abundant predators (bonito) or overfishing. In 2006 the catch increased again to 212 thousand t.

In 2010, total Black Sea catch has reached to 238 153 t and the major part is harvested by Turkey as 205 243 tons (Table 6.5.2.3.1.1).

Ukraine harvests both subspecies of anchovy - the Black Sea and Azov Sea anchovy. Their regulation and registration of national statistics of Ukraine, as well as Russian Federation, are made separately. Presented Ukrainian data for landing of anchovy belong exclusively to the Black Sea subspecies. In 1997-2006, the Ukrainian fleet fished the Black Sea anchovy, not only in their own waters, but also in waters of Georgia.

6.5.2.2 *Management regulations applicable in 2011 and 2012*

The lack of an adequate management in the Black Sea fisheries is also underlined by the fact that in spite of the obvious decline of stocks, the fishing effort continued to increase not only by the numbers of vessels but also the increased efficiency of fish finders, fishing nets and gears, modernization of the vessels and navigation instruments.

In the Black Sea countries, anchovy fishing are generally regulated by using closed seasons (May April to October to October/November for Bulgaria and Romania, April to October/November for Turkey, and no closed season for Ukraine), closed areas, mesh size regulations, minimum landing size (9 cm total length in general).

6.5.2.3 *Catches*

6.5.2.3.1 Landings

The anchovy landings during the period 1994 – 2011 by countries are presented on Tab. 6.5.2.3.1.1.

Table 6.5.2.3.1.1 Black Sea anchovy landings (t) by countries.

YEAR	BULGARIA	GEORGIA	ROMANIA	RUSSIAN FEDERATION	TURKEY	UKRAINE	TOTAL
1994		857	197	0	293167	4797	299018
1995	35	1301	190	11	389298	10260	401095
1996	23	1232	140	4	276137	3092	280628
1997	44	2288	45	11	221475	3328	227191
1998	48	2346	146		199363	2611	204514
1999	36	1264	155		315989	2423	319867
2000	64	1487	204		272390	5496	279641
2001	102	941	186		300569	7952	309750
2002	237	927	296		346869	9567	357896
2003	131	2665	160		278238	8159	289353
2004	88	2562	135		312603	7458	322846
2005	14	2600	154		125635	6860	135263
2006	6	9222	23		219171	3936	232358
2007	60	17447	87		361662	4935	384191
2008	28	25938	15		229632	9515	265128
2009	42		21		193630	9948	203641
2010	65	39857	50		203026	5051	248049
2011	18	25919	41		205243	6932	238153

6.5.2.3.2 Discards

Discards of Anchovy appear neglibible. Although no discards have been reported to EWG 12 16, some untargeted fish as dogfish, rays, turbot, marine mammals, small sized anchovies and blue fish have been caught due to use of purse seine nets, which has no selectivity, in shallow waters in the coasts of Turkey and Georgia.

6.5.2.4 *Fishing effort and CPUE*

There is no data available on CPUE in the Black Sea, mainly in Turkey. According to the surveys carried out in Romania, it is reported that mean CPUE values are 2437.3 kg per gears, 33.479 kg per soaking days and 36.296 kg per fishing days which derived using the pound net catch data.

For stock assessment purposes effective effort for specific fishing methods is needed. In case of Turkey, the Fisheries Information System (FIS) is progressing and according to the landing and effort as total HP (calculated by the number and the mean HP of the purse seiners) short term time series had been derived as follows;

Table 6.5.2.4.1 Fisshing effort on anchovy per age groups of ?

Years	**Total HP**	**0**	**1**	**2**	**3**
2006	273658	23368	142640	67087	6172
2007	302431	29180	255042	92125	5945
2008	361894	6575	120777	113175	8081
2009	308825	12878	110520	73142	7512
2010	261510	6517	80509	123078	12380
2011	245525	2724	126449	81633	3754

6.5.3 Scientific Surveys

A new project has started in the Black Sea EEZ of Turkey based on hydro acoustic surveys. There are limited. data available from preliminary surveys for the Eastern Black Sea.

6.5.4 Assessment of historic parameters

6.5.4.1 *Method 1: XSA*

6.5.4.1.1 Jusification

STECF EWG Black Sea12-16 found out that the data available in different national databases would allow performing a quantitative assessment of this stock by XSA. This however would be less straightforward than previous assessment of anchovy because of the specific seasonal and migration behaviour of anchovy: 86.18% of the catch is taken in Turkish waters (southern Black Sea) in the autumn and winter. The important Turkish data can be complemented by biological (age and individual size and growth) and survey information (acoustics. juveniles. egg-production) from Bulgaria. Romania and Ukraine.

An XSA was formultated tuned with the CPUE at age derived from the Turkish commercial purse seiner fishery.

6.5.4.1.2 Input parameters

STECF EWG 12-16 explored the available data by countries, which could be used for stock assessment purposes (Tab. 6.5.4.1.2.1) and the XSA input data for analyses.

Table 6.5.4.1.2.1. Data availability by countries.

Type of data	BG	RO	UKR	TR	Selection for Assessment	Comments
Official landings	1925-2008	1950-2008	1967 - 2011	1967 - 2010 (after 15th July)		
Illegal. Unreported Catch	no	no	no	No		
Fishing effort and CPUE	no	1980-2008	no	1998. 2000-2008		* to be reviewed
Number of fishing vessels				1993-2011		
Research surveys -adult			till 2005	1993-1998. 2000-2008		
Reserch surveys -juvenile		1995-2008	till 1992	No		
Hydroacoustic surveys	1984-87. 1990		1992. 1998-2003	1990-1993		
Length composition	1998-2000	1980-2008	till 2008	till 2011		
Weight at length (survey. landings)	1998-2000. *VII. VIII. IX. XI.1999	1980-2008	till 2006	till 2011		
Age composition	1995-2000. VII. VIII. IX. XI.1999	1980-2008	till 2005	till 2011		
Weight at age (survey. landings)	1995-2000	1980-2008	till 2005	till 2011		
Maturity at age		1980-2008		?		
Natural mortality		1980-2008	till 1990	till 2011		

Table 6.5.4.1.2.2 XSA input data.

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     year
age   2005   2006   2007   2008   2009   2010   2011
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units:  NA NA

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, , unit = unique, season = all, area = unique

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  1 1.1544e+07 1.2942e+07 1.0921e+07 1.3771e+07 2.4907e+07 3.3209e+06
  2 2.2981e+07 7.8935e+06 6.5783e+06 5.4547e+06 8.9937e+06 1.3378e+07
  3 2.9009e+06 6.0254e+06 3.4797e+06 1.3847e+06 2.0517e+06 8.6334e+06
  4 1.0000e+01 1.0000e+01 1.0000e+01 1.0512e+02 6.2510e+01 1.9893e+02
   year
age 2001       2002       2003       2004       2005       2006
  0 1.2065e+06 3.8938e+06 2.5962e+06 1.8715e+06 2.2032e+06 5.6734e+06
  1 3.8738e+06 2.3816e+07 1.0893e+07 1.6903e+07 4.2674e+06 1.6661e+07
  2 1.7547e+07 1.8111e+07 1.2658e+07 7.9303e+06 5.4487e+06 6.0700e+06
  3 5.9879e+06 3.3024e+06 4.6425e+06 6.6891e+06 1.3410e+06 3.9664e+05
  4 1.0000e+01 1.0000e+01 1.0000e+01 1.0000e+01 1.0000e+01 1.0000e+01
   year
age 2007       2008       2009       2010       2011
  0 7.1377e+06 2.1646e+06 3.1116e+06 2.9153e+06 8.0774e+05
  1 3.4151e+07 1.4698e+07 1.3221e+07 1.0662e+07 1.7140e+07
```

```
  2 9.2389e+06 1.1309e+07 6.5836e+06 1.1949e+07 8.3639e+06
  3 4.6861e+05 6.2396e+05 5.4494e+05 9.8525e+05 3.0650e+05
  4 1.0000e+01 1.0000e+01 1.0000e+01 1.0000e+01 1.4197e+03

units:  NA

Slot "catch.wt":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1995      1996      1997      1998      1999      2000      2001
  0 0.0034016 0.0034910 0.0037812 0.0044914 0.0035045 0.0040601 0.0043523
  1 0.0072173 0.0071901 0.0078804 0.0081214 0.0073709 0.0068545 0.0066780
  2 0.0108054 0.0112400 0.0116100 0.0107476 0.0107416 0.0090741 0.0106582
  3 0.0134922 0.0141600 0.0135500 0.0134512 0.0133301 0.0118195 0.0133038
  4 0.0188042 0.0188042 0.0188042 0.0188042 0.0188042 0.0188042 0.0188042
   year
age 2002      2003      2004      2005      2006      2007      2008
  0 0.0039232 0.0036261 0.0033089 0.0042543 0.0038231 0.0040589 0.0031867
  1 0.0061021 0.0071767 0.0085024 0.0082377 0.0080625 0.0074155 0.0086209
  2 0.0082717 0.0102397 0.0099891 0.0120228 0.0104487 0.0099036 0.0104991
  3 0.0112131 0.0129204 0.0131221 0.0140550 0.0146859 0.0125993 0.0135918
  4 0.0188042 0.0188042 0.0188042 0.0188042 0.0188042 0.0188042 0.0188042
   year
age 2009      2010      2011
  0 0.0039673 0.0024646 0.0036372
  1 0.0080139 0.0085855 0.0081965
  2 0.0106504 0.0113562 0.0108199
  3 0.0132162 0.0138364 0.0137245
  4 0.0188042 0.0188042 0.0157450

units:  NA

Slot "discards":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

     year
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  all 0    0    0    0    0    0    0    0    0    0    0    0    0    0
     year
age   2009 2010 2011
  all 0    0    0

units:  NA

Slot "discards.n":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009
  0 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  1 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  2 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  3 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  4 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
   year
age 2010 2011
  0 0    0
  1 0    0
  2 0    0
  3 0    0
  4 0    0

units:  NA

Slot "discards.wt":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique
```

```
   year
age 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009
  0 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  1 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  2 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  3 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  4 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
   year
age 2010 2011
  0 0    0
  1 0    0
  2 0    0
  3 0    0
  4 0    0

units:  NA

Slot "landings":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

     year
age   1995   1996   1997   1998   1999   2000   2001   2002   2003   2004
  all 385579 277730 219496 201147 314679 267921 297797 347446 277184 316899
     year
age   2005   2006   2007   2008   2009   2010   2011
  all 128883 225268 379618 260830 195617 248049 238153

units:  NA

Slot "landings.n":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1995       1996       1997       1998       1999       2000
  0 4.3515e+06 3.0449e+06 2.6207e+06 2.6840e+06 2.0353e+06 5.3503e+06
  1 1.1544e+07 1.2942e+07 1.0921e+07 1.3771e+07 2.4907e+07 3.3209e+06
  2 2.2981e+07 7.8935e+06 6.5783e+06 5.4547e+06 8.9937e+06 1.3378e+07
  3 2.9009e+06 6.0254e+06 3.4797e+06 1.3847e+06 2.0517e+06 8.6334e+06
  4 1.0000e+01 1.0000e+01 1.0000e+01 1.0512e+02 6.2510e+01 1.9893e+02
   year
age 2001       2002       2003       2004       2005       2006
  0 1.2065e+06 3.8938e+06 2.5962e+06 1.8715e+06 2.2032e+06 5.6734e+06
  1 3.8738e+06 2.3816e+07 1.0893e+07 1.6903e+07 4.2674e+06 1.6661e+07
  2 1.7547e+07 1.8111e+07 1.2658e+07 7.9303e+06 5.4487e+06 6.0700e+06
  3 5.9879e+06 3.3024e+06 4.6425e+06 6.6891e+06 1.3410e+06 3.9664e+05
  4 1.0000e+01 1.0000e+01 1.0000e+01 1.0000e+01 1.0000e+01 1.0000e+01
   year
age 2007       2008       2009       2010       2011
  0 7.1377e+06 2.1646e+06 3.1116e+06 2.9153e+06 8.0774e+05
  1 3.4151e+07 1.4698e+07 1.3221e+07 1.0662e+07 1.7140e+07
  2 9.2389e+06 1.1309e+07 6.5836e+06 1.1949e+07 8.3639e+06
  3 4.6861e+05 6.2396e+05 5.4494e+05 9.8525e+05 3.0650e+05
  4 1.0000e+01 1.0000e+01 1.0000e+01 1.0000e+01 1.4197e+03

units:  NA

Slot "landings.wt":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1995      1996      1997      1998      1999      2000      2001
  0 0.0034016 0.0034910 0.0037812 0.0044914 0.0035045 0.0040601 0.0043523
  1 0.0072173 0.0071901 0.0078804 0.0081214 0.0073709 0.0068545 0.0066780
  2 0.0108054 0.0112400 0.0116100 0.0107476 0.0107416 0.0090741 0.0106582
  3 0.0134922 0.0141600 0.0135500 0.0134512 0.0133301 0.0118195 0.0133038
  4 0.0188042 0.0188042 0.0188042 0.0188042 0.0188042 0.0188042 0.0188042
   year
```

```
age 2002      2003      2004      2005      2006      2007      2008
  0 0.0039232 0.0036261 0.0033089 0.0042543 0.0038231 0.0040589 0.0031867
  1 0.0061021 0.0071767 0.0085024 0.0082377 0.0080625 0.0074155 0.0086209
  2 0.0082717 0.0102397 0.0099891 0.0120228 0.0104487 0.0099036 0.0104991
  3 0.0112131 0.0129204 0.0131221 0.0140550 0.0146859 0.0125993 0.0135918
  4 0.0188042 0.0188042 0.0188042 0.0188042 0.0188042 0.0188042 0.0188042
   year
age 2009      2010      2011
  0 0.0039673 0.0024646 0.0036372
  1 0.0080139 0.0085855 0.0081965
  2 0.0106504 0.0113562 0.0108199
  3 0.0132162 0.0138364 0.0137245
  4 0.0188042 0.0188042 0.0157450

Slot "stock.wt":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1995      1996      1997      1998      1999      2000      2001
  0 0.0034016 0.0034910 0.0037812 0.0044914 0.0035045 0.0040601 0.0043523
  1 0.0072173 0.0071901 0.0078804 0.0081214 0.0073709 0.0068545 0.0066780
  2 0.0108054 0.0112400 0.0116100 0.0107476 0.0107416 0.0090741 0.0106582
  3 0.0134922 0.0141600 0.0135500 0.0134512 0.0133301 0.0118195 0.0133038
  4 0.0188042 0.0188042 0.0188042 0.0188042 0.0188042 0.0188042 0.0188042
   year
age 2002      2003      2004      2005      2006      2007      2008
  0 0.0039232 0.0036261 0.0033089 0.0042543 0.0038231 0.0040589 0.0031867
  1 0.0061021 0.0071767 0.0085024 0.0082377 0.0080625 0.0074155 0.0086209
  2 0.0082717 0.0102397 0.0099891 0.0120228 0.0104487 0.0099036 0.0104991
  3 0.0112131 0.0129204 0.0131221 0.0140550 0.0146859 0.0125993 0.0135918
  4 0.0188042 0.0188042 0.0188042 0.0188042 0.0188042 0.0188042 0.0188042
   year
age 2009      2010      2011
  0 0.0039673 0.0024646 0.0036372
  1 0.0080139 0.0085855 0.0081965
  2 0.0106504 0.0113562 0.0108199
  3 0.0132162 0.0138364 0.0137245
  4 0.0188042 0.0188042 0.0157450

units:  NA

Slot "m":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009
  0 1.32 1.32 1.32 1.32 1.32 1.32 1.32 1.32 1.32 1.32 1.32 1.32 1.32 1.32 1.32
  1 0.81 0.81 0.81 0.81 0.81 0.81 0.81 0.81 0.81 0.81 0.81 0.81 0.81 0.81 0.81
  2 0.81 0.81 0.81 0.81 0.81 0.81 0.81 0.81 0.81 0.81 0.81 0.81 0.81 0.81 0.81
  3 0.81 0.81 0.81 0.81 0.81 0.81 0.81 0.81 0.81 0.81 0.81 0.81 0.81 0.81 0.81
  4 0.81 0.81 0.81 0.81 0.81 0.81 0.81 0.81 0.81 0.81 0.81 0.81 0.81 0.81 0.81
   year
age 2010 2011
  0 1.32 1.32
  1 0.81 0.81
  2 0.81 0.81
  3 0.81 0.81
  4 0.81 0.81

units:  NA

Slot "mat":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009
  0 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  1 1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
```

```
  2 1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
  3 1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
  4 1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
   year
age 2010 2011
  0 0    0
  1 1    1
  2 1    1
  3 1    1
  4 1    1
```

6.5.4.1.3 Diagnostics and results

Table 6.5.4.1.3.1 Diagnostics of XSA.

```
FLR XSA Diagnostics 2012-11-06 16:19:16

CPUE data from indices

Catch data for 17 years 1995 to 2011. Ages 0 to 4.

                  fleet first age last age first year last year alpha beta
1 Turkish purse seiners         0         3       2006      2011  <NA> <NA>


 Time series weights :

    Tapered time weighting applied
   Power =   3 over  20 years

 Catchability analysis :

     Catchability independent of size for ages >   1

     Catchability independent of age for ages >   2

 Terminal population estimation :

     Survivor estimates shrunk towards the mean F
    of the final   5 years or the  2 oldest ages.

    S.E. of the mean to which the estimates are shrunk =   0.5

    Minimum standard error for population
    estimates derived from each fleet =  0.3

    prior weighting not applied

Regression weights
     year
age    2002 2003  2004  2005  2006  2007 2008  2009 2010 2011
  all 0.751 0.82 0.877 0.921 0.954 0.976 0.99 0.997    1    1


 Fishing mortalities
   year
age  2002  2003  2004  2005  2006  2007  2008  2009  2010  2011
  0 0.033 0.028 0.030 0.018 0.030 0.067 0.018 0.032 0.024 0.020
  1 0.247 0.323 0.750 0.226 0.510 0.765 0.530 0.376 0.397 0.543
  2 0.439 0.408 0.978 1.656 1.673 1.773 1.934 1.218 2.638 1.959
  3 0.358 0.382 0.913 0.996 1.181 1.390 1.356 1.024 1.612 1.383
  4 0.358 0.382 0.913 0.996 1.181 1.390 1.356 1.024 1.612 1.383


 XSA population number (Thousand)
     age
year          0         1        2        3    4
```

```
  2002 229042545 163030183 76485490 16468424   47
  2003 184862359  59172841 56640674 21945345   45
  2004 121849232  48041411 19058314 16754542   23
  2005 238176266  31582930 10097787  3188931   22
  2006 369444518  62486542 11203685   857925   20
  2007 214274541  95759381 16685044   935493   18
  2008 240749101  53551189 19821645  1260318   18
  2009 188709926  63193801 14019211  1274801   21
  2010 235301847  48802835 19294131  1845454   16
  2011  80591931  61350672 14599160   613474 2534


 Estimated population abundance at 1st Jan  2012
      age
year   0        1        2      3     4
  2012 0 21111460 15860150 916039 68478


 Fleet:  Turkish purse seiners

 Log catchability residuals.

    year
age   2006   2007   2008   2009   2010   2011
  0  0.050  0.626 -0.401  0.210 -0.387 -0.085
  1  0.029  0.009  0.066 -0.078 -0.030  0.006
  2 -0.026 -0.068  0.028 -0.349  0.395  0.016
  3 -0.043 -0.080 -0.085 -0.310  0.063 -0.121

 Regression statistics
 Ages with q dependent on year class strength
[1] "0.786518738742311" "0.561808461799771" "11.3431554791121"
[4] "10.9587963152975"


 Terminal year survivor and F summaries:

 ,Age 0 Year class =2011

source
                      scaledWts survivors yrcls
Turkish purse seiners     0.248  18948530  2011
fshk                      0.497  11128850  2011
nshk                      0.255  81811418  2011

 ,Age 1 Year class =2010

source
                      scaledWts survivors yrcls
Turkish purse seiners     0.617  16024419  2010
fshk                      0.383  15933159  2010

 ,Age 2 Year class =2009

source
                      scaledWts survivors yrcls
Turkish purse seiners     0.282    931111  2009
fshk                      0.718    907561  2009

 ,Age 3 Year class =2008

source
                      scaledWts survivors yrcls
Turkish purse seiners     0.411     60667  2008
fshk                      0.589     73705  2008
```

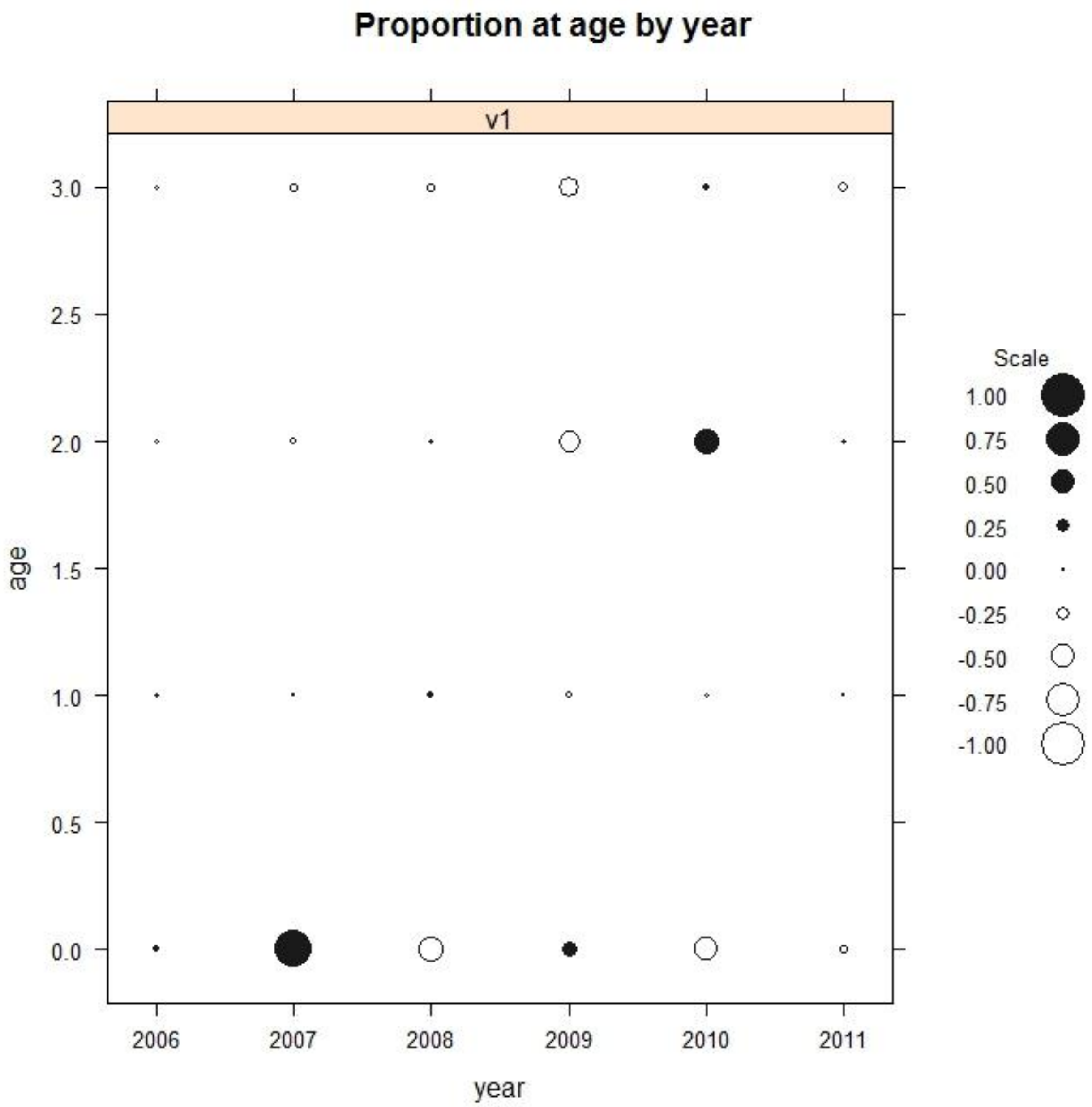


Fig. 6.5.4.1.3.1 Tuning results. Log transformed residuals of catchability.

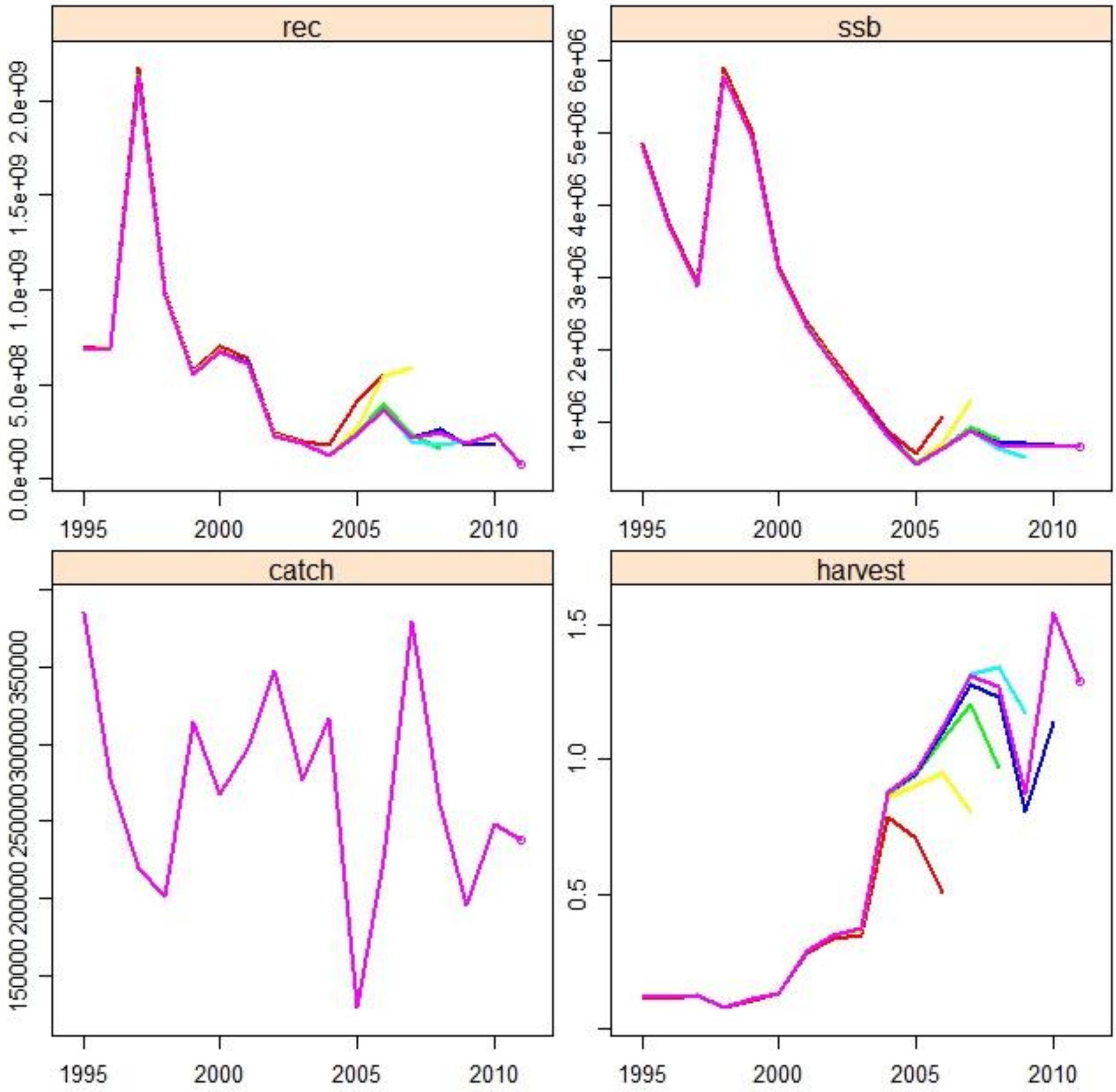


Fig. 6.5.4.1.3.2 Retrospective analysis of anchovy stock parameters.

Table 6.5.4.1.3.2 XSA results

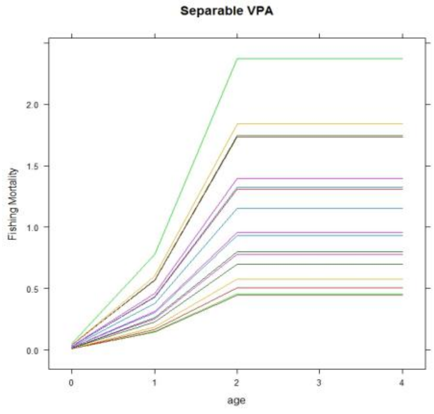
```
Slot "stock.n":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1995       1996       1997       1998       1999       2000
  0 6.8149e+08 6.9554e+08 2.1309e+09 9.7527e+08 5.5547e+08 6.7571e+08
  1 2.6827e+08 1.7980e+08 1.8423e+08 5.6788e+08 2.5914e+08 1.4733e+08
  2 2.1852e+08 1.1164e+08 7.1354e+07 7.4672e+07 2.4344e+08 9.8669e+07
  3 3.7537e+07 8.1884e+07 4.4401e+07 2.7355e+07 2.9580e+07 1.0230e+08
  4 1.2490e+02 1.3123e+02 1.2315e+02 2.0104e+03 8.7068e+02 2.2734e+03
   year
age 2001       2002       2003       2004       2005       2006
  0 6.1262e+08 2.2904e+08 1.8486e+08 1.2185e+08 2.3818e+08 3.6944e+08
  1 1.7774e+08 1.6303e+08 5.9173e+07 4.8041e+07 3.1583e+07 6.2487e+07
  2 6.3327e+07 7.6485e+07 5.6641e+07 1.9058e+07 1.0098e+07 1.1204e+07
  3 3.4971e+07 1.6468e+07 2.1945e+07 1.6755e+07 3.1889e+06 8.5792e+05
  4 5.5730e+01 4.7395e+01 4.4857e+01 2.2977e+01 2.1704e+01 1.9520e+01
```

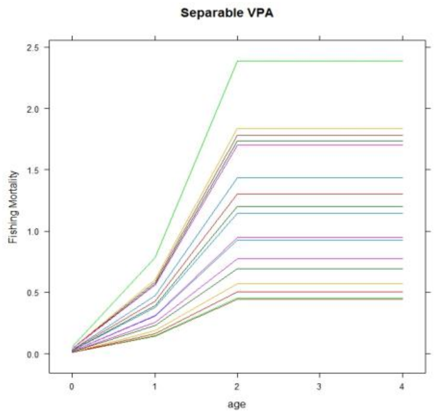
```
   year
age 2007       2008       2009       2010       2011
  0 2.1427e+08 2.4075e+08 1.8871e+08 2.3530e+08 8.0592e+07
  1 9.5759e+07 5.3551e+07 6.3194e+07 4.8803e+07 6.1351e+07
  2 1.6685e+07 1.9822e+07 1.4019e+07 1.9294e+07 1.4599e+07
  3 9.3549e+05 1.2603e+06 1.2748e+06 1.8455e+06 6.1347e+05
  4 1.7796e+01 1.8043e+01 2.1314e+01 1.6490e+01 2.5342e+03

Slot "harvest":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1995      1996      1997      1998      1999      2000      2001
  0 0.0124312 0.0085060 0.0023823 0.0053390 0.0071144 0.0154383 0.0038176
  1 0.0666895 0.1142013 0.0930777 0.0370358 0.1556076 0.0343791 0.0332229
  2 0.1715899 0.1120542 0.1487609 0.1159971 0.0569834 0.2272464 0.5368689
  3 0.1231461 0.1168997 0.1249961 0.0789308 0.1098051 0.1352845 0.2966767
  4 0.1231461 0.1168997 0.1249961 0.0789308 0.1098051 0.1352845 0.2966767
   year
age 2002      2003      2004      2005      2006      2007      2008
  0 0.0334451 0.0275482 0.0301677 0.0180598 0.0301620 0.0666201 0.0175491
  1 0.2472080 0.3229593 0.7497471 0.2263740 0.5104384 0.7650641 0.5302094
  2 0.4385460 0.4080580 0.9778178 1.6555554 1.6729248 1.7731489 1.9339845
  3 0.3576156 0.3815168 0.9127624 0.9955420 1.1814541 1.3904740 1.3558778
  4 0.3576156 0.3815168 0.9127624 0.9955420 1.1814541 1.3904740 1.3558778
   year
age 2009      2010      2011
  0 0.0324226 0.0242630 0.0195822
  1 0.3764053 0.3968244 0.5427956
  2 1.2177031 2.6384187 1.9586556
  3 1.0241599 1.6116570 1.3826148
  4 1.0241599 1.6116570 1.3826148

units:  f

Slot "harvest.spwn":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009
  0 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  1 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  2 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  3 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  4 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
   year
age 2010 2011
  0 0    0
  1 0    0
  2 0    0
  3 0    0
  4 0    0

units:  NA

Slot "m.spwn":
An object of class "FLQuant"
, , unit = unique, season = all, area = unique

   year
age 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009
  0 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  1 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  2 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  3 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
  4 0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
   year
age 2010 2011
  0 0    0
```

```
  1 0    0
  2 0    0
  3 0    0
  4 0    0

units:  NA

Slot "name":
[1] "BLACK SEA ANCHOVY Total,2011,COMBSEX,PLUSGROUP"

Slot "desc":
[1] "Imported from a VPA file. ( BSAn00IN_NEW.DAT ).  Tue Nov 06 16:16:43 2012 + FLAssess:
"

Slot "range":
      min       max plusgroup   minyear   maxyear   minfbar   maxfbar 
        0         4         4      1995      2011         1         3 

Stock summary

         ssb       fbar        rec    catch landings
1  4803931.2 0.12047517  681488950 385579.2   385579
2  3707164.5 0.11438506  695544114 277730.2   277730
3  2881877.4 0.12227822 2130880321 219496.2   219496
4  5782490.2 0.07732121  975274503 201149.0   201147
5  4919392.7 0.10746539  555465921 314680.2   314679
6  3114374.4 0.13230333  675708794 267921.0   267921
7  2327159.7 0.28892282  612624960 297797.2   297797
8  1812160.9 0.34778985  229042545 347446.2   347446
9  1288193.3 0.37084470  184862359 277184.2   277184
10  818696.5 0.88010909  121849232 316899.2   316899
11  426396.0 0.95915717  238176266 128883.2   128883
12  633458.5 1.12160576  369444518 225268.7   225268
13  887134.0 1.30956231  214274541 379618.6   379618
14  686900.8 1.27335725  240749101 260829.8   260830
15  672590.0 0.87275609  188709926 195617.6   195617
16  663637.7 1.54896671  235301847 248048.9   248049
17  669281.7 1.29468868   80591931 238153.4   238153
```

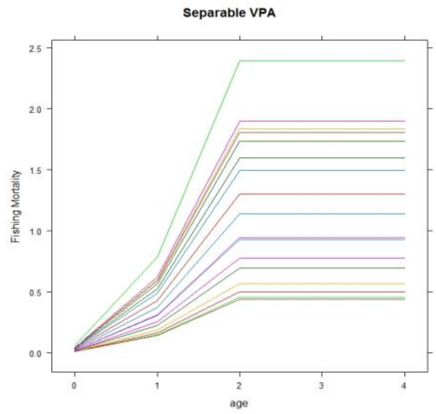
Three shrinkages as 0.5, 1.0 and 2.0 rates were performed and best results obtained with the level 0.5.

Separable VPA was also applied to input data and results given below as graphs (Fig. 6.5.4.1.3.4.)





A-SEPVPA08 B-SEPVPA12



C-SEPVPA16

Fig. 6.5.4.1.3.4.Separable VPA analyses on three levels.

Sensitivity analyses with different shrinkage levels are given in Figure 6.5.4.1.3.5.

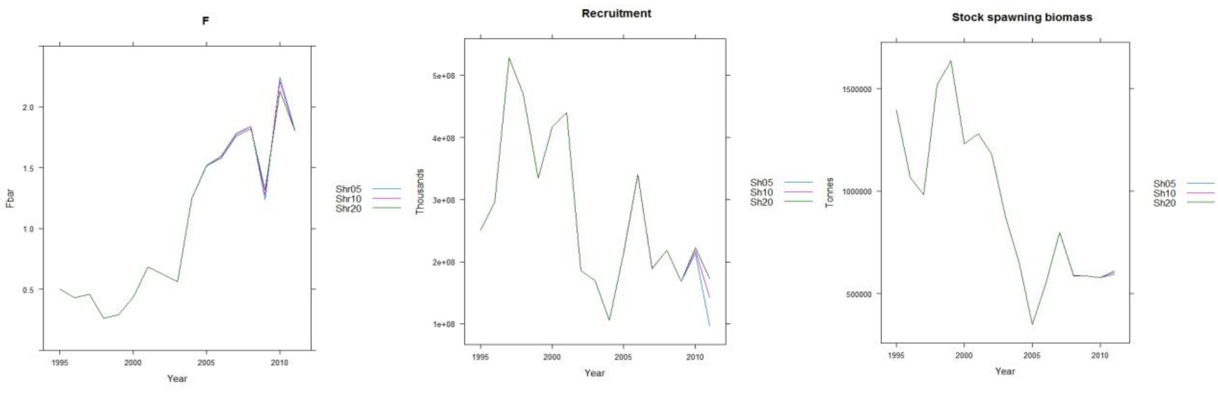


Fig. 6.5.4.1.3.5. Sensitivity analyses for different shrinkage levels.

6.5.5 Short term prediction of stock biomass and catch

6.5.5.1 *Input parameters*

Represent short term averages of the stock parameters represented in the preceding section 6.3.4.

6.5.5.2 *Results*

As the stock is subject to overfishing with F($_{1-3}$) = 1.295 exceeding E($_{1-3}$)=0.4 equals Fmsy ($_{1-3}$) in the range of 0.54 assuming that (M_{1-3}) 0.81. The resulting short term forcast indicates some dynamics in the relevant stock parameters: status quo catch 2012 equals 251 908 while catch in 2013 is estimated at 257 427 t. If the stock is sustainably exploited at Fmsy(0.54). the catch in 2013 should not exceed 41 % of previous years catch amount (141 616 t). Last year it was advised not to exceed 200 000 tons and the catch realised was 205 243 tons.

It is possible that XSA does not perform well with such a short living species - F start at age 3 years, and cannot resolve variable in time exploitation pattern (selectivity at age, partial recruitment). In future the EWG should look for more flexible and robust methods that work on the whole catch-at-age matrix. Tunning data are also judged as not very reliable as comming from uncalibrated purse seine fishing fleet. The major defficiency in this assessment is the lack of scientific survey data to be used to adjust the analystical population models.

Table 6.5.5.3.1 Short term projections of stock size and catches as management option table derived from various F-multipliers.

Fscenar	Fmult	Catch_2012	Catch_2013	Catch_201	SSB_2012	SSB_2013	SSB_2014	ChangeSSB_2012_2014	ChangeCatch_2013_2011
0.54	0.436	251908	141616	173014	664177	671175	759678	14	-41
0	0	251908	0	0	664177	671175	874698	32	-100
0.1239	0.1	251908	38564	55877	664177	671175	842718	27	-84
0.2478	0.2	251908	73071	100166	664177	671175	814504	23	-69
0.3716	0.3	251908	104111	135566	664177	671175	789468	19	-56
0.4955	0.4	251908	132181	164121	664177	671175	767124	15	-44
0.6194	0.5	251908	157696	187385	664177	671175	747065	12	-34
0.7433	0.6	251908	181007	206539	664177	671175	728955	10	-24
0.8672	0.7	251908	202406	222487	664177	671175	712512	7	-15
0.991	0.8	251908	222141	235919	664177	671175	697501	5	-7
1.1149	0.9	251908	240423	247364	664177	671175	683728	3	1
1.2388	1	251908	257427	257230	664177	671175	671027	1	8
1.3627	1.1	251908	273306	265834	664177	671175	659260	-1	15
1.4866	1.2	251908	288186	273418	664177	671175	648313	-2	21
1.6104	1.3	251908	302177	280174	664177	671175	638087	-4	27
1.7343	1.4	251908	315373	286250	664177	671175	628500	-5	32
1.8582	1.5	251908	327853	291763	664177	671175	619482	-7	38
1.9821	1.6	251908	339688	296806	664177	671175	610972	-8	43
2.106	1.7	251908	350937	301452	664177	671175	602920	-9	47
2.2298	1.8	251908	361651	305759	664177	671175	595283	-10	52
2.3537	1.9	251908	371877	309775	664177	671175	588023	-11	56
2.4776	2	251908	381654	313538	664177	671175	581106	-13	60

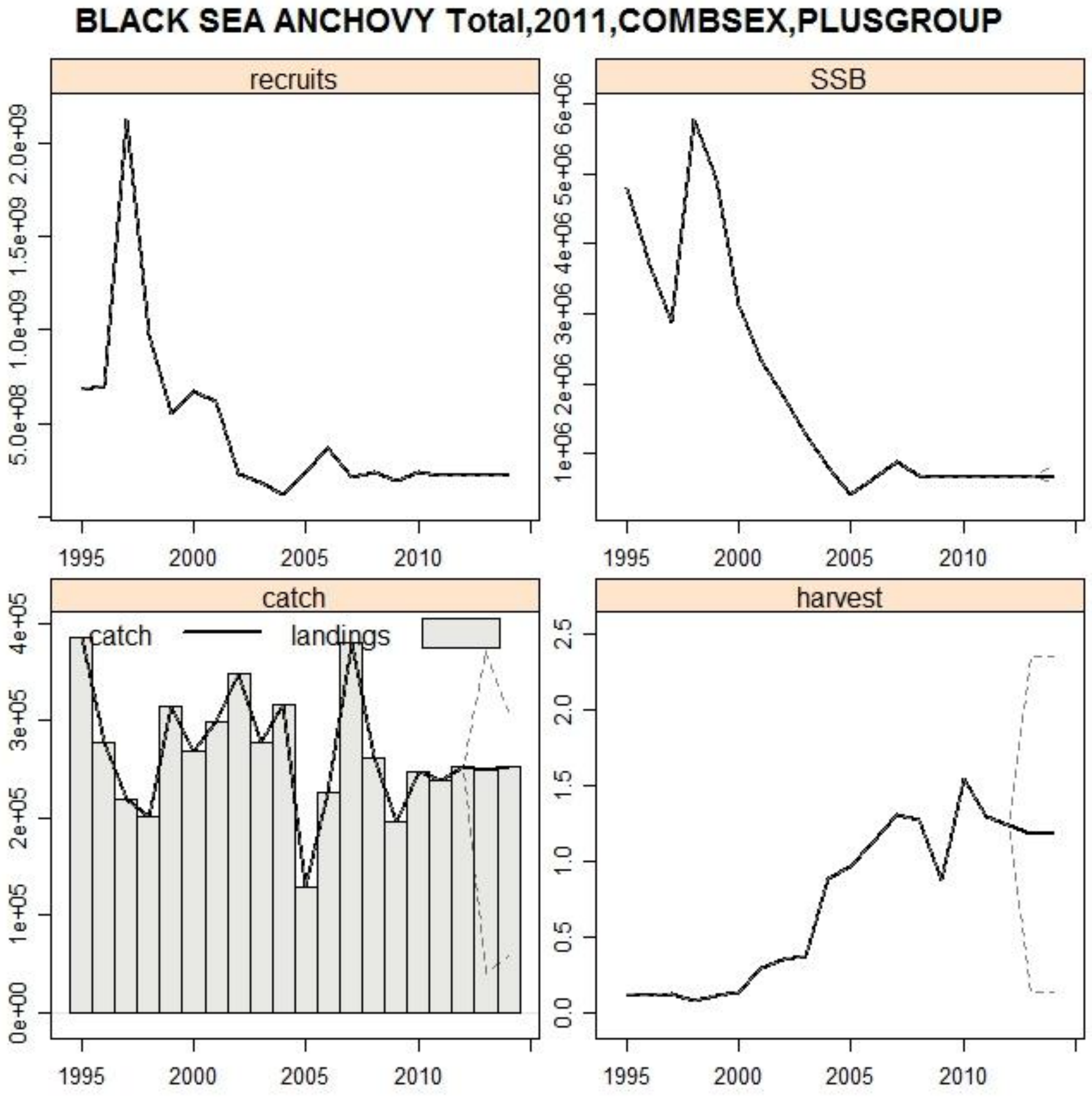


Table 6.5.5.3.1 Short term prediction of stock parameters assuming status quo fishing in 2012 and Fmsy in 2013.

6.5.6 Medium term prediction of stock biomass and catch

The STECF EWG 12-16 did not undertake medium term projections.

6.5.7 Long term predictions

No analyses were undertaken.

6.5.8 Scientific advice

The EWG 12 16 recognises several problems with the data and methods:

- shortage of time series and generally low quality vey)of data after 1990 (age and size composition, effort, CPUE, sur
- existing weight/length at age data are not in same quality among countries and even in the same countries,
- non member countries have no national data collection programs for appropriate methods and tasks,
- there is no harmonisation regarding the sampling size and timing,
- age reading is very important especially for the short lived species, any failure may strong effect on the analyses based on several age groups,
- analyses need to be supported by hydroacoustic surveys.

National agencies, EU, and GFCM should take into consideration all these failures in order to establish better data collection and evaluation system for the Black Sea.

6.5.8.1 *Short term considerations*

State of the spawning stock size

After 2000 the SSB has dropped and remained rather stable bellow 700 000 t since 2007. In the absence of a precautionary reference point the EWG cannot fully evaluate the stock size.

State of recruitment

During the period 2002 to 2009 the recruitment has varied without a clear trend.

State of exploitation

STECF EWG-12-16 proposes E≤0.4 as limit reference point consistent with high long term yield and low risk of fisheries collapses. The EWG classifies the stock as being subject to overfishing as the estimated $F(_{1\text{-}3})$= 1.81 exceeds such exploitation rate E≤0.4. which equals $F(_{1\text{-}3})$ = 0.54 (Fmsy proxy).

In accordance to the Fmsy proxy the STECF EWG 12 16 recommends the exploitation of anchovy is reduced by 41 % and the catch in 2013 not to exceed 141 616 t..

6.5.8.2 *Medium term considerations*

Given the limited knowledge of the stock productivity (shortage of time series) and the lack of fisheries independent data (surveys) covering the entire distribution of anchovy in the Black Sea. the EWG did not perform analyses covering the medium term future.

6.6 Piked Dogfish in the Black Sea

6.6.1 Biological features

6.6.1.1 Stock Identification

Piked dogfish inhabits the whole Black Sea shelf at the water temperatures 6 – 15º C – Fig. 6.6.1.1.1 and Fig. 6.6.1.1.2. It undertakes extensive migrations. In autumn feeding migrations are aimed at the grounds of the formation of the wintering concentrations of anchovy and horse mackerel in the vicinity of the Crimean, Caucasus and Anatolian coasts. With their disintegration picked dogfish disperses all over the shelf. Reproductive migrations of viviparous picked dogfish take place towards the coastal shallows with two peaks of intensity – in spring and autumn. The autumn migration for reproduction covers more individuals usually. The major grounds for reproduction of picked dogfish in the Ukrainian waters are located in Karkinitsky Bay, in front of Kerch Strait and in Feodosia Bay.

Piked dogfish belongs to long-living and viviparous fish; therefore reproduction process includes copulation and birth of fries. Near the coasts of Bulgaria, Georgia, Romania, Russian Federation and Ukraine the intense spawning season is in March-May. Two peaks of birth of juveniles can be distinguished – spring period (April-May) and summer-autumn (August-September, Serobaba et al., 1988). To give birth of juveniles the females approach the coastal zone in depth 10 – 30 m (Maklakova, Taranenko, 1974). At this time males keep separately from females in depth 30 – 50 m. The birth of picked dogfish juveniles takes place at the temperature of water 12 – 18°C.

In autumn piked dogfish aggregates into large schools, accompanying anchovy and horse mackerel, which migrate to wintering grounds along eastern and western coast. During wintering the densest concentrations of picked dogfish are observed, where picked dogfish feeds intensively. They are associated, above all, with major wintering areas of anchovy in the waters of Georgia and Turkey. In the North-western Black Sea in the waters of Ukraine and Romania in depth from 70-80 m down to 100-120 m abundant wintering concentrations of picked dogfish are also observed, where they are located on the grounds of whiting and sprat concentrations (Kirnosova, Lushnicova, 1990).

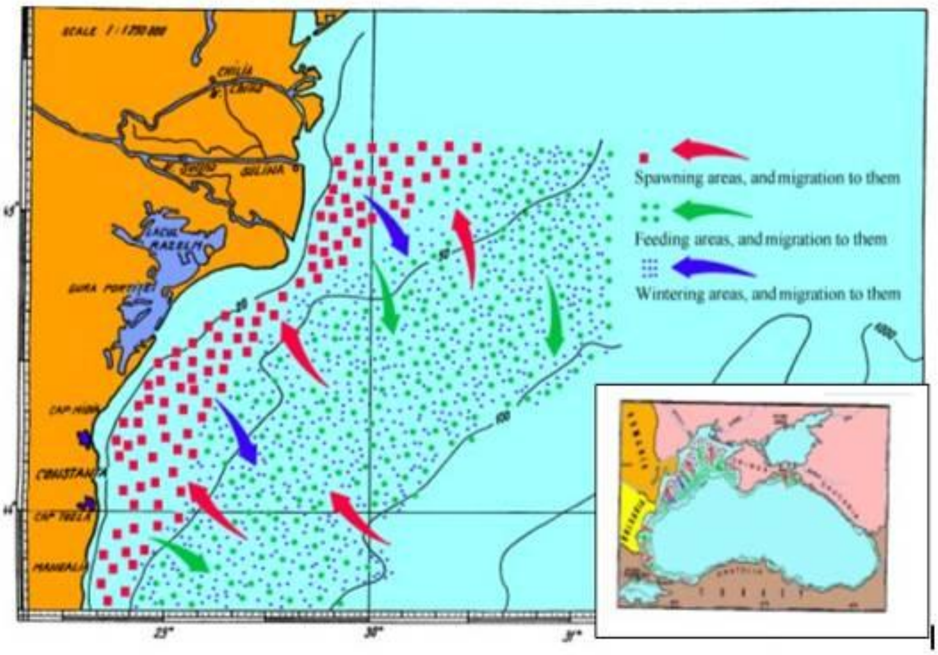


Fig. 6.6.1.1.1 Distribution and migration routes of the piked dogfish at Romanian littoral (Radu et al.,2009b, 2010a).

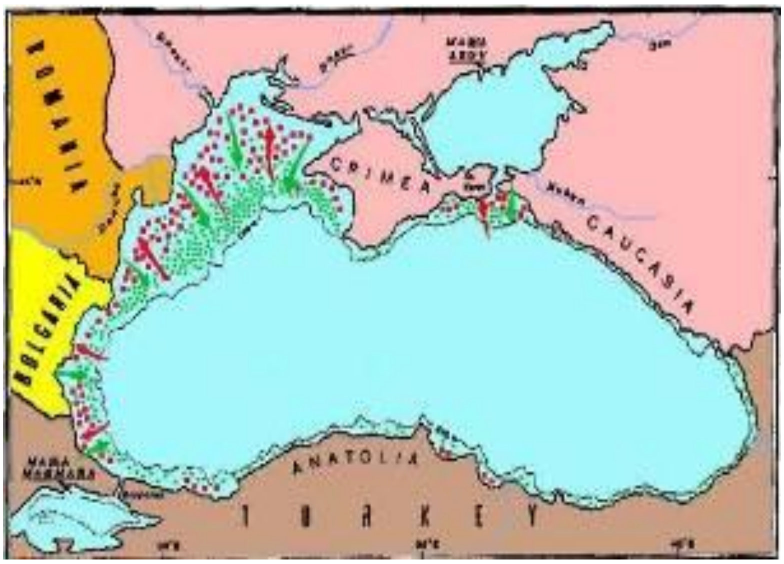


Fig. 6.6.1.1.2 Distribution and migration routes of the piked dogfish at Black Sea level.

6.6.1.2 *Growth*

Piked dogfish is a major demersal predator, reaching the Black Sea the length of about 1.50 m. According to investigations conducted in former USSR waters, Kirnosova, (1993) found that the piked dogfish maximum age is 20 years. The parameters in VBGF and natural mortality parameters are:

Males: K=0.029 t_0=-3.84; L_∞=272 cm; W_∞=47 kg; M=0.20÷0.23

Females: K=0.026 t_0=-3.32; L_∞=303 cm; W_∞=196 kg; M=0.15÷0.20

Age and length, at which 50% of individuals are mature, are 10.49 years and 87.57 cm for males and 11.99 years and 102.97 cm for females, respectively. Mean biennial fecundity is 19.4 eggs and 12.9 pups. The linear relationship between fecundity and length is: F_e = 0.09 x TLp + 2.12 (r = 0.5) for pups and F_o = 0.27 x T Lp - 21.59 (r = 0.7) for eggs (Demirhan and Seyhan, 2007).

Ukrainian data for the period 1971-2001 are: L_∞=282; t_0 = -3.6684 (year); a = 0.00000677; b =2.9593. For period 2002 – 2012 a= 0.00000640; b= 3.0000

Romanian data for 2011 are the following: $L\infty$ =136.3 cm; t_0=−1.30 (year); a = 0.0117; b = 2.76694; k = 0.191($year^{-1}$); M = 0.258

6.6.1.3 *Maturity*

Life-history parameters and food diet of picked dogfish (*Squalus acanthias*) from the SE Black Sea were studied (Demirhan and Seyhan, 2007). Picked dogfish at age 1 to 14 years old were observed, with dominance of 8 years old individuals for both sexes. The length–weight relationship was $W=0.0040*L^{2.95}$and the mean annual linear and somatic growth rates were 7.2 cm and 540.1 g, respectively. The estimated parameters in VBGF were: W_∞=12021 (g), L_∞=157 (cm), K=0.12 ($year^{-1}$) and t_0=−1.30 (year). The size at first maturity was 82 cm for males and 88 cm for females. Mean biennial fecundity was also found to be 8 pups per female. The relationships fecundity–length, fecundity–weight and fecundity–age were found to be:

F=−17.0842+0.2369*L (r=0.93)

F=0.3780+0.0018*W (r=0.89)

F =−0.7859+1.1609*A (r=0.94), respectively.

In conformity with Ukrainian data, the maturity ogive for last years is the following:

Year/ Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
2011	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.25	0.45	0.55	0.75	0.95	1.00	1.00	1.00	1.00	1.00

Maturity ogive from Romanian data

Year/ Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
2011	0.00	0.00	0.45	0.70	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

6.6.2 Fisheries

6.6.2.1 *General description*

In the Black Sea the largest catches of piked dogfish are along the coasts of Turkey, although this fish is not a target species of fisheries, being yielded as by-catch in trawl and purse seine operations mainly in the wintering period. In the 1989-1995 annual catches of Turkey are 1055-4558 t (Shlyakhov, Daskalov, 2008). In subsequent years, they have decreased about 2 times and did not exceed 2400 t. In the waters of Ukraine most of piked dogfish is harvested in spring and autumn months by target fishing with gill-nets of 100 mm mesh-size, long-lines, and as by-catch of sprat trawl fisheries. As in Turkish waters, in the last 20 years the maximum annual catches of picked dogfish are observed in 1989-1995, reaching 1200-1300 t. After 1994 the catches went down being between 20 and 200 t. In the rest of countries piked dogfish is harvested mainly as by-catch, annual catches are usually lower than the Ukraine. The maximum annual catches of picked dogfish in 1989-2005 were: Bulgaria - 126 t (2001), Georgia - 550 t (1998), Romania - 52 t (1992), Russian Federation - 183 t (1990). It should be noted that in the waters of Bulgaria, the highest catches were observed in the early 2000's. In Romania dogfish is caught mainly as by-catch of the sprat trawl fishery. The catches decreased very much because of decreasing of the trawling effort (Maximov et al., 2008b, 2010b; Radu et al., 2009b, 2010a,b).

In Turkey piked dogfish lost its commercial importance in recent years. In the last 20 years, the decrease of dogfish landing may be may be due to over-fishing (Demirhan , phD thesis,)

6.6.2.2 *Management regulations applicable in 2010 and 2011*

Romanian fisheries regulatory framework includes between others the following laws:

- Law on Fishing Fund, Fishery and Aquaculture No. 23 /2008;
- Annual Order on the Fishing Prohibition;
- Order no. 342/2008 on minimal size of the aquatic living resources;
- Order nr. 449/2008 on technical characteristics and practice conditions for fishing gears used in the commercial fishing.

Regarding Spiny dogfish, for protecting the reproduction and rehabilitation of the stock were adopted the following measures (Radu G. and Nicolaev S., 2010):

- in period April - June, 60 days, the fishing is prohibited;
- it is banned to use the trawl in marine zone under the 20 m depths;
- mesh size for dogfish gillnets: a = 100mm, 2a = 200 mm;
- minimum admissible length in catches is 120cm (TL)

In the Black Sea Fishes list IUCN status presented on the Black Sea Commission website (www.blacksea-commission.org) is included and categorized *Squalus acanthias* as follows (Table 6.6.2.2.1) in the BSC, 2011:

Table 6.6.2.2.1. The IUCN status of spiny dogfish in the Black Sea countries

Country	BG	GE	RO	RF	TR	UK
IUCN status	N/A	LC	NT	N/A	EN	NT

LC - least concerned; NT- near threatened; EN- endangered; N/A – no data

6.6.2.3 *Catches*

6.6.2.3.1 Landings

The landings of Piked dogfish by countries are given in Table 6.6.2.3.1.1.

Table 6.6.2.3.1.1. Piked dogfish landings by countries (FAO Fisheries Statistics, GFCM Capture Production 2006 – 2008, BSC data, input from experts).

Year	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine	TOTAL
1989	28	217.000	30	135.000	4558	1191.000	**6159.000**
1990	16	128.000	45	183.000	1059	1330.000	**2761.000**
1991	21	18.000	26	67.000	2017	775.000	**2924.000**
1992	15	14.000	52	15.000	2220	595.000	**2911.000**
1993	12	131.000	6	5.000	1055	409.000	**1618.000**
1994	12	45.000	2	11.000	2432	148.000	**2650.000**
1995	80	31.000	7	90.000	1562	67.000	**1837.000**
1996	64	71.000	5	19.000	1748	44.000	**1951.000**
1997	40	1.000	5	9.000	1510	20.000	**1585.000**
1998	28	550.000	5	6.000	855	38.000	**1482.000**
1999	25	18.000	5	9.000	1478	94.000	**1629.000**
2000	102	21.000	5	12.000	2390	71.000	**2601.000**
2001	126	27.000	5	27.000	576	134.000	**895.000**
2002	100	65.000	5	19.000	316	97.000	**602.000**
2003	51.3	40.000	5	29.000	184	172.000	**481.300**
2004	47.2	31.000	5	34.000	211	93.000	**421.200**
2005	14.5	35.000	5	19.000	102	75.000	**250.500**
2006	6.226	10.000	9	17.000	193	67.000	**302.226**
2007	23.98	2.000	17	32.000	91	45.000	**210.980**
2008	22.75	0.400	10	59.000	35	79.000	**206.150**
2009	9.46	1.500	4	14.000	159	47.000	**234.960**
2010	42	1.500	3	8.540	16	27.000	**98.040**
2011	38.06	1.500	4	3.610	26.5	30.537	**104.207**

6.6.2.3.2 Discards

Discarding may play a major role in the catch of piked dogfish. However, the EWG 12-16 has no quantitative information.

6.6.2.4 Fishing effort

The EWG 12-16 has no quantitative information for all riparian countries. In 2011, only Romania gives data regarding number of gillnets on vessel length:

Table 6.6.2.4.1 Number of fishing gillnets for dogfish in the Romanian area

Vessel length (m)	Number of gillnets for dogfish
< 6m	10
6-12 m	205
18-24 m	50
Total	265

6.6.2.5 *Commercial CPUE*

The EWG 12-16 has no quantitative information for all riparian countries. In last years, only Romania gives data regarding commercial CPUE for 2009-2011 period and CPUE in at sea surveys for 2010 and 2011.

Table 6.6.2.5.1 Romanian CPUE in commercial fishing.

YEAR	**Fishing gear**	**CPUE**
2009		
LOA 6-12 m	gillnets	0.24 kg/gear/day
LOA 18-24 m	gillnets	0.40 kg/gear/day
LOA 24-40 m	gillnets	0.89 kg/gear/day
2010		
LOA 6-12 m	gillnets	0.18 kg/gear/day
2011		
LOA 6-12 m	gillnets	0.248kg/gear/day
LOA 18-24 m	gillnets	0.91 kg/gear/day

Table 6.6.2.5.2 CPUE in the at sea surveys for Romanian Black Sea areas

YEAR	2010		2011	
Period	Spring	Autumn	Spring	Autumn
Range (kg/hour)	3.6 – 98.63	4.5 – 106.22	5.8 – 24.9	5.0 -24.83

6.6.3 Scientific Surveys

6.6.3.1 *Method 1: International and national surveys*

The following section describes results of various fisheries independent scientific surveys.

6.6.3.1.1 Geographical distribution patterns

In Romanian waters the agglomerations are distributed on the entire shelf, but especially at depth deeper than 20m. Two peaks of intense spawning and of birth of juveniles are in spring and autumn period at Romanian littoral.

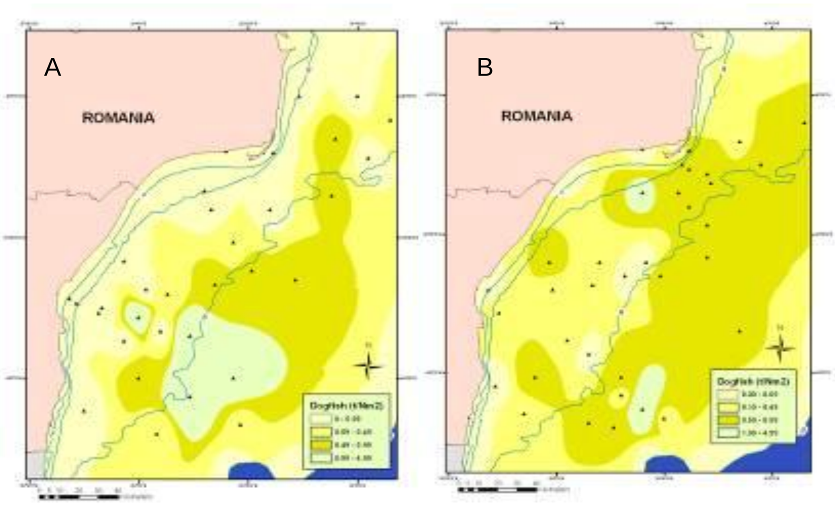


Fig. 6.6.3.1.1.1. Distribution of picked dogfish agglomeration during demersal trawl survey in 2009 (A - spring season, B - autumn season), Romanian Black Sea area.

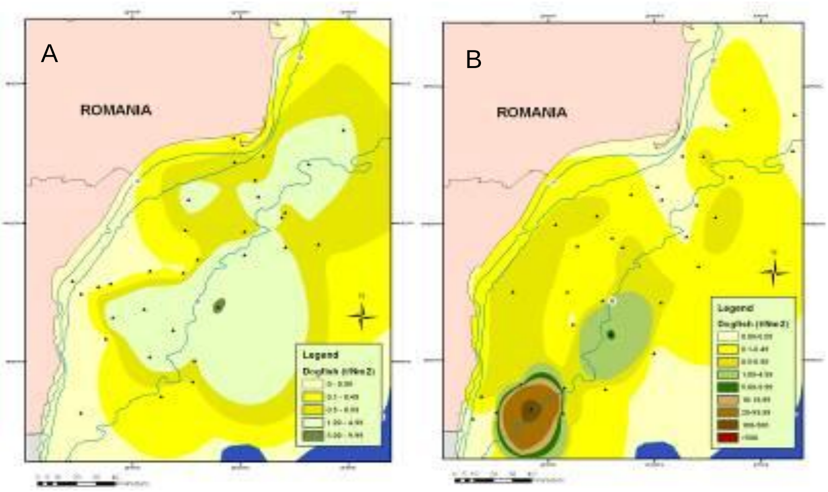


Fig. 6.6.3.1.1.2. Distribution of piked dogfish catches during demersal trawl survey in 2010 (A - spring season, B - autumn season), Romanian Black Sea area.

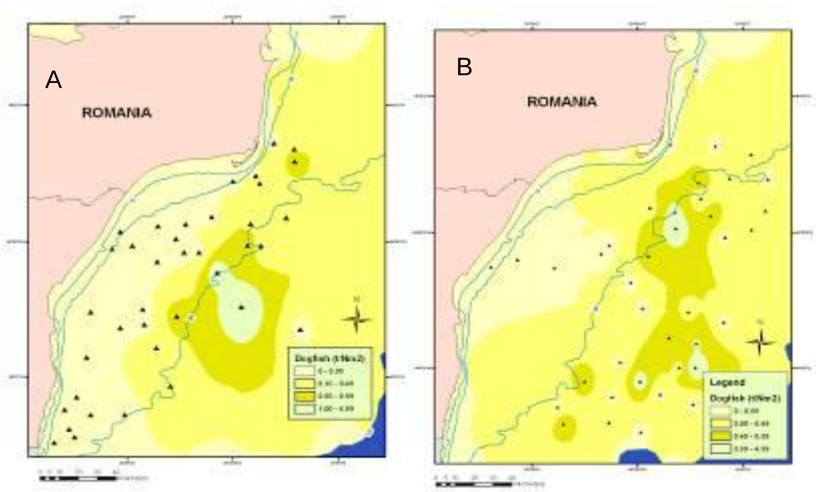


Fig. 6.6.3.1.1.3. Distribution of piked dogfish catches during demersal trawl survey in 2011 (A - spring season, B - autumn season), Romanian Black Sea area.

6.6.3.1.2 Trends in abundance and biomass

In the former USSR and later in Ukraine, to assess the piked dogfish stock, the swept area technique using bottom trawl surveys, as well as dynamic model of an isolated population, were applied (Shlyakhov, 1997). The abundance and biomass of picked dogfish in the waters adjacent to Georgia, the Russian Federation and Ukraine were assessed. Whole population of picked dogfish in 1972 – 1992 was assessed by VPA. The obtained results from stock assessments for whole Black Sea (Prodanov *et al.*, 1997, Daskalov 1998, Fig. 6.6.3.1.2.1), the former USSR and Ukrainian waters (Shlyakhov, Charova, 2006) in 1989 – 2005 are given in Table 6.6.3.1.2.1. According to the assessments, in 1989 – 2005 the stock of picked dogfish in the shelf area of the Black Sea and in Ukraine waters tends to be gradually reduced. Observed dynamics of stock corresponds with increasing CPUE in Turkish waters.

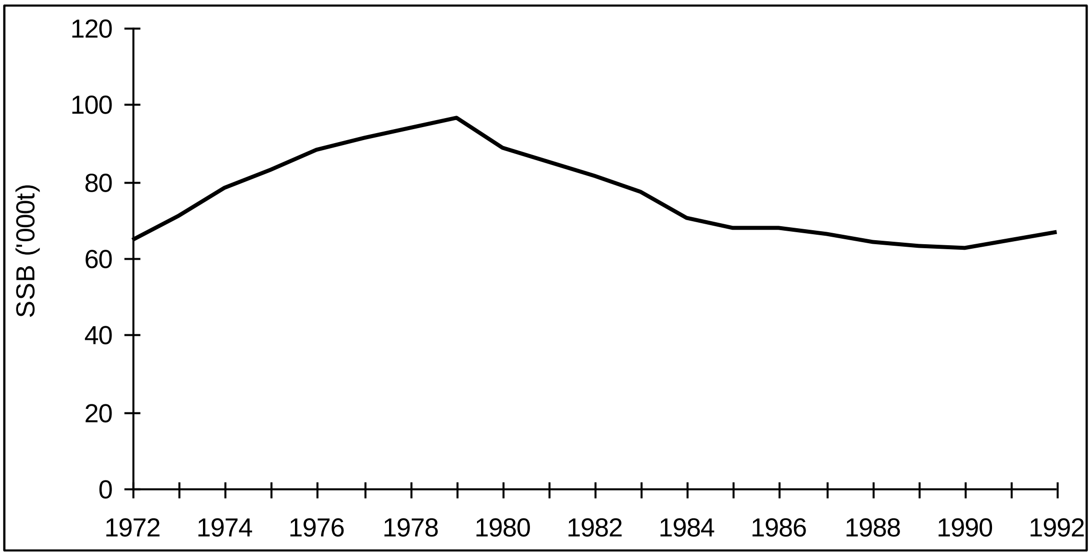


Fig. 6.6.3.1.2.1 Historical assessment of SSB by Daskalov (1998)

Table 6.6.3.1.2.1. Commercial stock of picked dogfish in the Black Sea and along the coast of the former USSR and in the water of Ukraine, th. tones.

Years	**Whole Black Sea shelf**	**Waters of Ukraine, the Russian Federation and Georgia**		**Waters of Ukraine**	
	VPA	**Trawl survey**	**Modeling**	**Trawl survey**	**Modeling**
1989	117.8	58.5	63.5	34.6	-
1990	112.9	58.7	63.2	48.8	-
1991	97.9	17.2/69.9*	64.0	14.4/58.5*	-
1992	90.0	62.9	60.3	56.9	-
1993	-	-	57.1	30.2	-
1994	-	-	52.9	36.0	42.1
1995	-	-	-	-	37.6
1996	-	-	-	-	32.1
1997	-	-	-	-	31.0
1998	-	-	-	32.0	30.8
1999	-	-	-	-	28.0
2000	-	-	-	-	24.3
2001	-	-	-	-	22.3
2002	-	-	-	-	21.0
2003	-	-	-	-	22.1
2004	-	-	-	-	22.3
2005	-	-	-	-	21.0

* stock assessment is reduced to the average area of the registration (survey) zone.

According to the assessments of Prodanov *et al.* (1997) and Daskalov (1998) picked dogfish stock has increased until 1981, after that it began to decrease. The authors explained the increase in picked dogfish with the increased abundance of main food species (whiting, sprat, anchovy and horse mackerel), and its subsequent reduction partially with intensification of the dogfish fishery during the period 1979 – 1984.

In Romanian waters the swept area method was applied for stock assessment of piked dogfish. Results for estimated piked dogfish biomasses in May and November of 2009- 2011 in Romanian waters are given on Tab. 6.6.3.1.2.2 - 6.6.3.1.2.7 (Maximov et al.2010b,c; Radu et al. 2009 a,b, 2010a,b). In May 2009 the biomass of dogfish was evaluated at 741 t, extrapolated to 967 t for the shelf till 50 Nm from the shore. In May 2010 the biomass of dogfish was evaluated at 2437 t, extrapolated to 5635 t for the shelf till 50 Nm from the shore. In the autumn period the biomass agglomeration increased at 2541 t (2009) and 13051 tons (2010).

Table 6.6.3.1.2.2 Assessment of piked dogfish biomass in May 2009 by demersal trawl, Romanian Black Sea area.

No. polygon	Surveyed area (Nm^2)	Range (t/Nm^2)	Average (t/Nm^2)	Total t in polygon (t)	Notes
1	1,227.13	0.00	0.00	0.0	Extrapolated at 967 t for the shelf till 50 Nm from shore
2	242.25	0.27 – 0.43	0.35	84.78	
3	165.00	0.23 – 0.28	0.26	42.90	
4	116.00	0.28	0.28	32.48	
5	724.25	0.53 0.76	0.63	456.27	
6	478.25	0.23 – 0.28	0.26	124.35	
7	265.63	0.00	0.0	0.00	
Total	3,218.5			740.78	

Table 6.6.3.1.2.3 Assessment of dogfish agglomeration in the Romanian area in the period May –June 2010, sampling gear demersal trawl

No. polygon	Polygon area (Nm^2)	Range (t/Nm^2)	Average (t/Nm^2)	Total tons in polygon(t)	Total on the shelf (t)
1	630.50	0.00	0.00	0.00	Extrapolated at 5635 tons for the shelf till 50 Nm from shore (about 5000 Nm2), including the new area (near Snake Island)
2	567.75	0.21-1.41	0.63	357.68	
3	216.75	0.24-0.68	0.47	101.87	
4	1155.00	0.56-5.62	2.11	2437.00	
Total	2570			2897.00	

Table 6.6.3.1.2.4. Assessment of picked dogfish biomass by demersal trawl in November 2009, Romanian Black Sea area.

No. polygon	Surveyed Area(Nm^2)	Range (t/Nm^2)	Average (t/Nm^2)	Total t in polygon (t)	Notes
1	926.25	0.26 – 0.81	0.41	379.76	Extrapolated at 2,541 t for the shelf till 50 Nm from shore
2	2,404.13	0.39 – 2.04	0.68	1,634.81	
Total	**3,330**			**2,015**	

Table 6.6.3.1.2.5 Assessment of dogfish agglomeration in the Romanian area in the period October –November 2010, sampling gear demersal trawl

No. polygon	Polygon area (Nm^2)	Range (t/Nm^2)	Average (t/Nm^2)	Total tons in polygon(t)	Total on the shelf (t)
1	40	164.48	164.48	6579.2	Extrapolated at 13051 tons for the shelf till 50 Nm from shore (about 5000 Nm2), including the new area (near Snake Island)
2	56	5.82	5.82	325.9	
3	1201	0.00-0.89	0.46	552.5	
4	315	0.00	0.00	0.00	
5	570	0.00	0.00	0.00	
6	868	0.28-1.01	0.58	503.44	
TOTAL	**3050**			**7961.04**	

Table 6.6.3.1.2.6 Assessment of dogfish agglomeration in the Romanian area in the spring 2011, sampling gear demersal trawl

Range of depths (m)	0 - 30	30-50	50-70	Total
Area (Nm^2)	675	1050	500	2225
Range of t/ Nm^2	0.00 – 0.00	0.00 – 1.11	0.00 – 2.53	
Biomass (t)	00.00	205.8	316	522.3*

* extrapolated at 1173 tons

Table 6.6.3.1.2.7 Assessment of dogfish agglomeration in the Romanian area in the autumn 2011, sampling gear demersal trawl

Range of depths (m)	**0 - 30**	**30-50**	**50-70**	**Total**
Area (Nm^2)	650	1225	1700	3575
Range of t/ Nm^2	0.00 – 0.00	0.00 – 1.53	0.00 – 2.53	
Biomass (t)	00.00	561.86	650.969	1212.8

* extrapolated at 1696 tons

6.6.3.1.3 Trends in abundance at length or age

Table 6.6.3.1.3.1 Indices of abundance at length of the piked dogfish over the Romanian littoral

			2008		**2009**		**2010**		**2011**	
		class (cm)	**%**	**Abundance (thousands)**	**%**	**Abundance (thousands)**	**%**	**Abundance (thousands)**	**%**	**Abundance (thousands)**
Year	**Biomass (t)**	89.5					1.00	17.62072219		
2008	883	92.5					0.00	0		
2009	2509	95.5					2.00	35.24144438		
2010	13051	98.5					2.99	52.86216657		
2011	1690	101.5					0.00	0	6.78	18.8960
Year	**Abundance (No.ind.)**	104.5	2.28	2.86822019	1.93	7.60112077	0.50	8.810361095	8.48	23.6200
2008	126067.217	107.5	1.51	1.90361497	8.21	32.3343013	7.98	140.9657775	16.95	47.2400
2009	393840.455	110.5	6.82	8.59549206	14.98	58.9973001	16.46	290.7419161	28.81	80.3090
2010	1766477.400	113.5	17.42	21.9609092	19.81	78.0197941	23.44	414.0869715	25.42	70.8610
2011	278718.000	116.5	28.04	35.3431352	27.05	106.533843	17.71	312.7678189	8.48	23.6200
		119.5	16.67	21.014259	16.43	64.7079867	9.73	171.8020414	3.39	9.4480
		122.5	14.39	18.1395444	7.24	28.5140489	4.49	79.29324986	0.00	0.0000
		125.5	6.82	8.59778419	1.93	7.60112077	2.99	52.86216657	1.70	4.7240
		128.5	2.27	2.86172582	0	0	8.73	154.1813192		
		131.5	2.27	2.86172582	1.45	5.71068659	2.00	35.24144438		
		134.5	1.52	1.9162217	0	0	0.00	0		
		137.5	0	0	0.97	3.82025241	0.00	0		
		Total	100	126.062633		393.840455		1766.4774		278.718

Table 6.6.3.1.3.2 The biomass at length of the piked dogfish over the Romanian littoral.

BIOMASS (t)								
	2008		**2009**		**2010**		**2011**	
class (cm)	**%**	**Biomass(t)**	**%**	**Biomass(t)**	**%**	**Biomass(t)**	**%**	**Biomass(t)**
89.5					0.41	52.86		
92.5					0.00	0.00		
95.5					0.91	118.50		
98.5					1.54	201.36		
101.5					0.00	0.00	6.476	109.8338510
104.5	0.93	8.24	1.27	31.86	0.30	38.59	7.654	129.8165260
107.5	1.03	9.09	6.74	169.08	5.32	693.93	15.373	260.7195790
110.5	5.11	45.16	13.80	346.17	12.82	1673.05	28.314	480.1983200
113.5	15.82	139.71	19.07	478.47	19.98	2607.85	26.826	454.9719650
116.5	27.11	239.37	27.13	680.81	16.97	2214.86	9.266	157.1450780
119.5	17.32	152.92	17.27	433.30	10.52	1372.70	4.003	67.8844060
122.5	16.29	143.83	8.43	211.57	6.18	806.90	0.000	0.0000000
125.5	8.03	70.90	2.28	57.19	5.02	655.49	2.089	35.4302750
128.5	2.81	24.79	0.00	0.00	15.99	2087.18		

131.5	2.96	26.11	1.90	47.57	4.04	527.74		
134.5	2.59	22.88	0.00	0.00	0.00	0.00		
137.5	0.00	0.00	2.11	52.94	0.00	0.00		
Total		883.00		2508.97		13051.00		1690.000

The population data of picked dogfish at the Romanian Black Sea area are given in the figures bellow – Length frequency data - Figs. 6.6.3.1.3.1 - Fig. 6.6.3.1.3.7 (Maximov et al.,2010a,c; Radu et al., 2010a).

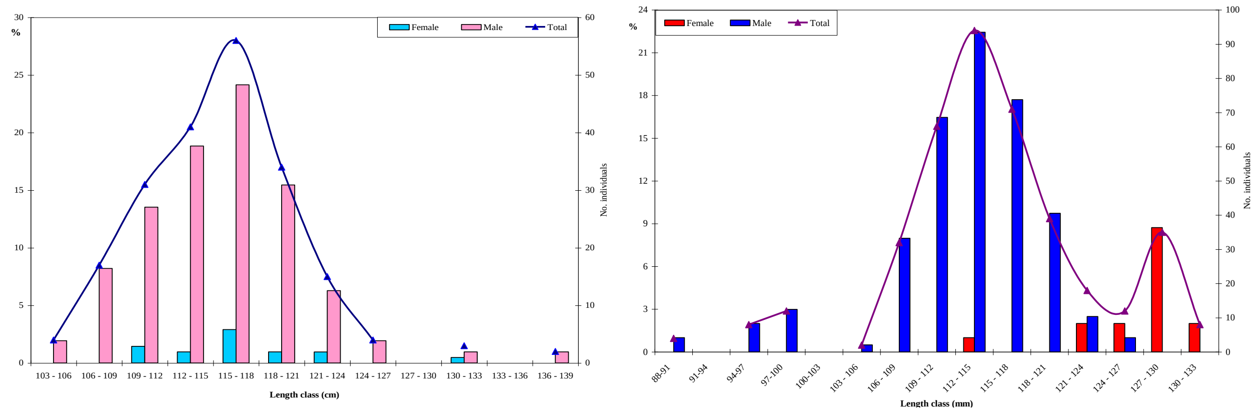


Fig. 6.6.3.1.3.1 Length frequency of piked dogfish in 2009 and in 2010, Romanian Black Sea area.

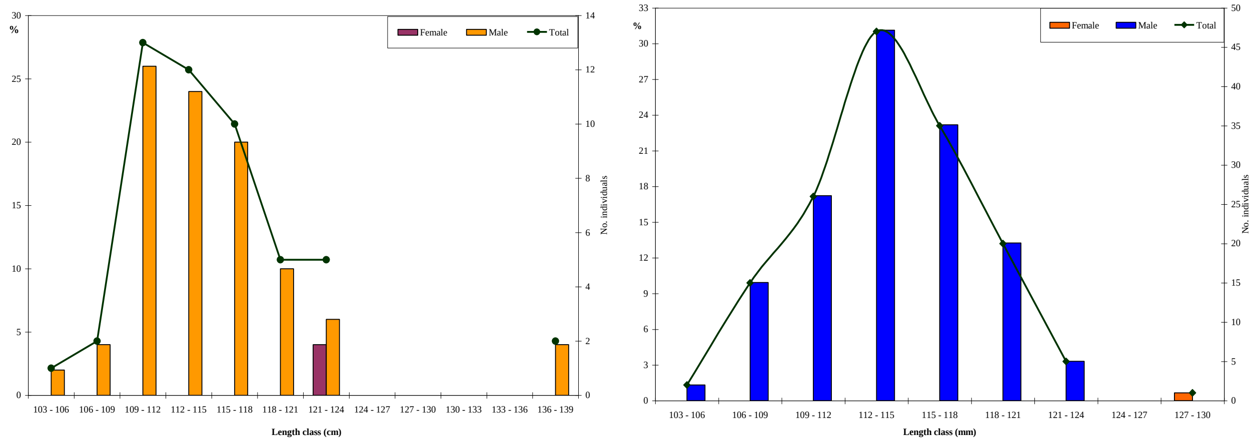


Fig. 6.6.3.1.3.2 Length frequency of piked dogfish in May 2009, in May 2010 at Romanian marine area.

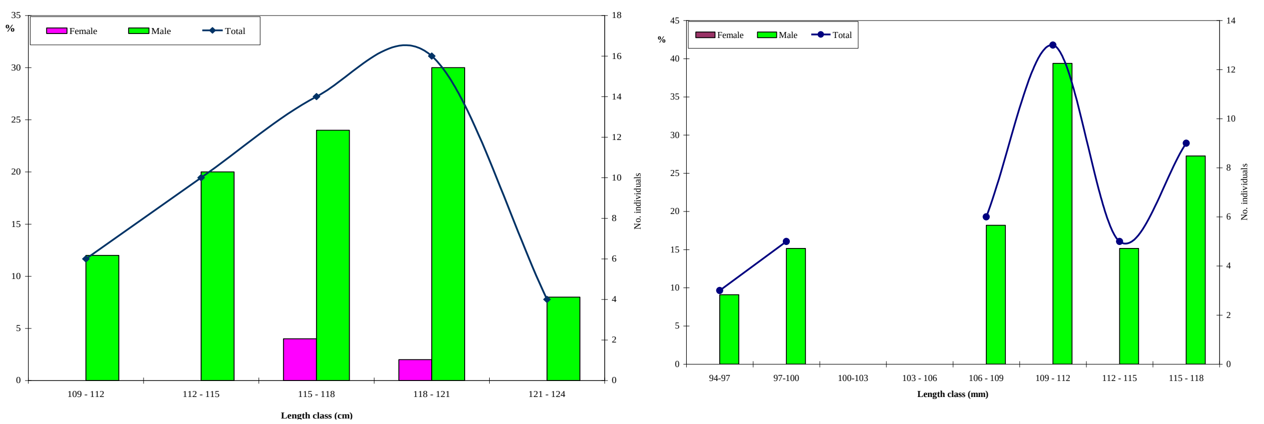


Fig. 6.6.3.1.3.3 Length frequency of piked dogfish in June 2009 and in June 2010 at Romanian marine area.

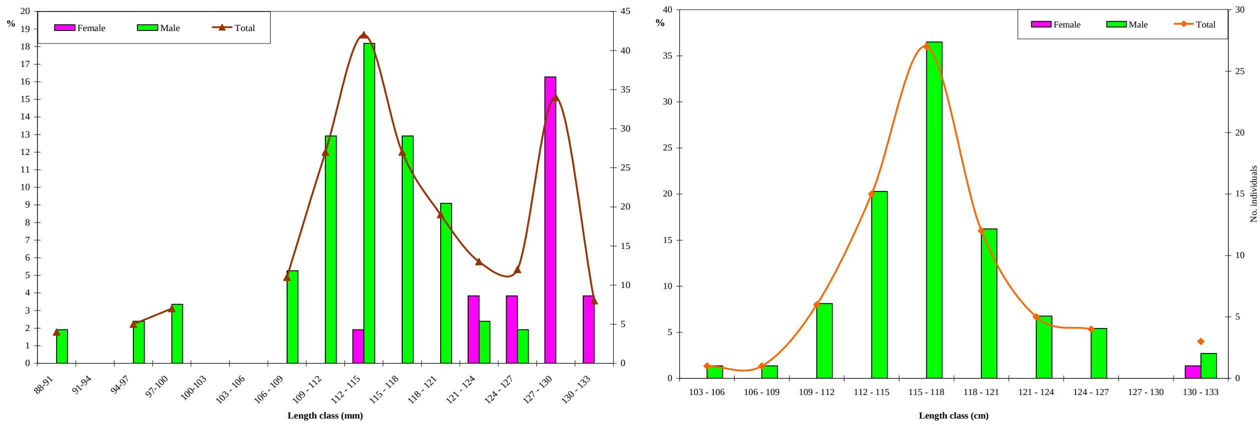


Fig. 6.6.3.1.3.4 Length frequency of piked dogfish in November 2009 and in November 2010.

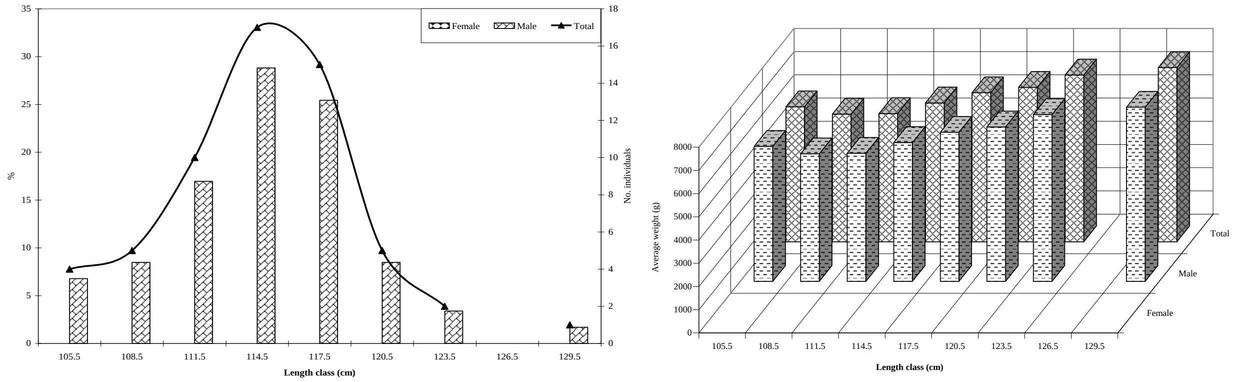


Fig. 6.6.3.1.3.5 Structure on length classes and average weight for dogfish at Romanian marine area in 2011.

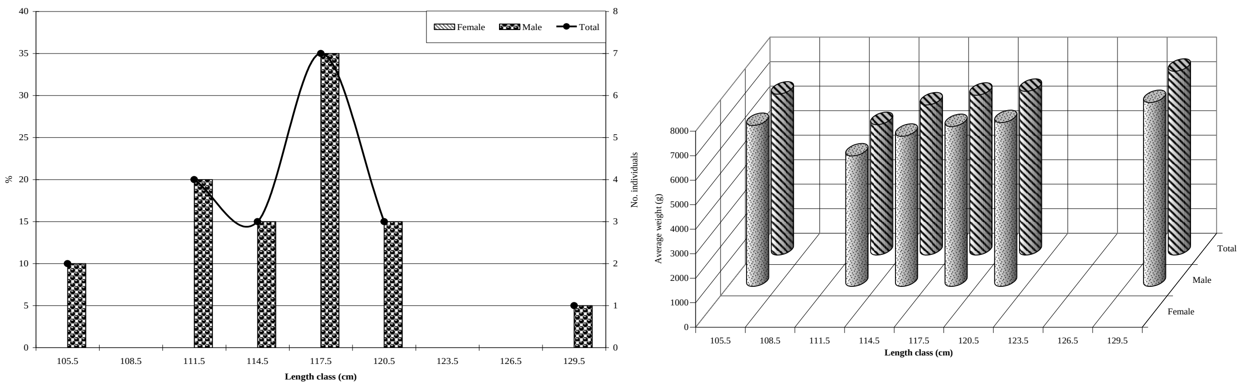


Fig. 6.6.3.1.3.6 Structure on length classes for dogfish at Romanian marine area in 2011, spring period

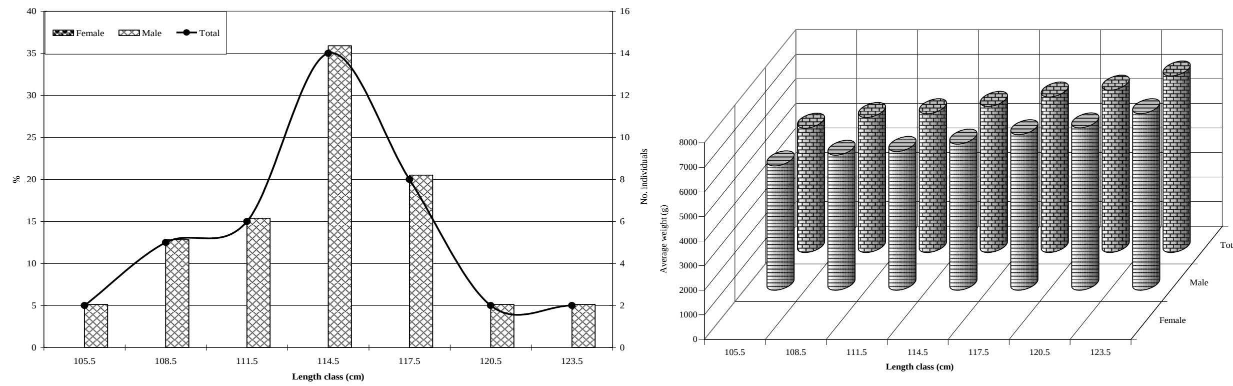


Fig. 6.6.3.1.3.7 Structure on length classes and average weight for dogfish at Romanian marine area in 2011, autumn period.

Table 6.6.3.1.3.3 Romanian catches in numbers of individuals by length classes.

		Catches in number of individuals and tons per length classes						
Year	**Catches (t)**		**2008**		**2009**		**2010**	
2008	**10.283**	**class (cm)**	**%**	**Abundance**	**%**	**Abundance**	**%**	**Abundance**
2009	4.27	89.5					1.00	4
2010	3.069	92.5					0.00	0
		95.5					2.00	8
year	Abundance (No.ind.)	98.5					2.99	12
2008	1468	101.5					0.00	0
2009	670	104.5	2.28	33	1.93	13	0.50	2
2010	415	107.5	1.51	22	8.21	55	7.98	33
		110.5	6.82	100	14.98	100	16.46	68
		113.5	17.42	256	19.81	133	23.44	97
		116.5	28.04	412	27.05	181	17.71	74
		119.5	16.67	245	16.43	110	9.73	40
		122.5	14.39	211	7.24	49	4.49	19
		125.5	6.82	100	1.93	13	2.99	12
		128.5	2.27	33	0	0	8.73	36
		131.5	2.27	33	1.45	10	2.00	8
		134.5	1.52	22	0	0	0.00	0
		137.5	0	0	0.97	7	0.00	0
		Total	100.00	1468	100	670	100.00	415

6.6.3.1.4 Trends in growth

No data available or analyses undertaken.

6.6.3.1.5 Trends in maturity

In Romanian waters the overall sex ratio of males was significantly positive with a rate of 84.29% compared to only 15.61 % females. In Bulgarian waters, the majority of the piked dogfish were females.

6.6.4 Assessment of historic parameters

6.6.4.1 *Justification*

EWG 12-16 used the VIT program for estimation of abundance and fishing mortality and YPR-LEN (NOAA Fisheries Toolbox Version 3.1) for obtaining the reference points for dogfish in the Black Sea.

The program VIT is conceived for the analysis of fisheries where the available information is limited. VIT is designed for the analysis of marine populations, exploited by one or several gears, based on single species' catch data (structured by age or size). The main assumption underlying the model is that of steady state, because the program works with pseudo-cohorts and it is therefore not suitable for historical data series.

The program uses the catch data and ancillary parameters for rebuilding the population of the species and the mortality vectors affecting it by means of Virtual Population Analysis (VPA).

Once the virtual population has been rebuilt, an analysis of the fishery can be carried out with the aid of several tools: Comprehensive VPA results, Yield-per-Recruit analysis based on the fishing mortality vector, analysis of sensitivity to parameter values and transition analysis. The latter permits non-equilibrium analysis of how a shift in exploitation regime is reflected in the fisheries. All these tools can be applied to specific studies of competition among fishing gears.

6.6.4.2 *Input data available*

Given the practice of previous studies, the picked dogfish can be assessed using age-structured methods (Prodanov et al. 1997, Shlyakhov, 1997, Daskalov 1998). Fisheries, biological (age and individual size and growth), trawl survey data and commercial CPUE from all countries need to be thoroughly compiled (Table 6.6.4.2.1).

At the first stage data must be carefully screened and organized into age structured matrices.

Table 6.6.4.2.1 Ukrainian dogfish age/length key (1996-1997).

1996					**A/SL key**								
	81-85	**86-90**	**91-95**	**96-100**	**101-105**	**106-110**	**111-115**	**116-120**	**121-125**	**126-130**	**131-135**	**136-140**	
6	0.036	0.01	0.009										
7	0.131	0.07	0.044										
8	0.298	0.18	0.132	0.0402	0.034	0.01							
9	0.274	0.26	0.228	0.1609	0.092	0.043		0.011					
10	0.143	0.33	0.237	0.2414	0.169	0.086	0.053	0.033					
11	0.119	0.09	0.184	0.2586	0.179	0.187	0.152	0.065	0.013	0.03704			
12		0.02	0.123	0.1897	0.217	0.211	0.181	0.054	0.038	0.04938			
13		0.01	0.044	0.0977	0.217	0.201	0.158	0.087	0.114	0.07407			
14		0.01		0.0115	0.092	0.177	0.24	0.185	0.228	0.08642			
15						0.072	0.181	0.413	0.165	0.23457			
16						0.014	0.035	0.109	0.278	0.22222	0.1111	0.25	
17								0.043	0.139	0.20988	0.2778	0.375	
18									0.025	0.08642	0.3889	0.125	0.25
19											0.1667	0.125	0.375
20											0.0556	0.125	0.125
21												0.166667	0.125
22												0.055556	0.125

1997					**A/SL key**							
	81-85	**86-90**	**91-95**	**96-100**	**101-105**	**106-110**	**111-115**	**116-120**	**121-125**	**126-130**	**131-135**	**136-140**

6	0.0357	0.0115	0.0088										
7	0.131	0.069	0.0439										
8	0.2976	0.1839	0.1316	0.0402	0.0338	0.0096							
9	0.2738	0.2644	0.2281	0.1609	0.0918	0.0431		0.011					
10	0.1429	0.3333	0.2368	0.2414	0.1691	0.0861	0.0526	0.033					
11	0.119	0.092	0.1842	0.2586	0.1787	0.1866	0.152	0.065	0.013	0.037			
12		0.023	0.1228	0.1897	0.2174	0.2105	0.1813	0.054	0.038	0.0494			
13		0.0115	0.0439	0.0977	0.2174	0.201	0.1579	0.087	0.114	0.0741			
14		0.0115		0.0115	0.0918	0.177	0.2398	0.185	0.228	0.0864			
15						0.0718	0.1813	0.413	0.165	0.2346			
16						0.0144	0.0351	0.109	0.278	0.2222	0.1111	0.25	
17								0.043	0.139	0.2099	0.2778	0.375	
18									0.025	0.0864	0.3889	0.125	0.25
19											0.1667	0.125	0.375
20											0.0556	0.125	0.125
21												0.1667	0.125
22												0.0556	0.125

6.6.4.3 *Results*

The VIT software was applied to assess population parameters based on pseudocohort analyses of average 1989-2011 data (Table 6.6.4.3.1) and 2011 data (Table 6.6.4.3.2). In the first variant the main share in total catch was represented by Turkey and Ukraine and in the last option the main share is divided between Bulgaria, Turkey and Ukraine. Three scenarios were run with M = 0.1, M=0.15, and, M = 0.2. The presented results are with M = 0.15.

From average of the catches by countries in the last 23 years (1989-2011), have been obtained Fc = 0.255, and SSB = 410 579 t, while for 2011 data the Fc = 0.262, SSB = 14 776t.

Comparing the obtained results it seems that in a period of 20 years the stock biomass has decreased almost of 30 times. On the other hand historical estimates for 1972-1992 (including a period of pre-industrial exploitation) using XSA and tuned by survey data have shown maximum SSB of about 100 000t (Fig. 6.6.3.1.1, Daskalov 1998) that is 4 times less than the average SS B estimated here for 1989-2011.

Table 6.6.4.3.1 Summary results for 1989 -2011 data

---	Catch mean age	Catch mean length	Mean F	Global F	Total catch	Catch/ D%	Catch/ B%	B/R	28368.24
Total	13.985	130.65	0.255	0.069	1.04E+11	38.4	9.36	SSB/R	10489.63
BG	14.69	133.811	0	0	1.79E+08	0.07	0.02	Y/R	2654.105
GE	13.984	130.646	0.001	0	3.4E+08	0.13	0.03	Y/R BG	4.568
RO	14.69	133.811	0	0	14769381	0.01	0	Y/R GE	8.699
RF	13.984	130.643	0	0	1.08E+08	0.04	0.01	Y/R RO	0.377
TR	13.984	130.644	0.241	0.065	9.81E+10	36.28	8.84	Y/R RF	2.766
UK	13.984	130.645	0.013	0.003	5.09E+09	1.88	0.46	Y/R TR	2507.542
								Y/R UK	130.152

Current Stock Mean Age	10.353
Current Stock Critical Age	8
Virgin Stock Critical Age	8
Current Stock Mean Length	116.558
Current Stock Critical Length	105.63
Virgin Stock Critical Length	105.63
Number of recruits, R	39141358.44

Mean Biomass, Bmean (g)	1.11037E+12
Spawning Stock Biomass, SSB (g)	4.10579E+11
Biomass Balance, D	2.70558E+11
Natural death/D	61.6
Bmax/Bmean	14.09
Turnover, D/Bmean	24.37

Table 6.6.4.3.2 Full Results for 1989-2011 data

Class	**Lower Age**	**Mean Age**	**Lower Length**	**Mean Length**	**Lower Weight**	**Mean Weight**	**Maturity ratio**
1	7	7.487	99.081	102.338	3898.445	4266.985	0
2	8	8.487	105.63	108.515	4653.802	5016.931	0
3	9	9.486	111.439	113.996	5396.798	5748.829	0.1
4	10	10.484	116.591	118.847	6115.671	6450.664	0.25
5	11	11.481	121.161	123.151	6802.042	7117.266	0.45
6	12	12.48	125.213	126.976	7450.331	7745.415	0.55
7	13	13.475	128.808	130.354	8057.211	8328.644	0.75
8	14	14.474	131.996	133.363	8621.11	8871.348	0.95
9	15	15.466	134.823	136.018	9141.802	9368.278	1
10	16	16.439	137.331	138.329	9620.052	9815.186	1
11	17	17.423	139.555	140.41	10057.34	10229.12	1
12	18	18.426	141.528	142.291	10455.62	10612.59	1
13	19	19.453	143.277	143.995	10817.17	10968.08	1
+	20	---	144.829	---	11144.4	---	
Catch in Numbers							
Class	Total catch	Catch of BG	Catch of GE	Catch of RO	Catch of RF	Catch of TR	Catch of UK
1	78392.14	0	257.4	0	82.28	74203.58	3848.88
2	330653.4	0	1085.37	0	346.06	312980.4	16241.61
3	364968.72	0	1196.91	0	379.94	345458.1	17933.79
4	1001747.62	0	3290.43	0	1045.44	948189.2	49222.53
5	1378928.5	0	4525.95	0	1439.9	1305226	67736.97
6	1211428.84	1395.24	3972.54	115.71	1263.24	1145240	59441.97
7	1640523.26	1796.9	5379.66	147.9	1710.94	1550993	80494.68
8	1325178.91	9177.78	4320.03	757.77	1374.56	1244931	64618.05
9	1427689.47	6583.6	4663.23	543.75	1483.46	1344621	69794.13
10	1893888.41	597.96	6216.21	49.59	1977.14	1792027	93020.13
11	1095255.16	398.64	3595.02	33.06	1142.24	1036301	53784.78
12	413904.05	0	1359.93	0	433.18	391771.6	20339.34
13	105323.05	0	347.49	0	108.9	99690.58	5176.08
Total	12267881.53	19950.12	40210.17	1647.78	12787.28	11591633	601652.9
Mean Age	13.985	14.69	13.984	14.69	13.984	13.984	13.984
Mean Length	130.65	133.811	130.646	133.811	130.643	130.644	130.645
Catch in Weight							
Class	Total catch	Catch of BG	Catch of GE	Catch of RO	Catch of RF	Catch of TR	Catch of UK
1	334498112.7	0	1098322	0	351087.6	3.17E+08	16423115
2	1658865203	0	5445226	0	1736159	1.57E+09	81483032
3	2098142736	0	6880831	0	2184210	1.99E+09	1.03E+08
4	6461937619	0	21225459	0	6743782	6.12E+09	3.18E+08
5	9814200836	0	32212390	0	10248151	9.29E+09	4.82E+08

6	9383019004	10806713	30768971	896222	9784318	8.87E+09	4.6E+08	
7	13663334145	14965740	44805273	1231806	14249810	1.29E+10	6.7E+08	
8	11756122994	81419278	38324489	6722441	12194200	1.1E+10	5.73E+08	
9	13374992565	61676998	43686437	5094001	13897466	1.26E+10	6.54E+08	
10	18588867834	5869089	61013260	486735.1	19405998	1.76E+10	9.13E+08	
11	11203500010	4077738	36773903	338174.8	11684114	1.06E+10	5.5E+08	
12	4392592995	0	14432376	0	4597161	4.16E+09	2.16E+08	
13	1155191875	0	3811299	0	1194424	1.09E+09	56771671	
Total	1.03885E+11	1.79E+08	3.4E+08	14769381	1.08E+08	9.81E+10	5.09E+09	
Percentage	---	0.17	0.33	0.01	0.1	94.48	4.9	
VPA Results--Numbers								
Class	Initial number	Mean number						
1	39141358.44	36308964						
2	33616621.72	31055382						
3	28627661.09	26405719						
4	24301834.53	22075147						
5	19988814.92	17881446						
6	15927669.53	14192095						
7	12587426.41	10870011						
8	9316401.56	7988368						
9	6792967.49	5583954						
10	4527684.87	3195532						
11	2154466.6	1401817						
12	848938.93	559961.5						
13	345441.04	263307.6						
Total	---	1.78E+08						
Stock Mean Age	---	10.353						
Stock Mean Length	---	116.558						
VPA Results--Weight								
Class	Initial Weight	Mean Weight						
1	1.5259E+11	1.55E+11						
2	1.56445E+11	1.56E+11						
3	1.54498E+11	1.52E+11						
4	1.48622E+11	1.42E+11						
5	1.35965E+11	1.27E+11						
6	1.18666E+11	1.1E+11						
7	1.0142E+11	9.05E+10						
8	80317722015	7.09E+10						
9	62099961522	5.23E+10						
10	43556562568	3.14E+10						
11	21668196747	1.43E+10						
12	8876182849	5.94E+09						
13	3736695082	2.89E+09						
Total	---	1.11E+12						
SSB	---	4.11E+11						
VPA Results--Mortalities								
Class	Z	Total F	F of BG	F of GE	F of RO	F of RF	F of TR	F of UK
1	0.152	0.002	0	0	0	0	0.002	0
2	0.161	0.011	0	0	0	0	0.01	0.001
3	0.164	0.014	0	0	0	0	0.013	0.001
4	0.195	0.045	0	0	0	0	0.043	0.002

5	0.227	0.077	0	0	0	0	0.073	0.004
6	0.235	0.085	0	0	0	0	0.081	0.004
7	0.301	0.151	0	0	0	0	0.143	0.007
8	0.316	0.166	0.001	0.001	0	0	0.156	0.008
9	0.406	0.256	0.001	0.001	0	0	0.241	0.012
10	0.743	0.593	0	0.002	0	0.001	0.561	0.029
11	0.931	0.781	0	0.003	0	0.001	0.739	0.038
12	0.899	0.739	0	0.002	0	0.001	0.7	0.036
13	0.57	0.4	0	0.001	0	0	0.379	0.02
Mean Mort. rates	0.408	0.255	0	0.001	0	0	0.241	0.013
Global Fs	---	0.069	0	0	0	0	0.065	0.003
---	Critical age	Critical length						
Current stock	8	105.63						
Virgin stock	8	105.63						
Total Biomass balance (D): 270558147815.89								
---	Biomass	Percentage						
Recruitment	1.5259E+11	56.4						
Growth	1.17968E+11	43.6						
Natural death	1.66673E+11	61.6						
Fishing	1.03885E+11	38.4						
R/B(mean)	13.74							
D/B(mean)	24.37							
B(max)/B(mean)	14.09							
B(max)/D	57.82							

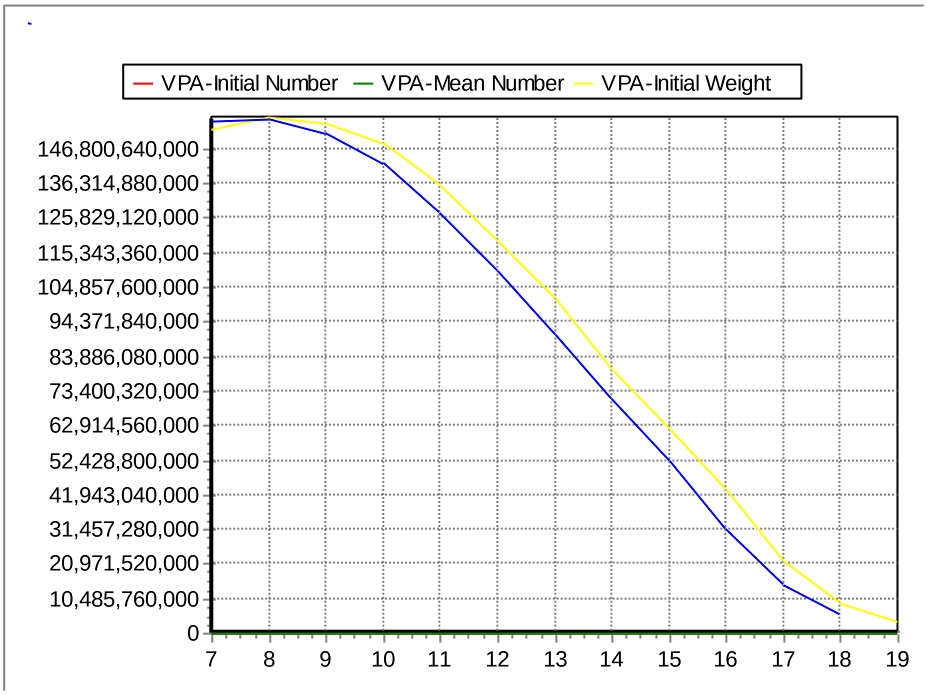


Fig. 6.6.4.3.1. VPA per age classes for Black Sea Dogfish, 1989-2011 data.

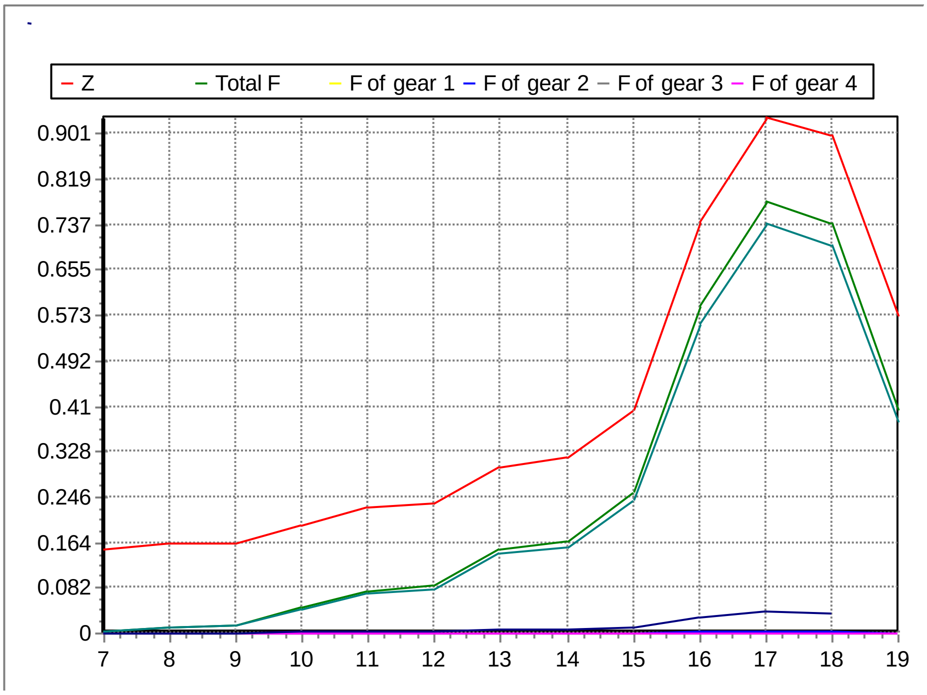


Fig. 6.6.4.3.2 Total mortality and Fishing mortality by countries (fishing gears), 1989-2011 data.

Table 6.6.4.3.3 Summary results for 2011 data.

---	Catch mean age	Catch mean length	Mean F	Global F	Total catch	Catch/D %	Catch/B %	B/R	28367.25
Total	13.983	130.642	0.255	0.069	3.74E+09	38.4	9.36	SSB/R	10490.63
BG	13.983	130.642	0.119	0.032	1.74E+09	17.86	4.35	Y/R	2653.883
GE	13.983	130.658	0	0	2707092	0.03	0.01	Y/R BG	1234.184
RO	13.979	130.623	0.001	0	19208570	0.2	0.05	Y/R GE	1.922
RF	13.994	130.679	0.001	0	15625151	0.16	0.04	Y/R RO	13.637
TR	13.983	130.641	0.058	0.016	8.43E+08	8.66	2.11	Y/R RF	11.093
UK	13.983	130.641	0.076	0.021	1.12E+09	11.5	2.8	Y/R TR	598.453
								Y/R UK	794.593

Current Stock Mean Age	10.353
Current Stock Critical Age	8
Virgin Stock Critical Age	8
Current Stock Mean Length	116.559
Current Stock Critical Length	105.63
Virgin Stock Critical Length	105.63
Number of recruits, R	1408513
Mean Biomass, Bmean(g)	39955644680
Spawning Stock Biomass, SSB (g)	14776182201
Biomass Balance, D	9735602356
Natural death/D	61.6
Bmax/Bmean	14.09
Turnover, D/Bmean	24.37

Table 6.6.4.3.4 Full Results for 2011 data

Class	Lower Age	Mean Age	Lower Length	Mean Length	Lower Weight	Mean Weight	Maturity ratio	
1.00	7.00	7.49	99.08	102.34	3898.45	4266.99	0.00	
2.00	8.00	8.49	105.63	108.52	4653.80	5016.93	0.00	
3.00	9.00	9.49	111.44	114.00	5396.80	5748.83	0.10	
4.00	10.00	10.48	116.59	118.85	6115.67	6450.66	0.25	
5.00	11.00	11.48	121.16	123.15	6802.04	7117.26	0.45	
6.00	12.00	12.48	125.21	126.98	7450.33	7745.41	0.55	
7.00	13.00	13.48	128.81	130.35	8057.21	8328.63	0.75	
8.00	14.00	14.47	132.00	133.36	8621.11	8871.39	0.95	
9.00	15.00	15.47	134.82	136.02	9141.80	9368.32	1.00	
10.00	16.00	16.44	137.33	138.33	9620.05	9815.19	1.00	
11.00	17.00	17.42	139.56	140.41	10057.34	10229.12	1.00	
12.00	18.00	18.43	141.53	142.29	10455.62	10612.62	1.00	
13.00	19.00	19.45	143.28	144.00	10817.17	10968.08	1.00	
+	20.00	---	144.83	---	11144.40	---		
Catch in Numbers								
Class	Total catch	Catch of BG	Catch of GE	Catch of RO	Catch of RF	Catch of TR	Catch of UK	
1.00	2827.64	1314.72	1.44	15.36	10.38	635.75	849.99	
2.00	11940.96	5551.04	8.64	61.44	48.44	2695.58	3575.82	
3.00	13172.77	6135.36	10.08	69.12	55.36	2975.31	3927.54	
4.00	36114.67	16799.20	25.92	184.32	152.24	8137.60	10815.39	
5.00	49722.15	23117.16	36.00	257.28	207.60	11214.63	14889.48	
6.00	43620.05	20268.60	31.68	222.72	183.38	9841.41	13072.26	
7.00	59083.82	27463.04	43.20	303.36	245.66	13325.32	17703.24	
8.00	47398.42	22058.08	34.56	241.92	197.22	10680.60	14186.04	
9.00	51202.31	23811.04	37.44	264.96	214.52	11545.22	15329.13	
10.00	68232.22	31735.88	48.96	349.44	283.72	15385.15	20429.07	
11.00	39480.39	18369.56	28.80	203.52	166.08	8900.50	11811.93	
12.00	14899.84	6938.80	10.08	76.80	62.28	3356.76	4455.12	
13.00	3800.05	1752.96	2.88	19.20	17.30	864.62	1143.09	
Total	441495.29	205315.44	319.68	2269.44	1844.18	99558.45	132188.10	
Mean Age	13.98	13.98	13.98	13.98	13.99	13.98	13.98	
Mean Length	130.64	130.64	130.66	130.62	130.68	130.64	130.64	
Catch in Weight								
Class	Total catch	Catch of BG	Catch of GE	Catch of RO	Catch of RF	Catch of TR	Catch of UK	
1.00	12065497.54	5609890.55	6144.46	65540.89	44291.30	2712735.73	3626894.60	
2.00	59906941.01	27849170.07	43346.26	308240.08	243020.01	13523531.78	17939632.81	
3.00	75727967.97	35271119.56	57948.17	397358.88	318255.03	17104540.68	22578745.65	
4.00	232963428.06	108365913.92	167201.09	1188985.50	982048.36	52492884.25	69766394.93	
5.00	353885289.53	164530754.60	256221.23	1831127.72	1477542.43	79817396.97	105972246.59	
6.00	337855197.95	156988629.43	245374.61	1725057.85	1420353.40	76225761.40	101250021.26	
7.00	492087529.58	228729616.81	359797.00	2526574.50	2046012.30	110981717.15	147443811.81	
8.00	420489862.56	195685827.24	306595.23	2146166.63	1749615.51	94751766.54	125849891.41	
9.00	479679678.38	223069467.16	350749.94	2482230.34	2009692.23	108159327.51	143608211.20	
10.00	669712407.08	311493786.74	480551.85	3429821.04	2784766.55	151008216.35	200515264.55	
11.00	403849602.06	187904412.70	294598.62	2081830.27	1698852.06	91044272.44	120825635.97	
12.00	158126365.84	73638859.70	106975.23	815049.35	660954.08	35624024.14	47280503.35	
13.00	41679260.96	19226609.46	31588.08	210587.18	189747.82	9483223.28	12537505.14	
Total	3738029028.52	1738364057.95	2707091.76	19208570.24	15625151.08	842929398.22	1119194759.27	
Percentage	---	46.50	0.07	0.51	0.42	22.55	29.94	
VPA Results--Numbers								
Class	Initial number	Mean number						

1.00	1408513.00	1306585.22						
2.00	1209697.58	1117510.37						
3.00	1030130.07	950156.79						
4.00	874433.78	794278.21						
5.00	719177.38	643301.56						
6.00	572959.99	510505.91						
7.00	452764.06	390951.04						
8.00	335037.58	287411.20						
9.00	244527.48	201107.25						
10.00	163159.08	115163.11						
11.00	77652.40	50522.07						
12.00	30593.70	20189.76						
13.00	12463.49	9500.12						
Total	---	6397182.61						
Stock Mean Age	---	10.35						
Stock Mean Length	---	116.56						
VPA Results--Weight								
Class	Initial Weight	Mean Weight						
1.00	5491010597.01	5575179555.83						
2.00	5629692694.15	5606469479.19						
3.00	5559404281.55	5462286447.14						
4.00	5347749460.75	5123618022.71						
5.00	4891874476.91	4578542143.15						
6.00	4268741733.67	3954077878.14						
7.00	3648015309.78	3256088246.25						
8.00	2888395809.42	2549736786.43						
9.00	2235421728.44	1884037309.76						
10.00	1569598808.89	1130348175.64						
11.00	780976313.30	516796223.56						
12.00	319876056.51	214266260.12						
13.00	134819758.31	104198152.41						
Total	---	39955644680.34						
SSB	---	14776182201.07						
VPA Results--Mortalities								
Class	Z	Total F	F of BG	F of GE	F of RO	F of RF	F of TR	F of UK
1.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	0.16	0.01	0.01	0.00	0.00	0.00	0.00	0.00
3.00	0.16	0.01	0.01	0.00	0.00	0.00	0.00	0.00
4.00	0.20	0.05	0.02	0.00	0.00	0.00	0.01	0.01
5.00	0.23	0.08	0.04	0.00	0.00	0.00	0.02	0.02
6.00	0.24	0.09	0.04	0.00	0.00	0.00	0.02	0.03
7.00	0.30	0.15	0.07	0.00	0.00	0.00	0.03	0.05
8.00	0.32	0.17	0.08	0.00	0.00	0.00	0.04	0.05
9.00	0.41	0.26	0.12	0.00	0.00	0.00	0.06	0.08
10.00	0.74	0.59	0.28	0.00	0.00	0.00	0.13	0.18
11.00	0.93	0.78	0.36	0.00	0.00	0.00	0.18	0.23
12.00	0.90	0.74	0.34	0.00	0.00	0.00	0.17	0.22
13.00	0.57	0.40	0.19	0.00	0.00	0.00	0.09	0.12
Mean Mort. rates	0.41	0.26	0.12	0.00	0.00	0.00	0.06	0.08
Global Fs	---	0.07	0.03	0.00	0.00	0.00	0.02	0.02
---	Critical age	Critical length						
Current stock	8.00	105.63						
Virgin stock	8.00	105.63						
Total Biomass balance (D): 9735602356.22								

---	Biomass	Percentage							
Recruitment	5491010597.01	56.40							
Growth	4244591759.21	43.60							
Natural death	5997573327.70	61.60							
Fishing	3738029028.52	38.40							
R/B(mean)	13.74								
D/B(mean)	24.37								
B(max)/B(mean)	14.09								
B(max)/D	57.83								

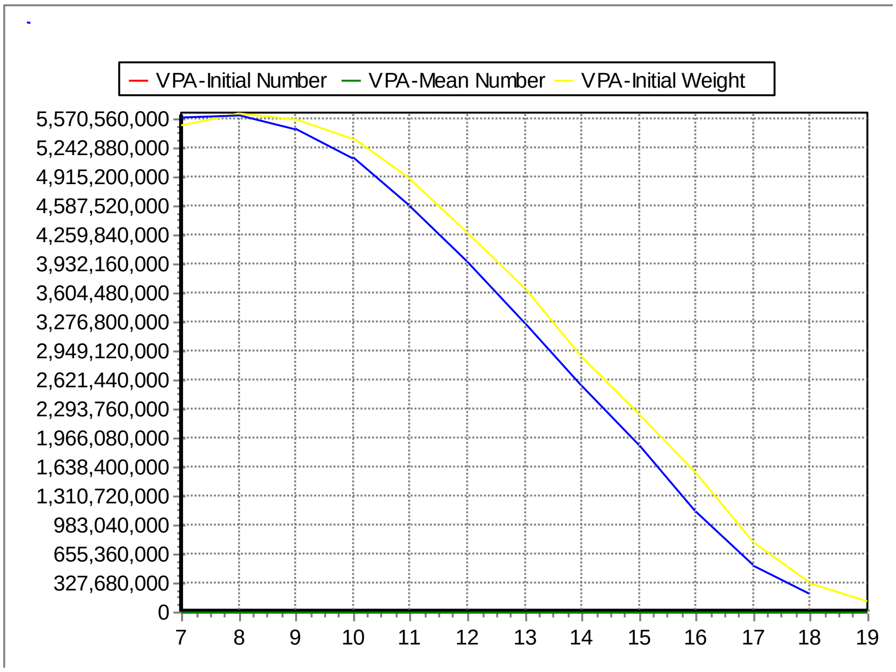


Fig. 6.6.4.3.3 VPA per age classes for Black Sea Dogfish, 2011 data

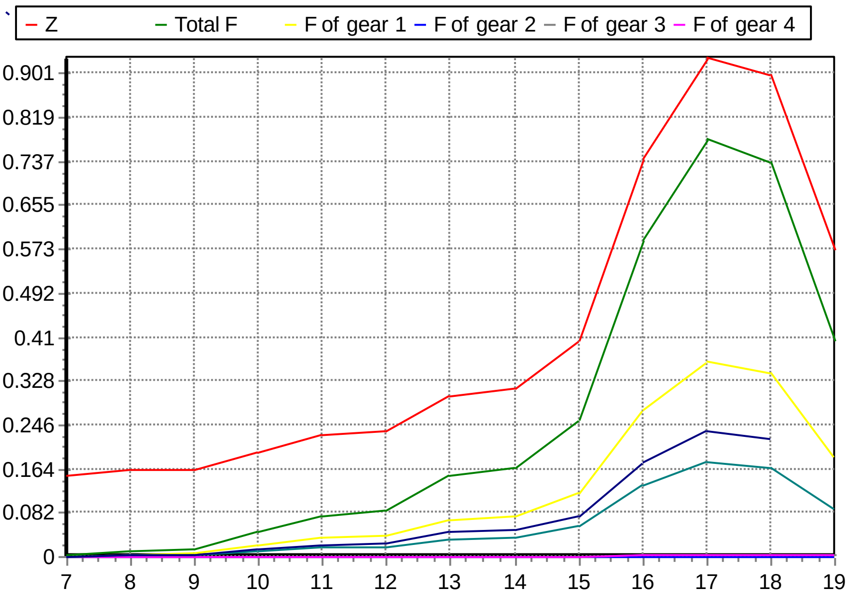


Fig. 6.6.4.3.4 Total mortality and Fishing mortality by countries (fishing gears), 2011 data.

Table 6.6.4.3.5 Reference points for Black Sea Dogfish.

Reference points	F	YPR	SSB/R	TSB/R
F-zero	0	0	19036.64	27482.64
F-0.1	0.227	1630.065	7333.682	15746.88
F-Max	1.1	1854.714	1905.248	10231.72
F at 25% MSP	0.389	1790.293	4768.058	13161.09

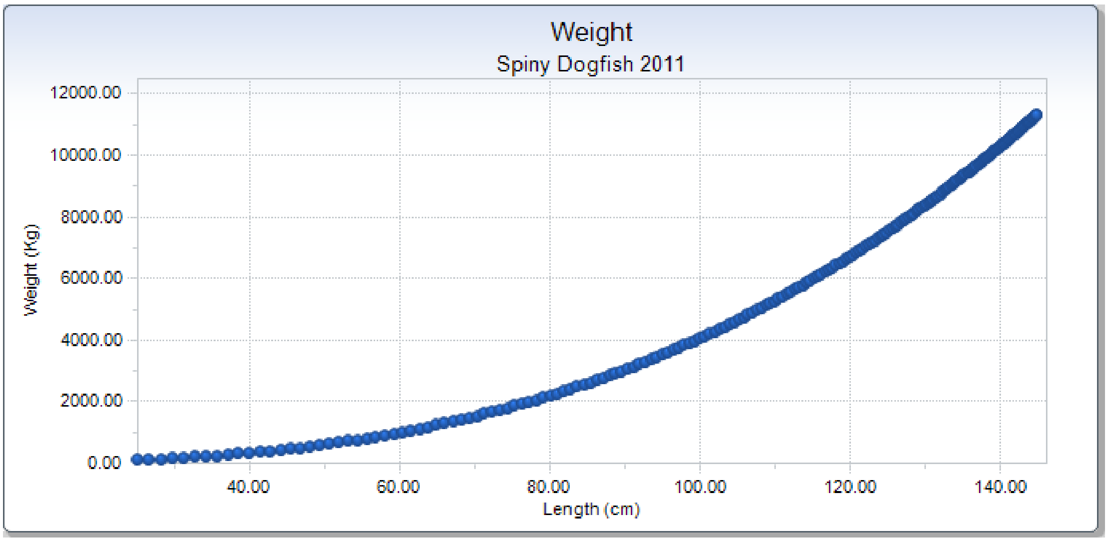


Fig. 6.6.4.3.5 Length – Weight Relationship for the Black Sea Dogfish.

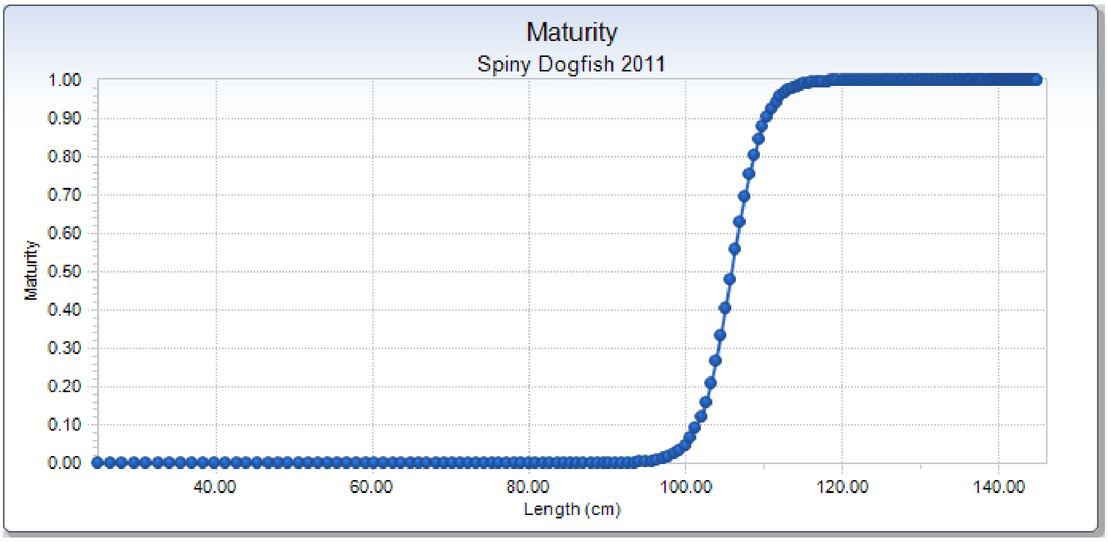


Fig. 6.6.4.3.6 Length – Maturity Relationship for the Black Sea Dogfish.

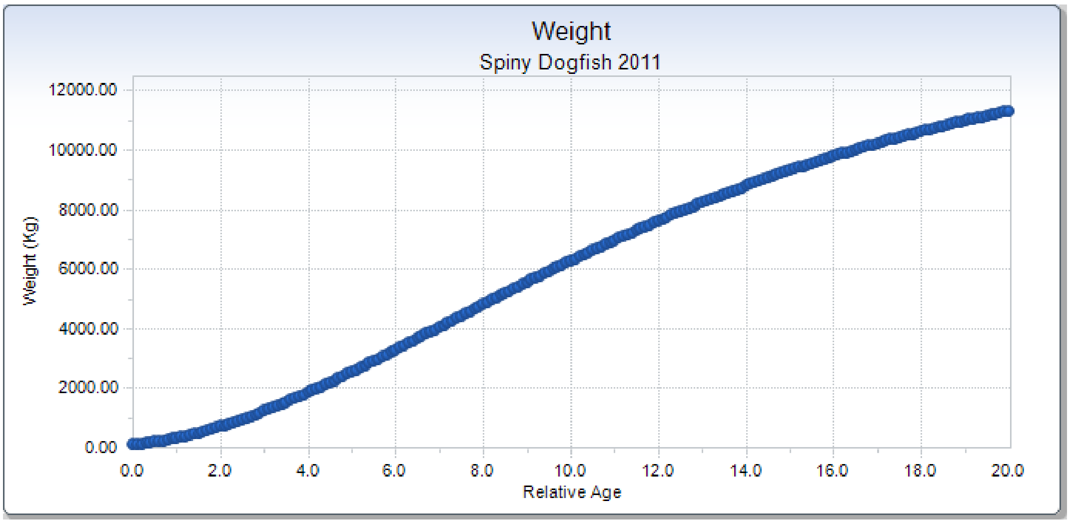


Fig. 6.6.4.3.7 Relative age – Weight Relationship for the Black Sea Dogfish.

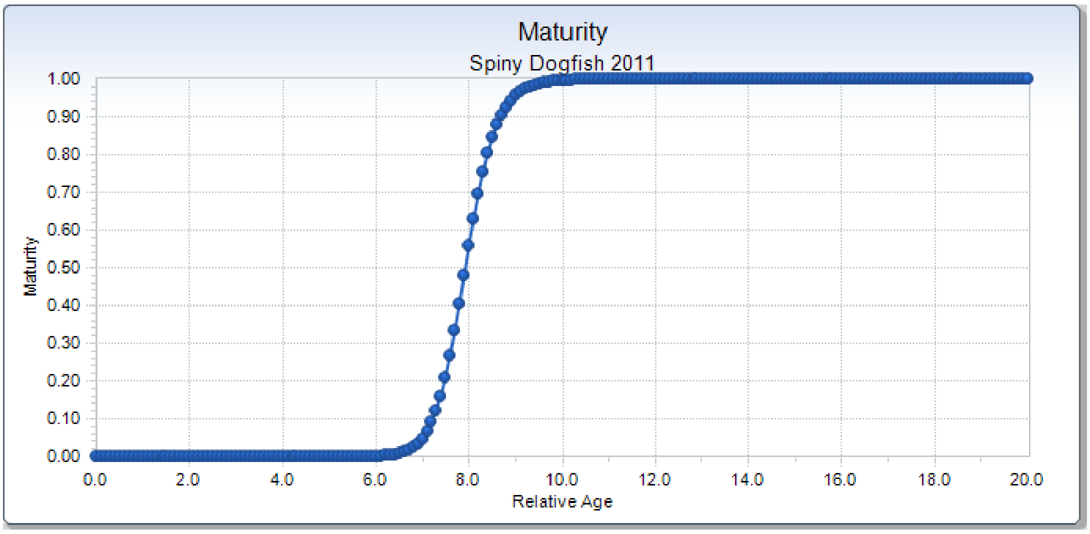


Fig. 6.6.4.3.8 Relative age – Maturity Relationship for the Black Sea Dogfish.

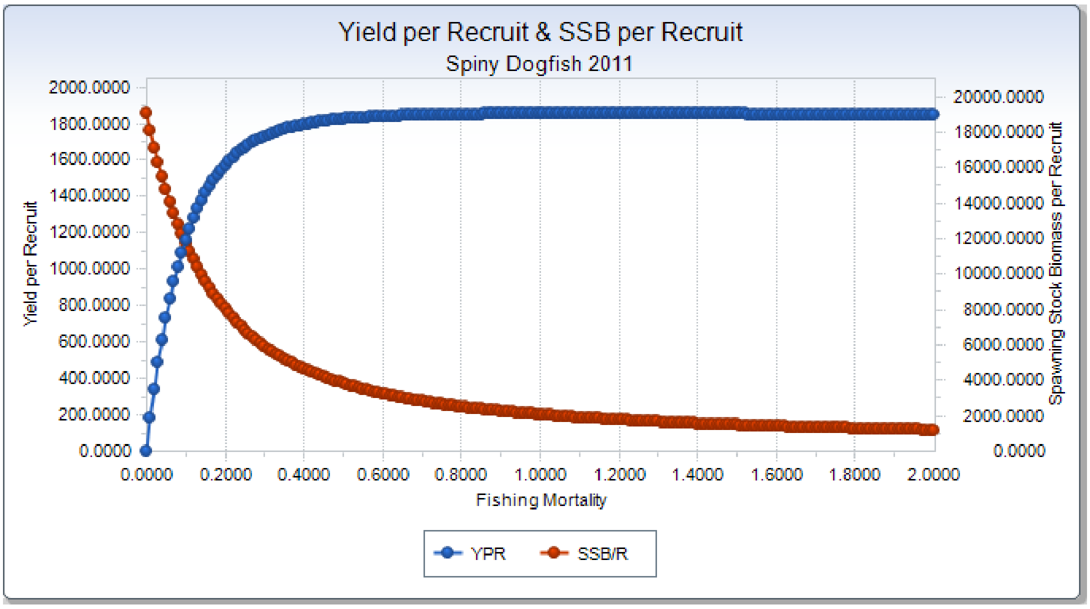


Fig. 6.6.4.3.9 Fishing mortality – Yield per recruit and SSB per Recruit Relationship for Black Sea Dogfish.

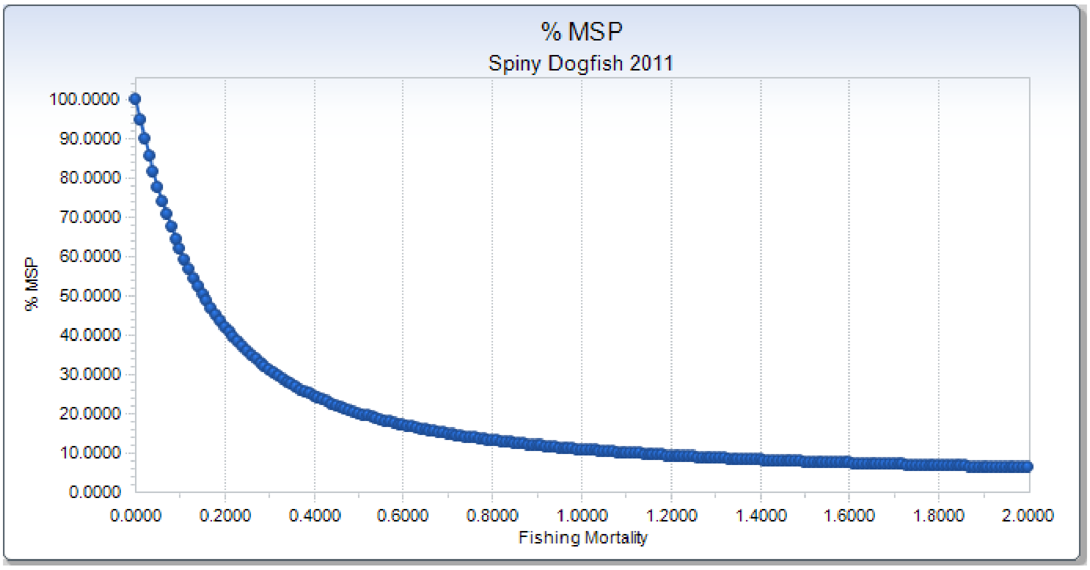


Fig. 6.6.4.3.10 Fishing mortality – % MSP (percent maximum spawning potential) for Black Sea Dogfish.

6.6.5 Short term prediction of stock biomass and catch

The current state of the assessment does not allow any reliable formulation of a short term prediction of stock size and biomass under various management scenarios.

6.6.6 Medium term prediction of stock biomass and catch

The current state of the assessment does not allow any reliable formulation of a medium term prediction of stock size and biomass under various management scenarios.

6.6.7 Long term predictions

The current state of the assessment does not allow any reliable formulation of a long term prediction of stock size and biomass to conclude on biological reference points consistent with high long term yields.

6.6.8 Scientific advice

The lack of a fishery independent scientific survey to monitor dogfish all over the Black Sea to indicate trends in total mortality and recruitment appears the major data deficiency in the assessment. EWG 12 16 recommends such a survey to be established. Also age reading of dogfish needs to be calibrated between different national laboratories to avoid discrepancy between national catch-at-data.

The present results from the pseudocohort analysis are judged by the EWG 12-16 not enough reliable to formulate adequate advice to managers. In future proper catch at age matrices need to be constructed and stock should be assessed using age-structured assessment methods, preferably tunned by fisheries independent survey data.

6.6.8.1 Short term considerations

State of the spawning stock size:

The assessment is considered only indicative of relative stock status and trends. The SSB is estimated to be 14,776 tons in 2011 that seems to be several times bellow the historical high (about 100 000t). In the absence of biological reference points, EWG 12-16 is unable to fully evaluate the stock size with regard to the precautionary approach.

State of recruitment:

The recruitment in 2011 is estimated to 1 408 513.

State of exploitation:

The STECF EWG 12-16 estimates $F_{0.1}$ = 0.227 (Fmsy proxy) as a limit reference point consistent with high long term yields and low risk of fishery collapse for dogfish in the Black Sea. Taking into account that the current F = 0.262 the stock is considered to be overexploited.

The STECF EWG 12-16 recommends the establishment of demersal fish research surveys to monitor the dog fish stock across all national waters of the Black Sea, including Bulgaria, Romania, Georgia, Russia, Turkey and Ukraine. The STECF EWG 12-16 recommends to enhancing the knowledge on the influence of environment and species interactions on abundance and survival of dogfish.

6.6.8.2 Medium term considerations

Given the current state of the assessment of dogfish in the Black Sea, EWG 12-16 is unable to provide advice for the medium term future.

6.7 Red mullet (*Mullus barbatus*) in the Black Sea

6.7.1 Biological features

6.7.1.1 Stock Identification

The red mullet (*Mullus barbatus*) is a demersal species in the Black Sea and Azov ecosystem. Red mullet inhabits temperate and tropical waters in small schooling groups. It distributes on sandy-muddy or wholly muddy bottoms feeding on crustacean and small invertebrates. According to sea water temperature it makes seasonal migrations for spawning and feeding (Whitehead et al., 1986). The stock is vulnerable to fishery all year long. Furthermore, its delicious meat raises it economical value. According to Ivanov and Beverton (1985) red mullet is a gregarious, demersal species, found on muddy bottoms or gravels and sandy bottoms of the continental shelf between 5m and 100m depth. In the spring, at temperature of 7-8 ^{o} C, appears near of the shore; when the water is warming at 15-16 ^{o} C, going back to bigger depths. Reproduction occurs in the period June-September, on muddy or sandy bottoms, from 10m to 55m.

Red mullet is bottom benthic fish reaches a length of 20 cm and more, and the age of 10-12 years (Svetovidov, 1964), usually until 4–5 years old. Red mullet prefers waters with the temperature higher 8º C and salinity more than 17‰. Red mullet spawns in June - September, on muddy or sandy bottoms, from 10 m to 55 m with a maximum in mid-summer. Eggs and juveniles (up to the age of 1.5 months) are pelagic; adults live near bottom, feeding on *Polychaetae,* crustaceans and mollusks. In the vicinity of the Crimean and Caucasus coasts, it is customarily distinguished in two particular forms – “settled” (“sedentary”) and migratory ones. In the waters of Ukraine and the Russian Federation migratory form has the greater commercial value, moving to the Kerch Strait and the Sea of Azov for fattening and spawning in spring and coming back to the coasts of the Crimea for wintering. Along coasts of Romania and Bulgaria in September-November red mullet migrates to the Turkish waters of the Black Sea and Sea of Marmara for wintering. Some years it schools remain on the Bulgarian coast and die in cold winters.

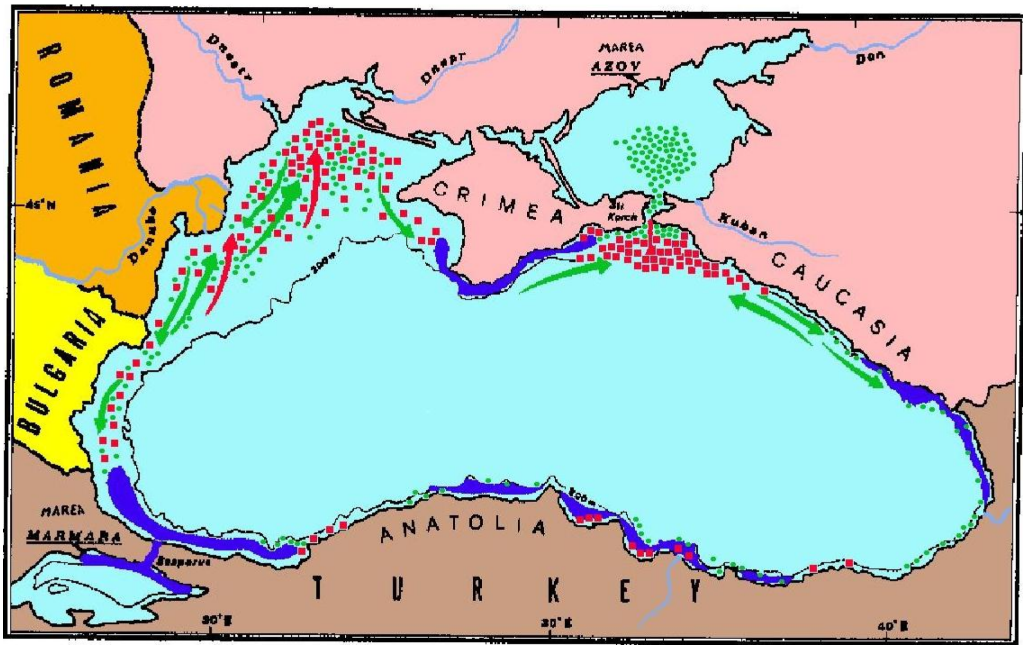


Fig. 6.7.1.1.1 Migration routes, spawning, feeding and wintering areas for red mullet

In eastern Black Sea, a study about bio-ecological features of red mullet for 1991-1996 (Genç, 2000) reported that red mullet moves toward shallow waters to spawn in May and by the end of reproduction period (nearly August) it turns toward to 20-50 depths. By October-November it prefers deeper waters to spend the winter. At the end of reproduction period (August) recruitment is observed by 4-5 cm and 0+ age juveniles.

6.7.1.2 Growth, mortality

In southern-eastern black Sea; total lengths of the red mullet specimen ranged from 4.4 to 23.5 cm. Size ranges were 7.2-19.6 and 6.1-23.5 cm for males and females respectively, while mean total length values were estimated as 12.49 ±0.02 cm for whole population, 12.43±0.02 cm for males and 13.73±0.03 cm for females. Size differences between the sexes seemed to be significant in favour of females for the years 1991-1996 (Genç, 2000).

Sex ratio in whole population is around 1:1, however, the ratio seems to vary between age and size groups. Males are dominant during the early ages, but after age of 3 and size of 14.5 cm, ratio change in favour of females. Maximum age is 9 years for females and 8 years for males. Fish from 0^+, 1^+ and 2^+ age groups consist of approximately 80% of the population (Genç, 2000).

Table 6.7.1.2.1. VBGF parameters for mullet calculated in the Black Sea

COUNTRY	YEAR- PERIOD	SPECIES	SEX	L_INF	K	t_0	a	b	Reference
Ukraine	1988-1990	MUT	C	17.97	0.316	-1.876	0.0085	3.338	Domashenko (1990)
Turkey	1991-1996	MUT	F	25.55	0.238	-1.324	0.0064	3.177	Genç (2000)
	1991-1996	MUT	M	23.83	0.227	-1.624	0.0074	3.114	Genç (2000)
Turkey	2004-2005	MUT	C	20.15	0.33		0.0107	2.9717	Aksu et al, 2011

Instantaneous mortality rates (Z) ranged from 1.16 to 1.51, natural mortality rate (M) 0.36-0.44 and finally fishing mortality (F), 0.62-1.08 were between 1991 and 1996, while overall mean values are calculated as Z=1.41, M=0.39 and F=1.02. Fishing rates vary from 0.62-0.74 for years and the mean value for the study period was calculated as 0.72. Estimated total biomass values in entire eastern Black Sea were 1329, 3011 and 4850 tons during 1990-1992, respectively. Selectivity values (L_{50}) have been calculated as 12.57, 13.19 and 13.77 cm for trawl with cod-end mesh sizes of 18, 20 and 22 mm, respectively (Genç, 2000).

Aksu et al. (2011) reported some population parameters of red mullet from southern-middle Black Sea for the years of 2004-2005 as $W=0.0107L^{2.9717}$, L_{inf} =20.15, K=0.33, M=0.68 and F=0.60.

In Ukrainian waters; there are differences in the growth for two forms of red mullet. The migratory form has higher rate of growth. The parameters in VBGF, the length-weight relationships and natural mortality M are):

Migratory form: K= 0.316 t_0= -1.876; L_∞= 17.97 cm; W_∞= 100.5 g

$W= 0.0085 \times L^{3.338}$; M = 0.8 (Domashenko ,1990).

According to Jones method, fishing mortality rate of red mullet in Ukrainian waters of the Black Sea in 2000-2011 increased (Table 6.7.1.2.1), but less that target TAC level ($F_{0.1}$=0.6).

Table 6.7.1.2.1. Fishing mortality of red mullet in Ukrainian Black Sea waters in 2000-2011

Sl_i. mm	**F_i**			
	2000-2002	**2003-2005**	**2006-2008**	**2009-2011**
61-65	0.000	0.000	0.000	0.000
66-70	0.000	0.000	0.001	0.000
71-75	0.001	0.000	0.007	0.002
76-80	0.002	0.001	0.014	0.023
81-85	0.016	0.013	0.036	0.073
86-90	0.085	0.053	0.128	0.273
91-95	0.136	0.079	0.237	0.501
96-100	0.278	0.141	0.335	0.505
101-105	0.437	0.232	0.412	0.734
106-110	0.414	0.312	0.506	0.962
111-115	0.453	0.377	0.544	0.934
116-120	0.467	0.449	0.609	1.016
121-125	0.695	0.619	0.605	0.767
126-130	0.756	0.561	0.658	0.727
131-135	1.006	0.557	0.689	1.894
136-140	1.177	0.572	0.700	1.774
141-145	1.269	0.515	0.747	2.394
146-150	3.334	0.749	0.808	1.948
151-155	2.703	0.590	0.750	2.703
Fav.	0.161	0.121	0.174	0.257

6.7.1.3 Maturity

In eastern Black Sea, Genç (2000) reported that the first sexual maturity is attained at 10.17 cm in males and 11.28 cm in females. In general, fish of these sizes are at age of one. Red mullets in this region spawn from end of May up to beginning of August. Spawning take place in surface layers of above 20 m at 18-25°C, salinity of 17-18‰ and dissolved oxygen concentrations of 6-9 mg/L. Mean size of ovulated egg ready for release has been measured as 756±2.21 (545-1050) µ and average relative fecundity is 149.7±8.97 eggs/g.

In Ukraine, the migratory form of red mullet matures at ages of 1+ (the main part recruitments of the spawning stock) or 2+ (Sirotenko and Danilevsky, 1979). In the Sea of Azov red mullet not breed. Even if red mullet at ages of 1+ with maturing gonads come into the Sea of Azov, it will be absorbed.

6.7.2 Fisheries

6.7.2.1 General description

Red mullet is one of the most important fish species fished and consumed traditionally in the Black Sea countries. In Turkey, it is mostly caught by bottom trawls as a target fish species. Red mullet is the second species after whiting composing 9.5% of total demersal catches between 1991 and 1996 (Genç, 2000). The gillnets are also allowed in red mullet fishery all along Turkish coasts and through all seasons but only 10% of total landing obtained by this method.

In the waters of Georgia according to the data of official statistics in 1989 – 1996 catches of red mullet were absent or was categorized within the “other fish” group. In 1997 – 2005, its mean annual catch was equal to 28 tons. According to Komakhidze *et al.* (2003), the red mullet was captured recently in higher amounts that provided an indirect evidence of increasing abundance.

Along the coasts of the Russian Federation target fisheries of red mullet are performed mainly with passive fishing gears. The stocks exceeded over 100 tons by 1998 which was mainly related to the reduction of *Mnemiopsis leidyi* population (Volovik and Agapov, 2003). In 2002, the total biomass was estimated as 1200 tons exploited biomass as 960 tons and TAC as 200 tons.

In Ukrainian waters, target fishing of the red mullet was permitted only with beach seines and bottom set traps; however, the greater part of its catches corresponded to the non-target fishing with bottom traps (Shlyakhov and Charova, 2003). The major share of red mullet was harvested in autumn in Balaklava Bay, near Sebastopol. The amount of non-registered catches of red mullet was undefined. For 3-year periods in the last decade, landings (Y), spawning stock biomass (SSB), recruitment (R) and fishing mortality (F) of red mullet represented in figure 6.7.2.1.1.

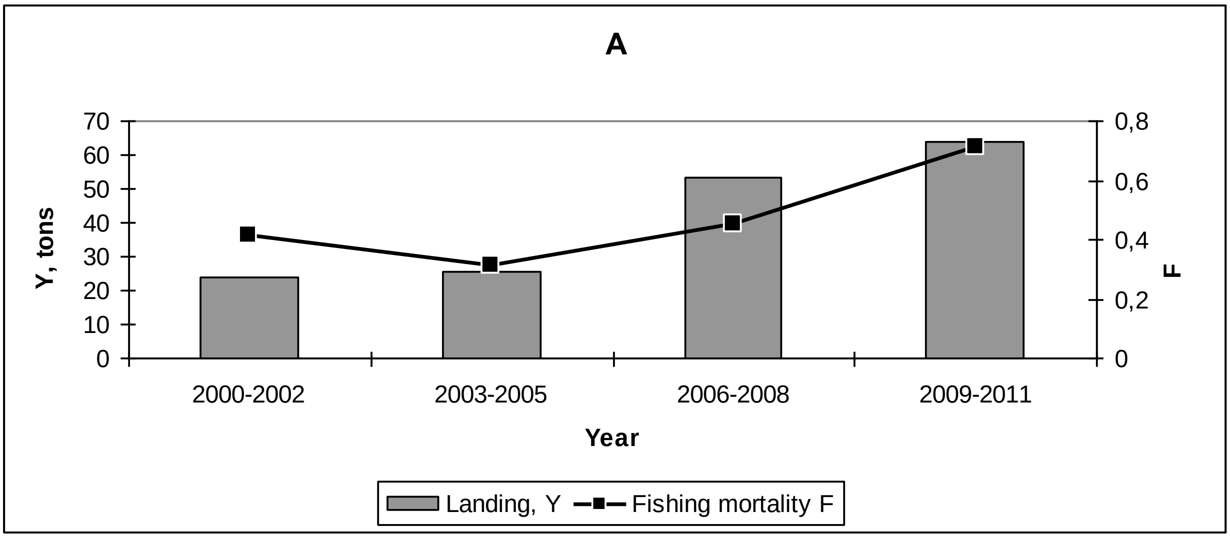


Fig 6.7.2.1.1 Jones method results for red mullet in Ukrainian waters of the Black Sea: A – landings and fishery mortality. B – spawning stock biomass and recruitment

6.7.2.2 Management regulations applicable in 2010 and 2011

The Turkish regulations for red mullet fishery:

(1) Area closures: Bottom trawling is prohibited in waters between a) Sinop city. İnceburun (42° 05.959' N-34° 56.695' E) and Samsun city Çayağzı cape (41° 41.040' N-35° 25.193' E), b) Ordu city; Ünye. Taşkana cape (41° 08.725' N-37° 17.531' E) and Georgia border. Furthermore, it is also banned within 2 miles from land between Zonguldak city; Ereğli. Baba cape (41° 17.342' N-31° 23.937' E) and Bartın city; Amasra. Tekke cape (41° 43.485' N-32° 19.258' E) (Figure 1). In other areas open to trawling allowed distance is 3 miles.

(2) Time closures: In open areas, turbot fishery with bottom trawling is banned between April 15 and September 15. Gillnets were allowed all along the Turkish coasts for red mullet fishery except April 15-June 15.

(3) Mesh size limitations: Cod end mesh size should not be lower than 40 mm in bottom trawl nets.

(4) Minimum legal catch size: Minimum legal size (total length) was determined as 13 cm for all kind of fishing gears.

The Ukrainian regulations of fisheries establish the minimum commercial fishing size for red mullet as 8.5 cm (SL); the allowable by-catch of juveniles (in non-target fishing – not more than 8% of the total weight of haul. in target fishing – not more than 20% by counting); the mesh size in beach seines and in scrapers – 10 mm.

Table. 6.7.1.3.1 Minimum landing size of red mullet in the Black sea region

	BG	**GE**	**RO**	**RU**	**TR**	**UK**
Mullus barbatus	TL=12cm	SL=8.5cm	no	SL= 8.5 cm	TL=13.0	SL=8.5cm

6.7.2.3 Catches

6.7.2.3.1 Landings

Landings of the red mullet in the Black Sea were reported by the Black Sea countries (Table 6.7.1.4.1.1) and some particular data from Ukraine. General trends in amount of landings appear different for countries (Figure 6.8.2.3.1.1). Landings significantly decreased by fluctuations in the last 15 years in Turkish data where a remarkable increase arise in Bulgarian catch in 2011. Ukraine and Russian catches of red mullet were relatively constant for the last ten and twenty years respectively.

Table 6.7.1.4.1.1 Red mullet landings (tons) in the Black Sea.

Years	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine
1988				129		
1989				324		
1990				132		
1991				210		
1992				37		
1993				2		
1994				25		
1995				324		
1996				76	2249	
1997				68	1173	
1998				119	1423	
1999				92	1853	
2000	5.0			127	910	10.3
2001	26.0			119	1110	20.9
2002	33.0			47	867	40.7
2003	36.0			177	506	35.8
2004	17.0			99	668	23.0
2005	1.0			151	1093	17.5
2006	6.0			140	960	56.1
2007	12.5			87	781	54.4
2008	17.0			115	706	48.9
2009	48.2			291.65	799	65.2
2010	72.4			200.28	507	68.2
2011	176.2	22	1.9	290.94	326.1	58.2

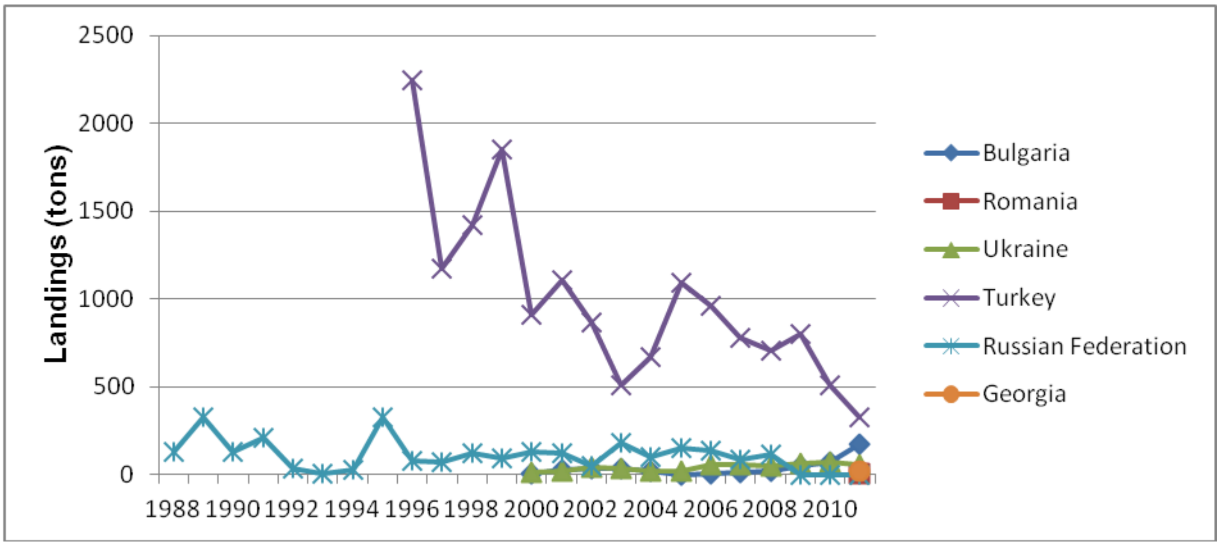


Fig. 6.7.1.4.1.1 Trends in landing of red mullet in Black Sea countries

6.7.2.3.2 Discards

No information has been tabled during the EWG 12-16 meeting.

6.7.2.4 Fishing effort

No information has been tabled during the EWG 12-16 meeting

6.7.2.5 Commercial CPUE

No data was available.

6.7.3 Scientific Surveys

No specific fisheries independent scientific surveys have been conducted.

6.7.4 Assessment of historic parameters

6.7.4.1 Method 1: Separable VPA

The EWG 12-16 found out that data available in different national databases would allow performing a quantitative assessment of the red mullet stock.

The lack of any tuning series to estimate terminal fishing mortalies in 2010, the EWG 12-16 decided to run 3 versions of Separable VPA (Pope and Shepherd 1982) starting with F=0.5, F=0.8 and F=1 at the last year (based of F from LCA Table) as arbitrary inputs, respectively. Natural mortality is set to M=0.8.

Table 6.7.4.1.1 Data availability by countries.

Type of data	Turkey	Romania	Bulgaria	Ukraine	Georgia	Russian Federation	Comment
Catch	1996-2011	2011	2011	2000-2011	2011	2009-2011	yearly
Fishing gears	yes	yes	yes	yes	no	no	Bottom trawls beach seines. bottom set traps
Fishing seasons	yes	yes	yes		no	no	for Turkey see:6.8.2.2. Bulgaria: May-October (as by catch). Romania; April-September
Fishing areas	yes	yes	yes	yes	yes	no	for Turkey see:6.8.2.2. Romania:Sulina - Vama - Veche
Fishing and natural mortality	1991-1996 2004-2005	no	no	2000-2011	no	no	
Mean individual weights	no	2011	2011	2000-2011	no	no	
Catch-at-age	no	2011	no	2000-2011	no	no	
Length and weight at age	no	2011	no	2000-2011	no	no	
CPUE from commercial yield and surveys	no	no	no	no	no	no	
Migration routes (spawning.fattening.wintering grounds)	no	yes	no	yes	no	no	
Existing fishery regulations in country	yes	yes	yes	yes	yes	yes	Minimum legal size
Existing analyses for 1950-2011	no	no	no	no	no	no	

6.7.4.1.1 Input parameters

Catch at age

Table 6.7.4.1.1.1 Aggregated catch of red mullet at age in number 10^{-3} of Blak Sea countries.

Age Years	**0**	**1**	**2**	**3**	**4**
2000	5436,857	29230,41	15901,34	6079,926	1812,286
2001	21576,44	16170,16	10179,4	779,2846	
2002	935,3732	25666,64	6846,932	2806,119	1159,863
2003	2304,54	20798,47	4983,568	720,1687	
2004	139,6318	22927,54	4161,027	698,1588	
2005	2446,622	39977,81	5725,096	782,9191	
2006	5133,093	24476,75	19938,01	4484,702	
2007	1892,538	14572,54	14875,35	5564,062	946,269
2008	4107,175	20820,53	14436,11	1260,618	40,6651
2009	4088,399	25477,7	13461,8	5235,145	1595,473
2010	1726,899	16139,86	9996,086	4483,294	863,4493
2011	2237,328	12186,86	9449,42	2447,9	

Weight at age in the catch Table

Table 6.7.4.1.1.2 Weight at age in the catch (in g).

Age Years	**0**	**1**	**2**	**3**	**4**
2000	8.5	13.2	18.4	36.9	57
2001	13.1	35	38	52	
2002	10.2	23.3	31.6	36.4	53.1
2003	10.6	25.5	33.7	44.7	
2004	9.4	27.4	32.5	60.5	
2005	8.5	24.7	35.5	65.1	
2006	8.6	18.7	22.5	47.2	
2007	8.2	18.1	20.9	50.4	67.9
2008	7.8	19.5	26.3	52.7	66.7
2009	8	12.2	19.1	40.5	62.5
2010	8.6	12.6	20.2	40.1	55.2
2011	8.4	16.1	27.1	46.3	

Table 6.7.4.1.1.3 Red mullet maturity at age.

	0	1	2	3	4	5
2000	0.00	0.8	1.00	1.00	1.00	1.00
2001	0.00	0.8	1.00	1.00	1.00	1.00
2002	0.00	0.8	1.00	1.00	1.00	1.00
2003	0.00	0.8	1.00	1.00	1.00	1.00
2004	0.00	0.8	1.00	1.00	1.00	1.00
2005	0.00	0.8	1.00	1.00	1.00	1.00
2006	0.00	0.8	1.00	1.00	1.00	1.00
2007	0.00	0.8	1.00	1.00	1.00	1.00
2008	0.00	0.8	1.00	1.00	1.00	1.00
2009	0.00	0.8	1.00	1.00	1.00	1.00
2010	0.00	0.8	1.00	1.00	1.00	1.00
2011	0.00	0.8	1.00	1.00	1.00	1.00

6.7.4.1.2 Results

Three versions of Separable VPA (Pope and Shepherd 1982) with F=0.5, F=0.8 and F=1 and Selectivity at the last age S3=1 were ran.

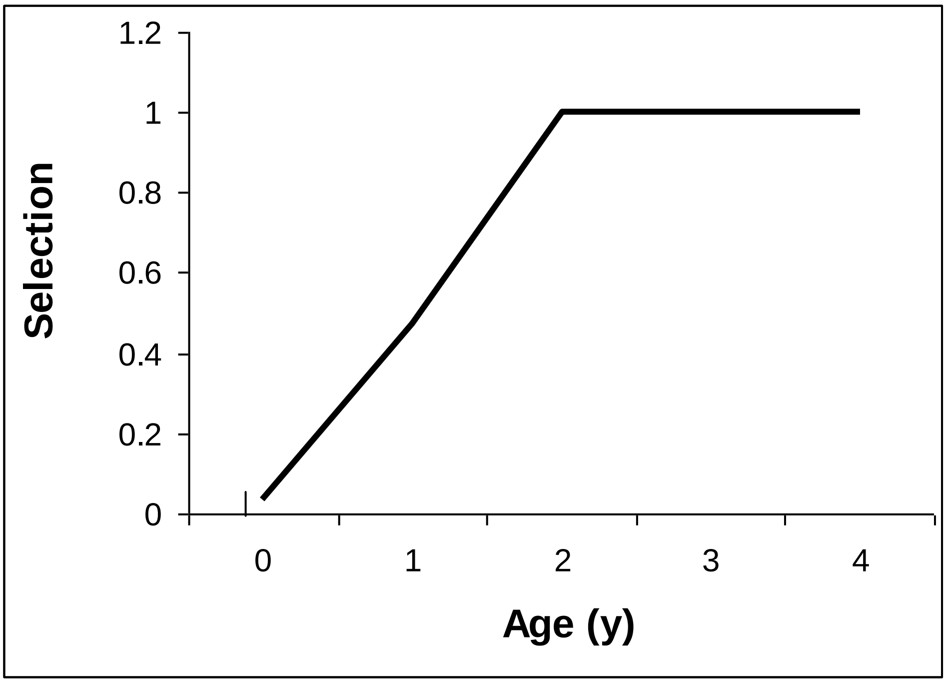


Fig. 6.7.4.1.2.1 Selection pattern estimated by the separable model.

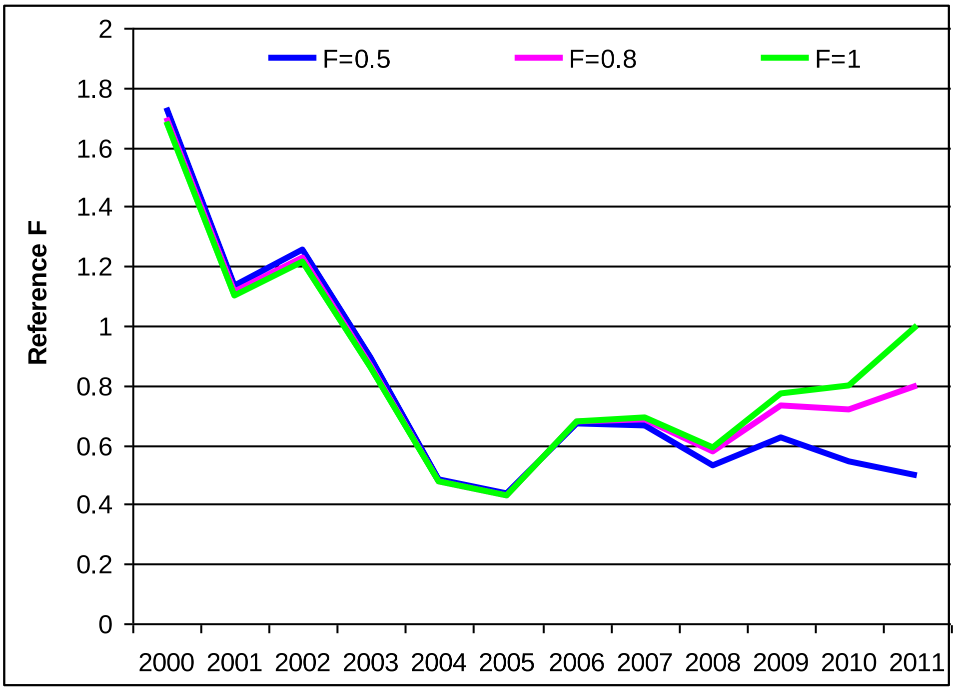


Fig. 6.7.4.1.2.2 Reference separable F (at age 2 years) from the separable model starting with F=0.5, F=0.8 and F=1 at the last year

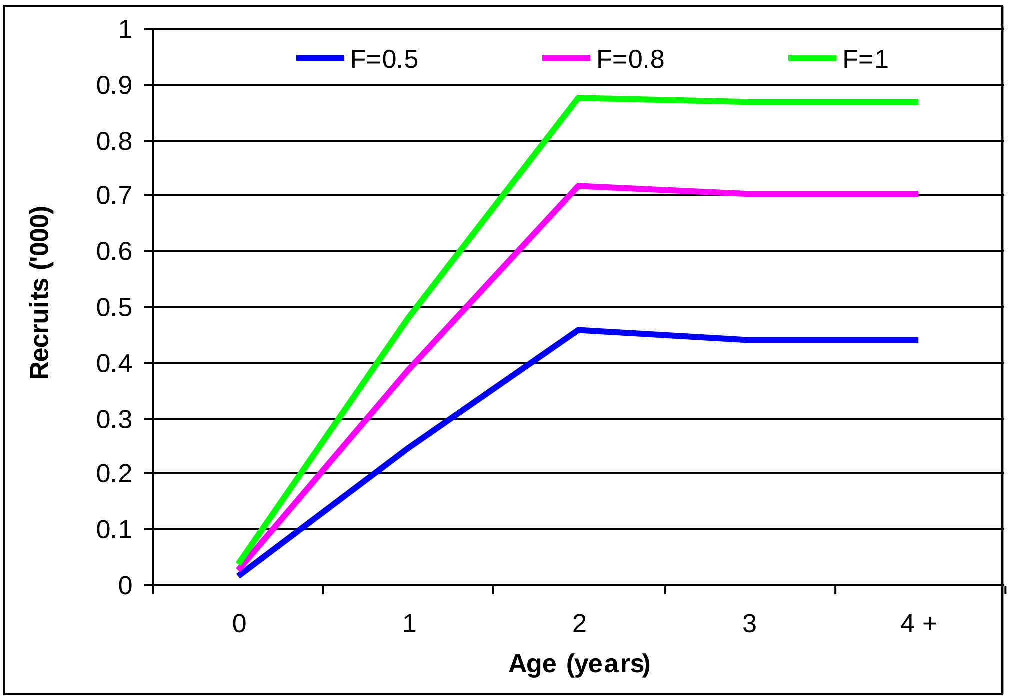


Fig. 6.7.4.1.2.3 Fishing mortality F at age in the last year (2011) from the Separable VPA starting with F=0.5, F=0.8 and F=1 at the last year

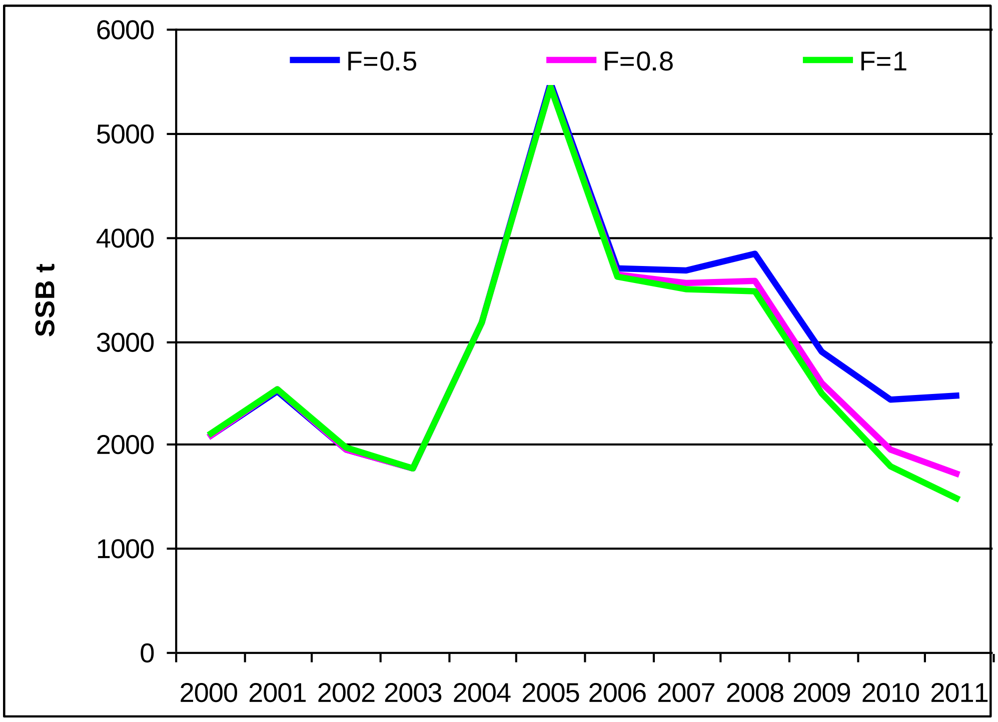


Fig. 6.7.4.1.2.4 SST (t) from the Separable VPA starting with F=0.5, F=0.8 and F=1 at the last year

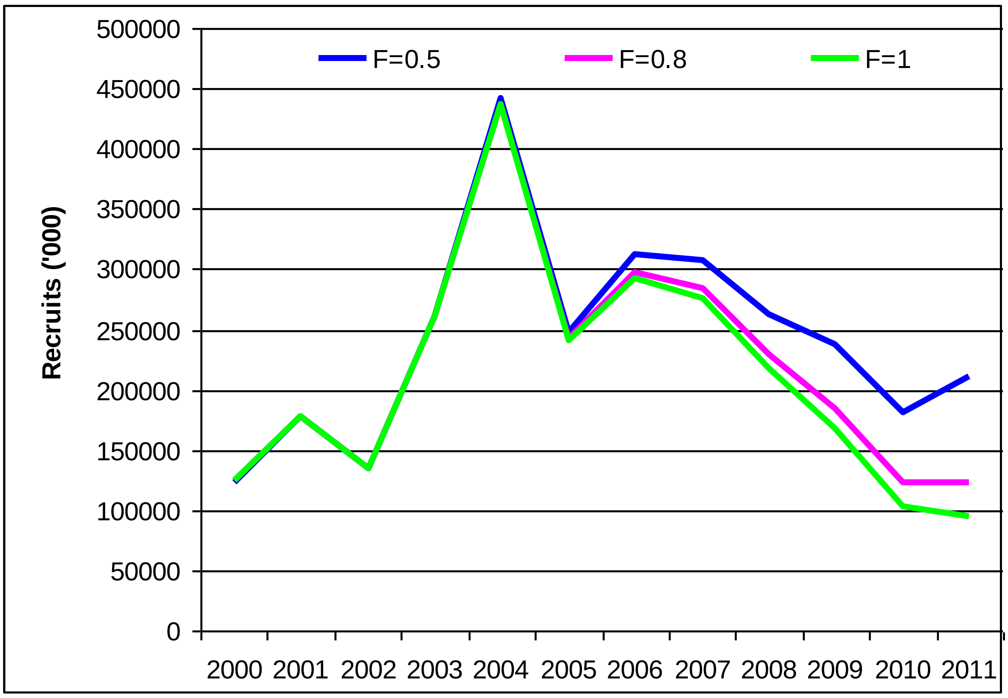


Fig. 6.7.4.1.2.5 Recruitment from the Separable VPA starting with F=0.5, F=0.8 and F=1 at the last year.

The results shown indicate that historical estimates clearly converge towards 2000 (Fig 6.7.1.5.2.1- 6.7.1.5.2.5). However, the abundance and mortality estimates in last year differ by 20-60% according to the different options, corresponding to the differences in the starting Fs.

Given the uncertainty in the estimates in the recent years this assessment cannot be used for short-term forecasts, but is indicative only for the trends in the stock abundance and the level of exploitation.

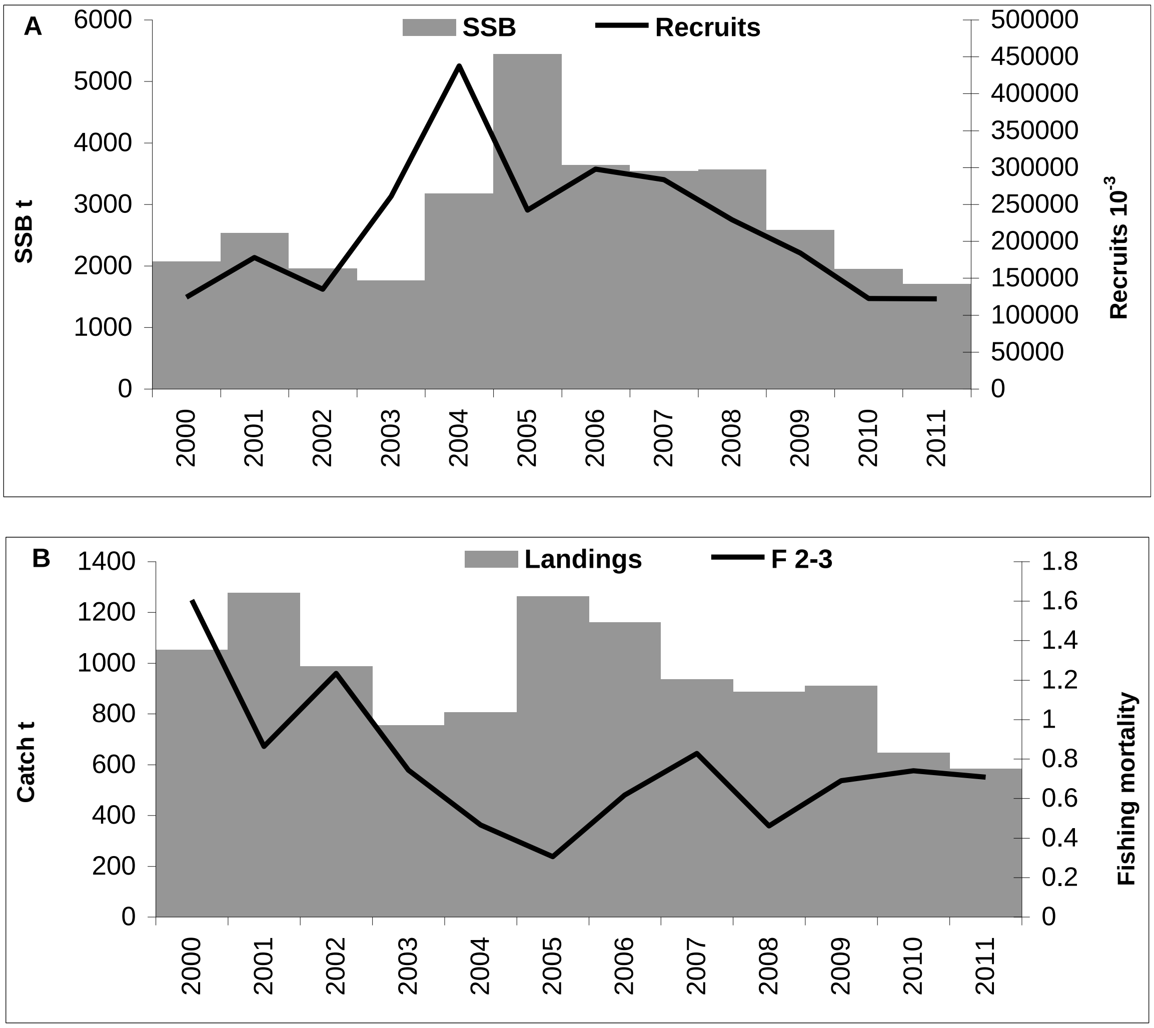


Fig. 6.7.4.1.2.6 Time-series of red mullet population estimates from the Separable VPA with starting reference F = 0.8: A. recruitment (line) and SSB (grey); B. landings (grey) and average fishing mortality (ages 2-3, line).

In the figure 6.7.4.1.2.6, the summary of the population estimates from the Separable VPA with starting reference F = 0.8 are presented. The trends in recruitment and SSB increase by 2004-2008 and after 2008 start to decrease. The levels of exploitation seem to be higher in the early 2000s (F=1-1.5), then drop to about 0.6 - 0.8 in the recent years. From this analysis becomes clear that the red mullet in the Black Sea is a short living fish which stock is driven mainly by changes in recruitment.

Table. 6.7.4.1.2.1 Output from the Separable VPA with last year reference F = 0.8

Run title : mullet 2011

At 12/10/2012 11:54

Traditional vpa Terminal populations from weighted Separable populations

Table 8 Fishing mortality (F) at age

YEAR	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
AGE												
0	0.0655	0.1911	0.0101	0.0129	0.0005	0.0148	0.0253	0.0097	0.0263	0.0327	0.0207	0.0269
1	0.5414	0.5682	0.7706	0.6592	0.3307	0.3413	0.3905	0.1748	0.2686	0.444	0.3373	0.3864
2	1.8373	0.794	1.1848	0.701	0.5423	0.2472	0.5877	0.9751	0.5301	0.5708	0.6569	0.7141
3	1.3739	0.9323	1.2811	0.7861	0.3901	0.3638	0.6471	0.6809	0.3902	0.8083	0.8243	0.7026
+gp	1.3739	0.9323	1.2811	0.7861	0.3901	0.3638	0.6471	0.6809	0.3902	0.8083	0.8243	0.7026
0 FBAR 0	0.9545	0.6214	0.8117	0.5398	0.3159	0.2417	0.4126	0.4601	0.3038	0.464	0.4598	0.4575
	1.6056	0.86315	1.23295	0.74355	0.4662	0.3055	0.6174	0.828	0.46015	0.68955	0.7406	0.70835

Traditional vpa Terminal populations from weighted Separable populations

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
AGE												
0	124115	177941	134848	260988	437369	242191	297945	283515	229145	184205	122369	122165
1	98068	52235	66045	59981	115766	196431	107228	130530	126157	100285	80105	53858
2	24584	25644	13297	13732	13941	37371	62742	32605	49247	43332	28905	25688
3	10855	1759	5208	1827	3061	3642	13115	15664	5526	13024	11002	6734
+gp	3236	2	2153	3	4	5	3	2664	178	3969	2119	3
0 TOTA	260857	257581	221551	336531	570142	479640	481033	464977	410252	344815	244500	208447

Table 17 Summary (with SOP correction)

Traditional vpa Terminal populations from weighted Separable populations

	RE(Age 0	TOTALB	TOTSPE	LANDIN	YIELD/SS	SOPCOFAC
2000	124115	3387	2073	1052	0.5076	1
2001	177941	5225	2529	1276	0.5046	1
2002	134848	3638	1955	988	0.5052	1
2003	260988	4839	1768	755	0.427	0.9997
2004	437369	7921	3176	807	0.2541	0.9999
2005	242191	8474	5445	1262	0.2318	1
2006	297945	6598	3635	1162	0.3197	0.9999
2007	283515	6339	3542	935	0.2639	1
2008	229145	5846	3566	887	0.2487	1
2009	184205	4300	2582	912	0.3534	1
2010	122369	3204	1950	648	0.3322	1
2011	122165	2901	1702	584	0.3435	0.9999
Arith. Mean	218066	5223	2827	939	0.3576	
0 Units	(Thousan	(Tonnes)	(Tonnes)	(Tonnes)		

Table. 6.7.4.1.2.2 Diagnostic tables from the Separable VPA with last year reference F = 0.8

Title : mullet 2011

At 18/10/2012 10:11

Separable analysis
from 2000 to 2011 on ages 0 to 3
with Terminal F of .800 on age 2 and Terminal S of 1.000

Initial sum of squared residuals was   186.127 and
final sum of squared residuals is   28.941 after 49 iterations

Matrix of Residuals

Years	2000/*	2001/*	2002/**	2003/**	2004/**	2005/**	2006/**	2007/**	2008/**	2009/**	2010/**	TOT	WT
Ages													
		1.506	-1.804	-1.17	-4.02	-0.152	0.658	-0.861	0.092	0.291	-0.175	-0.001	0.293
0/ 1	0.076	0.13	0.557	0.527	0.926	0.712	-0.001	-0.636	0.17	0.38	0.083	0	0.943
1/ 2	-0.328	-0.563	0.005	-0.153	0.306	-0.627	-0.192	0.851	-0.187	-0.443	-0.027	0	1
2/ 3	0.288												
		0.001	0.001	0.001	0.001	0	-0.001	-0.001	0.001	0.001	0	-3.781	
TOT	0	0.001	0.001	0.001	0.001	0.001	1	1	1	1	1		
WTS	0.001												

Fishing Mortalities (F)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
F-valu	1.6977	1.1113	1.2286	0.8691	0.4777	0.4297	0.6777	0.686	0.5768	0.7286	0.7148	0.8

Selection-at-age (S)

	0	1	2	3
S-valu	0.0337	0.4711	1	1

1

Run title : mullet 2011

At 18/10/2012 10:11

Traditional vpa Terminal populations from weighted Separable populations

Fishing mortality residuals

YEA	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
AGE												
0	0.0083	0.1537	-0.0312	-0.0164	-0.0156	0.0003	0.0025	-0.0134	0.0069	0.0082	-0.0034	0
1	-0.2584	0.0447	0.1918	0.2498	0.1056	0.1389	0.0712	-0.1484	-0.0031	0.1008	0.0006	0.0096
2	0.1396	-0.3173	-0.0438	-0.1681	0.0646	-0.1825	-0.09	0.2891	-0.0467	-0.1578	-0.058	-0.0859
3	-0.3239	-0.179	0.0526	-0.0829	-0.0876	-0.0659	-0.0307	-0.0051	-0.1865	0.0798	0.1095	-0.0974

6.7.5 Short term prediction of stock biomass and catch

The current state of the assessment does not allow any reliable formulation of a short term prediction of stock size and biomass under various management scenarios.

6.7.6 Medium term prediction of stock biomass and catch

The current state of the assessment does not allow any reliable formulation of a medium term prediction of stock size and biomass under various management scenarios.

6.7.7 Long term predictions

The current state of the assessment does not allow any reliable formulation of a long term prediction of stock size and biomass to conclude on biological reference points consistent with high long term yields.

6.7.8 Scientific advice

The lack of a fishery independent scientific survey to monitor red mullet all over the Black Sea to indicate trends in total mortality and recruitment appears the major data deficiency in the assessment. The EWG 12-16 recommends such survey to be established.

6.7.8.1 Short term considerations

State of the spawning stock size:

The assessment is considered only indicative of relative stock trends. All three assessment formulations indicate that the SSB in recent years is reduced from higher levels over 2004-2008. In the absence of total stock size estimates and biological reference points, EWG 12-16 is unable to fully evaluate the stock size with regard to the precautionary approach.

State of recruitment:

Recruitment has been higher over 2003-2007 but after 2008 has decreased about 2-3 times.

State of exploitation:

Given the current state of the assessment EWG 12-16 is unable to provide a biological reference point consistent with high long term yield nor to quantify the expoitation rate. Based on the assessment results the exploitation rate has decreased from F = 1-1.5 in the early 2000s to the levels of F = 0.6 -0.8 in recent years. In the absence of a biological reference points, EWG 12-16 is unable to fully evaluate the exploitation state with regard to the precautionary approach.

6.7.8.2 Medium term consideratins

Given the current state of the assessment EWG 12-16 is unable to provide advice for the medium term future.

7 TURBOT SELECTIVITY

During the last years the issue of selectivity of bottom set gillnets targeting turbot in the Black Sea has been frequently raised in particular with regard to the establishment of a set of minimum standards for this fishery. In this context, the EU presented to the 36 Session of GFCM a proposal for a recommendation to establish such standards at a minimum landing size of 45 cm for turbot and a mesh size of 400 mm for the bottom set gillnets in question. These proposed measures were in line with the EU legislation adopted for the years 2009 and 2010 that was further implemented at national level by Bulgaria and Romania following the entry into force of the Lisbon Treaty. The proposal for such a recommendation was not supported subject to further discussions regarding selectivity of these gears.

In order to take stock of the current state of knowledge of bottom set gillnets in the Black Sea, participants were invited to provide the group with scientific literature on the issue.

A number of papers were provided by Turkish (2 abstracts showing summary results) and Romanian (1 paper) participants (List of background documents). These documents were discussed by the group and the different results crosscheked in order to clarify whether a clearer idea of selectivity aspects of bottom set gillnets could be obtained.

The different outcomes of these papers can be summarised as follows:

Turkey

According to the work of Kara et al published in 2004, single walled gillnets with a mesh size of 340 mm or larger do not cause significant problem for sustainability on the basis of a minimum landing size for turbot of 40 cm.

The PhD Thesis of Erdem (1996) establishes different selectivity parameters but no information on the mesh sizes used can be found in the abstract.

Romania

The work of Eugene Anton does not show conclusive results, given that for the turbot size range between 42 and 45 cms correlation between retained individuls by a 360 mm net and a 400 mm nets is not clear. Notwithstnding this, the author suggests that a mesh size of 400 mm fit with the minimum landing size of 45 cm.

Against this background the group considers that further work is needed in order to have a clearer idea of the selectivity aspects of the gillnet fishery for turbot in the Black Sea. To this end the group recommends that an international study is launched according to a harmonised methodology. The group invites the EU to explore whether such study could be supported by the EU budget.

8 GAPS IN CURRENT KNOWLEDGE AND MONITORING FOR FISHERIES, STOCKS, VITAL FISH HABITATS AND OTHER ENVIRONMENTAL ASPECTS RELEVANT TO FISHERIES

STECF EWG 12-16 reviewed gaps in current knowledge and data, evaluated the progress made in addressing such gaps since last year, and formulated recommendations for addressing such gaps in future.

The most pressing problem recognised by the EWG 12-16 is the generally low quality of the input data for assessments (in terms age and size composition, fishing effort, CPUE and research surveys). This low quality is due to a shortage of surveys of both commercial fisheries as well as independent scientific surveys to cover the entire stock areas of distribution. In the cases when such surveys are performed they are usually limited in space and time. The lack of quality survey information deteriorates the estimates of the current population parameters (abundance and mortality) in stock assessments and decrease the reliability of the short term predictions and management advice.

Two new scientific surveys (demersal and hydro-acoustic) have started in 2010 in EU water (Bulgaria and Romania) funded under the DCF, but results from them do not seem yet to improve the quality of the assessments. Under the DCF, EU members (Bulgaria and Romania) are obliged to survey commercial fisheries in order to collect input data for stock assessments (in terms age and size composition, fishing effort, CPUE), but such surveys are not funded till now. Instead, research institutes try to use project funding in order to collect data for the most important fisheries.

Another important gap that has been noted by the EWG since its establishment in 2008, was the need of training of the experts in stock assessment methods. Although some of the best scientists in the region are attending the EWG, their background is usually in fish biology and general fisheries science, lacking special training in state of the art stock assessment methodology. As a result, only 2 or 3 of the experts attending the group are able to fully commit to run the models and perform assessments that create a serious over-load for them, giving the growing demand from the EU to assess new stocks.

The EWG 12-16 recommends that a training course in population dynamics, stock assessment methods and using of the specialised software is organised to answer the needs of the majority of the scientists in the region.

The EWG 12-16 sensed that age reading in various species (incl. turbot, anchovy, whiting and others) may have important differences between countries that deteriorate the quality of catch-at-age data. There is also no harmonisation regarding the sampling size and timing, that lead to inconsistencies in aggregating national catches to international figures.

With this respect, the EWG 12-16 recommends to organise workshop(s) for inter-calibration of age readings between different laboratories and scientists in the region and harmonisation of the frameworks and methods of sampling of commercial fisheries and scientific surveys.

Other identified gaps that need to be addressed in the near future include:

- Insufficient knowledge of stock units
- Lack of knowledge, evaluations and monitoring programs for assessing the IUU and discards
- Lack of reliable frameworks of assessing and standardising of the commercial fleets fishing effort and CPUE

9 IDENTIFICATION OF OTHER IMPORTANT FISHERIES AND STOCKS

The EWG 12-16 identified the stock of the Atlantic bonito as very important and suggests to start exploring the state of data and knowledge in order to evaluate the possibility to assess this stock in the near future.

On the other hand, the EWG 12-16 acknowledged that the state of knowledge of the population biology and the available data are not enough to perform a whole Black Sea assessment of Rapa whelk. The EWG recommends that more efforts are made by national institutions (mainly in the bigger producers Turkey and Bulgaria) to collect the necessary data and develop methods for assessing of Rapa whelk.

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- Antom E Selectivity of the stationary Turbot Gillnet Gear.

12 APPENDIX 1: EWG-12-16 LIST OF PARTICIPANTS

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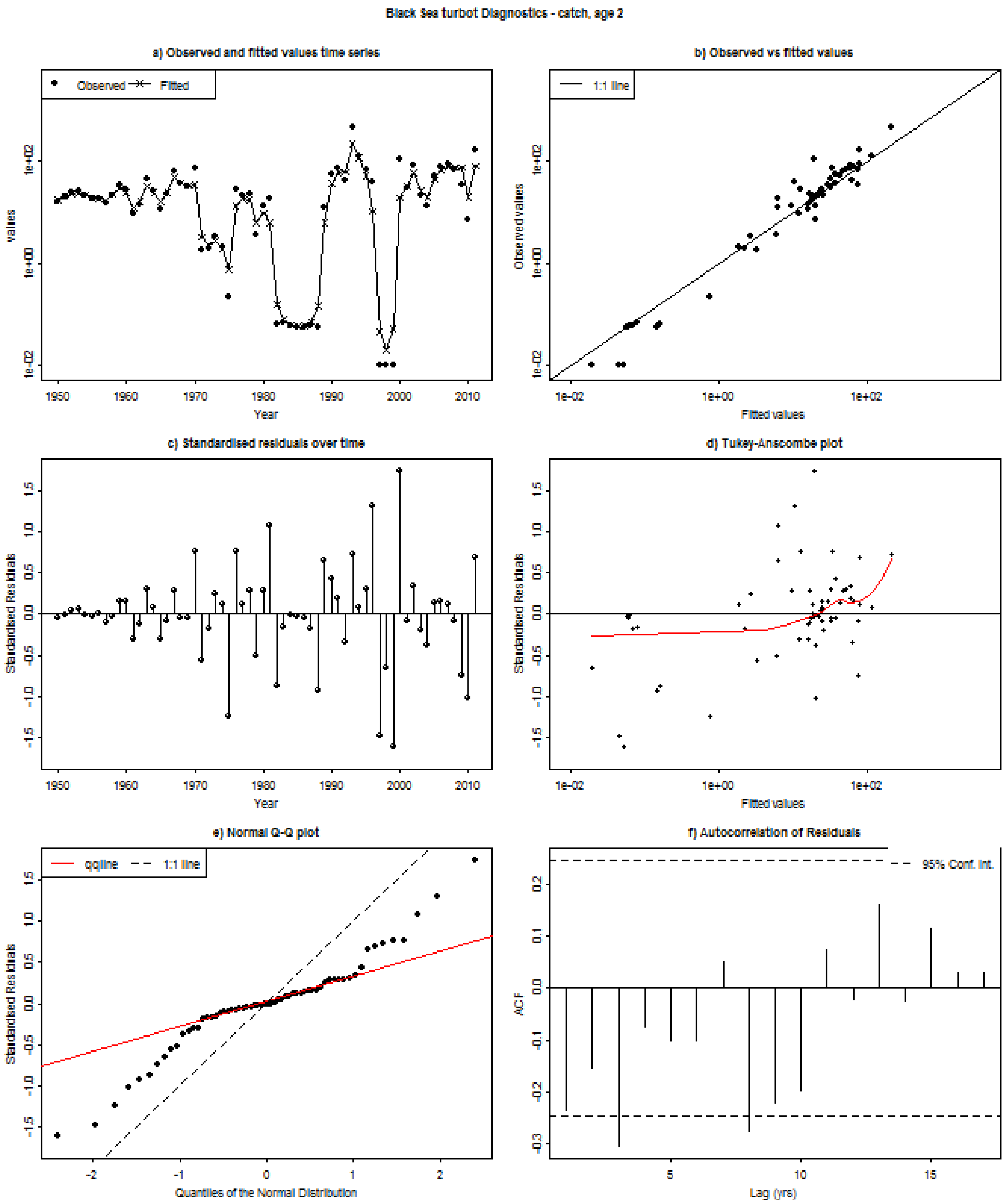
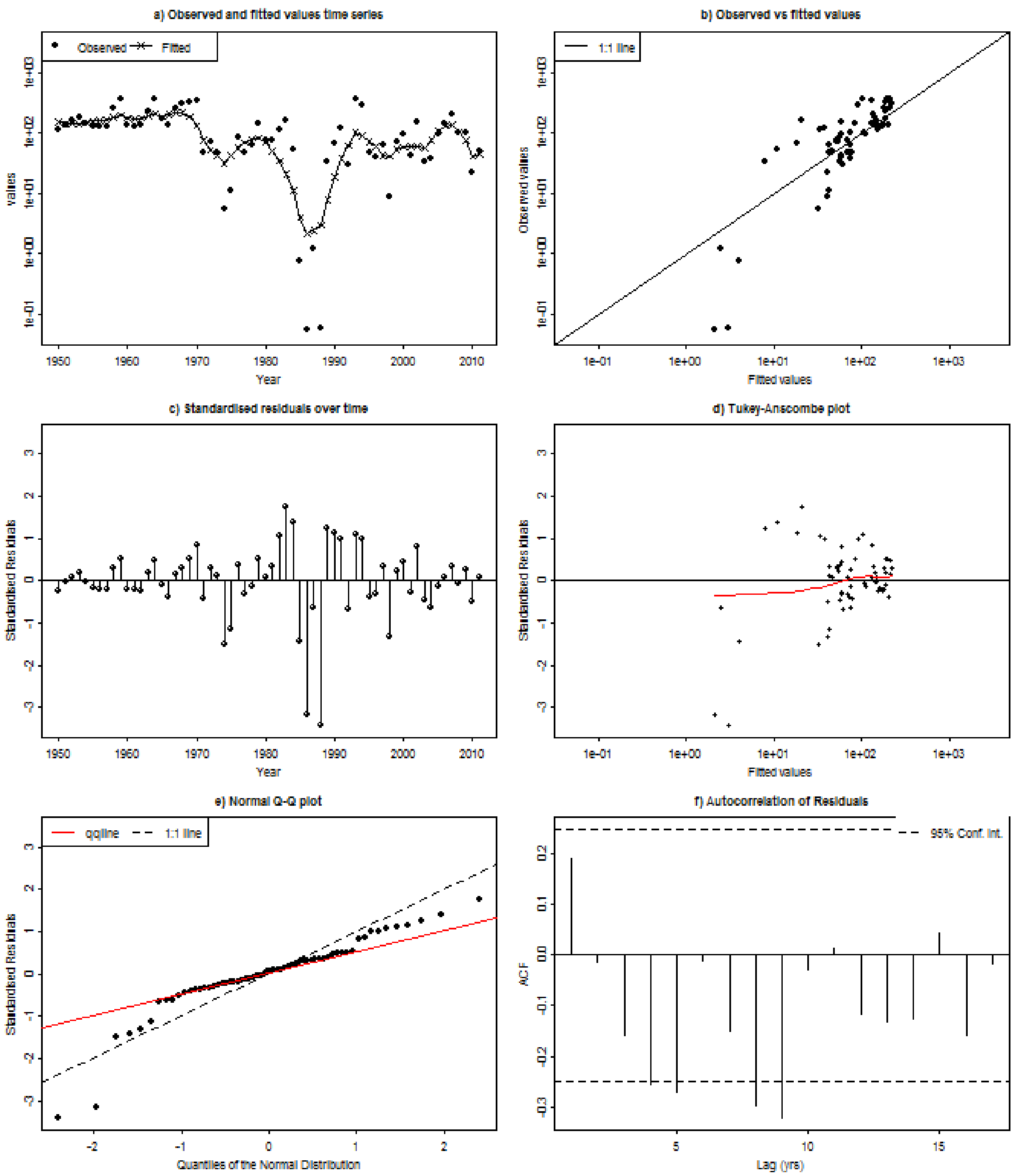
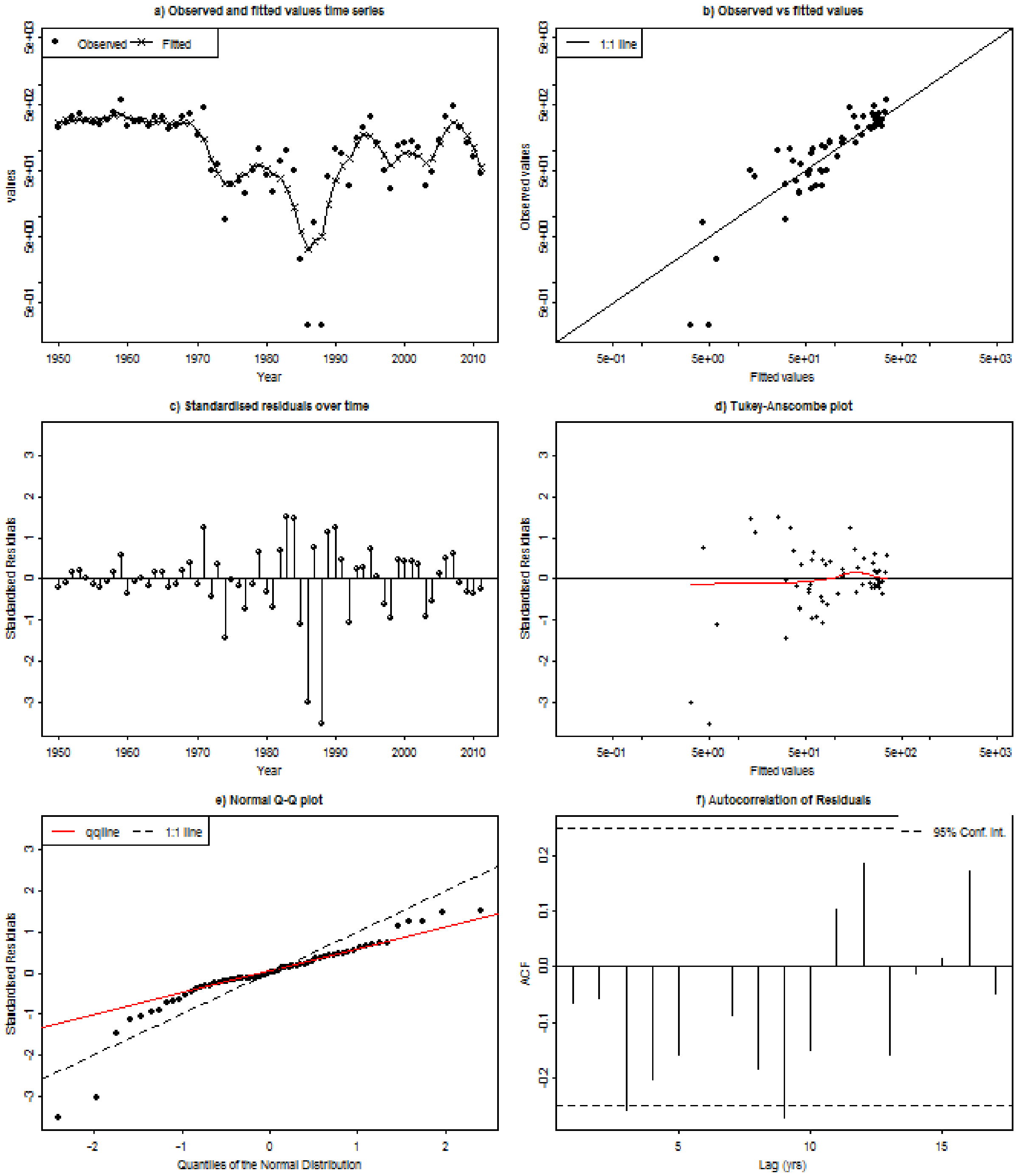
13 APENDIX 2: *EXPLORATION ANALYSIS OF DATA FOR TURBOT STOCK ASSESSMENT*

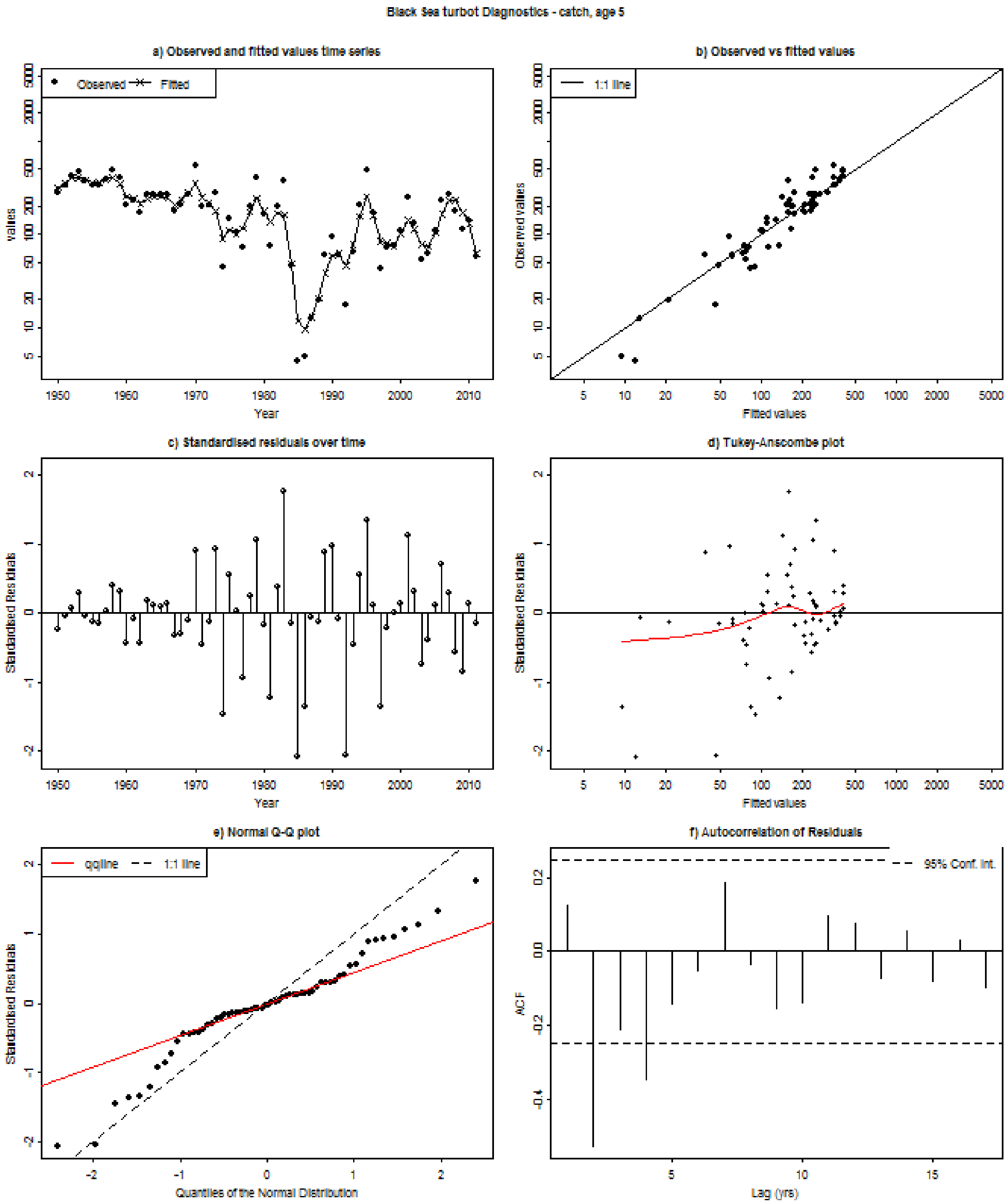


Black Sea turbot Diagnostics - catch, age 3



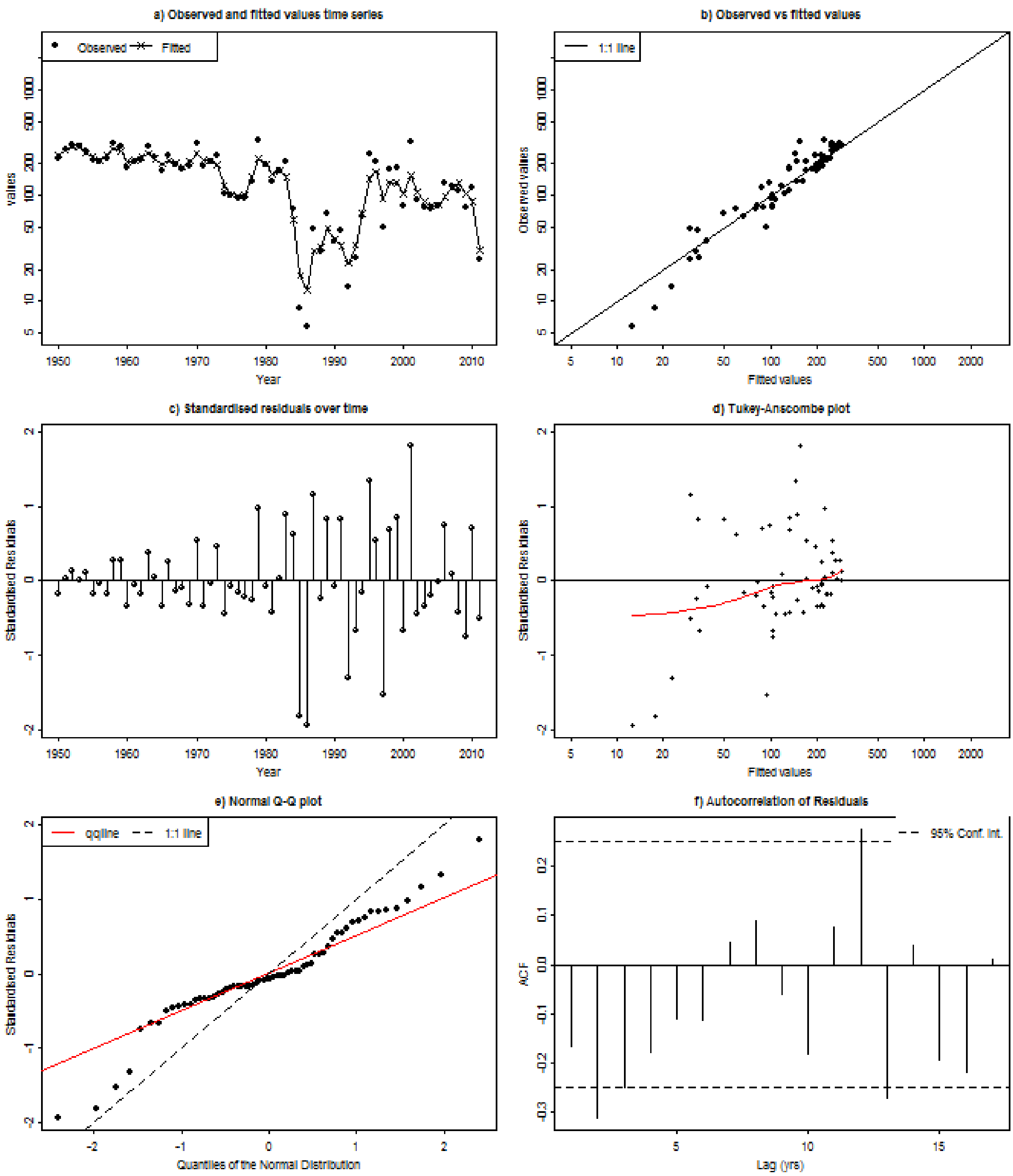
Black Sea turbot Diagnostics - catch, age 4



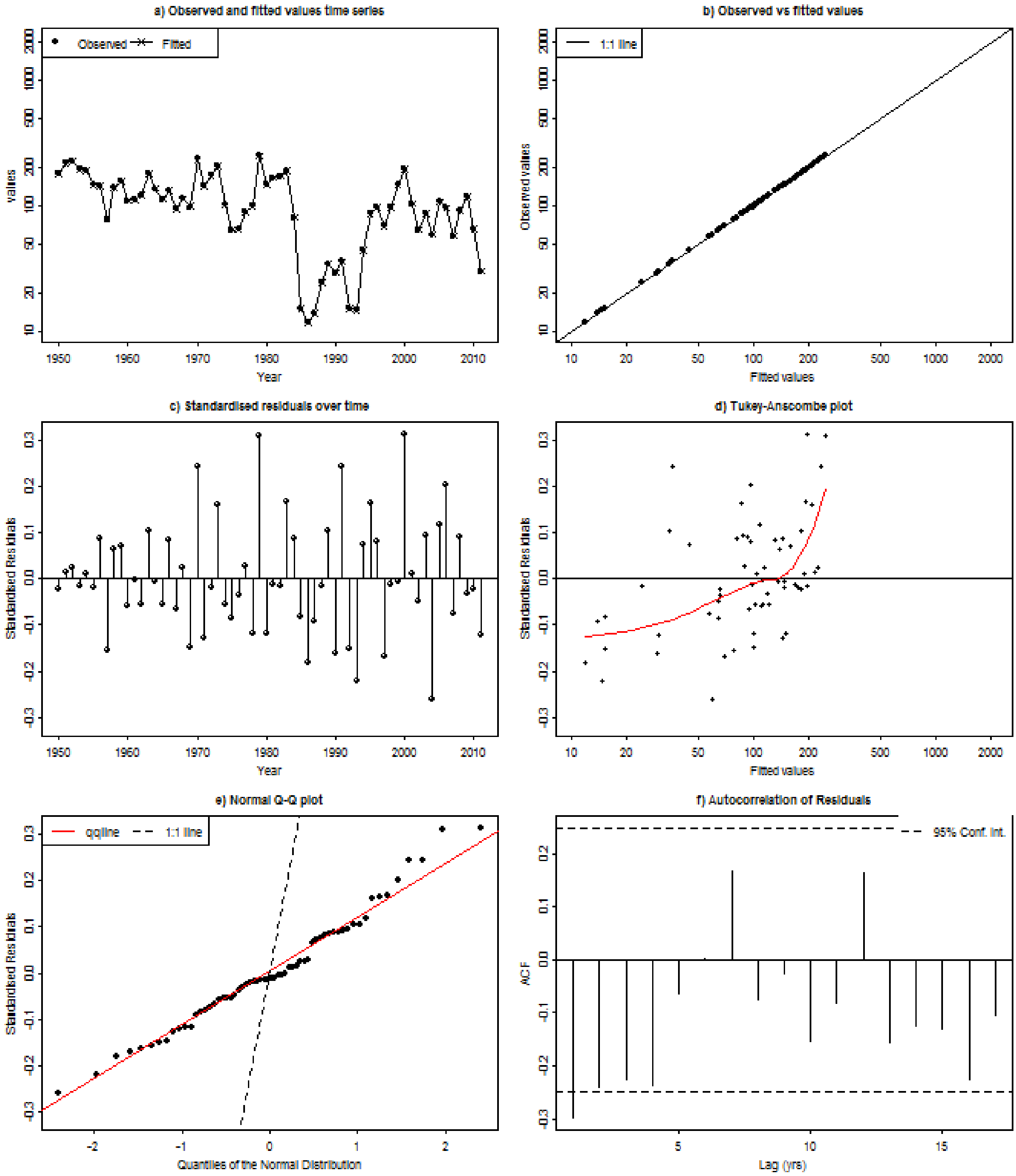


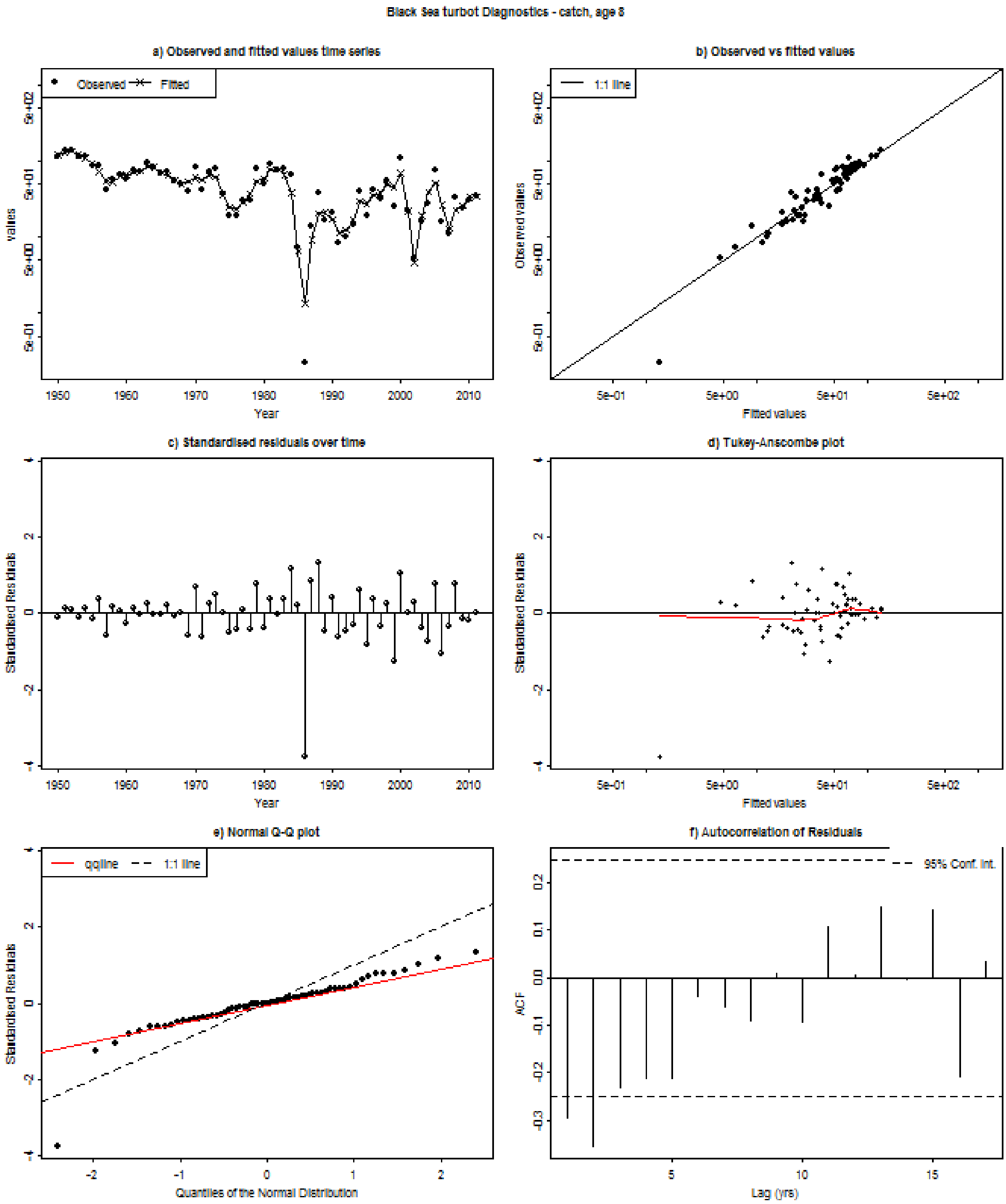
Black Sea turbot Diagnostics - catch, age 5
a) Observed and fitted values time series
Observed
Fitted
values
Year
b) Observed vs fitted values
1:1 line
Observed values
Fitted values
c) Standardised residuals over time
Standardised Residuals
Year
d) Tukey-Anscombe plot
Standardised Residuals
Fitted values
e) Normal Q-Q plot
qqline
1:1 line
Standardised Residuals
Quantiles of the Normal Distribution
f) Autocorrelation of Residuals
95% Conf. Int.
ACF
Lag (yrs)

Black Sea turbot Diagnostics - catch, age 6



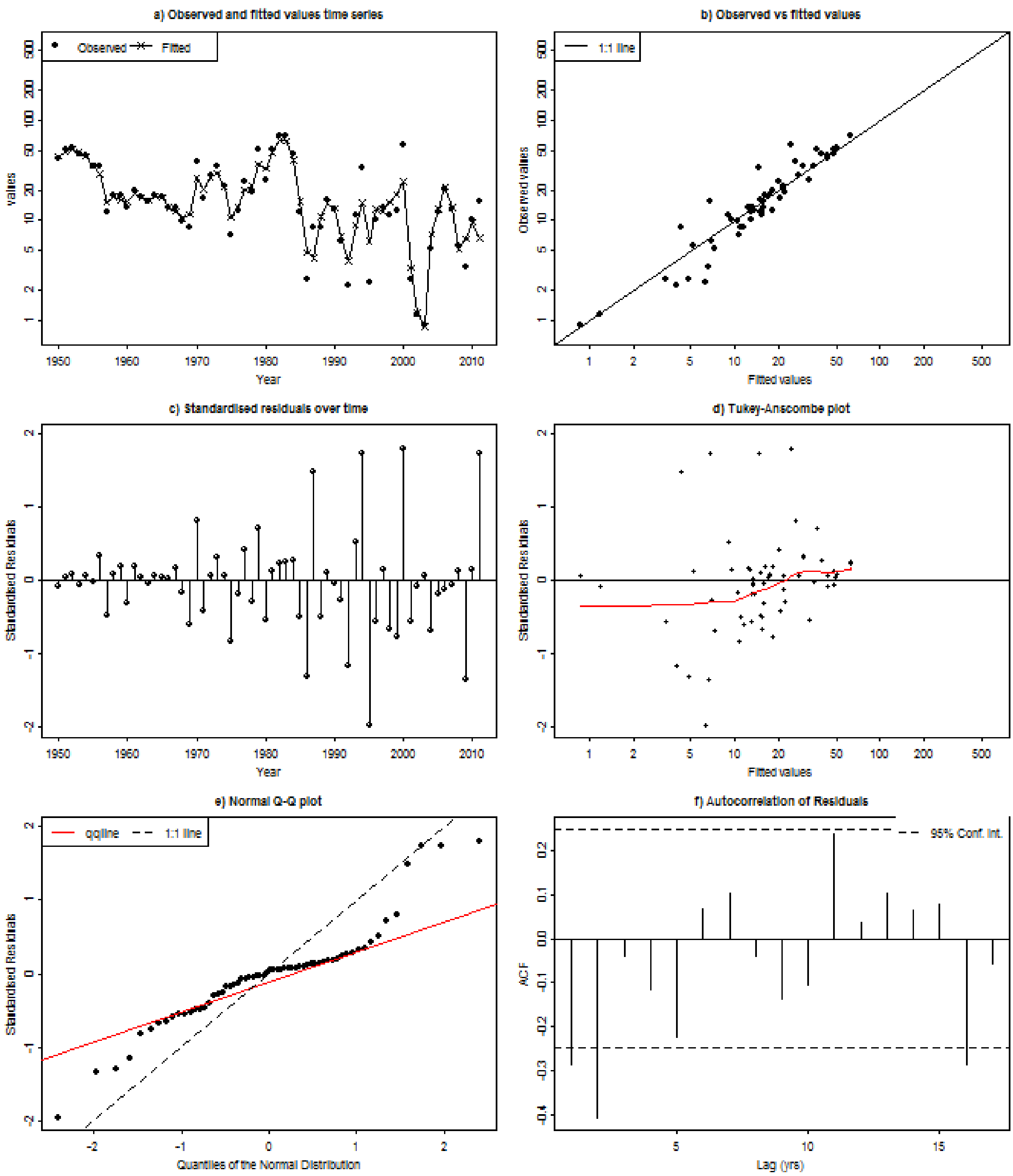
Black Sea turbot Diagnostics - catch, age 7



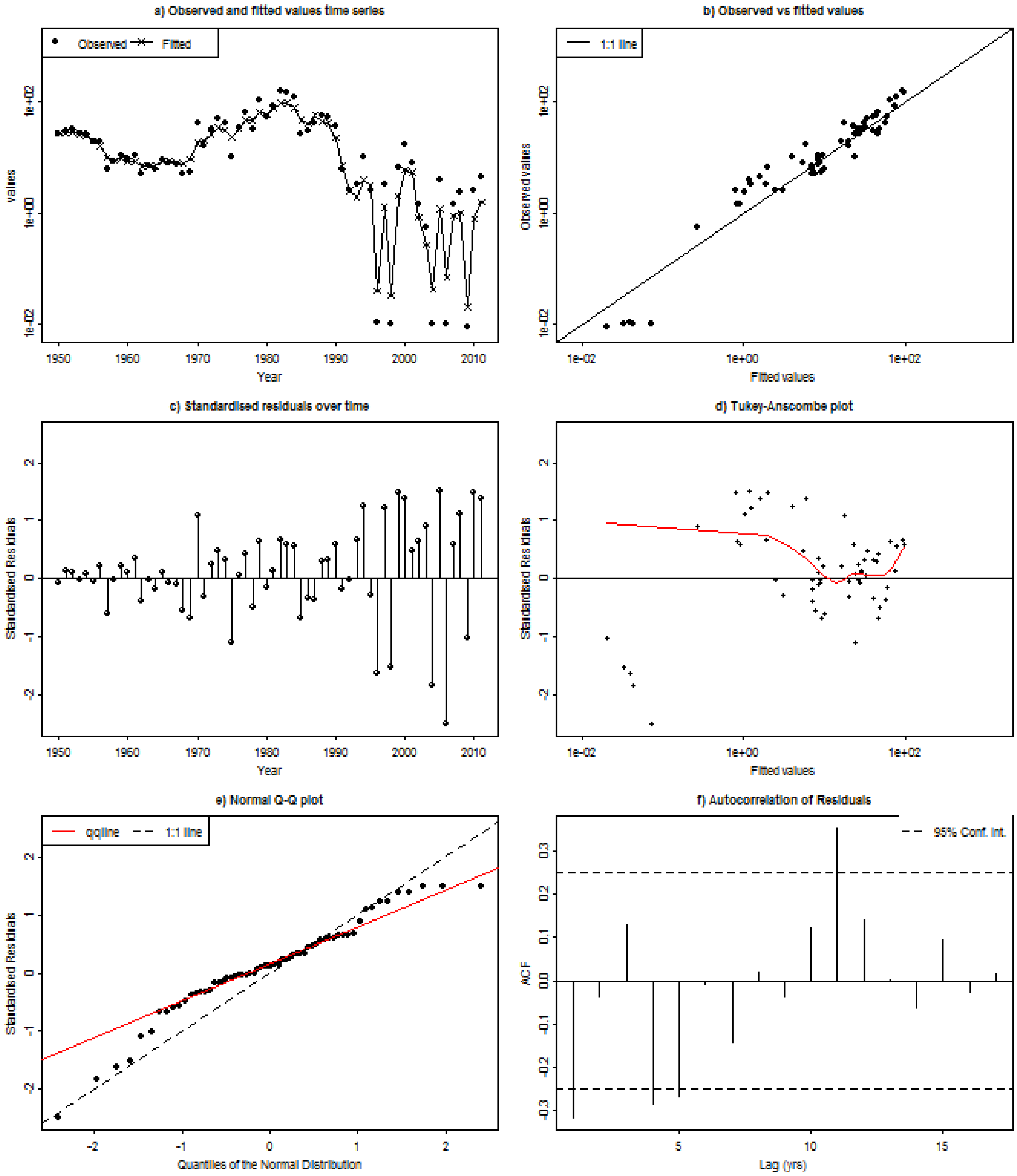


Black Sea turbot Diagnostics - catch, age 8
a) Observed and fitted values time series
Observed
Fitted
values
Year
b) Observed vs fitted values
1:1 line
Observed values
Fitted values
c) Standardised residuals over time
Standardised Residuals
Year
d) Tukey-Anscombe plot
Standardised Residuals
Fitted values
e) Normal Q-Q plot
qqline
1:1 line
Standardised Residuals
Quantiles of the Normal Distribution
f) Autocorrelation of Residuals
95% Conf. Int.
ACF
Lag (yrs)

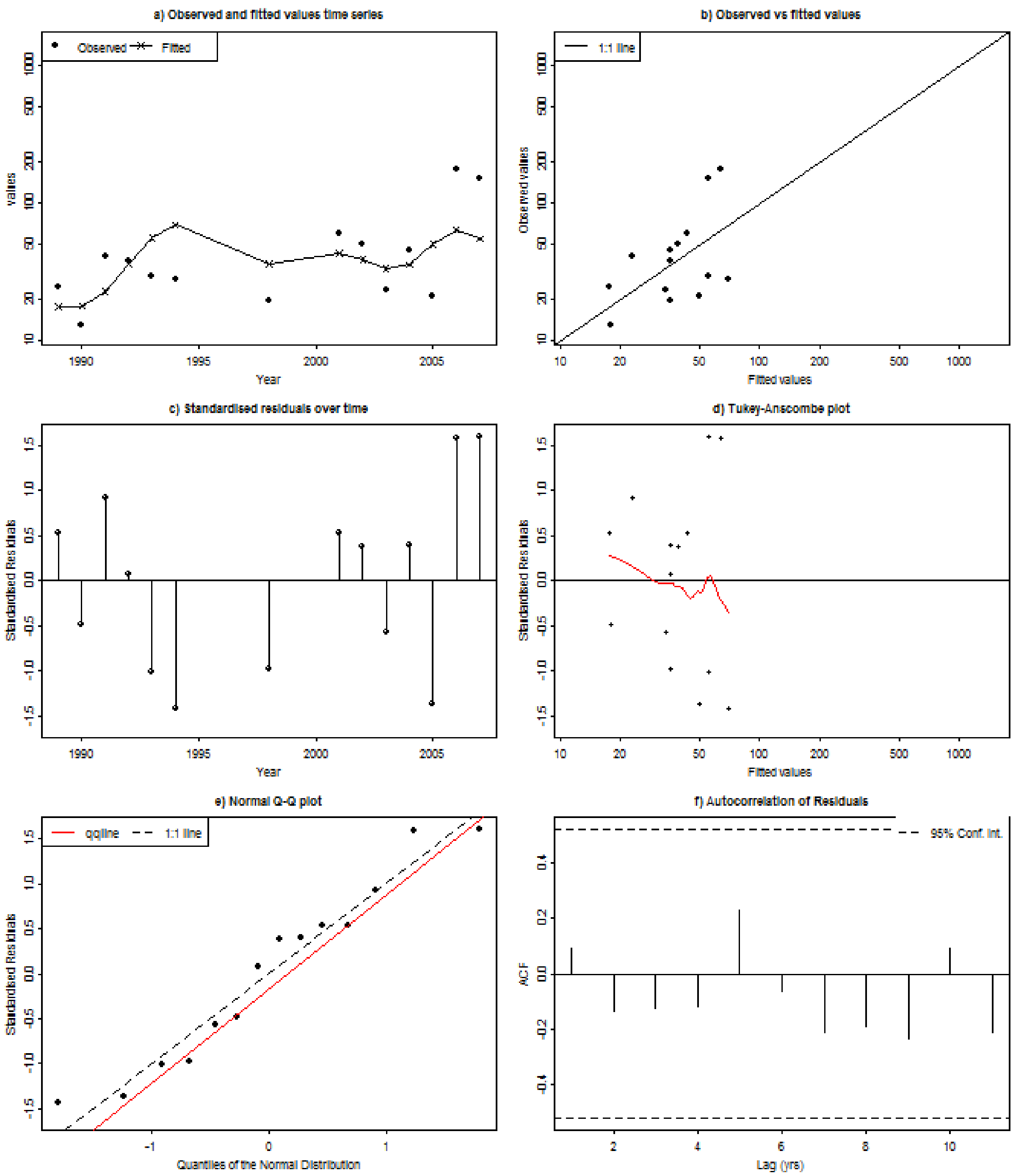
Black Sea turbot Diagnostics - catch, age 9

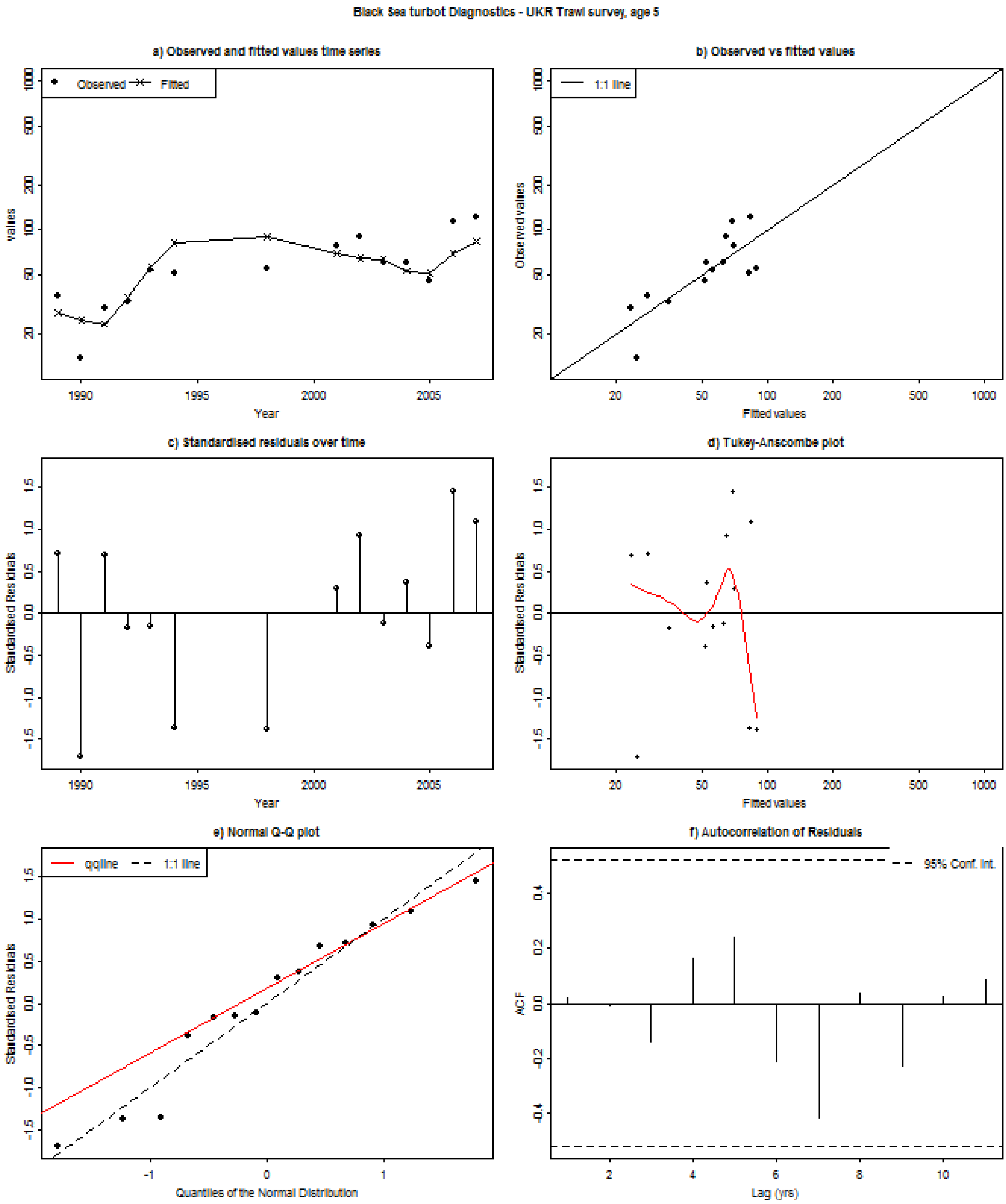


Black Sea turbot Diagnostics - catch, age 10



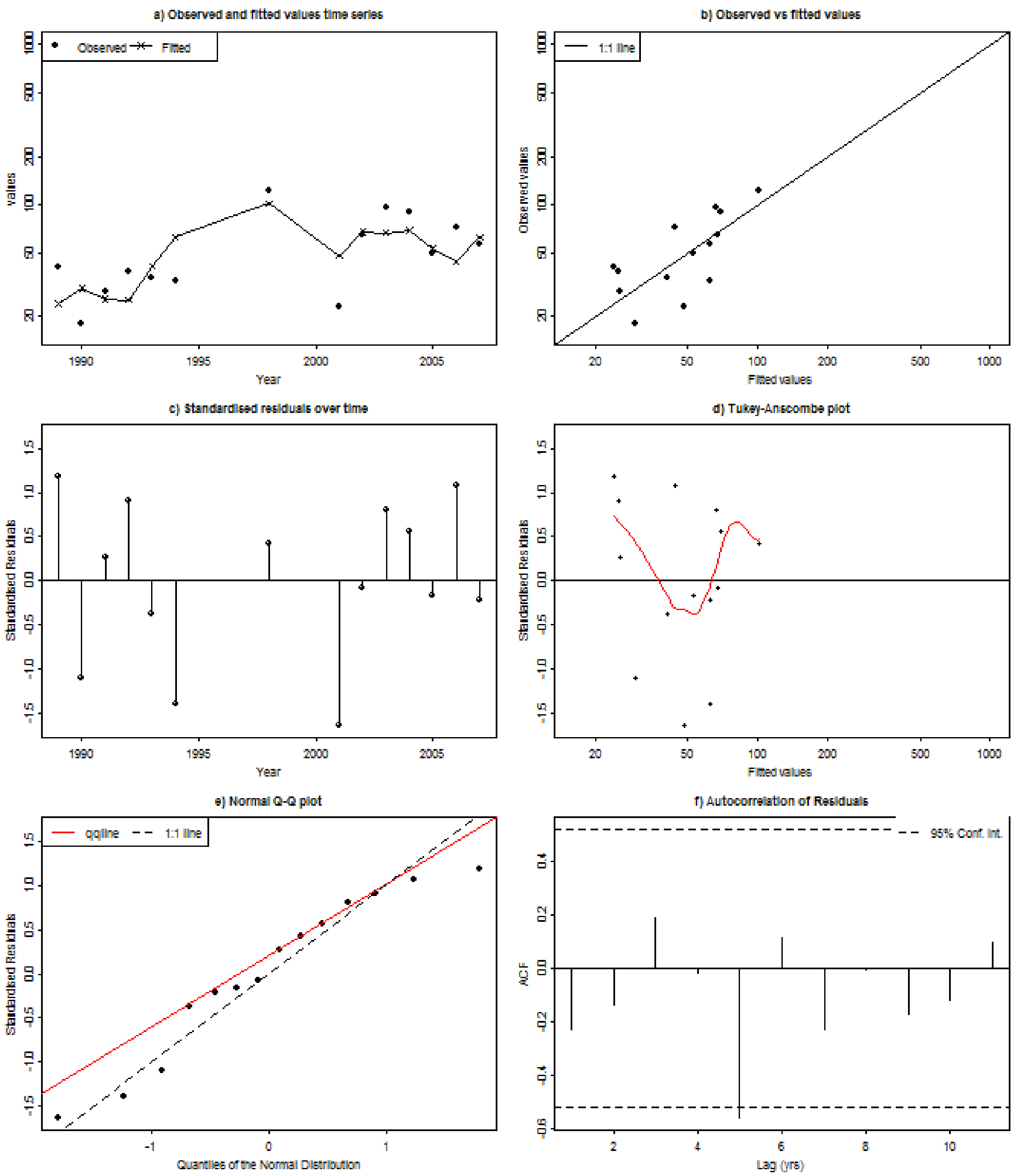
Black Sea turbot Diagnostics - UKR Trawl survey, age 4



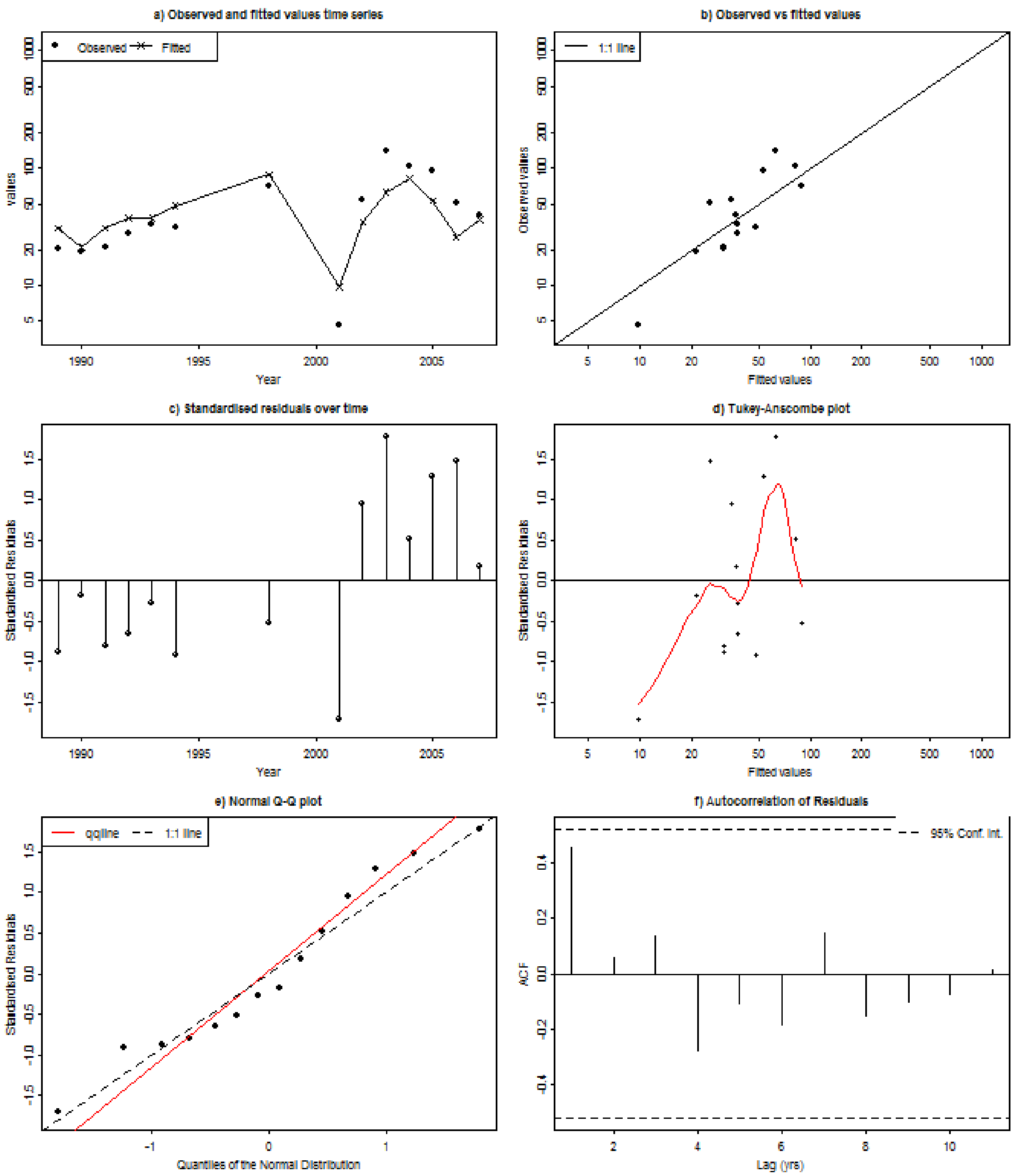


Black Sea turbot Diagnostics - UKR Trawl survey, age 5
a) Observed and fitted values time series
Observed
Fitted
values
Year
b) Observed vs fitted values
1:1 line
Observed values
Fitted values
c) Standardised residuals over time
Standardised Residuals
Year
d) Tukey-Anscombe plot
Standardised Residuals
Fitted values
e) Normal Q-Q plot
qqline
1:1 line
Standardised Residuals
Quantiles of the Normal Distribution
f) Autocorrelation of Residuals
95% Conf. Int.
ACF
Lag (yrs)

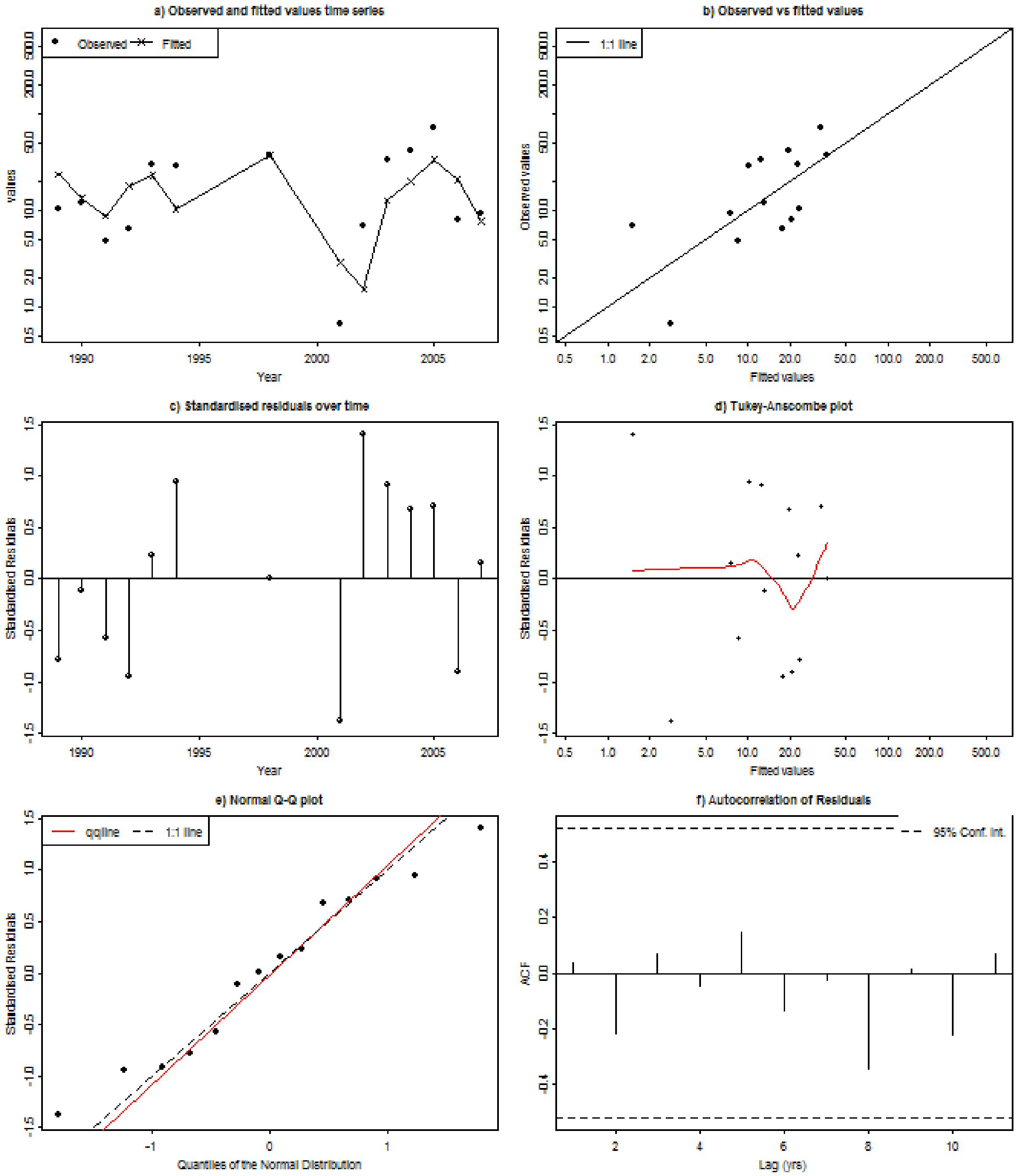
Black Sea turbot Diagnostics - UKR Trawl survey, age 6



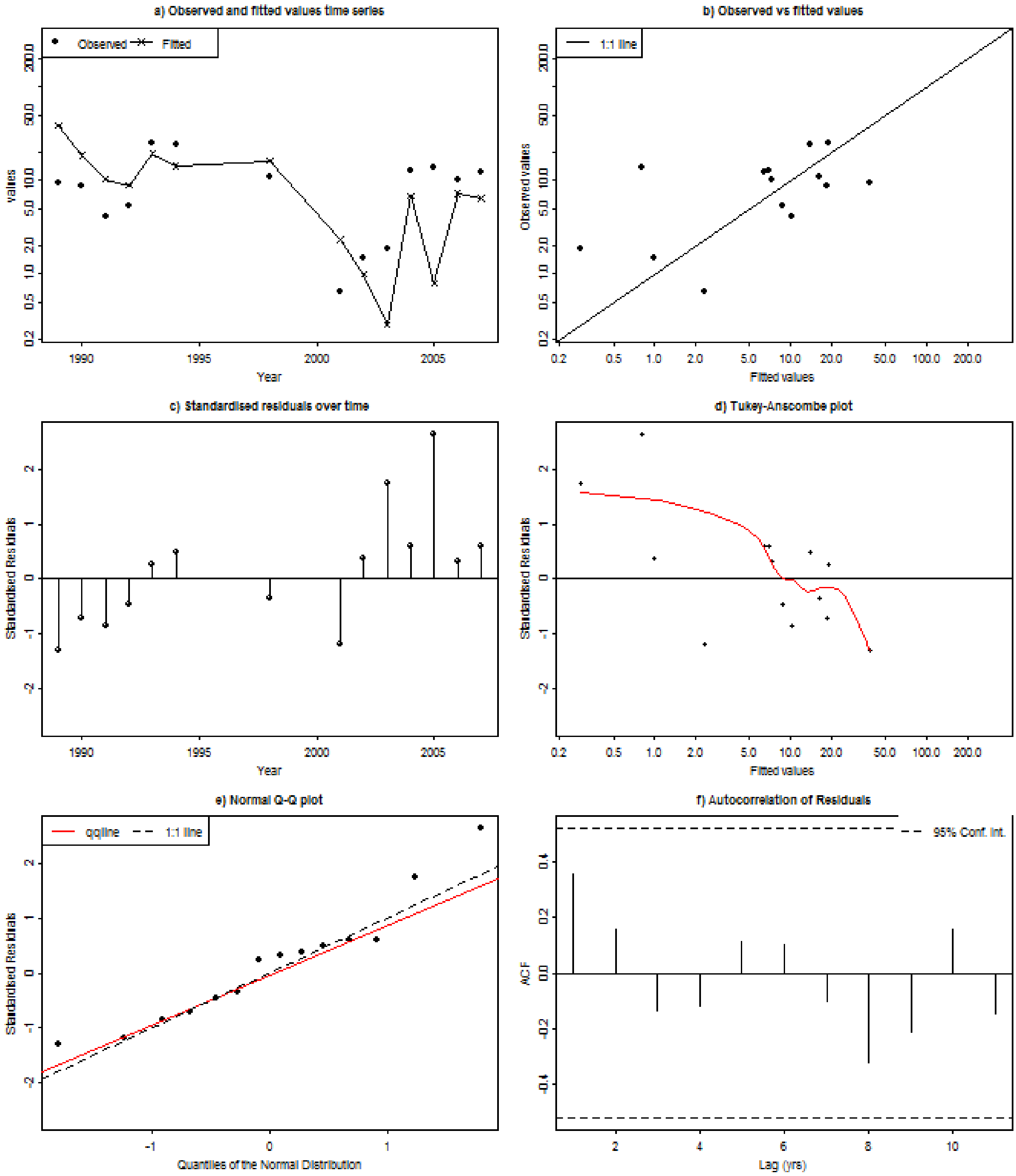
Black Sea turbot Diagnostics - UKR Trawl survey, age 7



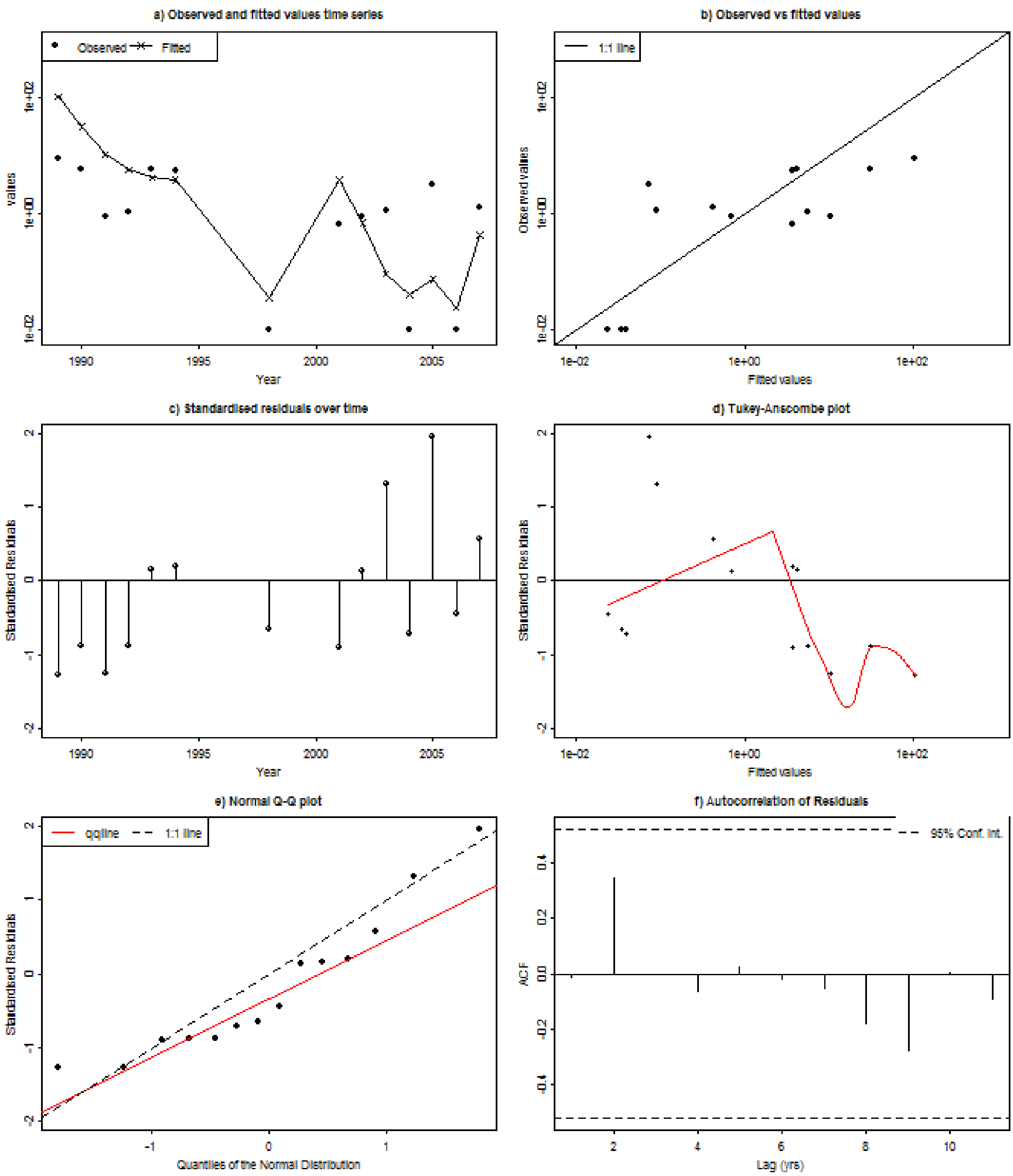
Black Sea turbot Diagnostics - UKR Trawl survey, age 8



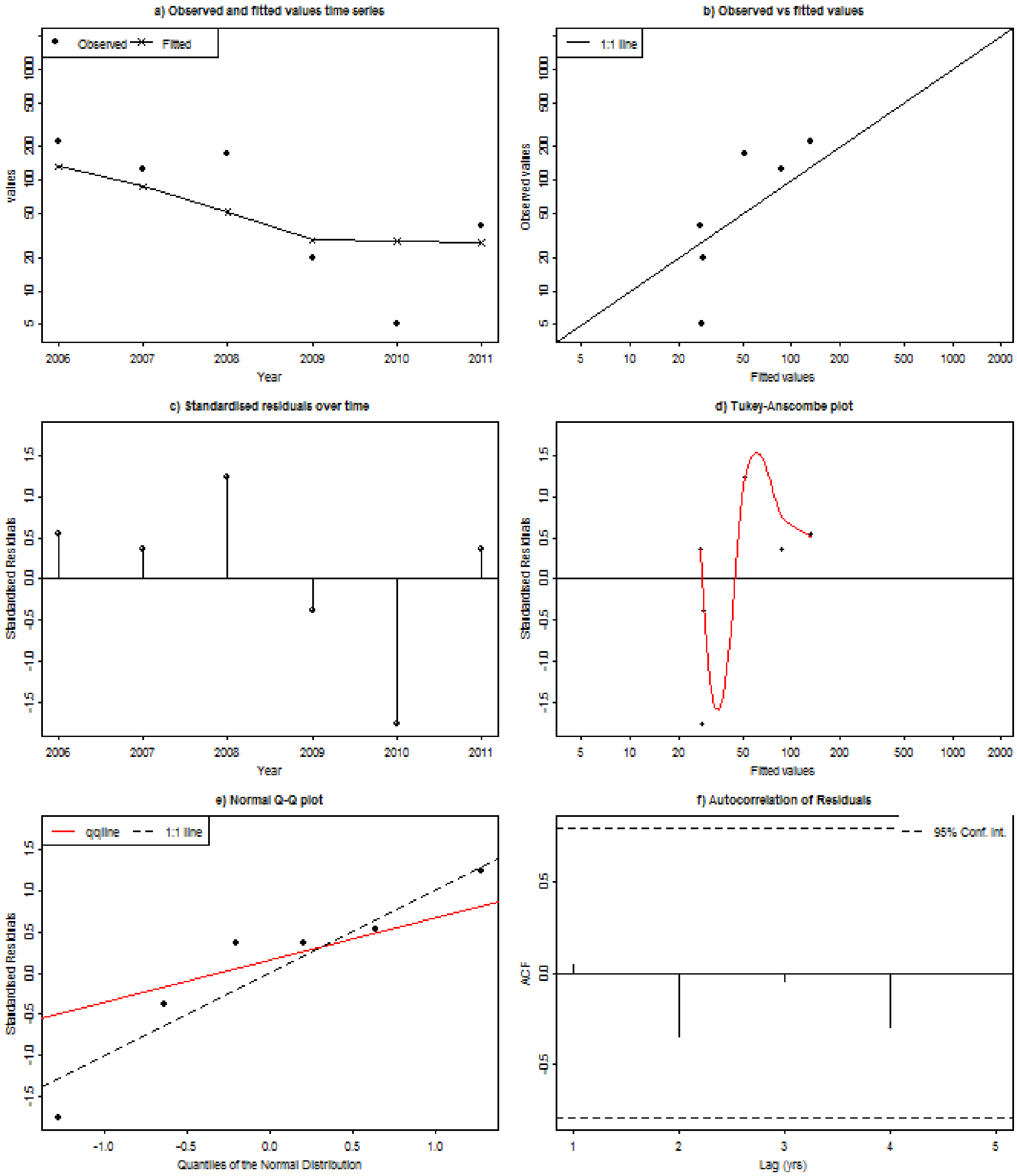
Black Sea turbot Diagnostics - UKR Trawl survey, age 9



Black Sea turbot Diagnostics - UKR Trawl survey, age 10



Black Sea turbot Diagnostics - BG Trawl survey, age 2



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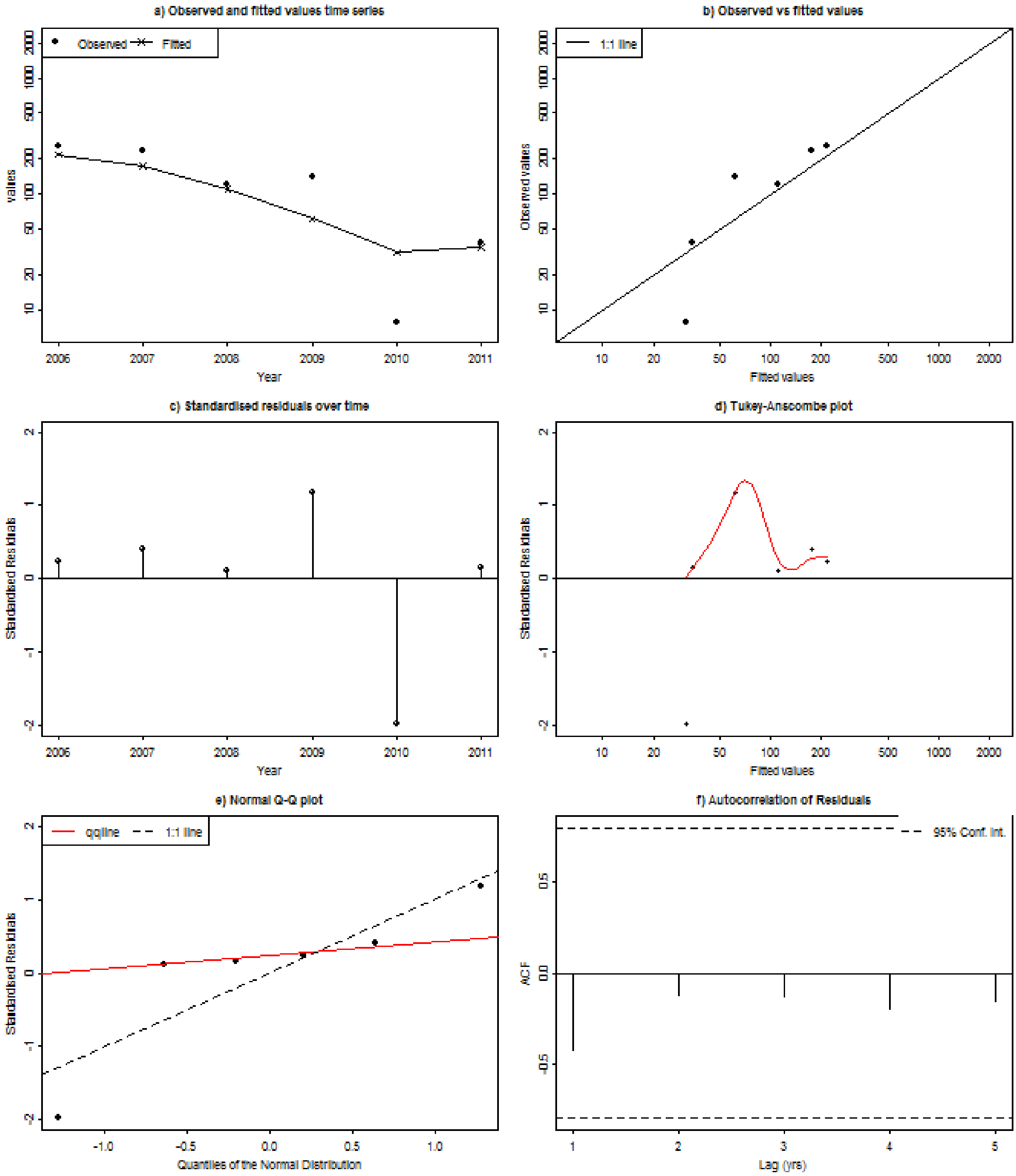
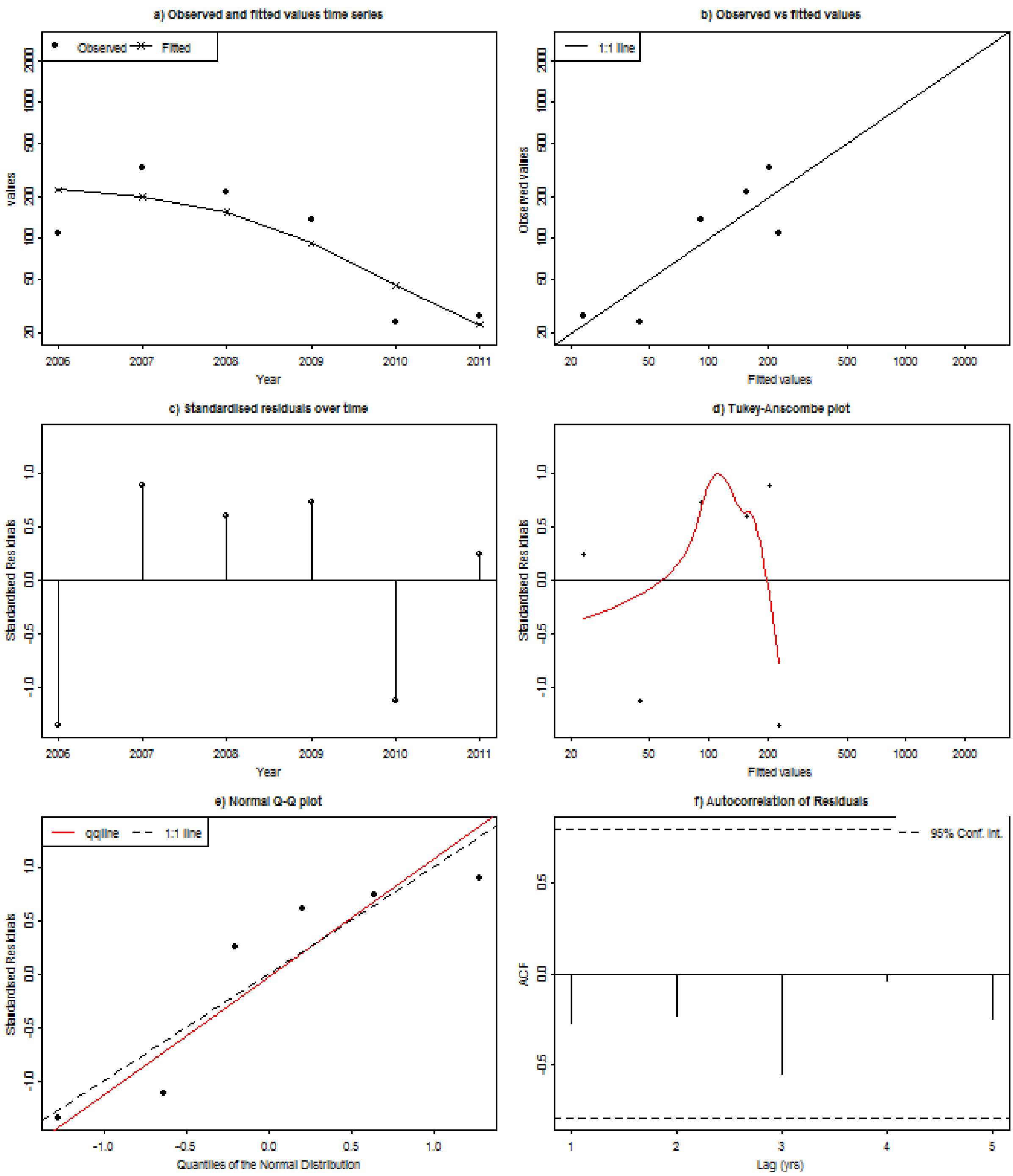
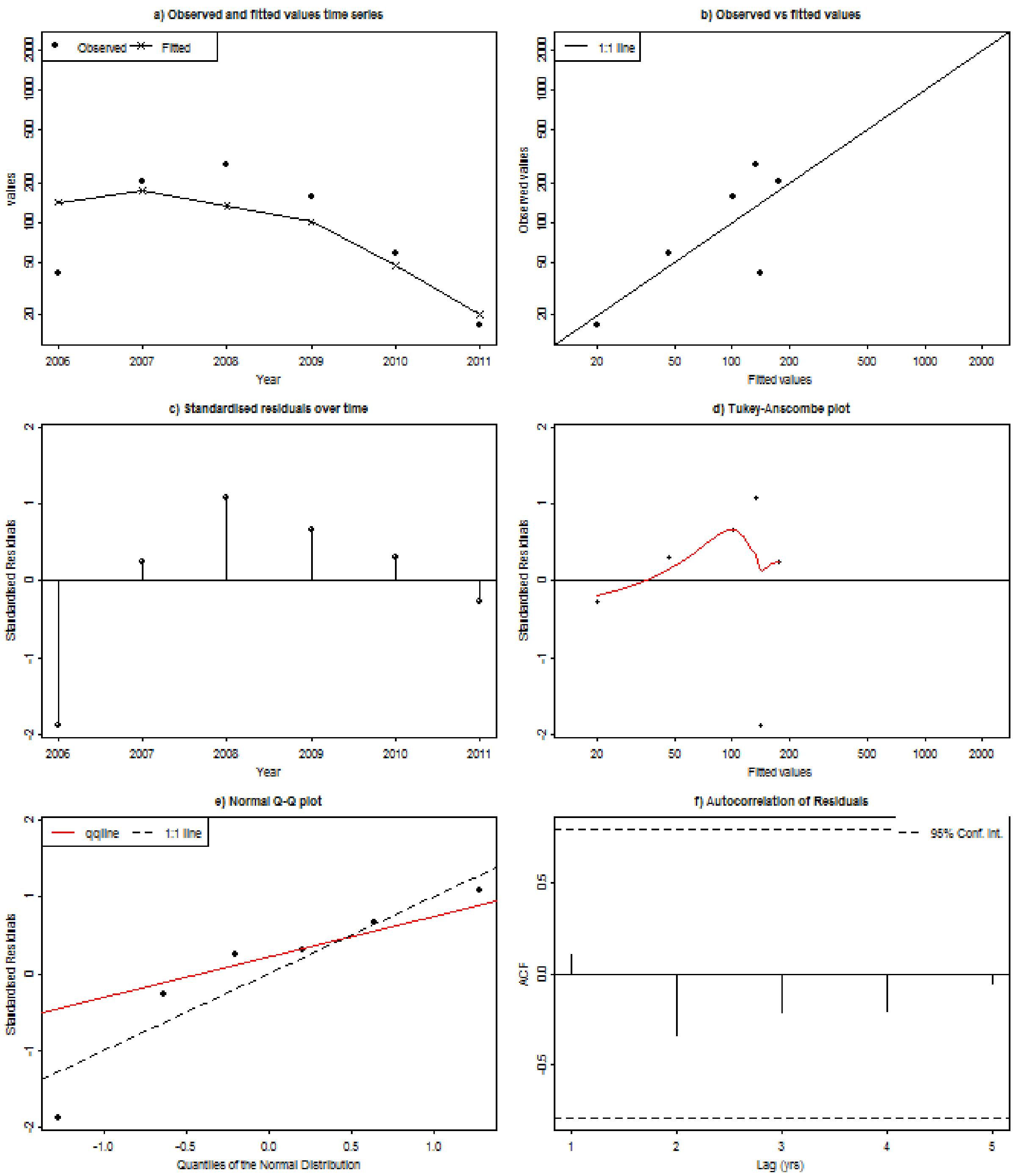
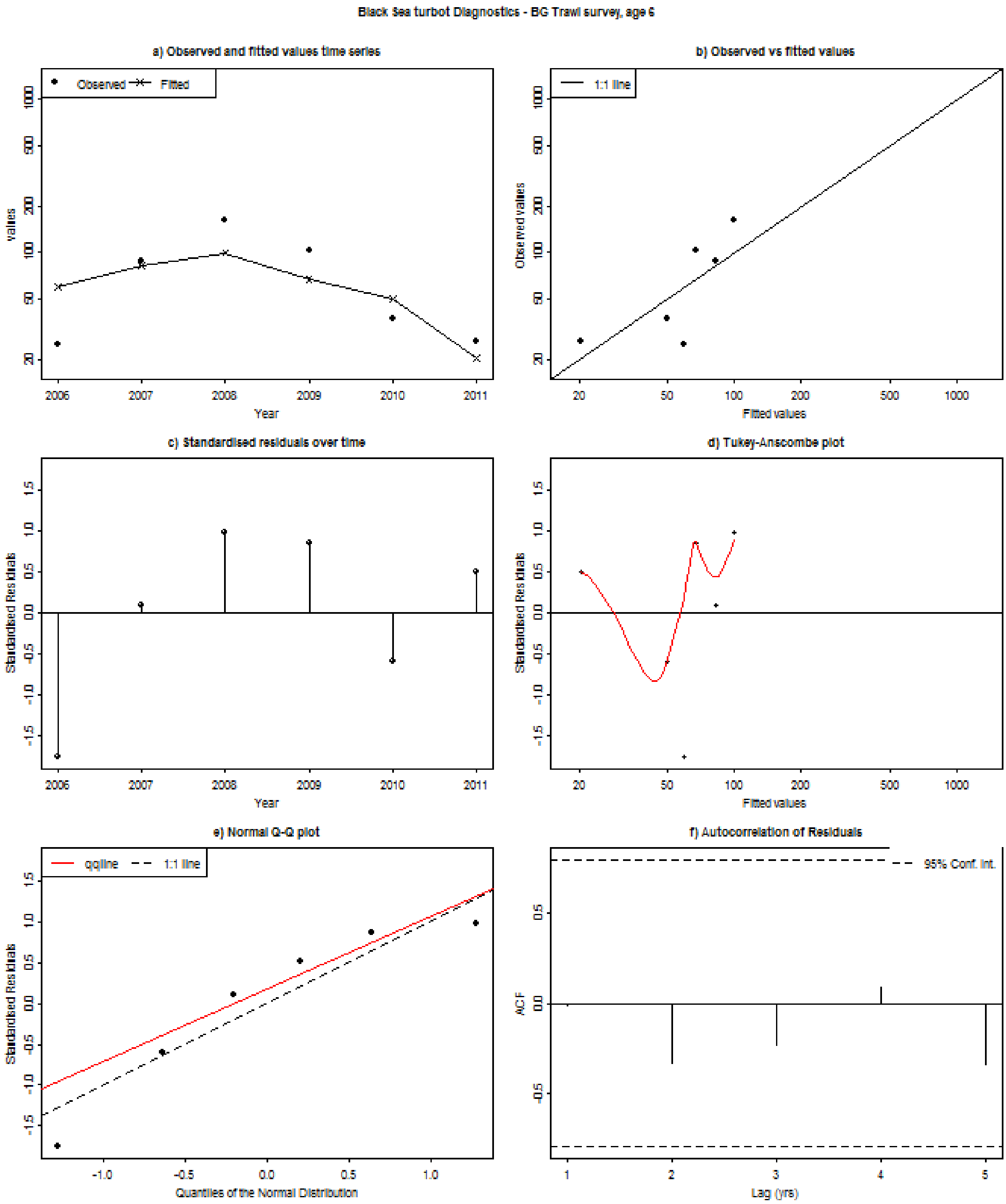


Black Sea turbot Diagnostics - BG Trawl survey, age 4



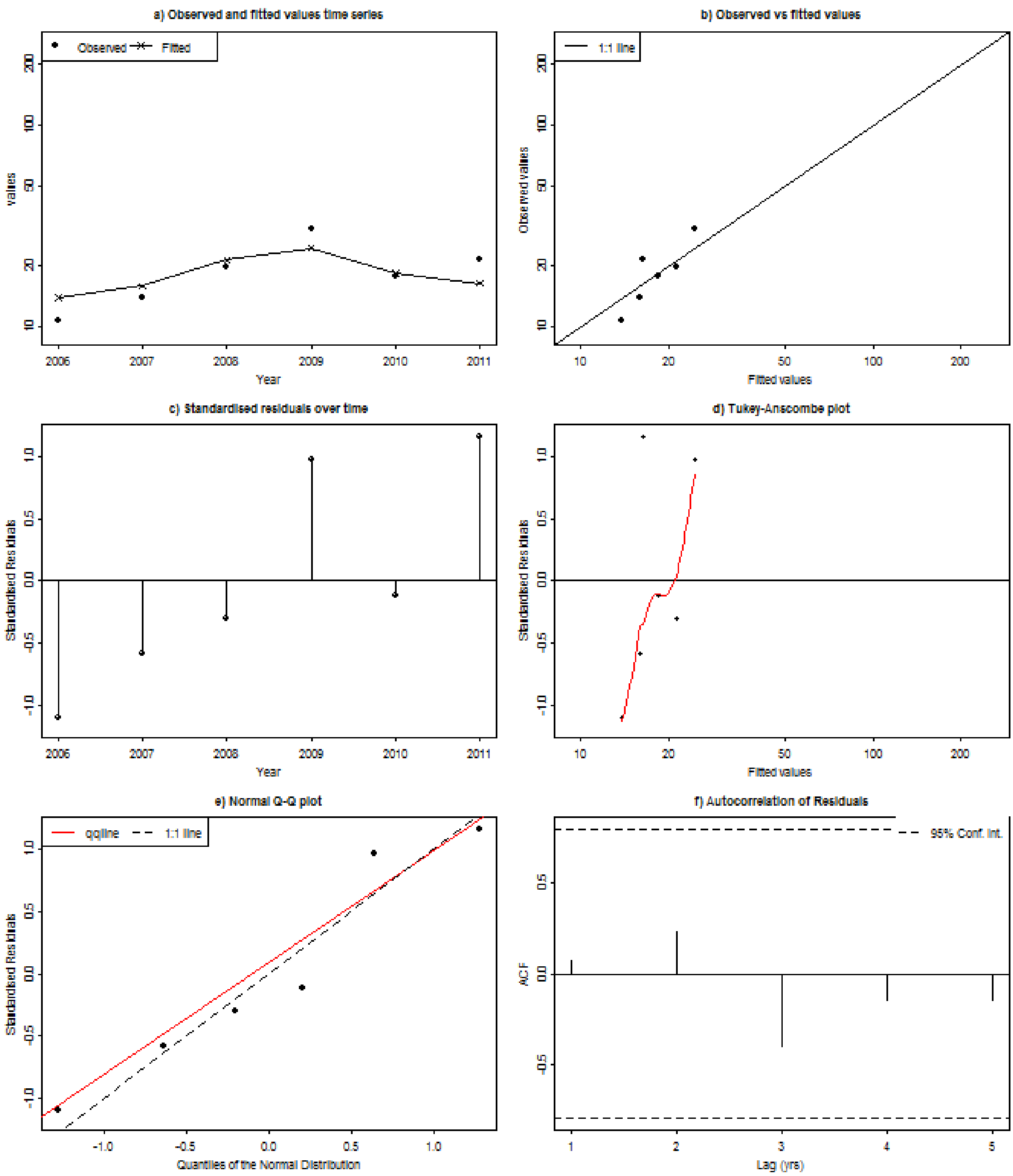
Black Sea turbot Diagnostics - BG Trawl survey, age 5



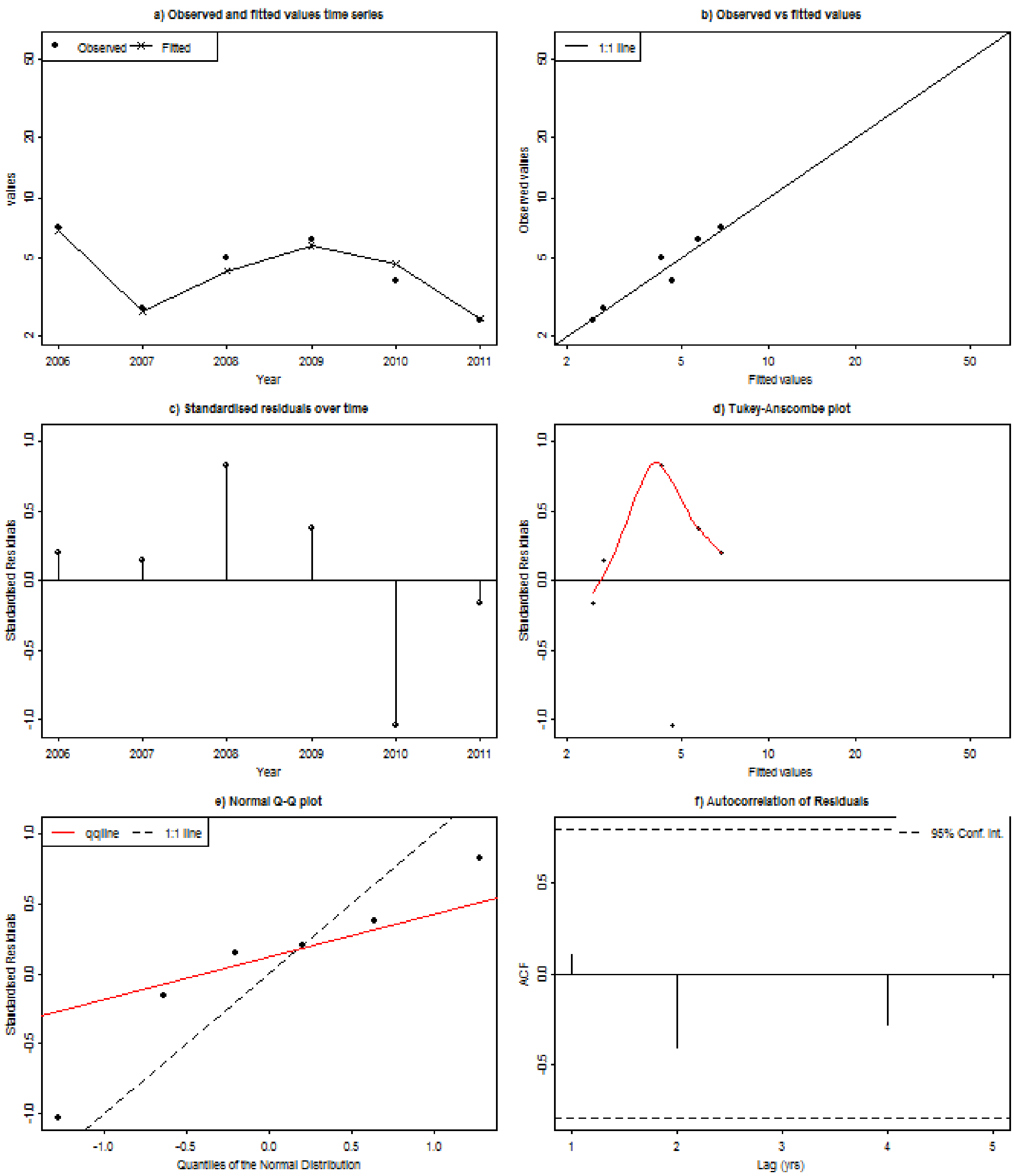


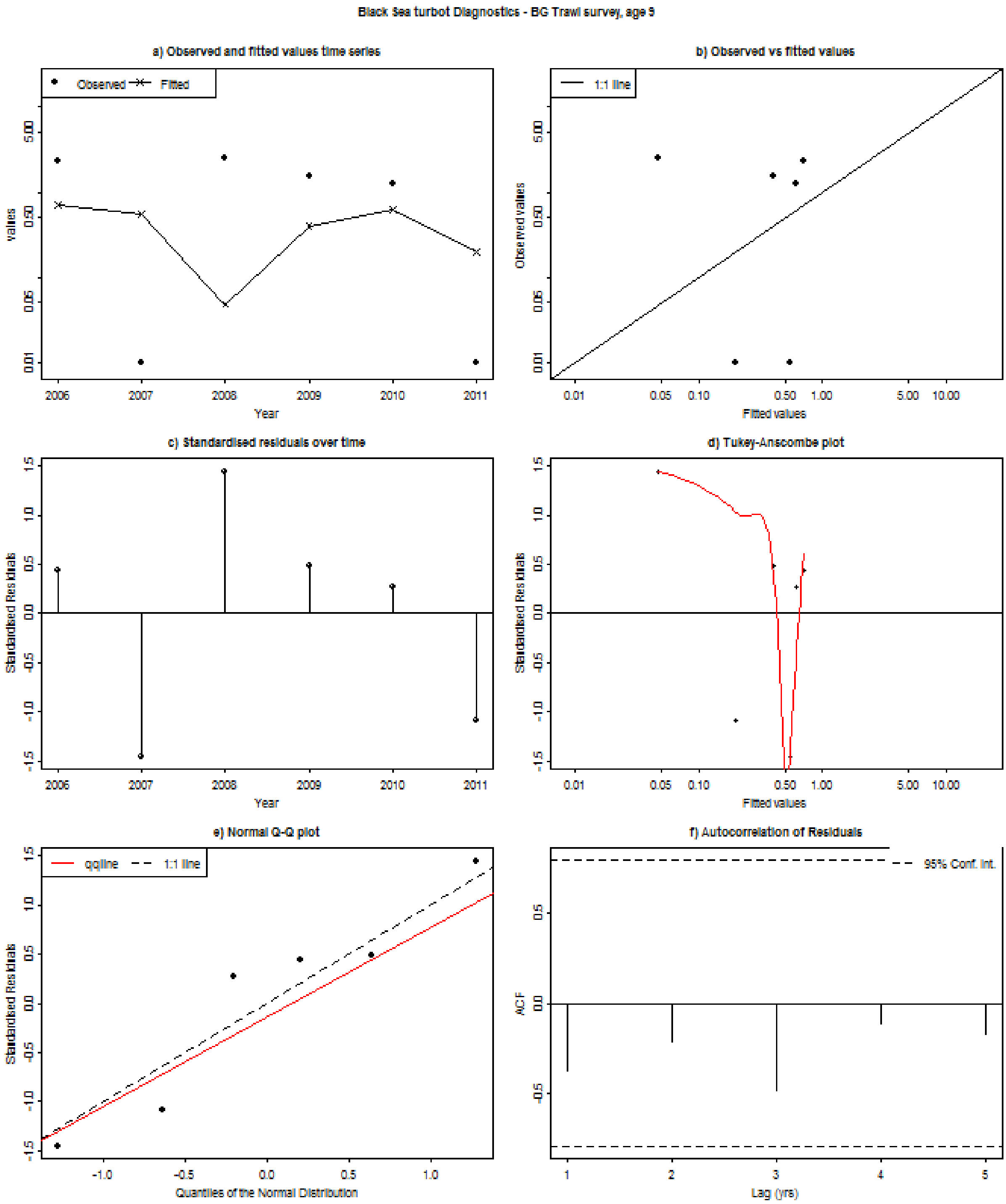
Black Sea turbot Diagnostics - BG Trawl survey, age 6
a) Observed and fitted values time series
Observed
Fitted
values
Year
b) Observed vs fitted values
1:1 line
Observed values
Fitted values
c) Standardised residuals over time
Standardised Residuals
Year
d) Tukey-Anscombe plot
Standardised Residuals
Fitted values
e) Normal Q-Q plot
qqline
1:1 line
Standardised Residuals
Quantiles of the Normal Distribution
f) Autocorrelation of Residuals
95% Conf. Int.
ACF
Lag (yrs)

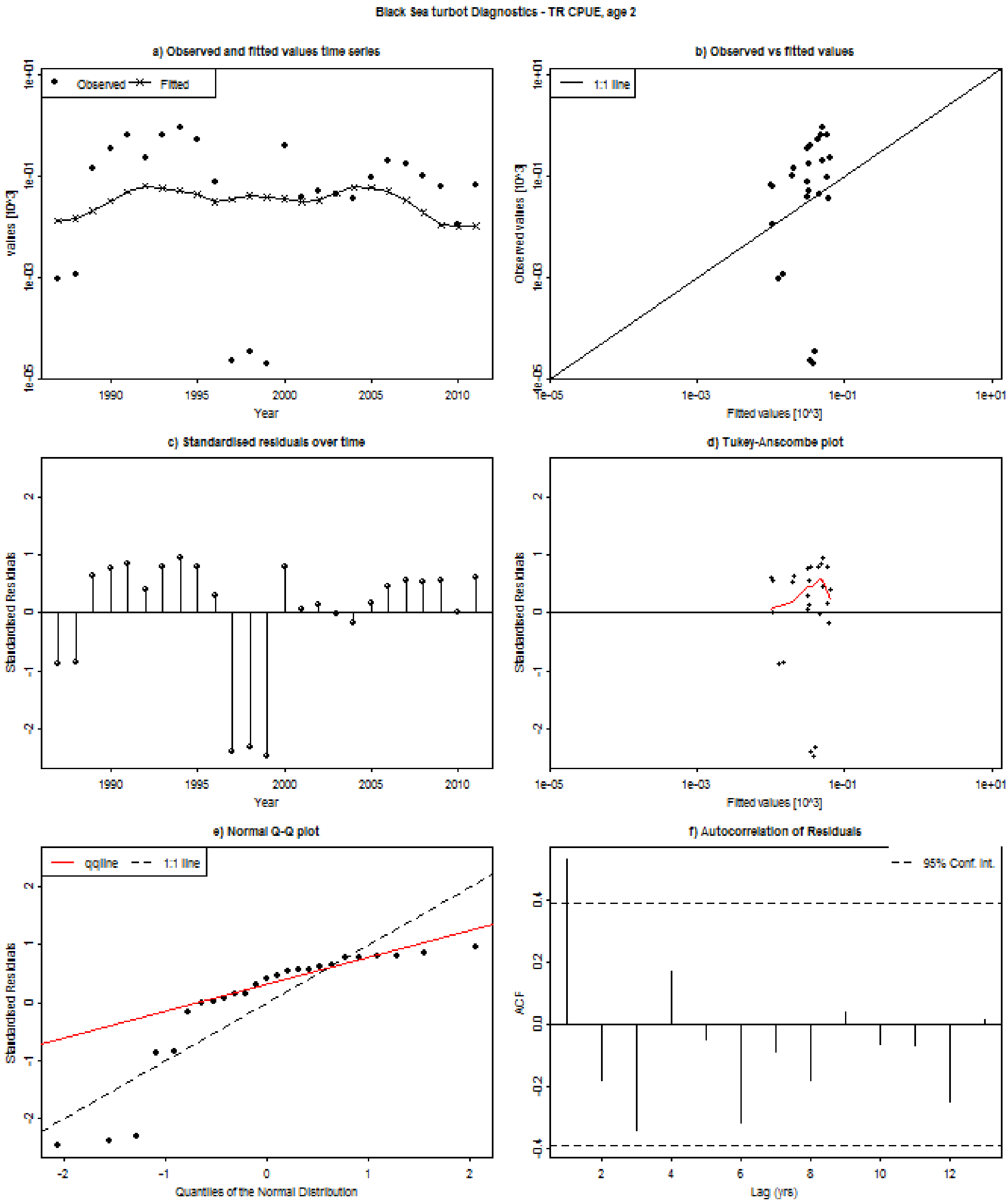
Black Sea turbot Diagnostics - BG Trawl survey, age 7



Black Sea turbot Diagnostics - BG Trawl survey, age 8

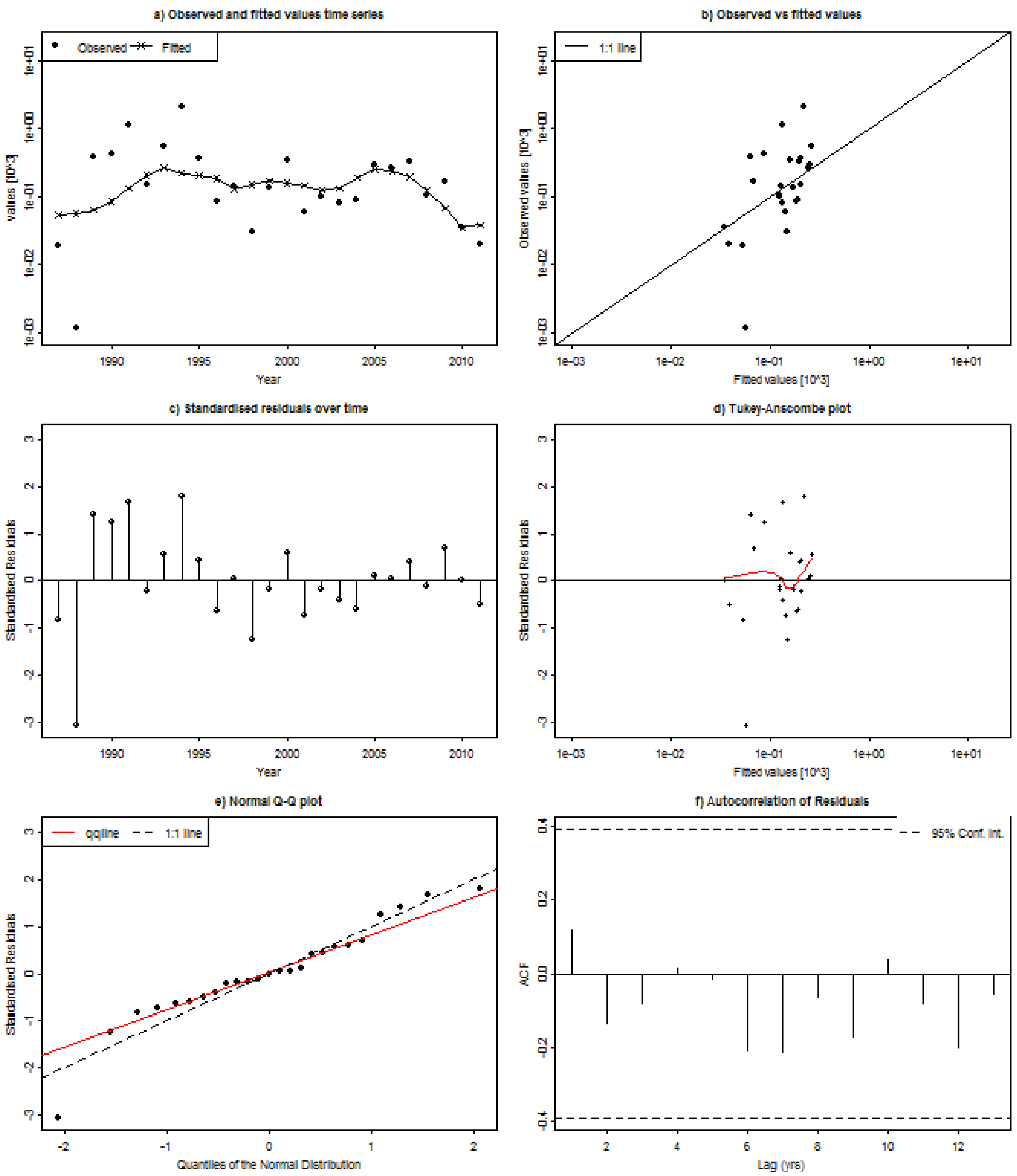



Black Sea turbot Diagnostics - BG Trawl survey, age 9
a) Observed and fitted values time series
Observed
Fitted
values
Year
b) Observed vs fitted values
1:1 line
Observed values
Fitted values
c) Standardised residuals over time
Standardised Residuals
Year
d) Tukey-Anscombe plot
Standardised Residuals
Fitted values
e) Normal Q-Q plot
qqline
1:1 line
Standardised Residuals
Quantiles of the Normal Distribution
f) Autocorrelation of Residuals
95% Conf. Int.
ACF
Lag (yrs)

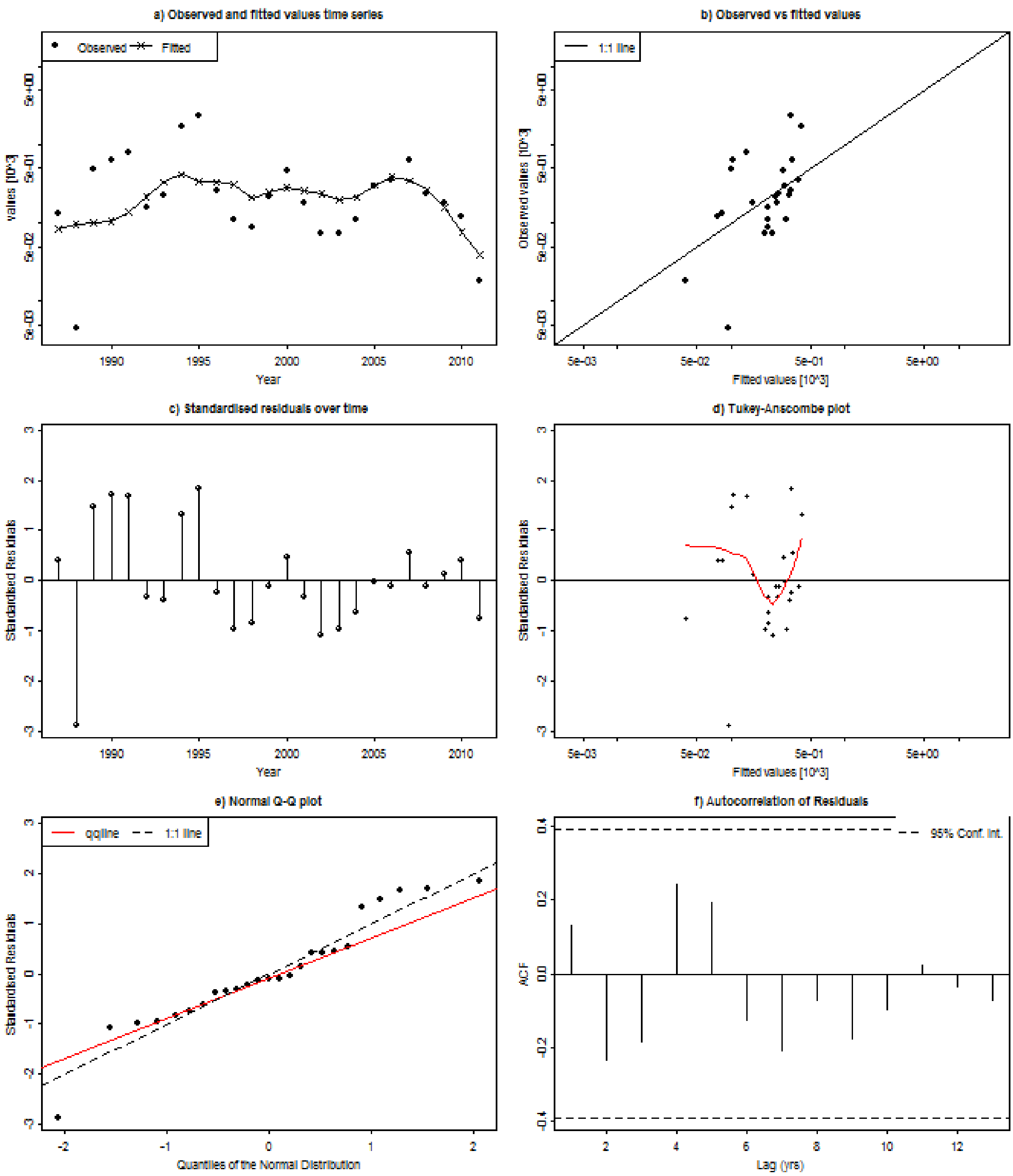


Black Sea turbot Diagnostics - TR CPUE, age 2
a) Observed and fitted values time series
Observed
Fitted
values [10^3]
Year
b) Observed vs fitted values
1:1 line
Observed values [10^3]
Fitted values [10^3]
c) Standardised residuals over time
Standardised Residuals
Year
d) Tukey-Anscombe plot
Standardised Residuals
Fitted values [10^3]
e) Normal Q-Q plot
qqline
1:1 line
Standardised Residuals
Quantiles of the Normal Distribution
f) Autocorrelation of Residuals
95% Conf. Int.
ACF
Lag (yrs)

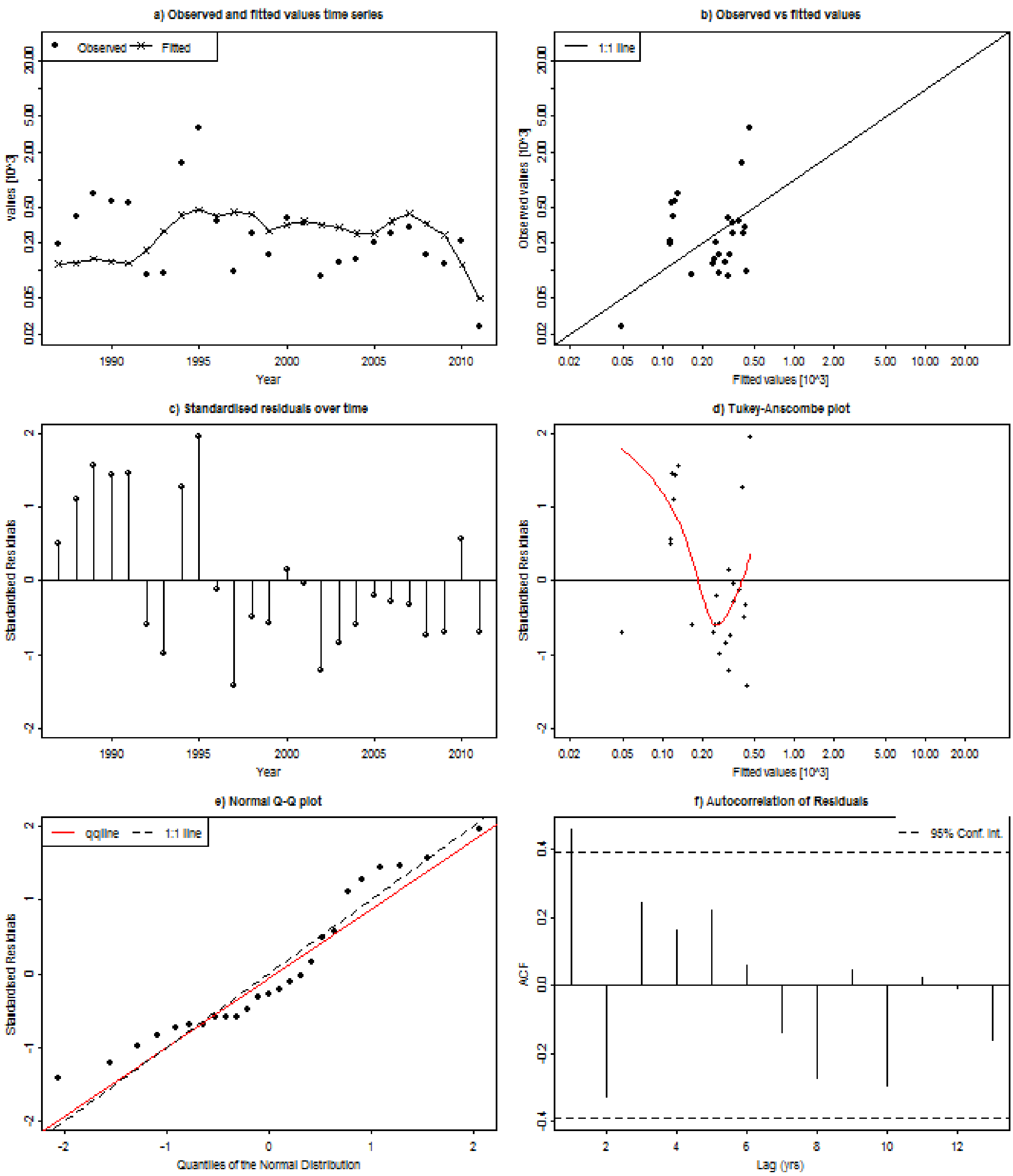
Black Sea turbot Diagnostics - TR CPUE, age 3

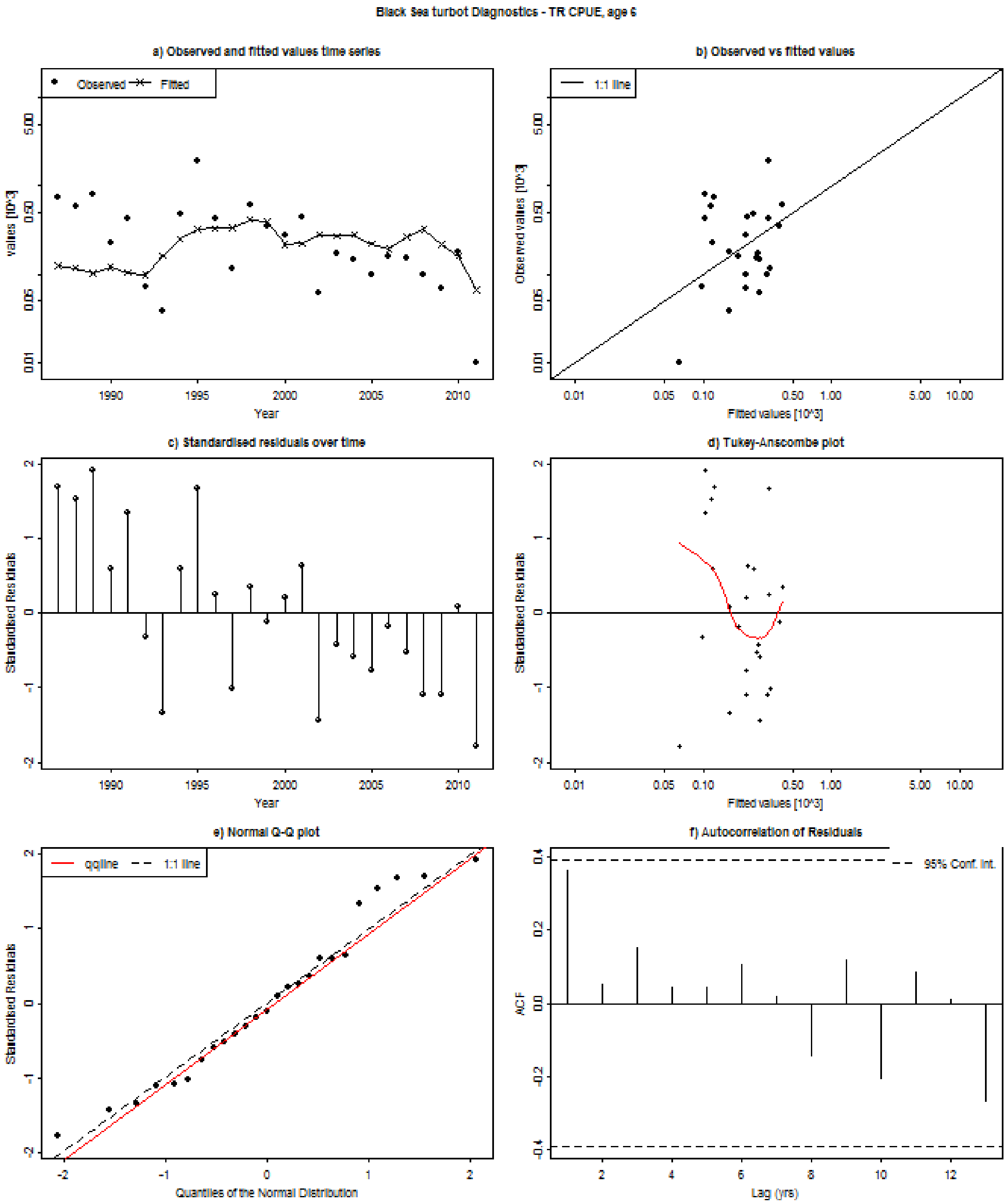


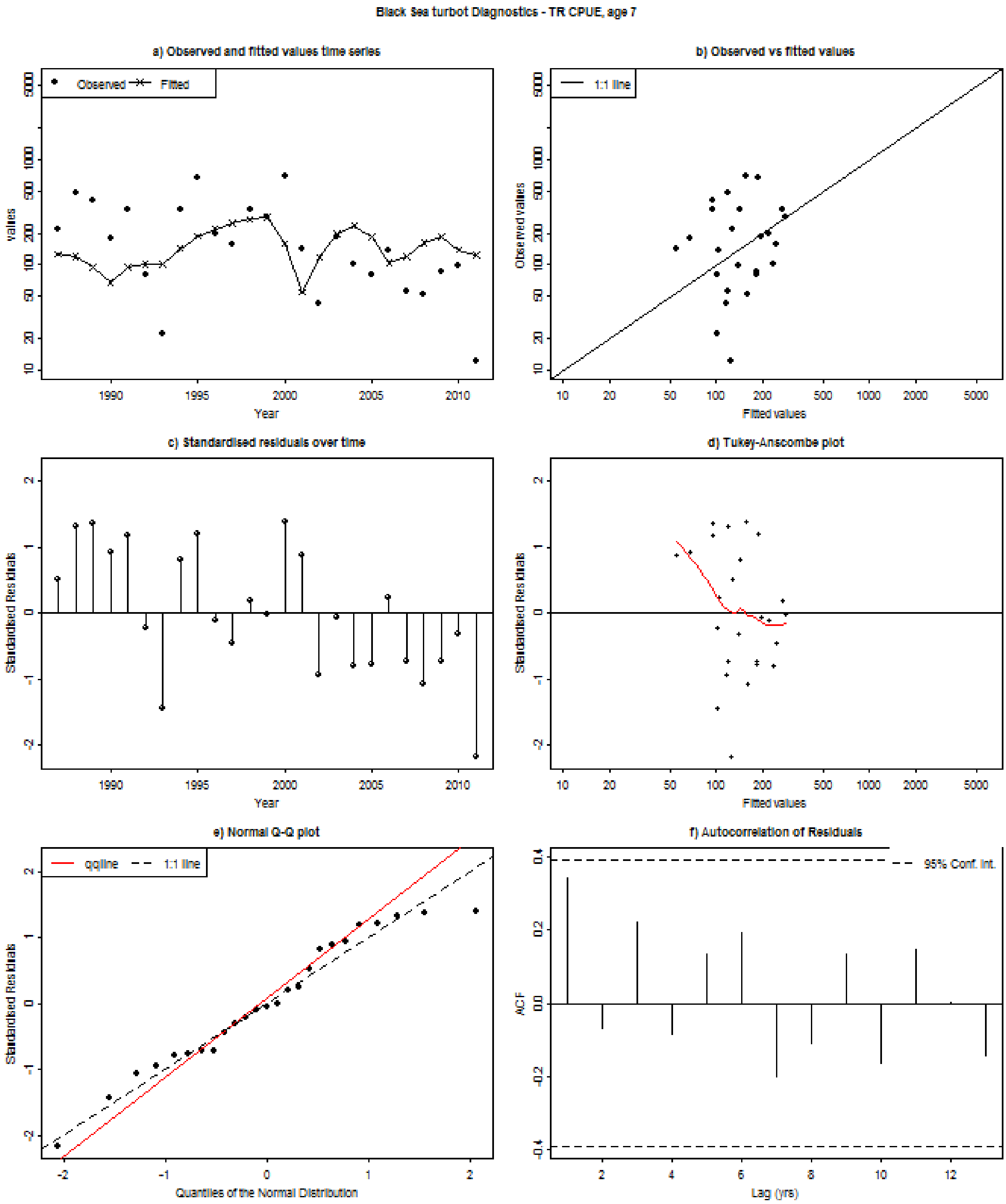
Black Sea turbot Diagnostics - TR CPUE, age 4



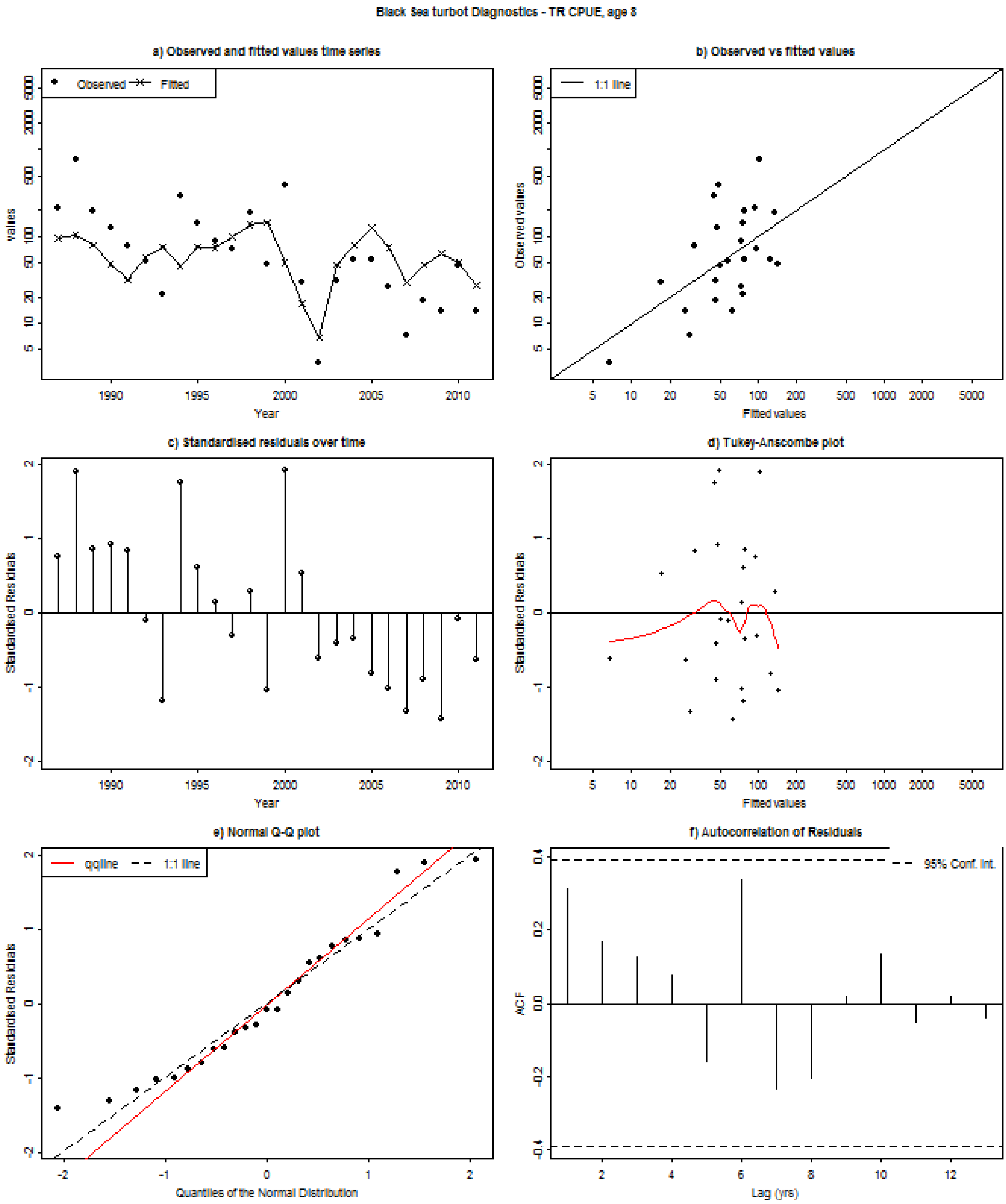
Black Sea turbot Diagnostics - TR CPUE, age 5




Black Sea turbot Diagnostics - TR CPUE, age 6
a) Observed and fitted values time series
Observed
Fitted
values [10^3]
Year
b) Observed vs fitted values
1:1 line
Observed values [10^3]
Fitted values [10^3]
c) Standardised residuals over time
Standardised Residuals
Year
d) Tukey-Anscombe plot
Standardised Residuals
Fitted values [10^3]
e) Normal Q-Q plot
qqline
1:1 line
Standardised Residuals
Quantiles of the Normal Distribution
f) Autocorrelation of Residuals
95% Conf. Int.
ACF
Lag (yrs)

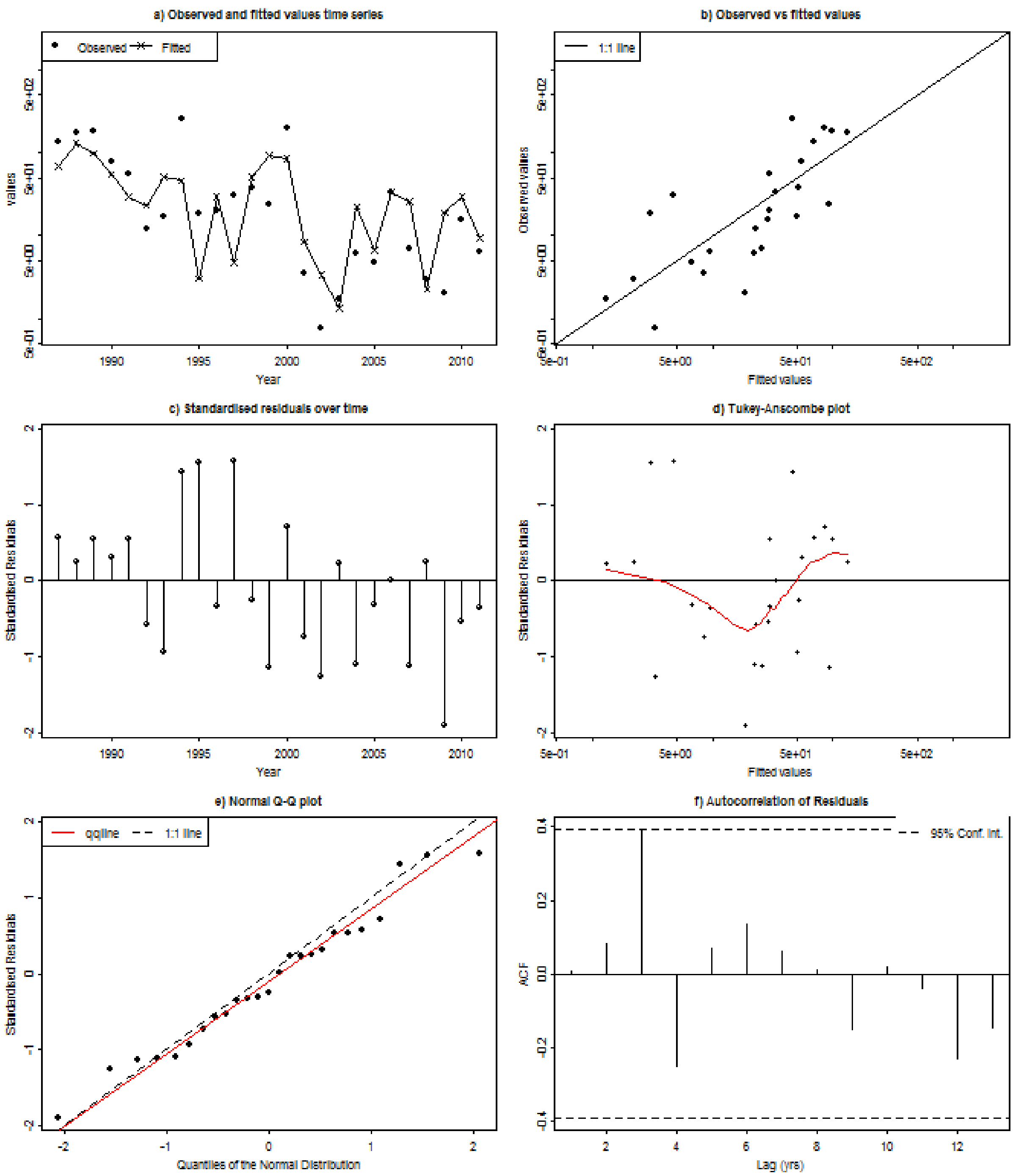


Black Sea turbot Diagnostics - TR CPUE, age 7
a) Observed and fitted values time series
Observed
Fitted
values
Year
b) Observed vs fitted values
1:1 line
Observed values
Fitted values
c) Standardised residuals over time
Standardised Residuals
Year
d) Tukey-Anscombe plot
Standardised Residuals
Fitted values
e) Normal Q-Q plot
qqline
1:1 line
Standardised Residuals
Quantiles of the Normal Distribution
f) Autocorrelation of Residuals
95% Conf. Int.
ACF
Lag (yrs)

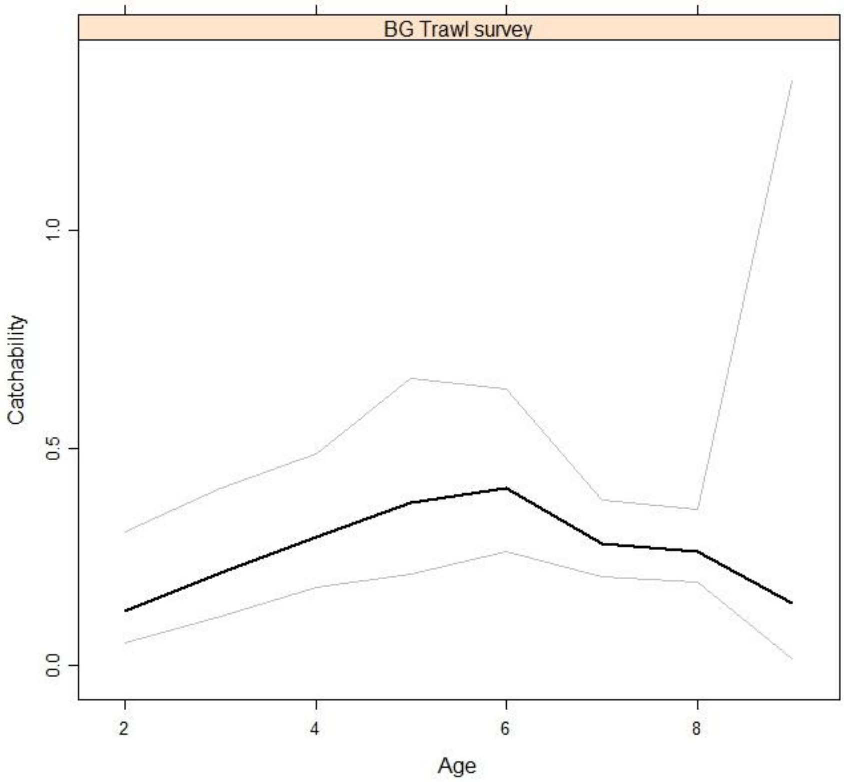


Black Sea turbot Diagnostics - TR CPUE, age 8
a) Observed and fitted values time series
Observed
Fitted
values
Year
b) Observed vs fitted values
1:1 line
Observed values
Fitted values
c) Standardised residuals over time
Standardised Residuals
Year
d) Tukey-Anscombe plot
Standardised Residuals
Fitted values
e) Normal Q-Q plot
qqline
1:1 line
Standardised Residuals
Quantiles of the Normal Distribution
f) Autocorrelation of Residuals
95% Conf. Int.
ACF
Lag (yrs)

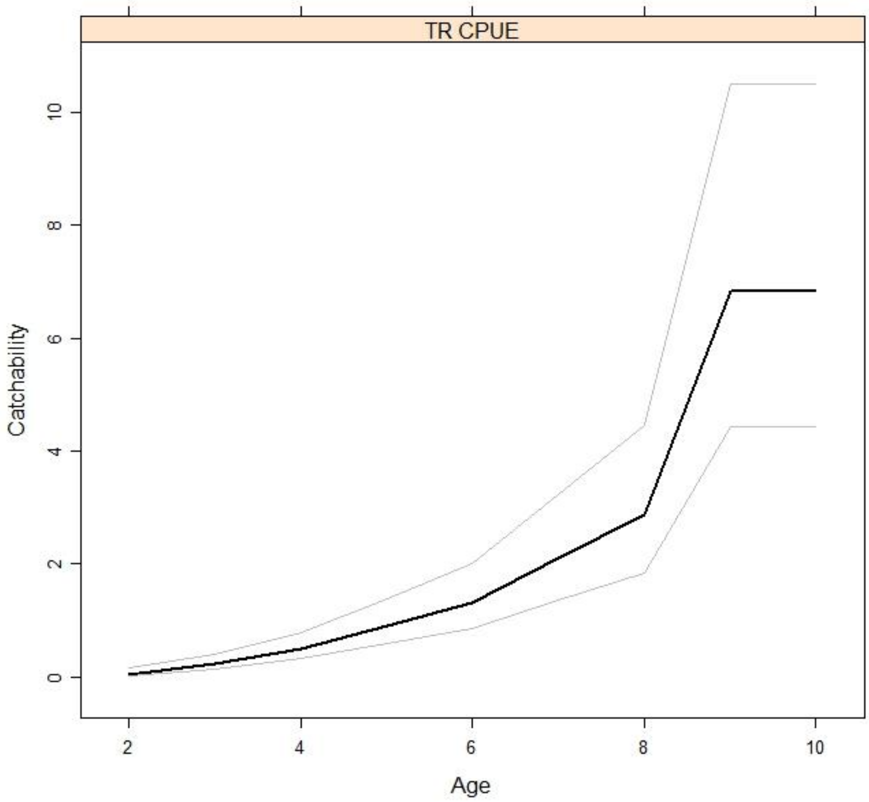
Black Sea turbot Diagnostics - TR CPUE, age 9

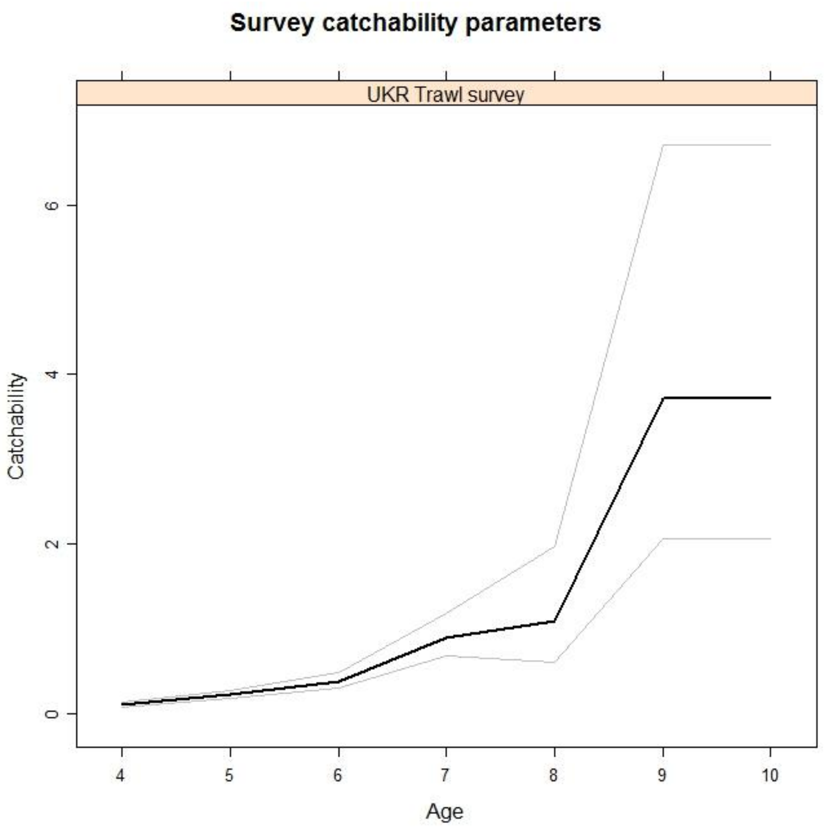


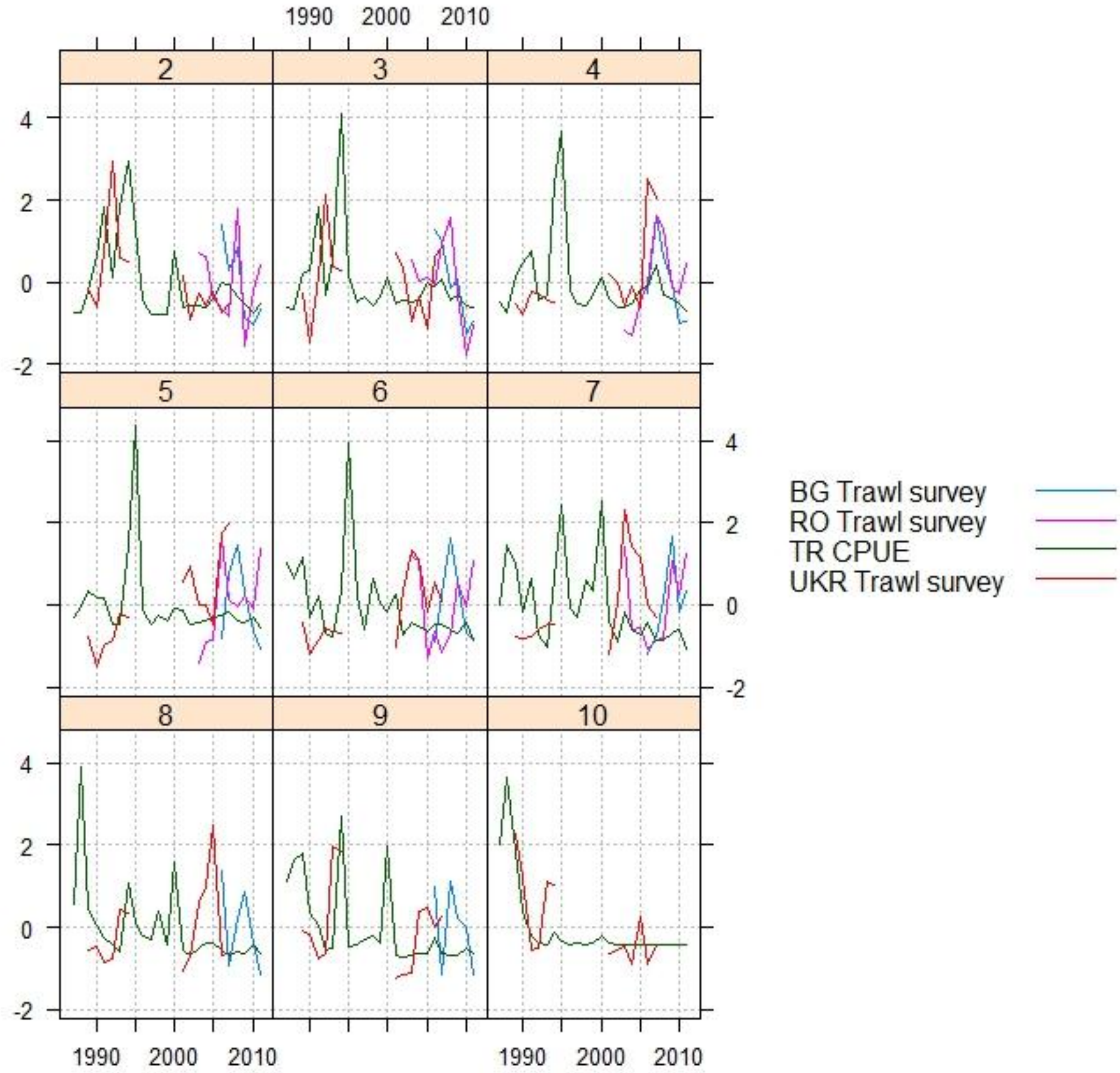
Survey catchability parameters



Survey catchability parameters

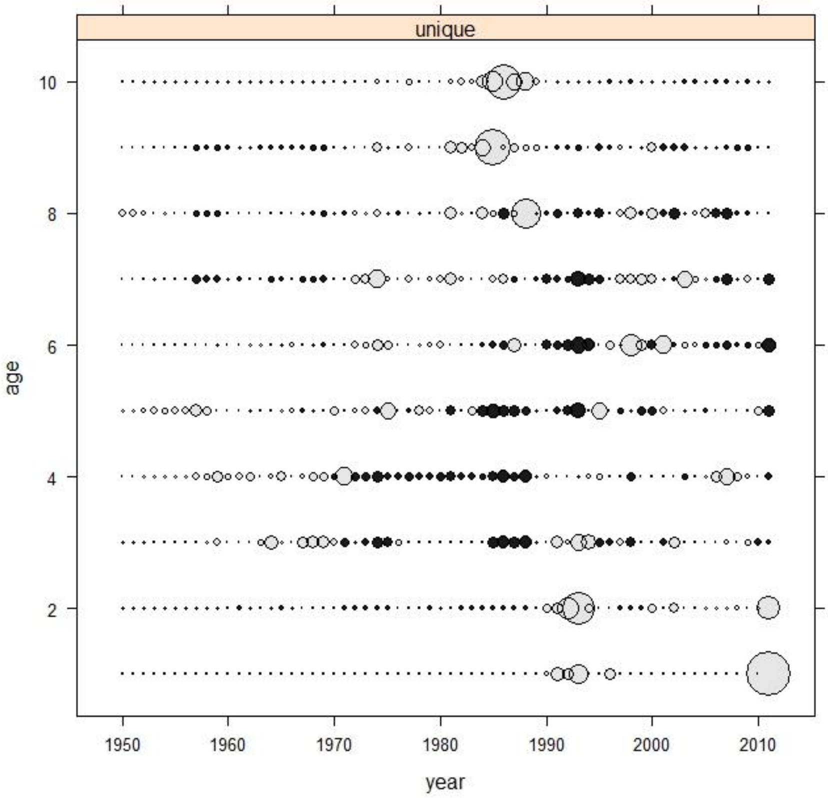



Survey catchability parameters
UKR Trawl survey
Catchability
Age
0
2
4
6
4
5
6
7
8
9
10

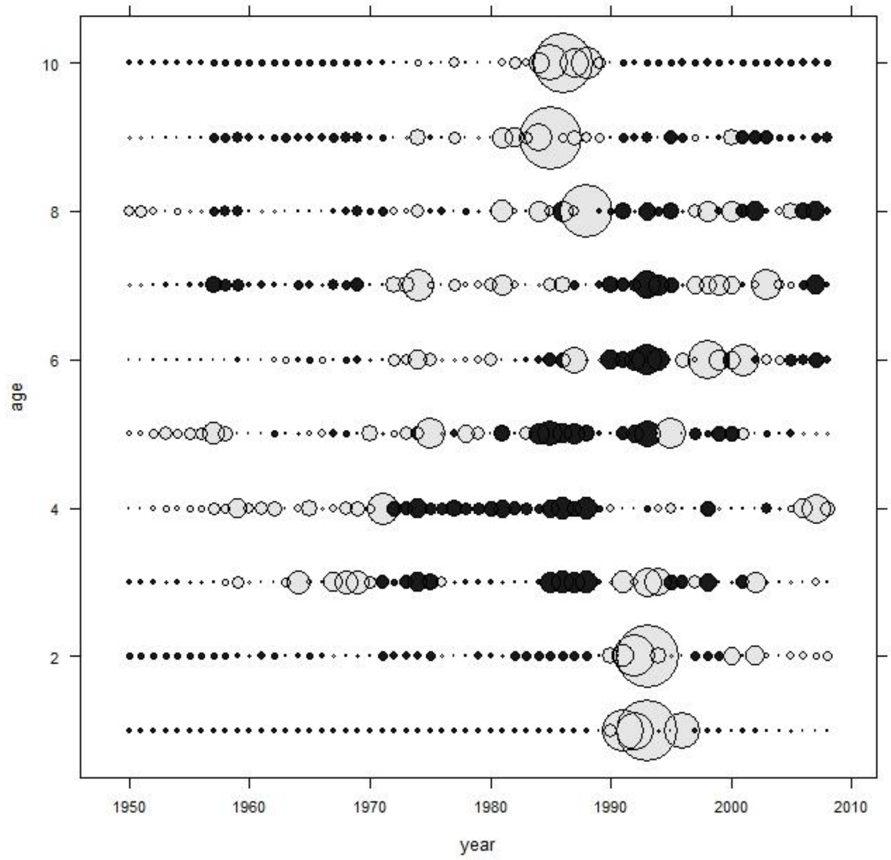


2
3
4
5
6
7
8
9
10
1990
2000
2010
4
2
0
-2
BG Trawl survey
RO Trawl survey
TR CPUE
UKR Trawl survey

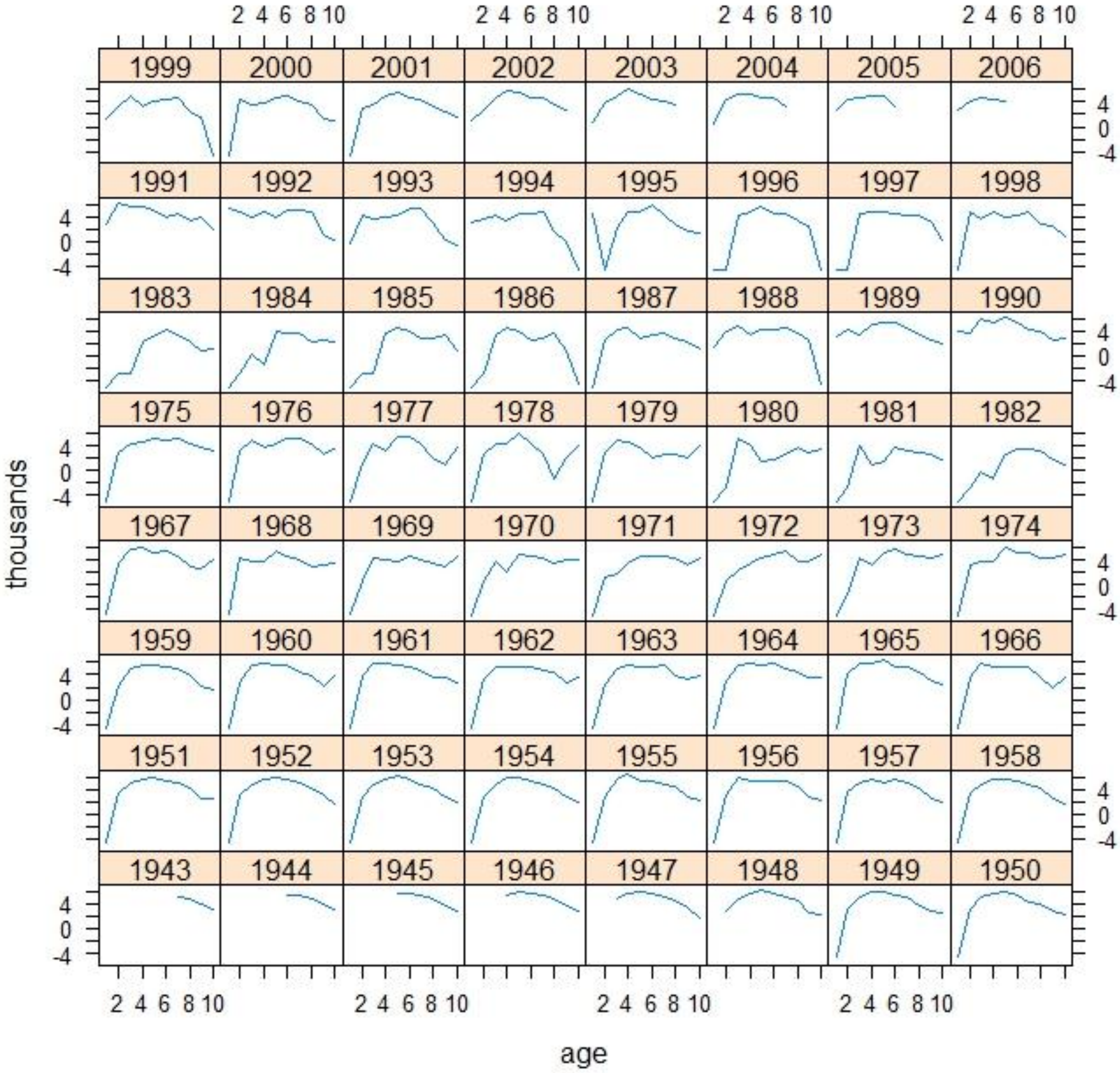
Black Sea turbot

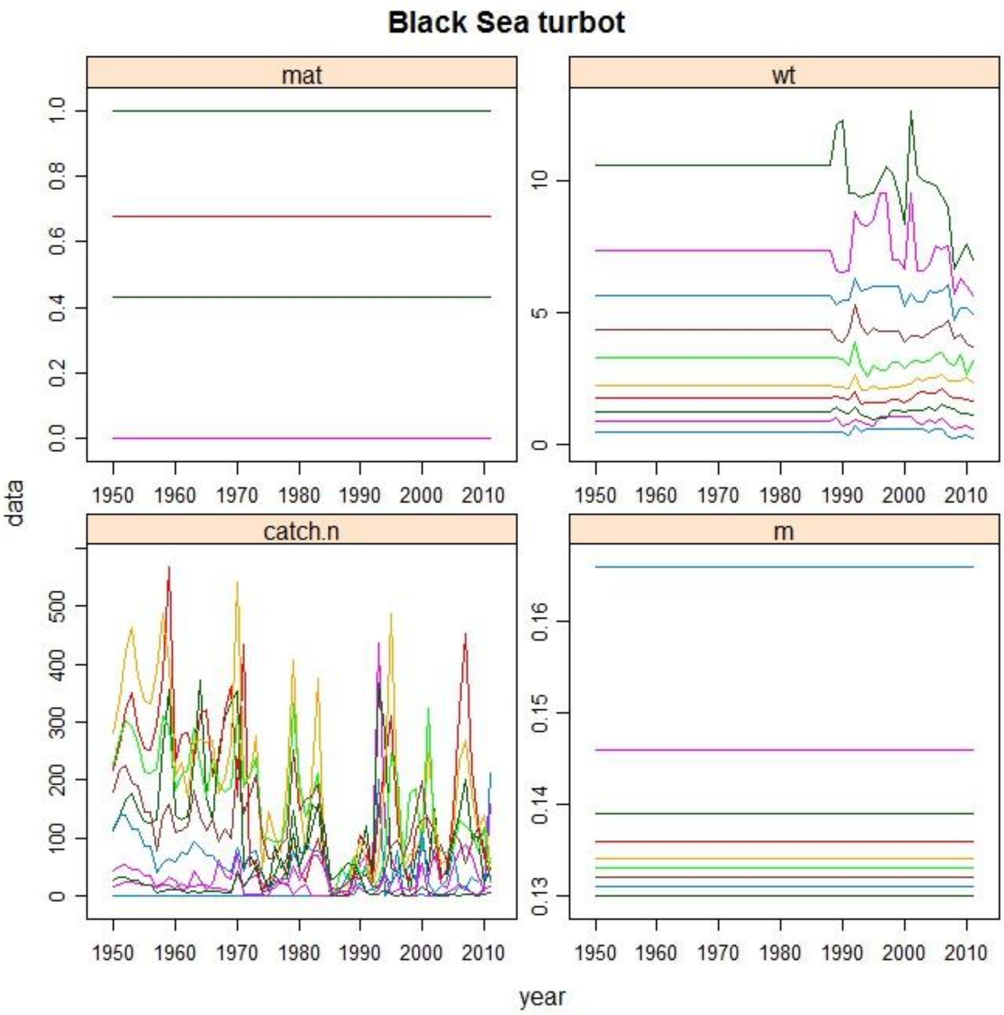


Standardized catch proportion at age for Black Sea turbot



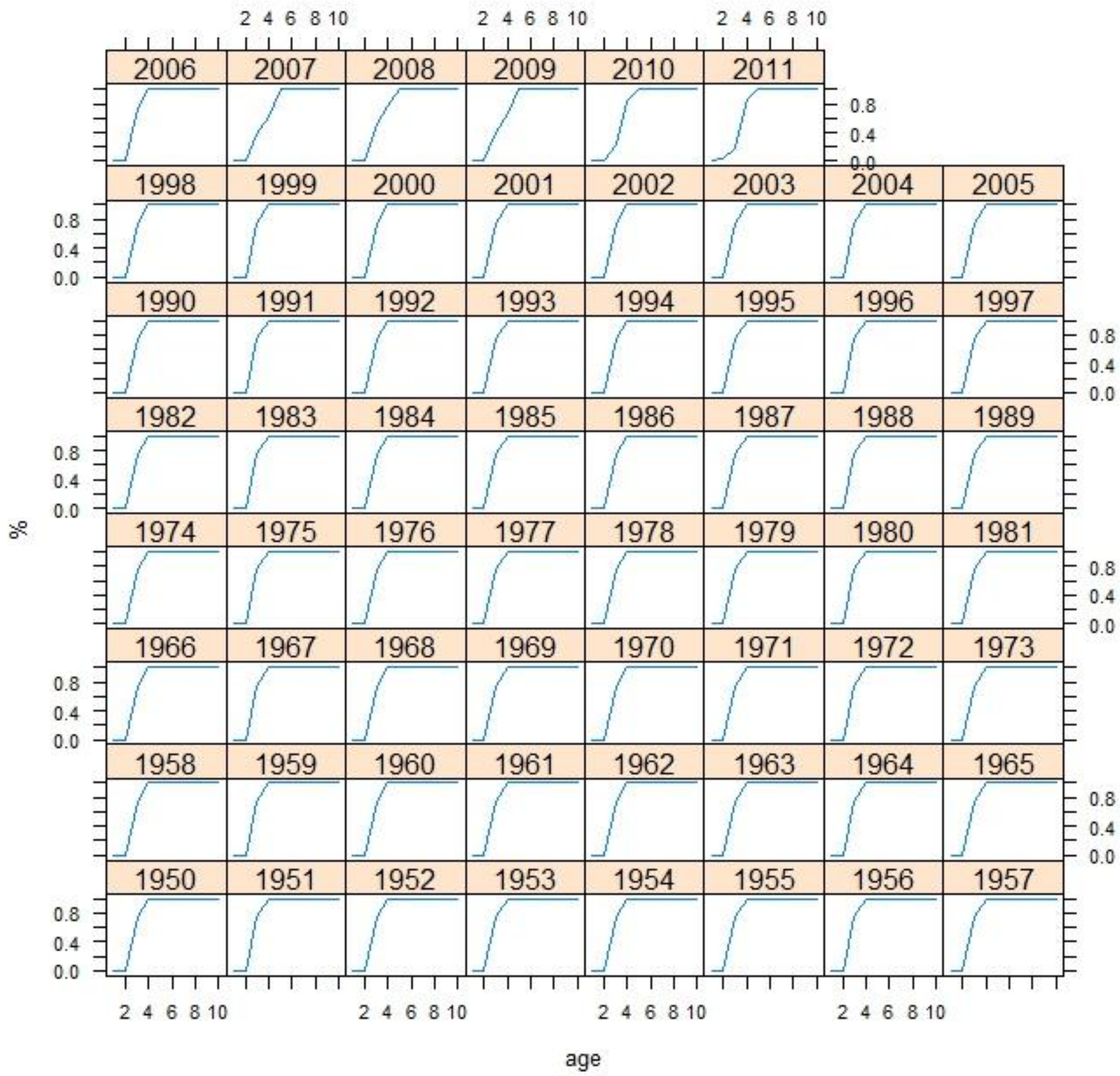
Black Sea turbot





Black Sea turbot
mat
wt
catch.n
m
data
year

Maturity ogive for Black Sea turbot



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Abstract
In response to the ToR the STECF EWG 12-16 on Black Sea stock assessments has accomplished eight stock assessments approaches of sprat, turbot, anchovy, whiting, horse mackerel, piked dogfish, red mullet and rapa whelk. Relevant data have been compiled and reviewed, including those called officially by DG Mare through the 2012 DCF data call for the Mediterranean and Black Sea. Expert knowledge completed the data underlying the stock assessment approaches. The methods and data of the seven stock assessment approaches are documented in section 6 of the present report. For three analytically assessed stocks, i.e. sprat, turbot, and whiting, fisheries management advice is provided.

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The Scientific, Technical and Economic Committee for Fisheries (STECF) has been established by the European Commission. The STECF is being consulted at regular intervals on matters pertaining to the conservation and management of living aquatic resources, including biological, economic, environmental, social and technical considerations.

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