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Scientific, Technical and Economic Committee for Fisheries (STECF)

Report of the SGMED-09-01 Review of advice on Black Sea stocks for 2009

23-27 MARCH 2009, RANCO, ITALY

Edited by Georgi Daskalov & Hans-Joachim Rätz

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SCIENTIFIC, TECHNICAL AND ECONOMIC

COMMITTEE FOR FISHERIES (STECF)

STECF COMMENTS ON THE REPORT OF THE SGMED-09-01 WORKING GROUP ON THE REVIEW OF ADVICE ON BLACK SEA STOCKS FOR 2009 23-27th March 2009, Ranco, Italy

STECF UNDERTOOK THE REVIEW DURING THE PLENARY MEETING

HELD IN GALWAY, IRELAND, 20-24th April 2009

1. BACKGROUND

No specific comment made by STECF.

2. TERMS OF REFERENCE

STECF is requested to review the report of the SGMED-09-01 Working Group of March 23 – 27, 2009 (Ispra) meeting, evaluate the findings and make any appropriate comments and recommendations.

3. STECF OBSERVATIONS

No specific observations were formulated.

4. STECF COMMENTS AND CONCLUSIONS

The Chair of the Expert Group, Georgi Daskalov, presented the Group's main findings and proposals to the plenary.

STECF compliments the Working Group on its work. The WG addressed all its Terms of reference with limited participation.

Sprat in the Black Sea

STECF notes that SG-MED 09-01 carried out an assessment of the sprat stock in the Black Sea applying two alternative models, an Integrated Catch-at-age model (ICA; Patterson and Melvin, 1996) and an Extended survivor analysis model (XSA; Darby and Flatman, 1994).

STECF notes that the XSA diagnostics from both commercial tuning indices (Bulgarian and Ukaine), used in the assessment are rather poor (less than 50% of the final survivor estimates for all ages is derived from the tuning fleets). However no other reliable information (e.g. survey estimates) is available for this stock.

STECF also notes that the input exploitation pattern for ages 4 and 5 used in the ICA are adjusted to a very low level without a clear justification. Since age groups older than 3 are not

well represented in the catches or the population, STECF considers that an age rage of 1-3 should be used to derive reference fishing mortality estimates.

It is apparent that the large discrepancy in the terminal estimates of Fbar (1-4) between ICA and XSA are largely due to the input selection pattern of the ICA. The reduced exploitation pattern on age 4 and age 5 in ICA results in a higher SSB from the ICA model compared to the XSA model and this gives rise to fishing mortality estimates which are substantially lower from the ICA model compared to the XSA model. STECF investigated which of the two terminal estimates of fishing mortality is likely to be the most plausible by comparing the total mortality derived from a catch curve analysis of the Ukranian and Bulgarian commercial CPUE indices. The estimated fishing mortalities were in the region of F=0.8 - F=1.0, which are in line with the estimate from XSA. STECF concludes that the lower estimate of F from ICA is likely to be an underestimate resulting from the choice of input exploitation pattern.

Both models give similar trends in Fishing mortality, SSB and recruitment. Short term forecasts with inputs from both models also indicate that with status quo fishing in 2009 (around 43,000t of international landings), SSB will remain stable at a low level.

STECF agrees with the findings of the SG-MED 09-01 concerning possible reference points. The yield/recruit graphs increase with increasing mortality with no evidence of a plateau. It seems very likely therefore that the use of Fmax or F0.1 are not suitable as candidate reference points. A general production model assuming a Ricker stock-recruit relationship suggests Fmsy values between 0.6 and 0.7, depending on the ICA or the XSA inputs.

If F_{msy} is taken as a reference point, the ICA results indicate that the stock is under exploited whereas the XSA results indicate overexploitation. Given that the XSA estimate of F in 2007 appears more likely to be a reflection of the true fishing mortality, to achieve F_{msy} in 2009 fishing mortality should be reduced by about 20% compared to 2007, implying a total international catch of around 37,000 t in 2009.

In the absence of an allocation key for the international sprat catches, STECF is unable to advice on a specific EU TAC for sprat in the Black Sea.

STECF notes that the 2008 EU TAC (15,000 t) was not taken. Total EU landings in 2008 amounted to 4,538 t.

Turbot in the Black Sea

STECF notes that SGMED 09-01 has reviewed historic and recent landings statistics of turbot in the Black Sea and that uncertainties about the accuracy of such statistics were raised. Given these uncertainties in the data, STECF endorses the valuation of SGMED regarding the assessment of turbot (XSA) in the Black Sea being representative of relative trends in the stock parameters only, while no absolute values of historic or recent stock size or exploitation rates could be provided. Furthermore, the relative character of the stock assessment prevented SGMED-09-01 from undertaking reliable short term predictions of stock biomass and catches as well as estimating reliable reference points for fisheries management.

STECF endorses the relative assessment of the turbot stock in the Black Sea, based on the best data available to SGMED-09-01. The turbot SSB during recent years is indicated to be at low level compared to historical biomass. In 2003, the SSB is estimated to be at an all time low in the time series (1970 – 2007). Relative abundance estimates are confirmed by CPUE data. Catches have also dropped since 2002. A gradual recovery in SSB and catches is observed since 2004. Recruitment was at the minimum in 2000-2001 and started to increase since 2002. The increase in recruitment since 2002 may have had a positive influence on SSB

but given that many small and immature turbot are caught by the fisheries, such a positive influence may not materialise in an increase in SSB over the next few years. Fishing mortality has peaked in 2000-2001. The catches decreased since 2002 but fishing mortality is indicated to be high thereafter.

STECF endorses the recommendation of SGMED 09-01 to keep the exploitation of turbot in the Black Sea at the lowest possible level in order to allow the stock to recover.

STECF notes that the EU-TAC for Turbot given to Bulgaria and Romania in 2009 summed to 100 t (Council Reg. 1139/2008). This TAC for 2009 was kept unchanged from the TAC for 2008. Taking into account the historic international landing levels frequently exceeding 1,000 t, and the recent international landings ranging at the same level, the unilateral low catch regulation (100 t) appears not to constitute any major risk to the stock if fully enforced. Given that the assessment of turbot is only indicative of trends in stock parameters and exploitation and in absence of fisheries management reference points, STECF is unable to evaluate and comment on the exploitation state of the stock and the consequence of the recent international landings level officially reported. However, STECF emphasises that unilateral management measures do not necessarily lead to targets if not agreed and coordinated internationally within RFMO.

STECF also notes that the SGMED 09-01 was unable to map geographic density patterns of 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 turbot by fishing gear. STECF acknowledges the detailed planning of SGMED 09-01 preparing the requested geographical maps by correspondence before the second Black Sea expert meeting to be held in June 2009 in parallel to the SGECA/RST meeting in Brest on stock review.

STECF recognize that the Black Sea Working Group needs to build additional capacity in quantitative stock assessment and welcomes any initiative in planning for a stock assessment training course.

SGMED-09-01 WORKKING GROUP REPORT

WORKING GROUP ON THE REVIEW OF ADVICE ON BLACK SEA STOCKS FOR 2009
23-27th March 2009, Ranco, Italy

This report is the opinion of the Working Group on the Mediterranean (SGMED-09-01) and not of the Scientific, Technical and Economic Committee for Fisheries (STECF)

This report does not necessarily reflect the view of the European Commission and in no way anticipates the Commission's future policy in this area

1. EXECUTIVE SUMMARY AND RECOMMENDATIONS

See specific chapters on scientific advice for both stocks of sprat and turbot in the Black Sea.

2. INTRODUCTION

After its establishment in 2008 the STECF working group on Mediterranean stock assessments SGMED, covered by its mandate, also assesses exploited living resources in the Black Sea. STECF during its last plenary in July 2008 rejected the working group's recommendation regarding specific fisheries management options for 2009. It was decided a dedicated meeting to be held in the first quarter of 2009 to review these recommendations under specific terms of reference (ToR).

The meeting took place in the hotel Belvedere in Ranco, Italy, 23-27 March 2009.

2.3. Terms of Reference for SGMED-09-01

The STECF SG-MED 09-01 is requested to meet during the first quarter of 2009 with the following ToR:

1. • review and comment on the data quality compiled by SG Black Sea during its meeting in June 2008 (see Annexes to the report of SGMED-08-03).
2. • compile 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 for sprat and turbot by area for the longest time series available up to and including 2007. The data should be compiled based on official databases and best expert knowledge.
3. • compile all fishery independent data (pelagic, demersal, hydro-acoustic surveys) for sprat and turbot, 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 2007.
4. • compile complete sets of annual fishing effort data (number of vessels, kW*days, fished hours) by nation, for fleets and gears (mesh size where applicable) that catch sprat and turbot, and area for the longest time series available up to and including 2007.
5. • assess trends in historic stock parameters for sprat and turbot for the longest time series available up to and including 2007 (fishing mortality at age) and up to and including 2008 (spawning stock biomass, stock biomass, recruits at age). Different assessment models should be applied as appropriate, including analyses of retrospective effects.
6. • propose and evaluate candidate limit and target reference points consistent with maximum sustainable yield for sprat and turbot in the Black Sea.
7. • predict spawning stock biomass, stock biomass, recruits and catches at age and in weight for sprat and turbot in 2009 and the beginning of 2010 under different management scenarios including the status quo fishing (mean F at age 2005-2007, rescaled to 2007) and with a TAC constraint for 2009. Specifically comment on the consequences of the agreed TACs in 2009 for the stock parameters listed above with regard to reference points consistent with maximum sustainable yield.
8. • prepare 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 sprat and turbot by fishing gear.

9. report all results to the spring plenary of STECF in 2009.

2.4. Participants

The following Table 2.2.1 lists the participants of the meeting.

Table 2.2.1 List of participants.

Name	Institution	Email	Postal address
INVITED EXPERTS			
Dr. Georgi DASKALOV (chair)	Centre for Environment. Fisheries&Aquaculture Science (CEFAS).Lowestoft. UK	georgi.daskalov@cefas.co.uk	Centre for Environment. Fisheries&Aquaculture Science, (CEFAS). Pakefield Road. Lowestoft. Suffolk NR33 OHT UK
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Michael Roitmann	EC DG Maritime Affairs and Fisheries	Michael.Roitmann@ec.europa.eu	DG Maritime Affairs and Fisheries, Brussels, Belgium

3. STOCK ASSESSMENT OF SPRAT IN THE BLACK SEA

3.1. Stock identification and biological features

Sprat is a marine pelagic schooling species, sometimes entering in the estuaries (especially the juveniles) and tolerating salinities as low as 4‰. In the daytime, it keeps to bigger depths and in the night moves near the surface. Adults tend to remain under the seasonal thermocline, penetrating above it only during the spring and autumn homothermia. It forms big schools and undertakes seasonal movements between foraging (inshore) and spawning (open sea) areas (Ivanov and Beverton 1985). 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).

The sprat wintering offing at depths of 80-100m; in April - May is nearing of littoral area in exploitable quantities, while in the summer avoids high water temperature performing migrations from coast to offing. Sexual maturity attained at the age of 1 year when has about 7 cm.

Spawning takes place in almost all the time year, but with maximum intensity in November – March, laying of eggs does in portions. Eggs are pelagic, in spherical shape. In winter, eggs are encountering both in the surface layer as well as in one of deep; in summer only at depths below 10m (2-50m).

In the spring exists a tendency of movement of the shoals toward coast and northwards and toward offing in the autumn, but are not exist specific migrations of spawning or feeding. Juveniles occupy a large spread area at surface in the warm water. 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).

3.1.1.Stock Identification

There is agreement among scientific community that in the Black Sea sprat is represented by a unique stock. The migration routes and schools being strongly influenced by the environmental conditions and trophic base (Fig. 3.1.1.1).

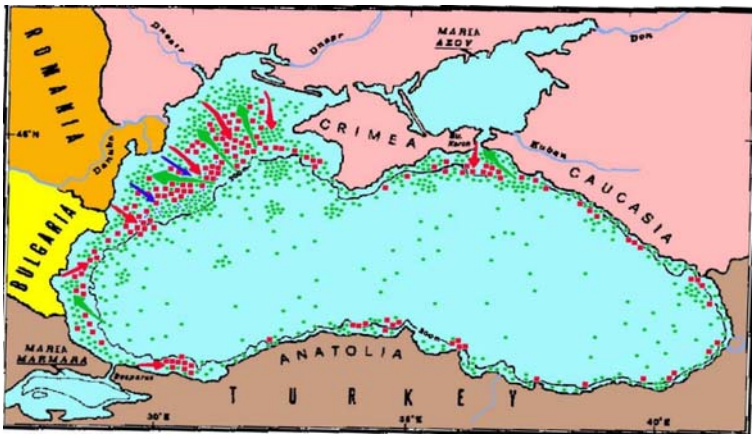


Fig. 3.1.1.1. Sprat migration routes in the Black Sea basin.

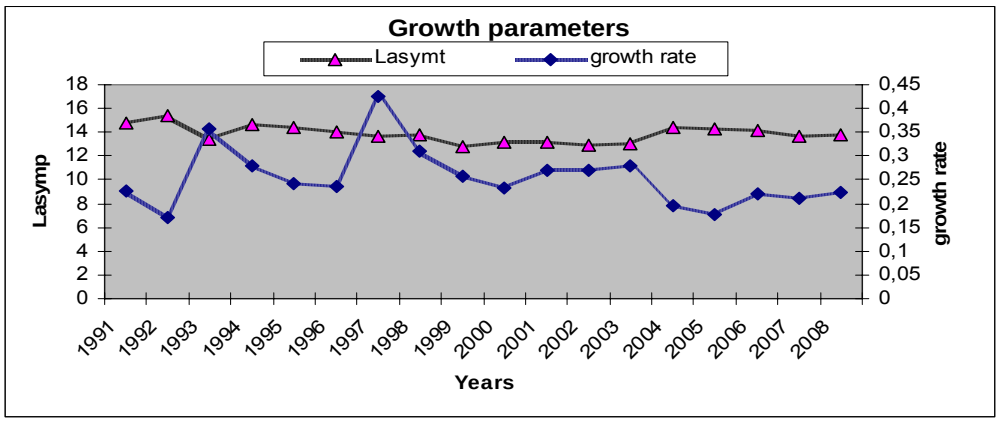
Legend:

Wintering areas and migration to them

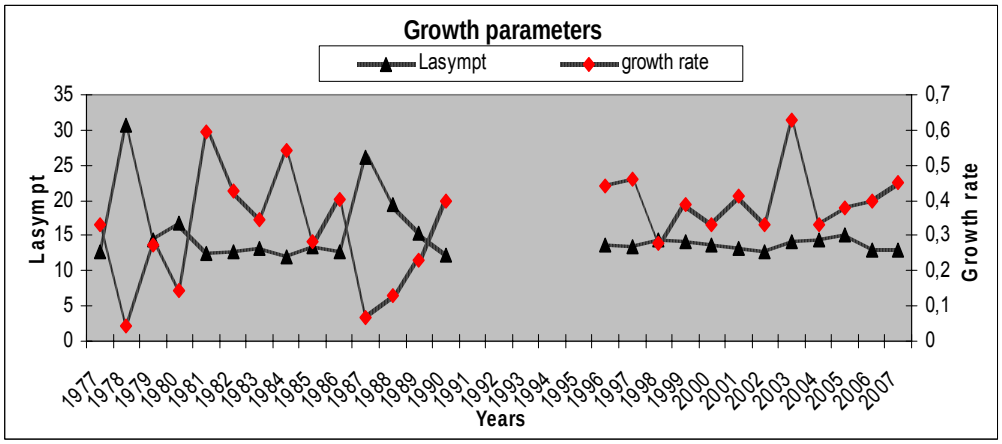
Spawning areas and migration to them

Feeding areas and migration to them

3.1.2.Growth



A) Romanian waters



B) Bulgarian waters

Fig.3.2.1.1 Growth parameters of sprat in Romanian (A) and Bulgarian (B) waters.

The resulted values of the Von Bertalanffy growth parameters in Romanian waters show relatively stable asymptotic length and growth rate over the researched period without any clear trends (Fig. 3.1.2.1 A). In Bulgarian waters (Fig. 3.1.2.1 B) asymptotic length and growth rates fluctuated during 1977-1990 (data from Prodanov et al., 1997), as growth was relatively slow between 1977-1981 and 1987-1989. After 1996 up to 2007 growth rate show one peak in 2003.The asymptotic length is quite stable for these years. No data from other Black Sea coastal states are available at the moment regarding long-term dynamics of growth in length.

In Turkish waters some investigations regarding growth have been done. The results (Sahin, 1999) show that the age range is from 1 up to 4 years. Age groups 2 and 3 were predominant in the catch composition. The mean length values were 10.72±0.052 cm for females, 10.67±0.253 cm for males and 10.69±0.038 for both sexes. The length-weight differences between females and males were no significant (P>0.05). The length –weight relationship and growth equations for females and males were estimated as follows, respectively:

$W=2.1411x10^{-3}xL^{3.4569}W=2.0463x10^{-3}xL^{3.4746}$

$L_t=14.622[1-e^{-0.2975(t+1.8824)}]$ $L_t=13.373[1-e^{-0.4177(t+1.2988)}]$

$W_t=22.801[1^{-e-0.2975(t+1.8824)}]^{3.4569}$, $W_t=16.756[1-e^{-0.4177(t+1.2988}]^{3.4746}$

3.1.3.Maturity

Analysis of the gonad maturation stage in Romanian waters (Tabl. 3.1.3.1) revealed that both females and males were in the spawning period, the gonads of the majority specimens being in the stage VI-II and II (34,46%, respectively 66,54% at beginning of fishing season); to 19.81% respectively 80.19% in the following months.

Table.3.1.3.1. Gonad maturation analysis of sprat in front the Romanian Black Sea waters.

0	1	2	3	4	5	6	7	8	9	10	11	12	13
	IV	F	84.61									15.38	**458**
		M	85.71									14.28	**389**
	V	F	79.66									20.34	**623**
		M	71.76									28.23	**514**
	VI	F	96.15	31107									**452**
		M	98.43	20821									**230**
2006	VII	F	100.0										**659**
		M	100.0										**521**
	VIII	F	100.0										**841**
		M	100.0										**634**
	IX	F	61.41	33.20	14366								**561**
		M	56.54	36.18	46935								**400**
	X	F	40.43	30.92	21.52	41456							**243**
		M	21.92	39.17	28.72	43739							**178**
	V	F	46.66									53.33	**1070**
		M	50.00									50.00	**865**
	VI	F	84.41									15.59	**1522**
		M	88.71									47423	**1189**
2007	VII	F	96.25									27454	**1830**
		M	98.62									13881	**1032**
	VIII	F	100.0										**1769**
		M	100.0										**1295**
	IX	F	88.15	31352									**662**
		M	78.34	21.66									**488**
	X	F	66.32	27.73	34820								**488**
		M	70.13	18.52	13089								**362**
	IV	F	77.32									22.68	**595**
		M	87.38									22981	**636**
	V	F	79.36									20.64	**1378**
		M	78.78									40168	**1257**
2008	VI	F	94.38									22767	**1295**
		M	93.75									45809	**1121**
	VII	F	100.0										**1830**
		M	100.0										**1032**
	VIII	F	100.0										**1928**
		M	100.0										**1410**
	IX	F	94.50	18384									**1323**
		M	93.65	12936									**1192**

3.2. Fisheries

3.2.1.General description of fisheries

Sprat fishing takes place on the continental shelf on 40-100 m of depth. The harvesting of the Black Sea sprat is conducted during the day time when its aggregations become denser and are successfully fished with trawls (TDA, 2007).The main fishing gears are mid-water otter trawl and uncovered pound nets. Trawl fishing has a seasonal pattern and is linked to the presence of the fish in the areas.

3.2.2.Management regulations applicable in 2007 and 2008

In Bulgaria and Romania, NAFA has attributions on making proposals and implementing the national strategy for fisheries and aquaculture and exercising his functions on main following domains, as follows:

- fishing quotas policy;
- conducting of FFR;
- licensing and authorising all fishing activities, aquaculture, processing fish and fishing products;
- conducting of aquaculture and processing units register;
- managing the all processes concerning the natural fish stocks recovering (Tabl. 3.2.2.1.);
- collecting and managing of statistical system for data collection of the specific activities;
- coordinating and monitoring the activities of fisheries and aquaculture, issuing the rowels organising fishing sites, including "Fisheries Inspection";
- issuing criteria to recognise the organizations and/or associations of fishermen and of the producers on aquaculture, processing and marketing of fish and fish products.

Table 3.2.2.1. Minimum allowable size of sprat in the Black sea region

	BG	GE	RO	RU	TR	UA
Sprattus sprattus phalericus	TL= 7cm	SL = 6cm	TL=7cm	SL=6cm	no	SL=6cm

3.2.3. Catches

3.2.3.2. Landings

Table 3.2.3.1.1. Sprat landings in the Black Sea during the period 1970 – 2008.

	Bulgaria	*Bulgaria	Romania	Romania*	Ukraine	Turkey	Turkey	Georgia	Russian Federation	Total
1970	1407		2678		353	0		0		4438
1971	2473		2517		846	0		0		5836
1972	2962		23		884	0		0	16	3885
1973	3383		22		878	0		0	22	4305
1974	4468		1245		477	0		0	23	6213
1975	5565		731		787	0		0	43	7126
1976	7199		161		1594	0		0	16	8970
1977	8754		1463		4346	0		0	2354	16917
1978	10596		149		1949	0		1	3317	16012
1979	13541		2269		36757	0		3466	17700	73733
1980	16568		989		47635	0		4571	14687	84450
1981	1888		2283		49175	0		5781	20165	79292
1982	16524		3004		3862	0		2462	15266	41118
1983	12023		3406		20755	0		886	3843	40913
1984	13921		4456		18021	0		847	5270	42515
1985	15924		6836		23657	0		1817	3365	51599
1986	1169		8979		33147	0		2939	7010	53244
1987	10979		9474		43158	0		697	8972	73280
1988	6199		6454		39835	0		7172	7157	66817
1989	7403		8911		63239	0		9708	16045	105306
1990	2651		3198		33174	0		6895	6955	52873
1991	1909		729		11094	0		2313	2675	17082
1992	2353	3266*	2074		11492	0		830	3221	19970
1993	2174	3705*	2439		9154	640		32	694	15133
1994	2200		2203		12615	700		308	1013	16861
1995	2874		1982		15218	157		288	1263	21782
1996	3535		2014		20720	937		185	1537	10280
1997	3646		3318		20208	468	3500**	85	706	28431
1998	3275		3293		30282	1236	3000**	24	1243	39353
1999	3595		1933		29238	421	2000*	45	4473	39705
2000	1737		1803		32644	6225	5000*	42	5543	47994
2001	695		1792		48938	1008	4000*	40	11122	63595
2002	11595		1617		45430	1965	7000*	34	11218	30972
2003	9155		1219		31366	5775	3804*	2	204	47721
2004	2889	7997*	135		30891	5186	4906*	12	143	39256
2005	2575	6500*	1487		35707	5271	8170*	19	1316	46375
2006	2655	8183*	492	1400*	21308	6681	11039*		8157	39293
2007	2559	2985*	208	400*	18013	11725	14800*		6077	39200
2008	4304		234		21111	***	***		7814	
Total										

* expert assessments
**Sprat plants reported (CFRI) tons - Turkey
***pending official statsitics reports

3.2.3.3. Discards

No discards surveys have been performed in the Black Sea region

3.2.4.Fishing effort and CPUE

Table 3.2.4.1. Romanian commercial fleet fishing effort and CPUE t/h by years.

			E F F O R T							
Years	Catch	No.	No.	No	No.	Depth		***C.P.U.E.***		
	(t)	vessel	day	hour	trawling	(m)	t/vessel	t/day	t/hour	t/trawl
1981	77	2	235	1028	634	20 - 40	38.5	0.32	0.07	0.12
1982	664	3	346	1543	951	20 - 40	221.3	33604	0.43	0.70
1983	1344	11	767	4132	2663	20 - 55	122.2	27395	0.32	0.50
1984	2946	11	1030	5650	3466	20 - 60	267.8	31444	0.52	0.85
1985	4266	15	980	5885	3840	20 - 50	284.4	12875	0.72	40118
1986	5954	14	1709	8756	5456	20 - 60	425.3	17593	0.68	40057
1987	6090	14	1589	8235	4986	20 - 65	435.0	30376	0.74	44562
1988	4661	14	1317	7559	4806	20 - 70	332.9	19784	0.62	0.97
1989	7055	20	1400	5850	3897	20 - 65	352.8	39908	43831	29587
1990	2105	13	650	3503	1964	20 - 65	161.9	45352	0.60	39995
1991	145	7	117	264	616	20 - 60	40014	45292	0.55	0.23
1992	1087	8	310	1553	936	20 - 65	135.5	17958	0.69	42370
1993	1297	8	632	2856	1700	20 - 40	162.1	39935	0.45	0.76
1994	1340	8	664	3024	1589	20 - 45	167.5	39846	0.44	0.84
1995	1715	9	784	2349	1535	20 - 50	190.6	43497	0.73	40148
1996	1658	11	1112	4521	3245	23 - 97	150.7	17899	0.37	0.51
1997	3225	13	2160	4259	6352	20 - 80	248.1	17899	0.75	0.50
1998	3201	14	959	4404	3515	20 - 70	228.6	12114	0.72	0.91
1999	1892	14	692	3086	2085	20 - 68	135.1	26696	0.61	0.91
2000	1750	12	646	2984	2028	20 - 68	145.8	25965	0.58	0.86
2001	1722	7	678	3498	2422	20 - 60	246.0	19756	0.49	0.71
2002	1443	7	878	2922	1971	20 - 68	206.2	23377	0.49	0.73
2003	1124	9	743	2067	2848	20 - 70	124.9	18994	0.54	0.39
2004	1255	8	762	2035	2675	20 - 60	156.9	23377	0.62	0.47
2005	1394	9	788	2110	2805	20 - 65	154.9	28126	0.66	0.50
2006	430	8	760	2020	2605	20 - 70	53.8	0.56	0.21	0.17
2007	158	3	290	1000	746	20 - 68	52.7	0.55	0.16	0.21
2008	209	3	129	587	293	20 - 50	69.7	22647	0.35	0.71

Table 3.2.4.2 Fishing effort of sprat mid-water trawl fishery in Bulgarian Black Sea waters – 2007.

Length of vessel	No.vessel	days at sea	KW	GT	KW*days at sea	GT*days at sea	type of fishing gear
from 6 to 12 м.	21	98	591.78	74.15	57994.44	7266.7	OTM
from 12 to 24 м.	17	680	2890.17	590.74	1965315.6	401703.2	OTM
over 24m	12	1523	3304.76	1583	5033149.48	2410909	OTM

Table 3.2.4.3 Sprat commercial CPUE (km/h).

	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec
1996		394	423	441
1997	196	416	315	268
1998	200	589	501	358
1999	209	532	482	288
2000	336	457	1090	507
2001	200	635	712	266
2002	200	618	966	385
2003	258	622	877	420
2004	211	543	845	287
2005	226	534		322
2006		488	787	
2007		510		

Table 3.2.4.4 CPUE (kg/h) from commercial fleet of Ukraine.

Year	CPUE kg/h
1992	0.95
1993	0.86
1994	0.95
1995	1.00
1996	0.82
1997	0.72
1998	0.92
1999	1.02
2000	1.81
2001	1.31
2002	1.78
2003	0.91
2004	0.96
2005	0.97
2006	1.07
2007	1.00

No data from Turkey, Georgia and Russian Federation have been provided concerning fishing effort and CPUE.

3.3. Scientific surveys

3.3.1.Sprat trawl survey, 2008

3.3.1.1. Methods

Bulgarian sprat Survey

Standard fishing and assessment techniques were utilized in Bulgarian waters so that the results can be reproduced and compared. Bulgarian research trawl surveys are conducted on annual basis. The techniques applied are a "swept area" trawl survey using a standard mid-water trawl with following dimensions: OTM – pelagic otter trawls with dimensions: 26m long. 8 m height. mesh size of codend 6.5mm;"effective" horizontal opening – 16 m. Stratified sampling is applied (Sparre&Venema. 1998). The area is divided to sub areas "strata" depending on the depth: first stratum is 35- 50 m second 50-75m and third 75-100m. (Table). The examined area is divided to 55 equally sized fields; each sector was assessed as 63 км^2 (5' Latitude × 5' Longitude). The trawling activities are carried out in meridian (north-south) direction. The present investigations has been carried out with F/V "FV 3"

The trawl has the following characteristics:

- vertical opening **- 4 m;**
- mesh size of the cod end: **6.5mm;**
- "effective" part of the trawl mouth – **16m;**

The vessel was equipped with "Waveon" type GPS with GSM modem GPRS (Vessel Monitoring System). The trawling (Figs 1-5) were carried out in the northern and southern part of the Bulgarian Black Sea coast, during the day with average vessel velocity 4.815 km/h. Information, send by the equipment on board consist the following parameters: Date, hour of signal, velocity, present coordinates. The positions were generated by the equipment in 1 minute interval. In further removed stations from the coast (above 15 miles) some parts remained unrecorded. Nevertheless, the information collected is good enough (reliable) and could serve for analysis of the data from the trawl survey and stock assessment of sprat in front the Bulgarian Black Sea coast. Also, on board of vessel was put electronic log-book for experimental use.

For the purposes of analysis, the standardization of the sampling gears is necessary and in northern and southern part the research was done with one and the same equipment and gears.

In 2008 the trawl survey was conducted in the 36 areas divided to sub areas "strata" depending on the depth: first stratum is 35- 50 m. second 50-75m and third 75-100m. The techniques applied are a "swept area" trawl survey using a standard mid-water trawl with following dimensions: OTM –pelagic otter trawls with dimensions: 26m long 8 m height, mesh size of cod end 6.5mm;"effective" horizontal opening – 16 m. The duration of each trawling is 60min with velocity 2.6 – 2.7 knots.

Method Pros:

1. Sampling procedure is under control;
2. The reliability of the data obtained; the data are independent from commercial fishery data;

Cons:

Representative character of the sampling (Foote, 1996); the trawl is selective and does not fully present exploited stock; sampling is possible on the soft bottom only.

Romanian sprat Surveys

Standard fishing and assessment techniques were utilized in Romanian waters so that the results can be reproduced and compared. The methodologies and techniques used both for data collecting, checking, processing and analyzing, and also for assessment of fish agglomerations were that usually accepted for Black Sea basin, and in compliance with international methodology.

Two types of survey were performed in Romanian waters: a pelagic trawl survey for assessing the adult stock size, and a survey assessing juvenile abundance using a juvenile trawl.

The trawling on the Romanian continental shelf, together with the data obtained in the industrial trawling were used for to assess the fish biomass. Main species targeted for assessment of the fishing agglomerations biomass was sprat, but were taken into account also other species like turbot, spiny dogfish, and whiting.

The utilized method was swept area, for sampling was used the commercial pelagic trawl in the demersal variant. Have been taking into account the following parameters:

- hauling speed;
- horizontal trawl opening - 22m;
- hauling time - 60`;

Taking into consideration that in the sampling time with commercial trawl as well as with trawl for juvenile fish and ichtyoplankton net have been observed a high quantity of jellyfish, have been evaluated its biomass in the survey area, establishing the influence degree on fishing agglomerations.

To assess the juvenile abundance and jellyfish agglomerations, using a juvenile trawl:

- hauling speed;
- horizontal trawl opening: 14m;
- hauling time: 15 minutes;
- hauling level: 0-5m;

Surveys realized along of the years confirmed that productivity oscillations, are closely linked with the environmental factors such as water temperature, and quantity and quality food for fish (plankton & benthos). Through modification of the spawning intensity, fish populations can adapt shoal size in relation to food supply. The correlation between growth of fish juveniles and plankton production can be used as indicator for recruitment strength.

3.3.1.2. Geographical distribution patterns

Bulgarian sprat Survey

The total catch weight from trawl survey in May 2008 was 11740.5 kg. In all of the investigated polygons, after the hauls with duration of one hour (operational effective time – 50min) the weight of the fish which has been caught by the trawl varied from 0 kg in polygon **F12** to 1650 kg in polygon **E11**. In the rest of the investigated area the catch weight was quite different as some high weights were detected: **E9** – 600kg; **M1** – 625kg; **E10** – 620kg; **F11** – 820kg; **B17** – 720;**A'15** – 880kg; **B16** – 564kg; **B14** - 840kg; **D17** – 820kg; D12 – 550kg;

Respectively, the highest calculated CPUE *kg/h* was in polygon E11 – 1980 kg/h, followed by the B14 – 1008 *kg/h*. The analysis showed similarity of the established CPUE in the following areas: **D12** (660 *kg/h*); **B16** (676.8 *kg/h*); **B17** (864 *kg/h*); **D17** (984 *kg/h*); **M1** (750 *kg/h*); **F11** (984 *kg*/h); The lowest

detections of the catch per unit effort were found in: **F12** (0 *kg/h*); **I5** (2.4 *kg/h*); **G8** (3 *kg/h*); **D14** (20 kg/h); **E17** (26.4 *kg/h*); **H7** (30 *kg/h*); The proposed methodology then suggest calculation of the catch per unit area, which serves as a base for biomass calculations. Accordingly, in areas with highest CPUE kg/h, the highest CPUA kg.km^2 was detected. (Fig. 3.3.1.2.1)

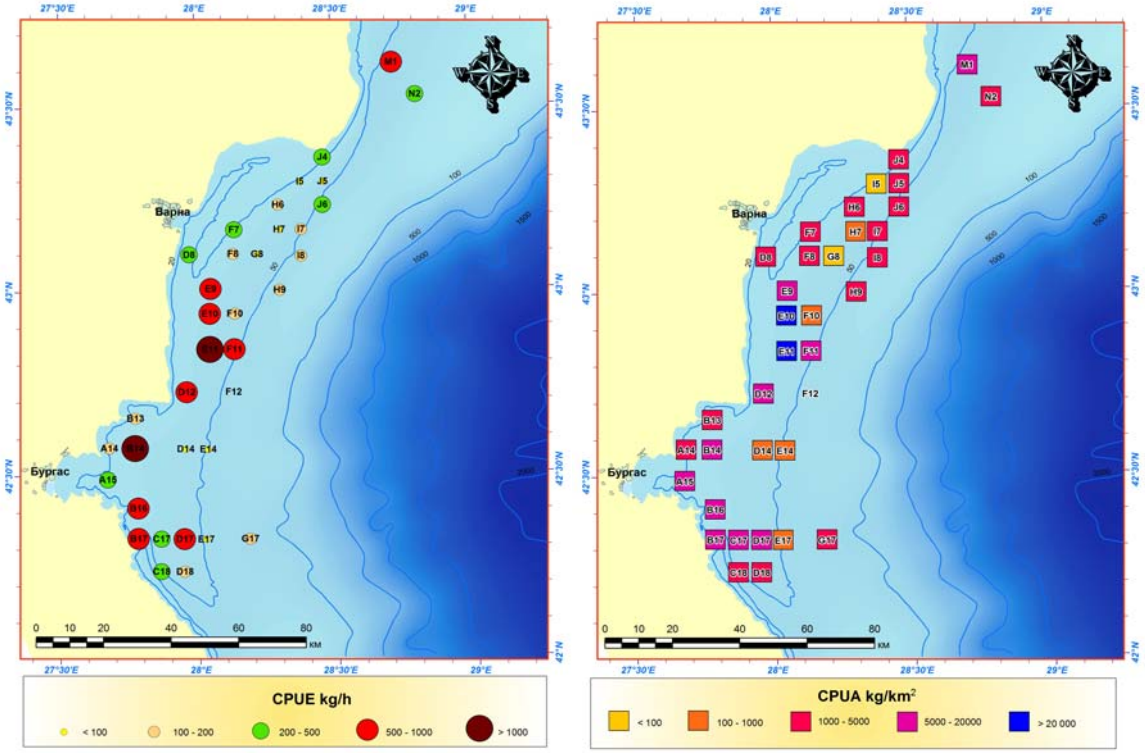


Fig 3.3.1.2.1 Catch per Unit Effort in the corresponding investigated areas.

In early part (first part of the trawl survey in 9-14 May 2008) sprat agglomerations were unstable, in scatter groups. The hydrometeriological conditions were changing very quickly. The air temperatures, SST and atmospheric pressure were low, possibly influencing sprat schools to move in deeper waters and to not form stable aggregations in bottom layers. Simultaneously, the CPUE kg/h in northern part show prevailing levels between 100-200kg/h, with peak in polygon M1 – close to Romanian border, southern direction transect from Cape Kaliakra, in front of Varna Bay and Place "Pasha Dere" some areas with 200-500 kg/h were observed.

In front of Biala and St.Atanas Cape the following levels of CPUE were detected: **E11** polygon (>1000 kg/h), **F11** (500-1000 kg/h). In **B14** area (Pomorie) >1000 kg/h, **B16** 500-1000 kg/h (Sozopol), Cape Maslen – 500-1000 kg/h (**B17, D17**).

The bulk of CPUA kg/km^2 in the northern part of the Bulgarian Black Sea ranged between 1000 and 5000 kg/km^2, with high values in front of the cape Kaliakra in strata 30-50m and toward southern direction from the Cape Kaliakra in depths 50-75m and 75-100m. Only in two investigated polygons from northern part catch per unit area was below 100 kg/km2. Similar CPUA kg/km^2 were detected in front the Varna Bay, in southern direction of Cape Galata in strata 30-50m.Toward southern direction in front the place "Kara Dere" and Cape "St.Atanas" at depths 35-46m the highest CPUA was discovered in all the examined area.

In front of the Cape Emine (**D12**) relatively high CPUA was detected, since going deeper (75-100m) at **F12** polygon the value was 0 kg/km^2.In front of Nessebar -30-50m stratum relatively high value in polygon **B13** was detected, as in front of Pomorie (**A14**) the situation was similar. At almost the same depth, little far from polygon **A14** at eastern direction CPUA increased (**B14**). Following the same transect, at **D14**(50-75m) and **E14** – more deeper, the values of CPUA decreased to levels ranged from 100-1000 kg/km^2.In polygon **A15**, in front of Chernomoretz the CPUA increased (Fig.). In front of the Sozopol (**B16**, 30-50m) the positive trend as regards high levels of CPUA remains. In front of Cape Maslen (**B17, C17, and D17**) – in stratums I and II very high levels (5000-20000) of CPUA were observed. In eastern direction, on the same transect **E17** polygon show decreasing of kg/km^2 at 75-100 m depths. Next investigated area **G17** (75-100 m), outermost from the coast in southern part of the investigated area, the CPUA show positive trend. In southern direction, in front of Tzarevo the value of CPUAkg/km^2 was relatively high (1000-5000 kg/km^2).

In conclusion, we should say that in first part of May highly changing weather conditions, changing atmospheric pressure, cloudy weather, low SST and extremely severe underwater gears were strong negative prerequisite for sprat aggregation formations and non-lucrative target fishery on sprat.

In the second half of May, the hydro-meteorological conditions improve, namely atmospheric pressure increased, the quantity and duration of sunlight has increased as well. We must emphasize that strong underwater gears in this period was extremely strong and were obstacle for active sprat search and proper work of the trawl in many areas. After 18th May the conditions for sprat fishery were improved and toward the end of the trawl survey (23-25 May in southern part) and 27th in the northern part relatively high CPUE, CPUA and sprat stock aggregations were observed (Raykov et al., 2008).

Romanian sprat Survey

In the complex survey from the end of May 2008 in Romania were collected and analysed 13 juvenile samples, the investigated area having a surface of 2435 Nm^2 between Mangalia and Mila 9.

Sample structure having about six species in the same number of families.

Like in previous years, the sprat juveniles were dominant for frequency (77%), spatial distribution (88%) and abundance (71%).

The sprat juveniles were signalled both in southern part and northern part of investigated area, generally till the isobaths of 50m (Fig. 3.3.1.2.2).

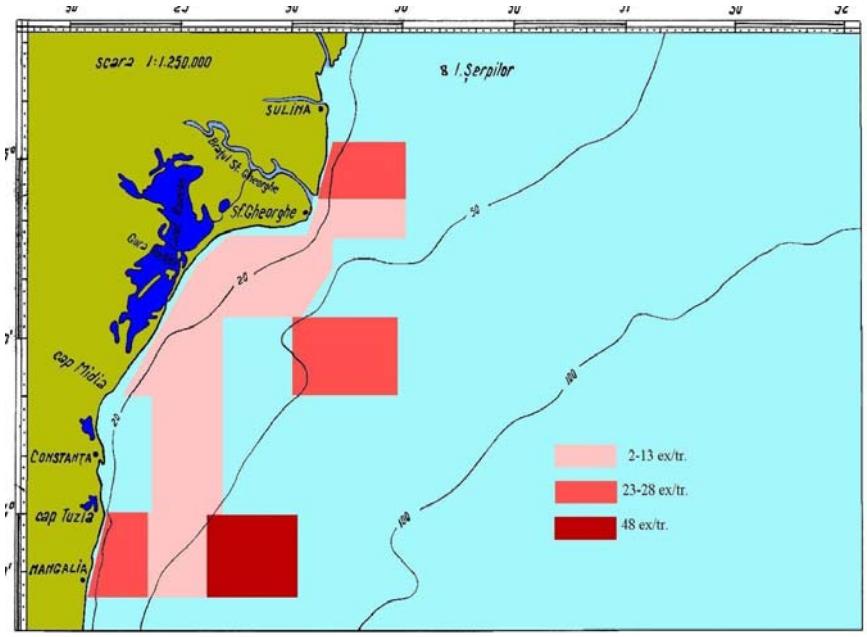


Fig. Fig. 3.3.1.2.2 Distribution of the sprat juveniles in the complex survey from May 2008, Romania

In May 2008, the situation was enough difficult from fishery point of view, the fishing agglomerations have been influenced by the jellyfish agglomerations (Tabl. 3.3.1.2.1 & 3.3.1.2.2 and Figs. 3.3.1.2.3.& 3.3.1.2.4).

Table Fig. 3.3.1.2.1 Assessment of the sprat agglomeration in May 2008, sampling gear - pelagic 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	108	4.860	4.860	524.88	
2	70	0.970	0.970	67.90	
3	63	0.970	0.970	61.11	
4	264	0.030	0.030	7.92	
5	84	8.360	8.360	700.56	
6	84	1.493	1.493	125.41	**9 285**
Total	**673**	**0.030 – 8.360**	**2 7805**	**1487.78**	

Table 3.3.1.2.2 Assessment of the jellyfish agglomerations in May, 2008.

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	120	4.86	4.86	583.2	
2	85.5	9.62	9.62	822.5	
3	183.5	0	0	0	
4	108	6.44	6.44	695.5	17 312.7
5	48	1.94	1.94	93.12	
6	128	4.53	4.53	579.84	
Total	673			2744.16	

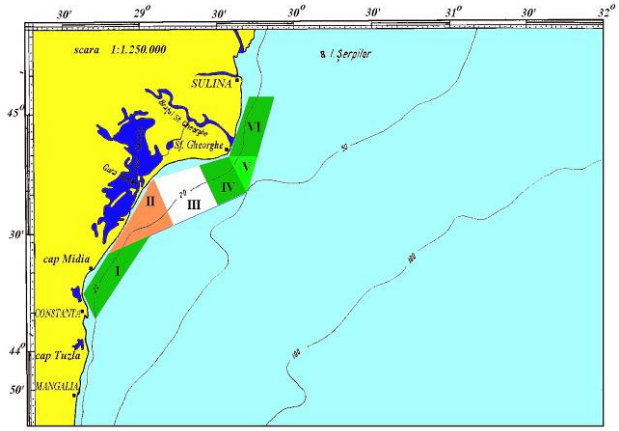
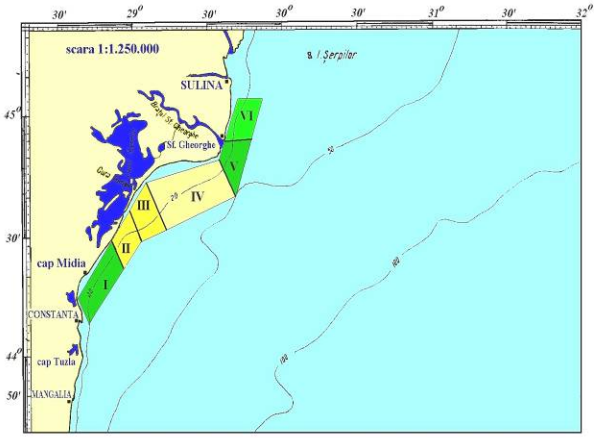


Fig. 3.3.1.2.3. Distribution and abundace of the sprat agglomerations in May 2008.



Fig, 3.3.1.2.4. Distribution and abundance of the jellyfish agglomerations in May 2008.

Biomass of the sprat agglomerations computed for a surveyed area of 673 Nm^2 was of 1,488 tons, extrapolated to **9285 tons** for shelf area up to 50 Nm from seashore.

Given the period 2007, in May 2008 the fishing agglomerations have been influenced considerable by the jellyfish agglomerations. The situation was the same with 2006 period. For surveyed area, the jellyfish biomass was appreciated at 2,744 tons, extrapolated to 17,313 tons for shelf area up to 50 Nm from seashore.

Table 3.3.1.2.3 Assessment of the sprat biomass in June 2008.

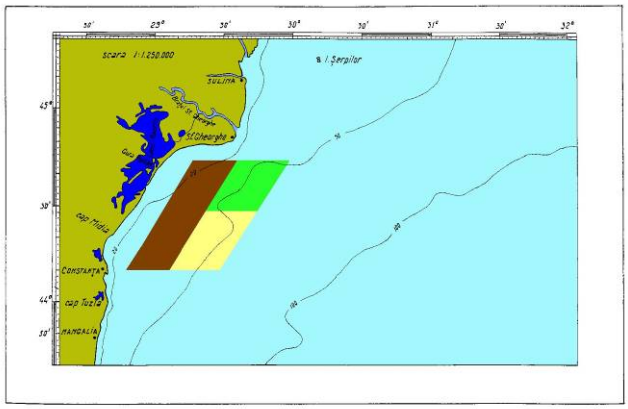
No. polygon	Polygon area (Nm^2)	Range (t/Nm^2)	Average (t/Nm^2)	Total tons in polygon (t)	Total on the shelf (t)
1	322	0.23	0.23	74.1	61900
2	238	1.9	1.9	452.2	
3	440	32.1-32.4	32.3	14 212	
Total	1000			14 738	

In June the sprat agglomerations were constituted especially at depths bigger than 20m, their biomass was estimated about 14,738 tones extrapolated to 61,900 tones for the shelf area until 50 Mm distance from the shore (Tabl. 3.3.1.2.3 & Fig. 3.3.1.2.5.). The biggest sprat concentrations were found in front of the marine DDBR area.

Table 3.3.1.2.4 Assessment of the jellyfish biomass in June, 2008.

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	560	6.15 – 17.48	11.82	6 619	27 800
2	440	0			

The research area was of 1,000 Nm^2 and the jellyfish biomass was estimated about 6,619 tones, being extrapolated to 27,800 tones for the shelf area until 50 Nm distance from the shore (Tabl. 1.1.3.1.2.4 & Fig. 1.1.3.1.2.6). The biggest jellyfish concentrations were found in Zaton area from DDBR area.



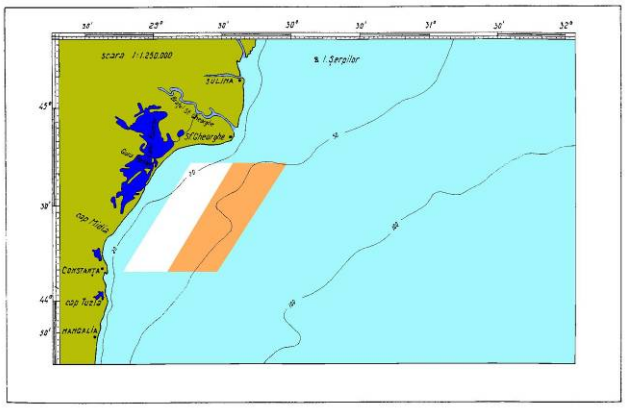


Fig 3.3.1.2.3 Sprat distribution in June, 2008 Fig. 3.3.1.2.4 Jellyfish distribution in June, 2008

In the research survey carried out in August 2008, 14 sampling hauls were carried out using a pelagic trawl.

The sprat biomass agglomerations was evaluated to 30,917.20 tons for a survey surface of 2,222 nm^2, being extrapolated to 58,439 tons for the shelf area until 50 Nm distance from the shore (Tab. 3.3.1.2.5&Fig. 3.3.1.2.7). The average values of the sprat capture were ranged between 0.93t/ nm^2 and 26.80 t/nm^2. The lowest capture values were registered in Costinesti - Mangalia marine sector (0.20 t/Nm^2) and the biggest was registered in Constanta - Sf Gheorghe marine sector (47.10 t/nm^2).

Table 3.3.1.2.5. Assessment of the sprat biomass in August 2008.

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	643.5	0.2 – 1.3	0.93	598.5	58 439
2	1,114.5	13.3 – 47.1	26.8	29 868.6	
3	464	0.3 – 1.7	0.97	450.1	
Total	2 222			30 9172	

In the time of the survey organized in the period 13-17 August 2008, jellyfish has a large horizontal and vertical distribution in the area between Constanta – Mangalia, with a big density in the area Costineşti-Olimp and Sf. Gheorghe, the agglomerations reaching to a maximum of 1.82 t/nm^2 , respectively 1,7 t/nm^2.

For the surveyed area, jellyfish biomass was of 817.70 t, extrapolated to 1.546 t for the shelf area until 50 Nm distance from the shore (Tabl. 3.3.1.2.6&Fig. 3.3.1.2.8).

Table 3.3.1.2.6. Assessment of the jellyfish biomass in August 2008.

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	616	0.2 – 1.8	0.9	554.4	1546
2	202.5	0.8 – 1.7	1.3	263.3	
Total	818.5			817.7	

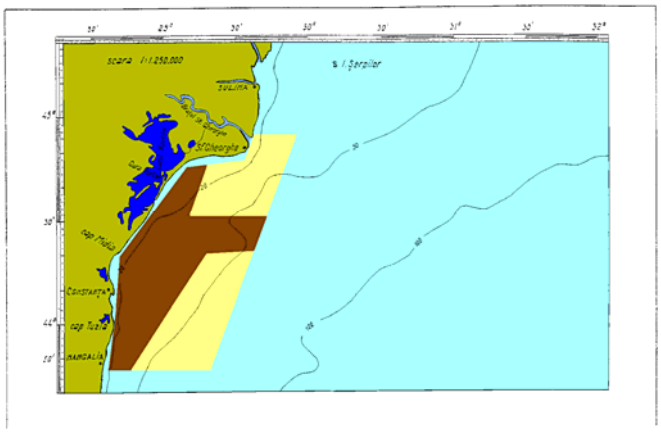


Fig. 3.3.1.2.7 Distribution of the sprat in August

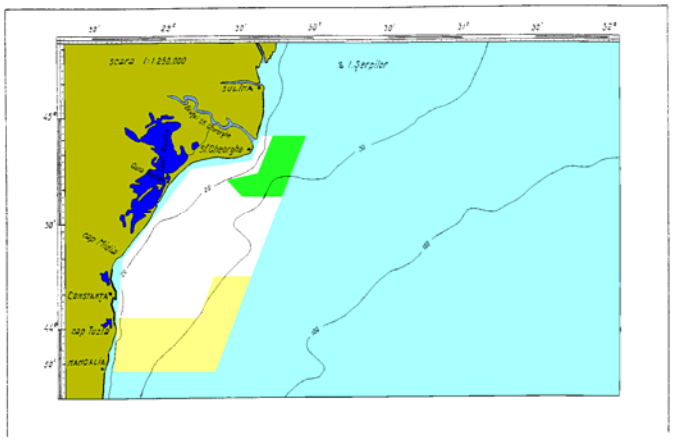


Fig. 3.3.1.2.8 Distribution of the jelly fish in August, 2008

In September 2008, sampling was carried out on a surface of 2069 Nm^2, the surveyed area being between isobaths of 20 – 65m, between Mangalia and Sf. Gheorghe (Tabl. 3.3.1.2.7&Fig. 3.3.1.2.9).

Table 3.3.1.2.7. Assessment of the sprat biomass in September 2008.

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	749.25	0.2 – 1.7	0.68	509.5	9 332
2	338.05	1 – 8.4	4.34	1,467.1	
3	85.5	28 – 33.3	30.65	2,620.6	
4	896.2	0	0	0	
Total	2,069				

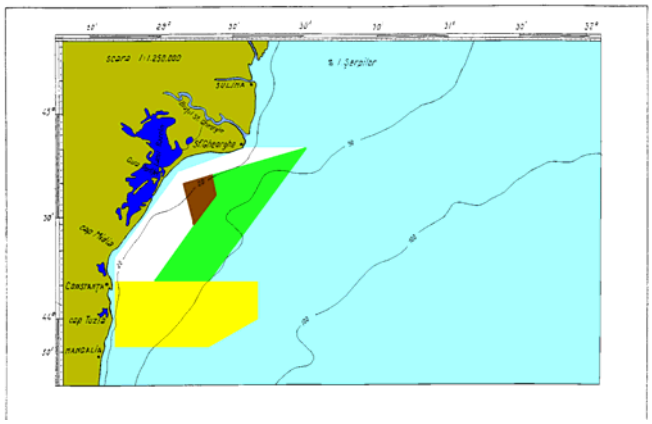


Fig 3.3.1.2.9. Distribution of the sprat in September 2008.

Ukrainian hydro-acoustic Survey 1999

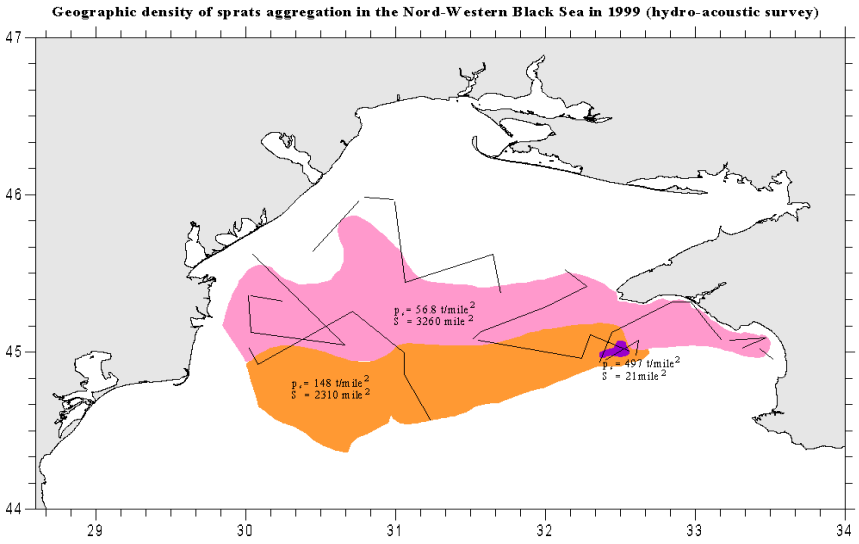


Fig. 3.3.1.2.10. Density of sprat aggregations in the north-western Black Sea by hydro-acoustic survey in 1999.

The latest hydro-acoustic survey of sprat aggregations in the waters of Ukraine was carried out in June 1999; the scheme presents its results for north-west (Fig. 3.3.1.2.10). In the frame of the area investigated – 5591 nm^2 the sprat aggregation biomass was estimated at 537 485 t.

It is seen, that the greater part of the sprat was distributed beyond the coastal shallow zone. Length structure of aggregations during the survey was characterized by the following proportions. In depths less 60 m the share of sprat of more than 9 cm long (TL) was equal to 0.23, in depth of more than 60 m – 0.34.

The next scheme (Fig. 3.3.1.2.11) demonstrates two main areas of sprat fisheries – Western and Crimean. Fisheries are concentrated exclusively in twelve-mile zone in depth not more than 60 meters. In the Western area vessels from Odessa, Nikolaev and Kherson are conducting fishing operations. In annual

catch their percentage makes about twenty-thirty percents. In the Crimean area a great number of vessels registered in the ports of the Crimea (Sebastopol and Kerch) is operating. On Fig. prohibited zones for trawl fishery, marked in red. The largest prohibited area is defined as *Phyllphora* sp. field protected area. The prohibited area next to the Danube River delta is important for the nursery and spawning of the Fam. Acipenceridae, as well as the eastern Crimean region (marked in red) which is closed area for trawl fishery.

Analysis of comparison of data of the survey and the data of Ukrainian sprat fisheries enables to make two conclusions. Firstly, in 1999 fisheries are conducted on spots where not more than 40% of biomass of aggregations took place. Secondly, younger length and age groups were the most-used by the fishing fleet. As for the situation for the recent years, it remains the same.

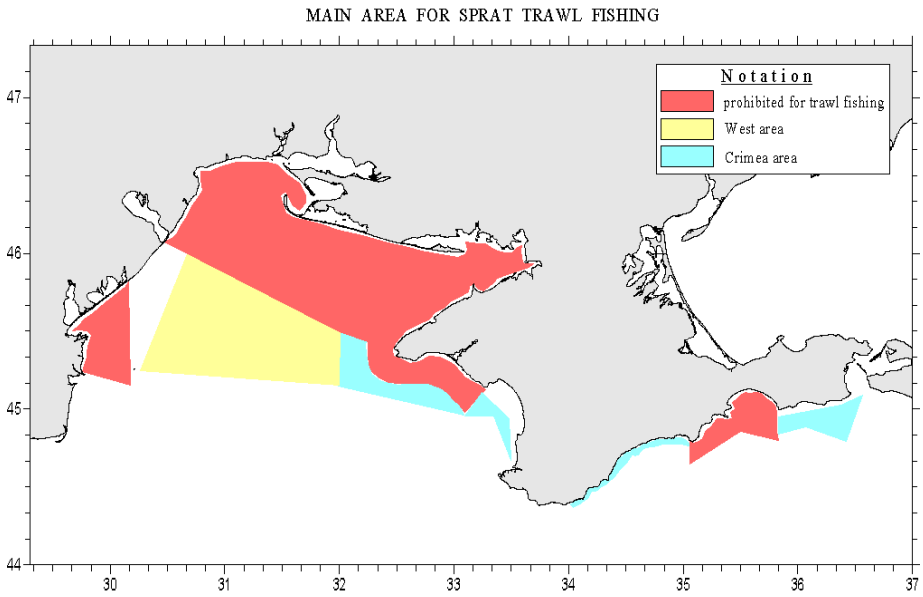


Fig. 3.3.1.2.11. Main fishing areas for sprat in Ukrainian waters.

3.3.1.3. Geographical distribution patterns

Bulgarian sprat Survey

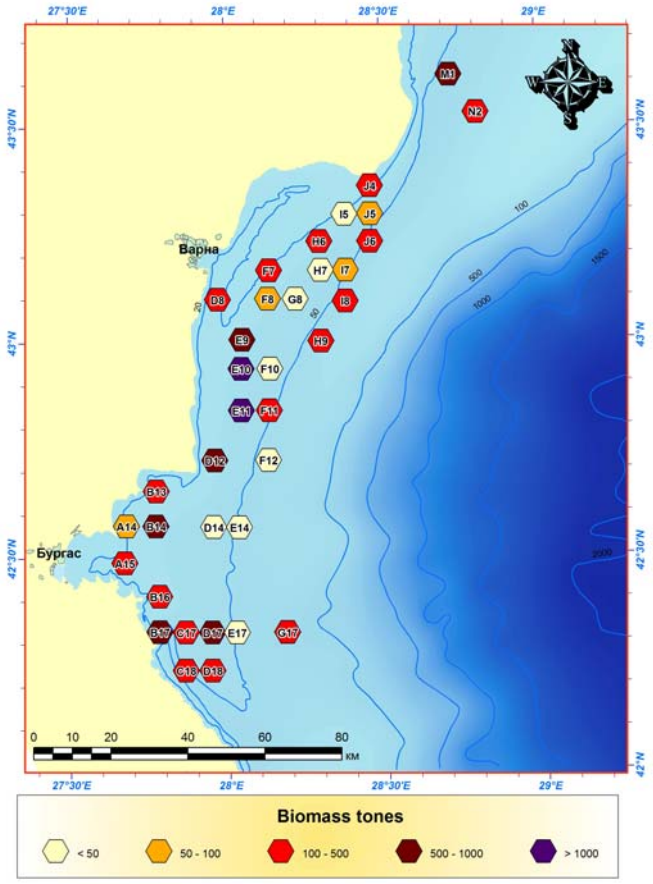


Fig. 3.3.1.3.1. Biomass of sprat aggregations of Bulgaria in May 2008.

Table 3.3.1.3.1. Biomass estimation by swept area method in Bulgarian waters.

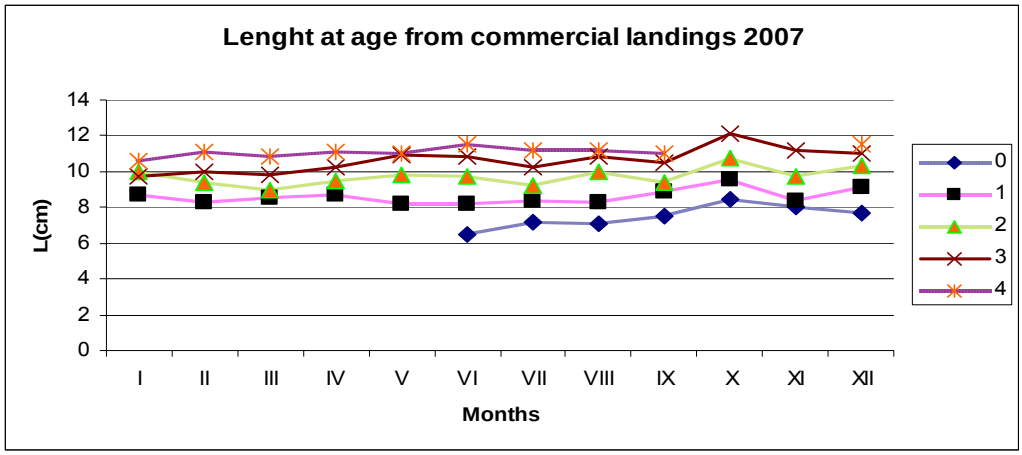
CPUA average		B (kg)	Ax	№ Fields
7524.026	30-50	13654753.7	1814.82	29
4329.259	50-75	11920701.2	2753.52	44
2853.464	75-100	7142791.16	2503.20	40
Total		**32 718246.1**	7071.54	113

The total number of fields in the frame of investigated area in front the Bulgarian Black sea coast was 113. The average CPUA prevails in the 30-50m strata: 7524.026 kg m^2, followed by CPUA in 50-75 m strata 4329.3.The lowest CPUA during the investigation was established in 75-100m strata, 2853.5 kg m^2, respectively. The total biomass in the corresponding investigated area was 32 718.246 kg (Tab. 3.3.1.3.1). Comparing with the previous research from the last year the exploitation biomass has been increased with

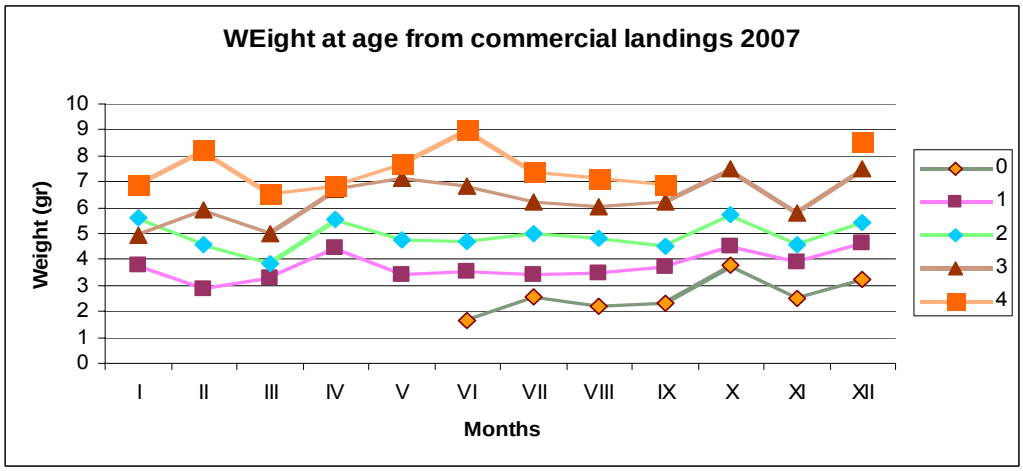
10.81%.The sprat schools (formation and movement) are strongly influenced by the physical and hydro meteorological conditions.(Fig. 3.3.1.3.1).

Possibly, the sprat agglomerations in May 2008 were dependant on temperature conditions (SST and bottom layer) of the water as well as on conditions and behaviour of the feeding zooplankton from the so called cold-preferring complex *Copepoda* and *Cladocera.*

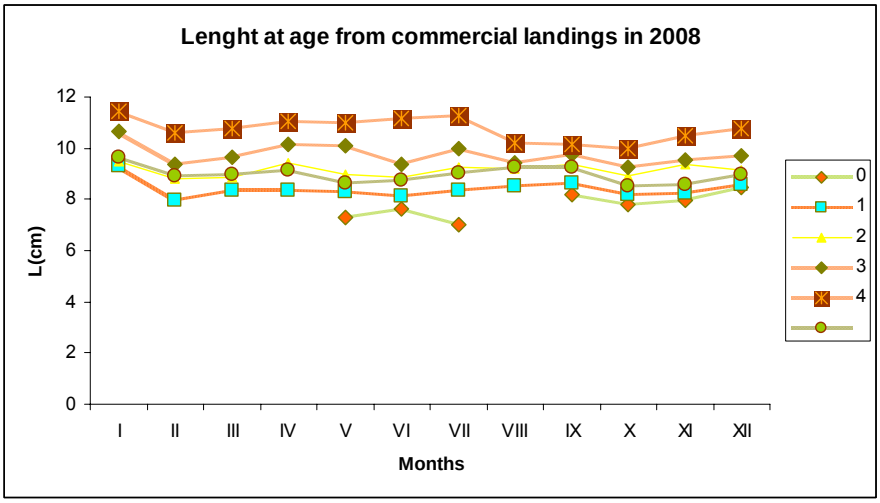
Trends in abundance by length or age



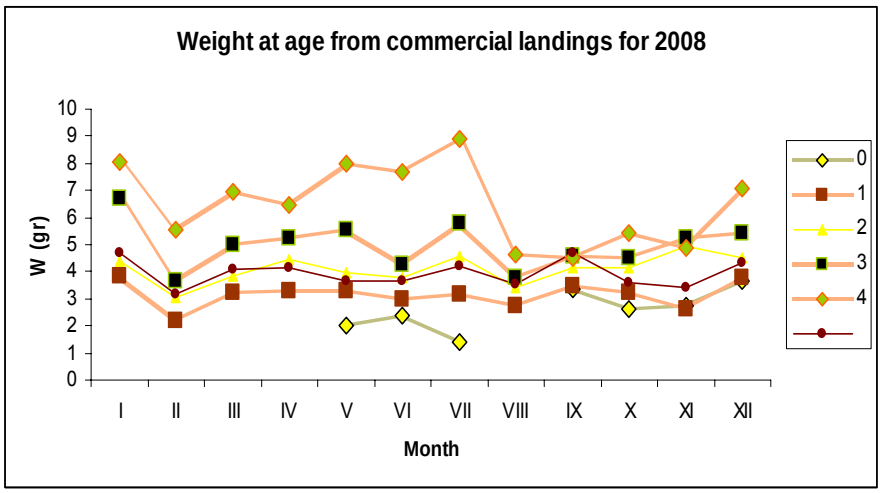
A) Sprat length at age by months for 2007 from commercial fishery.



B) Sprat individual weight at age by months for 2007 from commercial fishery.



C) Sprat length at age by months for 2008 from commercial fishery.



D) Sprat individual weight at age by months for 2008 from commercial fishery.

Fig. 3.3.1.3.2 Sprat length (A, C) and individual weight (B, D) from commercial fishery in 2007 and 2008 in Bulgarian waters.

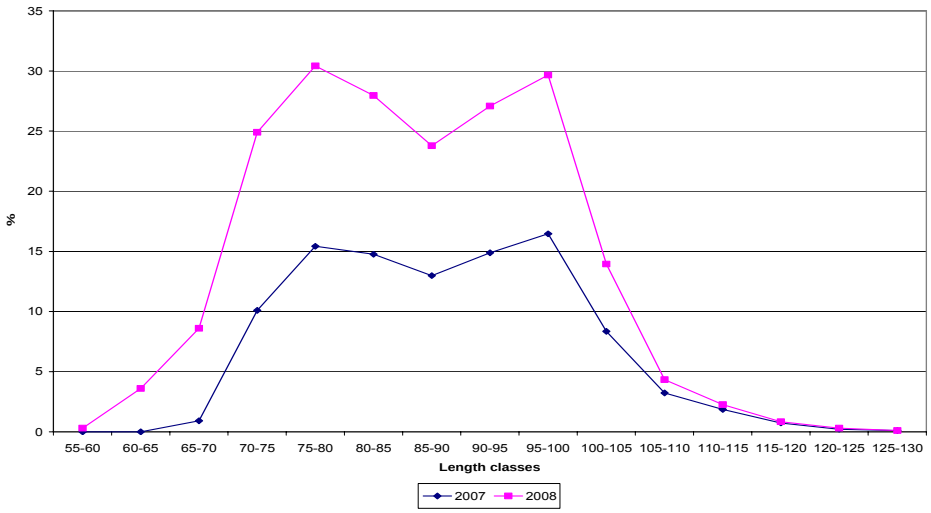


Fig. 3.3.1.3.3 Length distribution of sprat for 2007 and 2008 in Romanian waters.

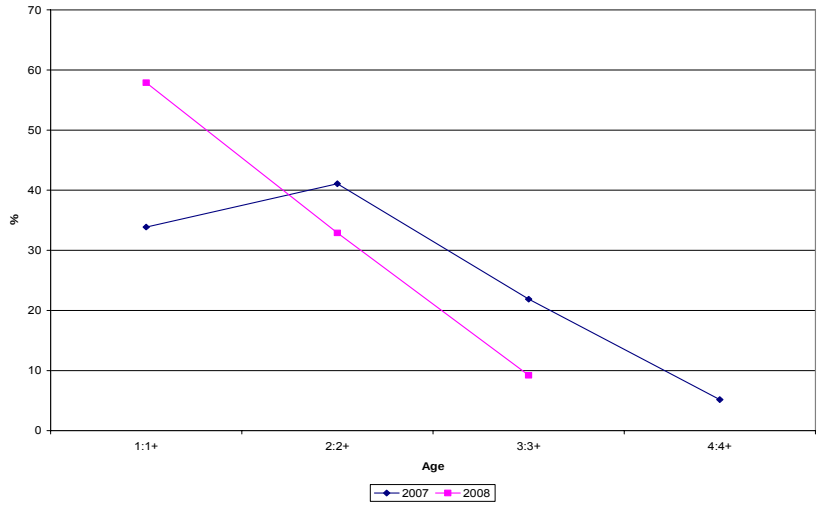
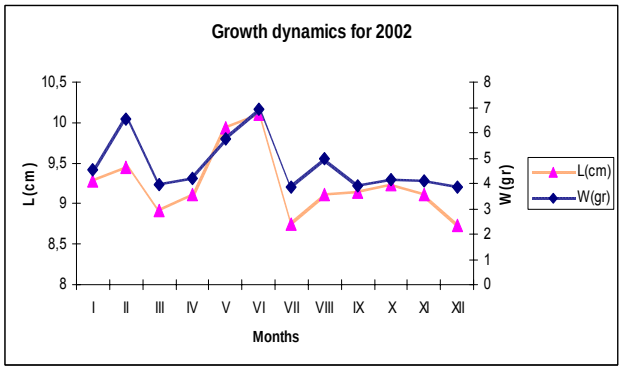
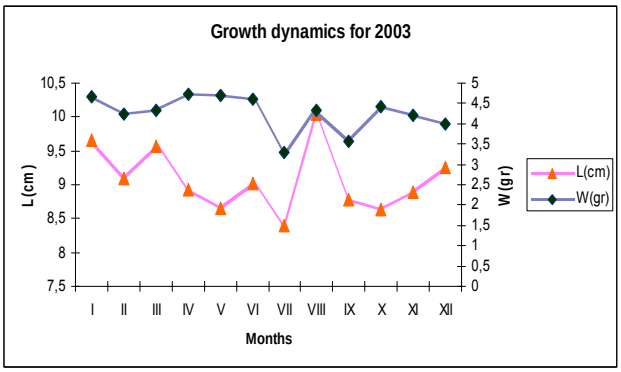
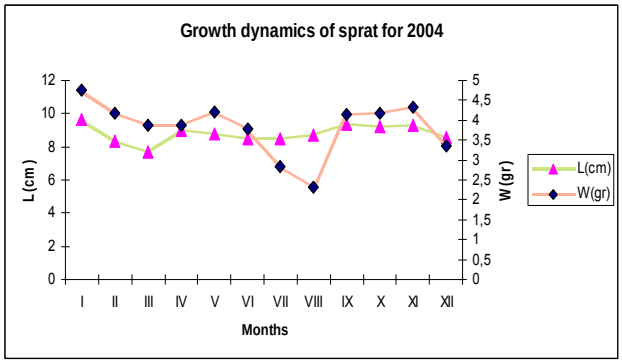


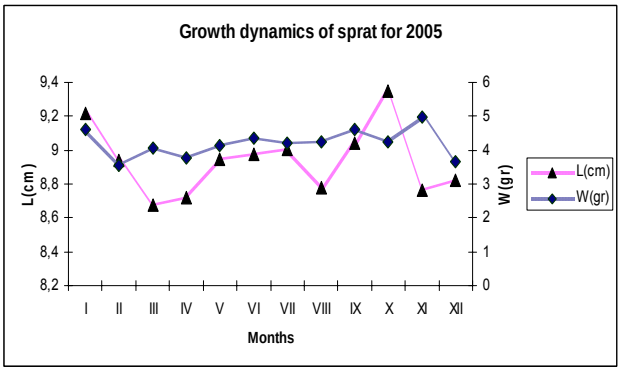
Fig. 3.3.1.3.4 Age distribution of sprat for 2007 and 2008 in Romanian waters.

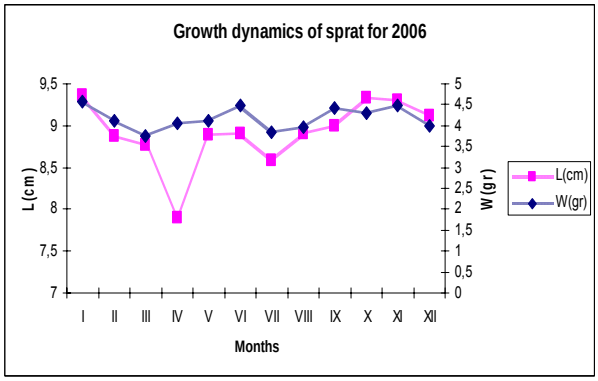
Trends in growth

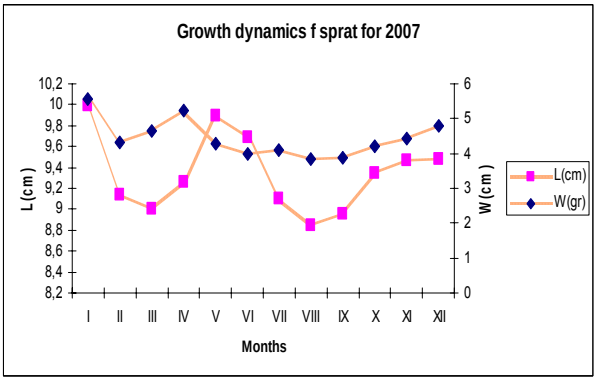


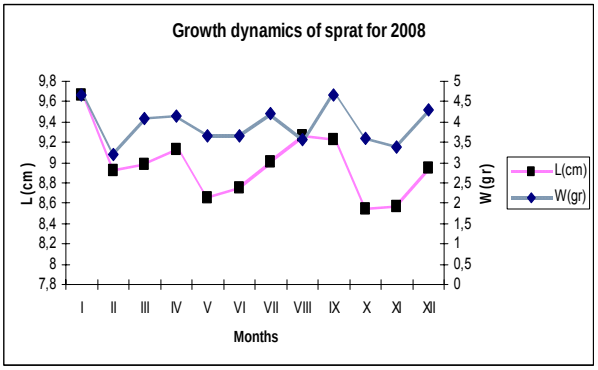












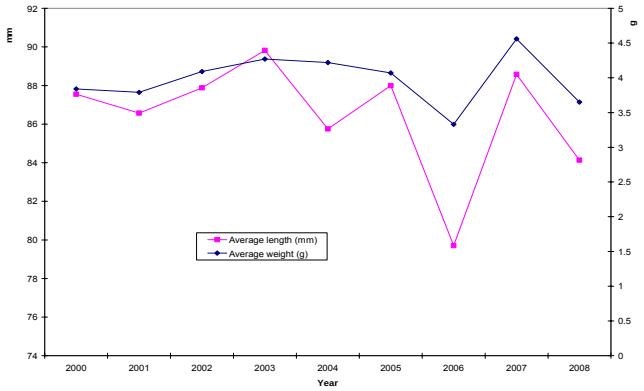


Fig. 3.3.1.3.5 Growth dynamics of sprat during the period 2002 – 2008.

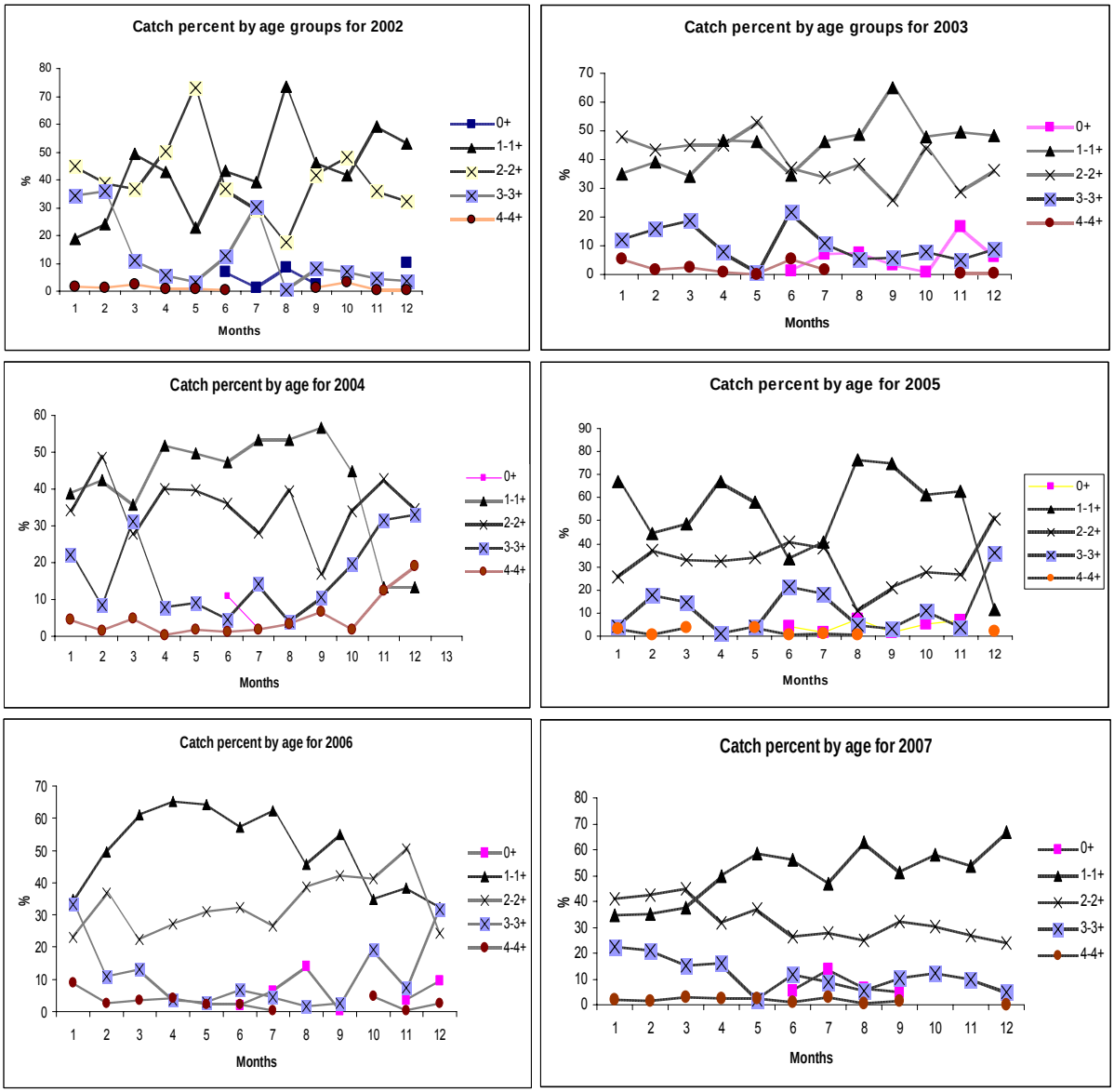
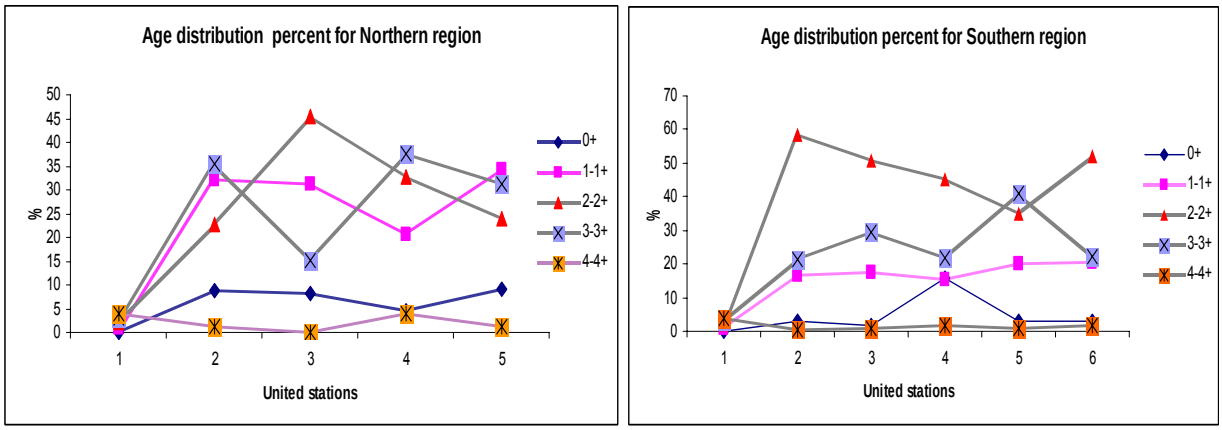


Fig. 3.3.1.3.6. Percent participation of age groups of sprat, monthly for 2002-2007.



(A) (B)

Fig. 3.3.1.3.7 Age composition of sprat by regions from trawl survey in May 2007, Bulgarian Black Sea waters.

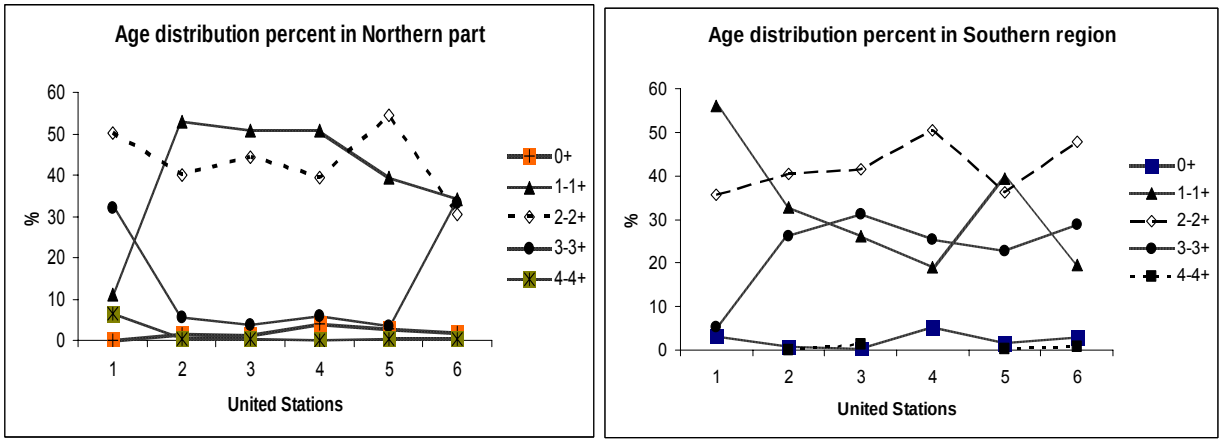


Fig. 3.3.1.3.8 Age composition of sprat from trawl survey in May-June 2008, Bulgarian Black Sea waters.

In all of the investigated areas during the trawl surveys the oldest age group 4-4+ was very weakly presented. In 2007 spring survey (Fig. 3.3.1.3.5) in northern part of the Bulgarian shelf, 2-2+ and 3-3+ age groups were very well presented, as well as good rate of recruitment (0+) have been observed. In southern region 2-3+ age groups were prevailing again, since 1-1+ show stable but lower trend (Raykov, 2008). Analysis for trawl survey in 2008 (Fig. 3.3.1.3.4) show stable high presence of 1-1+ and 2-2+ years old, since 3-4+ and 0+ were with low percent in the catches. In southern part of the researched area 2-2+ olds reached maximum, followed by 1-1+ and 3-3+ age groups. Recruitment (0+) and 4 years old were very low presented.

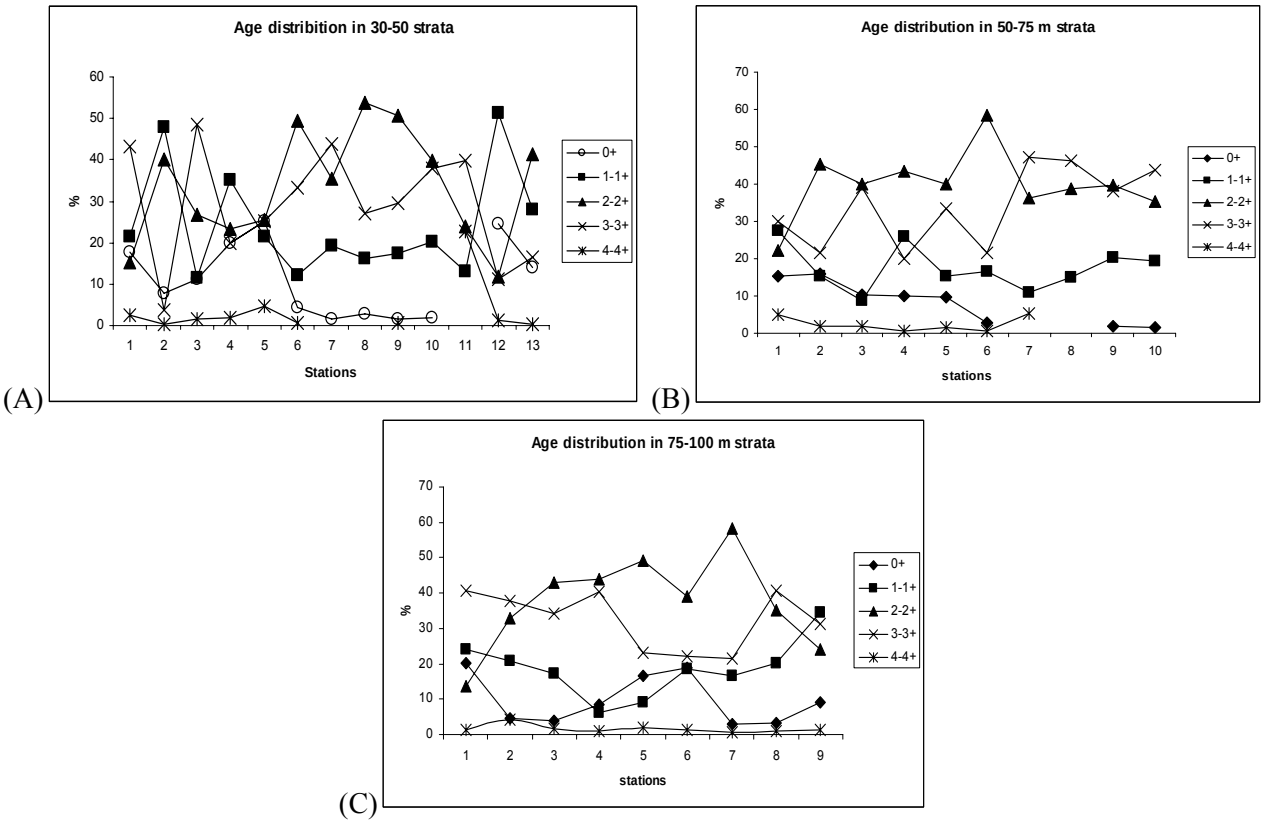


Fig. 3.3.1.3.9. Trends in age distribution of sprat from trawl survey in June 2007 off the Bulgarian coast

It is shown on Fig. 3.3.1.3.6 that prevailing age classes in I (30-50 m) and II strata (50-75 m) are 2-2+ and 3-3+.The percent of oldest age group 4-4+ is low at all of the stations. Recruitment (0+age) show similar trends in all investigated stratums as it was presented on figure. In third stratum (75-100 m),age group 2-2+ was dominant, followed by group 3-3+ and 1-1+ age group. The comparison with the samples taken from commercial trawl fishery show similarity as regards dominant role of 2-2+ and 3-3+ age groups and subordinate role of 1-1+group. In all of the observed cases, 4-4+ age group were presented with low percent, excluding XII.2004 samples from commercial fishery (Fig.3.3.1.3.7).

3.3.1.4. Trend in maturity

Not estimated

3.4. Assessment of historic stock parameters and predictions

The WG compiled data for age-structured stock assessment for 1994-2007 and used previously compiled data until 1993 from Daskalov (1998).

SGMED 09-01 applied two age structured methods to assess the historic stock parameters of sprat in the Black Sea: ICA and XSA. The results are presented in the following chapters.

3.4.1. Catch at age

Catch at age data were used as inputs for stock assessment (Tabl. 1.1.4.1). To obtain the annual catch at age numbers monthly catches were divided by monthly mean body weight and then distributed by age according to monthly age compositions. Monthly catch at age numbers were then summed to obtain annual catches. Monthly length-age keys from Bulgaria were applied to Ukrainian length composition in order to obtain the needed age compositions.

Table 3.4.1. Catch-at-age of sprat commercial landings from Black Sea.

Age groups	0	1	2	3	4	Sum
1994	9027	622713	3399843	852377	11614	4895574
1995	43082	2449178	2534917	398527	12985	5438690
1996	17334	3221877	2402148	748763	30180	6420302
1997	199729	4668032	2122678	511227	38619	7540285
1998	393354	3613018	3748674	693645	40918	8489609
1999	66574	8608599	2172350	269937	5185	11122644
2000	561788	7866266	3706776	640225	85942	12860997
2001	864651	10296283	7312555	556729	27815	19058032
2002	7488755	8694589	4370461	813203	46678	21413687
2003	1531125	5666801	5769868	1559559	264799	14792151
2004	3631294	9811084	2018852	464176	74387	15999793
2005	418383	9973221	3371749	1121807	82156	14967316
2006	1002127	7063316	2112700	461830	53537	10693510
2007	4496137	6731521	1642339	569431	79115	13518543

3.4.2. Weight at age in the stock

Weight-at-age in the stock were based on Bulgarian landings data from November of year *y-1* to February of year *y*.

Table 3.4.2.1 Individual Weight-at-age (in kg) in the Stock on the 1st of Jan.

	AGE				
Year	0	1	2	3	4
1994	0.001	.0035	.0041	.0048	.0062
1995	0.001	.0033	.0043	.0048	.0055
1996	0.001	.0028	.0043	.0047	.0053
1997	0.001	.0027	.0047	.0057	.0069
1998	0.001	.0034	.0046	.0064	.0082
1999	0.001	.0025	.0047	.0059	.0073
2000	0.001	.0032	.0044	.0056	.0072
2001	0.001	.0035	.0044	.0052	.0067
2002	0.001	.0036	.0045	.0061	.0074
2003	0.001	.0035	.0044	.0059	.0074
2004	0.001	.0034	.0044	.0060	.0072
2005	0.001	.0036	.0046	.0061	.0074
2006	0.001	.0036	.0046	.0057	.0074
2007	0.001	.0033	.0047	.0054	.007

3.4.3. Weight at age in the catch

Table 3.4.3.1 Individual mean weight-at-age (in kg) in the catch

	Age 0	Age 1	Age 2	Age 3	Age 4
1990	0.0015	0.003	0.0058	0.0069	0.0091
1991	0.0015	0.0021	0.0044	0.0071	0.0094
1992	0.0017	0.0021	0.0045	0.0068	0.0086
1993	0.0017	0.0025	0.0036	0.006	0.0077
1994	0.0023	0.0034	0.004	0.0047	0.0077
1995	0.0025	0.0038	0.0046	0.0054	0.0069
1996	0.0025	0.0038	0.0052	0.006	0.0074
1997	0.0023	0.0033	0.0049	0.0063	0.0072
1998	0.0024	0.004	0.0051	0.0076	0.0094
1999	0.0028	0.0032	0.005	0.0065	0.0073
2000	0.0023	0.0035	0.0045	0.006	0.0078
2001	0.0017	0.0025	0.004	0.0063	0.0069
2002	0.0018	0.0027	0.0041	0.0058	0.0077
2003	0.0017	0.0028	0.004	0.0061	0.0068
2004	0.0019	0.0029	0.0044	0.006	0.0073
2005	0.0021	0.0035	0.0047	0.0062	0.0077
2006	0.002	0.0033	0.0043	0.006	0.0073
2007	0.0017	0.0033	0.0049	0.0072	0.0087

3.4.4.Maturity at age

The maturity ogive applied is a knife edge assumed to reach 100% at age 1.

3.4.5.Natural mortality at age

The natural maturity of 0.64 of age 0.5 year and 0.95 for ages 1-5 years was used as estimated by Prodanov et al (1997).

3.4.6.Method 1: ICA

3.4.6.1. 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 (Pope and Shepherd, 1982). 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 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, $\hat{C}$, I, and $\hat{I}$ 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.

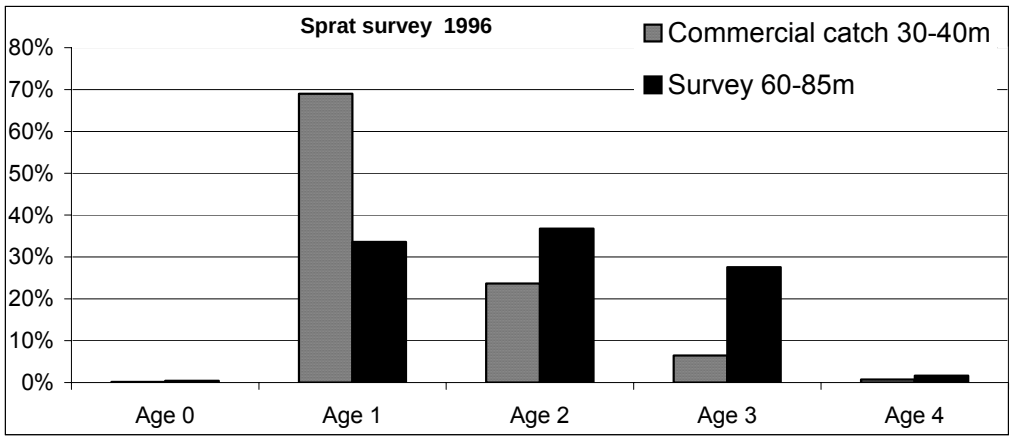
A particular reason to use ICA in Black Sea sprat assessment is that this method incorporate a separable model accounting for age effects. Black Sea sprat is short lived species (age 5 at maximum) and in the last decades fish of age 4 is not fully fished (Fig. 3.4.6.1.1 & Fig. 3.4.6.1.2). The low selection of larger fish (age 4) is mainly due to the economic constraints of small vessels, dominantly used in this fishery, to fish in deeper water where larger fish is preferably distributed (Fig. 3.4.6.1.1 & Fig. 3.4.6.1.2). During the 1980 when the highest catches were realised the former Soviet fleet was deploying larger vessels (Daskalov et al. 1996, Prodanov et al. 1997) and age composition of the landings was more representative for the stock age composition (unselective fishing of larger/older fish Fig).

For the reasons presented above a method assuming constant selectivity at the last ages i.e. F at age 4 equal to the average F over the younger ages, such as XSA would clearly over-estimate the actual terminal F and consequently inflate all F / reduce abundance estimates for younger ages and earlier years. XSA model was successfully used showing consistent results with other methods (VPA, ICA, Daskalov et al. 1996, Prodanov et al. 1997, Daskalov 1998) for the time period when age 4 fish was not selectively fished (1978-1993), but in recent decades (this report) it gives different results (especially in terms of F) from ICA because its is unable to account for reduced selectivity at age 4.

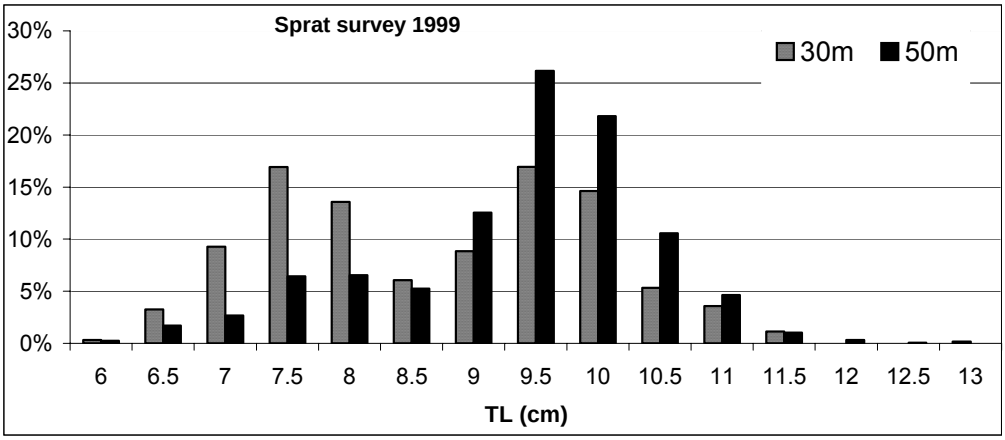
On the other hand ICA provides a way to apply a lower selectivity a the last age (S at age 4 as a ratio of F at age 4 to reference F -in this case F at age 2). The problem how this selectivity can be estimated in a objective way is discussed in the ICA results section.

ICA has previously been successfully applied to sprat by Daskalov (1998a), Daskalov et al. (2007a), and Daskalov & Mamedov (2007).

A.



B.



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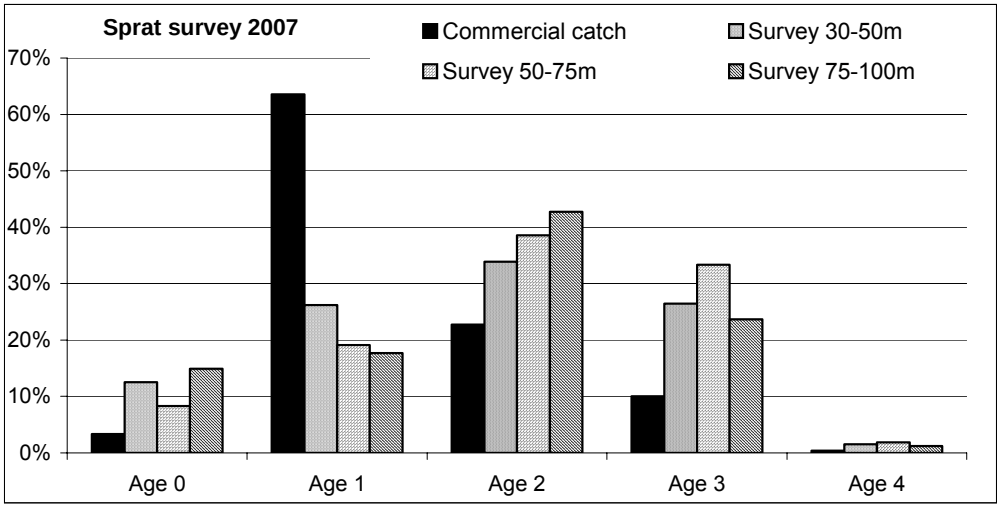

Fig. 3.4.6.1.1 Length and age composition of commercial and survey catches of sprat showing lower selectivity of larger/older fish by commercial fleet and at lower dept.

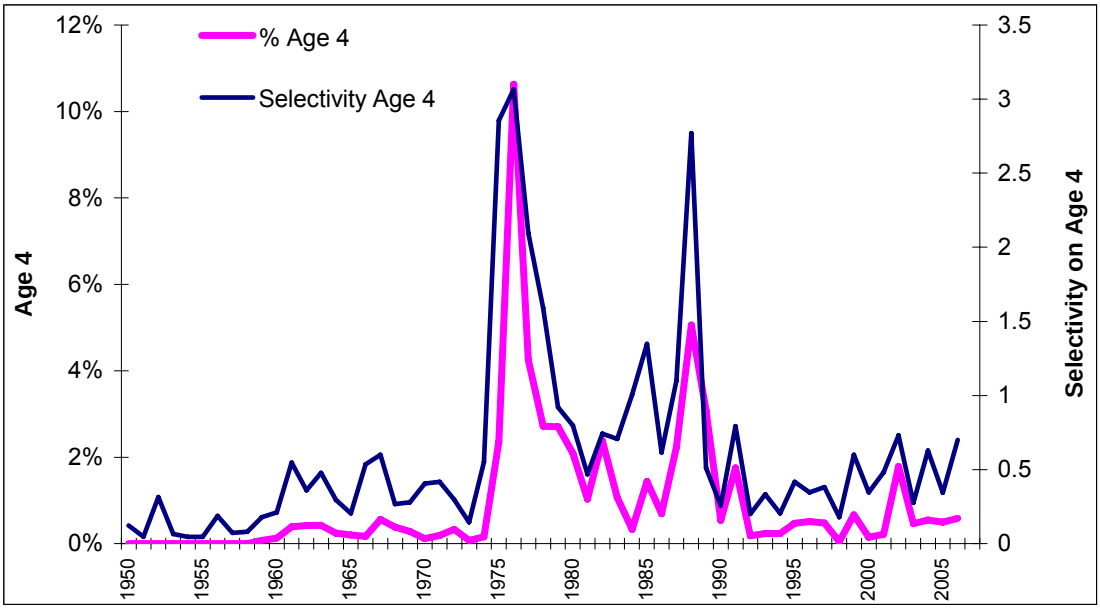

Fig. 3.4.6.1.2 Percentage of Age 4 in the catch and selection of Age 4 (estimated as F at Age 4/ mean F 2-3) showing higher share/selection of Age 4 during the 1970-1980 when the stock was strongly exploited at deeper water and using larger vessels (Prodanov et al 1997, Daskalov 1998).

3.4.6.1.1. Input parameters

Catch and weight at age, natural mortality, and 3 age structured indices are used to run ICA (Table 3.4.6.1.1.1). Adult stock indices are derived from commercial CPUE of Bulgarian and Ukrainian trawling fleets and an index of juvenile fish (age 0.5 in July) is obtained from Romanian juvenile survey.

Table 3.4.6.1.1.1Sprat input parameters.

Output Generated by ICA Version 1.4

SPRAT 2007

Catch in Number x 10^ 6

AGE	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	640	492	51	806	8	40	16	188	373	65	469	900	8731	1816	4167	402	1042	4108
1	5236	8047	2673	2044	572	2284	3034	4386	3428	8345	6569	10712	10137	6723	11257	9575	7343	6150
2	3093	1363	2114	1526	3122	2364	2262	1994	3557	2106	3096	7608	5095	6845	2316	3237	2196	1501
3	2322	106	528	293	783	372	705	480	658	262	535	579	948	1850	533	1077	480	520
4	359	55	96	9	11	12	28	36	39	5	72	29	54	314	85	79	56	72
5	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Weights at age in the catches (Kg)

AGE	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	0.0015	0.0015	0.0017	0.0017	0.0023	0.0025	0.0025	0.0023	0.0024	0.0028	0.0023	0.0017	0.0018	0.0017	0.0019	0.0021	0.002	0.0017
1	0.003	0.0021	0.0021	0.0025	0.0034	0.0038	0.0038	0.0033	0.004	0.0032	0.0035	0.0025	0.0027	0.0028	0.0029	0.0035	0.0033	0.0033
2	0.0058	0.0044	0.0045	0.0036	0.004	0.0046	0.0052	0.0049	0.0051	0.005	0.0045	0.004	0.0041	0.004	0.0044	0.0047	0.0043	0.0049
3	0.0069	0.0071	0.0068	0.006	0.0047	0.0054	0.006	0.0063	0.0076	0.0065	0.006	0.0063	0.0058	0.0061	0.006	0.0062	0.006	0.0072
4	0.0091	0.0094	0.0086	0.0077	0.0077	0.0069	0.0074	0.0072	0.0094	0.0073	0.0078	0.0069	0.0077	0.0068	0.0073	0.0077	0.0073	0.0087
5	0.0109	0.0108	0.0108	0.0108	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Weights at age in the stock (Kg)

AGE	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	0.0015	0.0015	0.0017	0.0017	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
1	0.003	0.0021	0.0021	0.0025	0.0035	0.0033	0.0028	0.0027	0.0034	0.0025	0.0032	0.0035	0.0036	0.0035	0.0034	0.0036	0.0036	0.0036
2	0.0058	0.0044	0.0045	0.0036	0.0041	0.0043	0.0043	0.0047	0.0046	0.0047	0.0044	0.0044	0.0045	0.0044	0.0044	0.0046	0.0046	0.0047
3	0.0069	0.0071	0.0068	0.006	0.0048	0.0048	0.0047	0.0057	0.0064	0.0059	0.0056	0.0052	0.0061	0.0059	0.006	0.0061	0.0057	0.0063
4	0.0091	0.0094	0.0086	0.0077	0.0062	0.0055	0.0053	0.0069	0.0082	0.0073	0.0072	0.0067	0.0074	0.0074	0.0072	0.0074	0.0074	0.0076
5	0.0109	0.0108	0.0108	0.0108	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Natural Mortality (per year)

AGE	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	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
1	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
2	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
3	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
4	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
5	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95

Proportion of fish spawning

AGE	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	0	0	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	1	1	1
2	1	1	1	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	1	1	1
4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

AGE-STRUCTURED INDICES

Bulgaria x 10 ^ 3

AGE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	9.78	19.59	41.06	53.32	52.36	101.06	96.51	87.64	55.09	77.19	80.83	93.69	78.82	62.03
2	57.49	48.77	38.16	28.37	58.52	30.6	68.95	60.47	52.66	67.63	54.71	61.73	42.02	35.73
3	16.27	7.36	9.45	6.21	5.28	4.54	6.28	3.43	17.09	19.49	19.67	20.83	8.17	11.02
4	0.25	0.23	0.59	0.61	0.54	0.3	0.61	0.2	0.93	3.48	4.85	2.09	2.53	1.88

Ukraine x 10 ^ 3

AGE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	34.01	129.93	101.19	141.88	91.55	234.51	304.5	126.65	87.69	67.67	83.72	24.96	77.18	115.99
2	172.78	95.68	63.45	50.52	86.14	51.42	122.88	27.6	33.92	72.8	2.72	6.82	13	5.59
3	39.39	9.39	21.09	4.85	10.56	3.49	18.44	4.83	3.8	17.95	1.12	2.18	3.38	0.99
4	0.48	0.59	0.88	0.85	0.89	0.05	3.65	1.06	0.26	2.88	0.06	0.15	0.24	0.1

Romania Young Fish Index

|	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	3727	320	1349	*******	1600	6300	2186	*******	*******	1475	*******	1213

3.4.6.1.2. Results

ICA was run assuming a constant selection pattern in 2004-2007 (Fig. 3.4.6.1.2.1, Table 3.4.6.1.2.1) with reference F at age 2 and S at age 4 equal 0.4. The WG recognises that the setting S age 4 at 0.4 is a concervative option, which possibly overestimates F (last year estimates were obtained using S at age 4 – 0.2, Pilling et al 2008). An objective method for estimating the selection pattern needs to be developed by the WG.

The results of the ICA show a reasonable agreement with tuning data (Fig. 3.4.6.1.2.3., Fig. 3.4.6.1.2.4., Fig. 3.4.6.1.2.5). The overall fit and partial SSR converged to unique minima (Fig. 3.4.6.1.2.1.). The fit between estimated population numbers and tuning indices is particularly poor for Ukrainian ages 2 and 3 index series which were subsequently down-weighted in the analysis.

Shrinking of the terminal Fs in the last year was applied using the last 10 years of the originally estimated F matrix (Table 3.4.6.1.2.1).

Retrospective analyses show that the model tends to overestimate F and under-estimate recruits and SSB (Fig. 3.4.6.1.2.7.). The reason for this is the assumption of a constant selection pattern with S at age 4 equal 0.4 over the last 4 years, while the 2007 run has estimated S at age 4 in the range of 0.27-0.3 in 1999-2003. Retrospective analyses are however designed to assess sensitivity of VPA which has the property to converge in earlier years. This is not really the case with ICA which estimate population parameters from an overall fit of a separable model and index matrices to catch-at-age data. For this reason trajectories in retrospective ICA runs (Fig. 3.4.6.1.2.7.) are always more dispersed compared to those in VPA or XSA (Fig. 3.4.6.1.2.1., Daskalov 1998a). Results from retrospective analyses indicate that selection at age 4 should possibly be lower than 0.4 assumed in this analysis.

The analyse of the main population parameters (abundance, catch, fishing mortality, Fig. 3.4.6.1.2.6, Table 3.4.6.1.2.1) reveals 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 early 2000s. The stock estimates, however, confirm the cyclic nature the sprat population dynamics. The year with relatively strong recruitment were followed by years of low to medium recruitment which leads to a relative decrease of the Spawning Stock Biomass (SSB). High fishing mortalities (F_{1-4}) were observed in 1990-1994, 1998, and 2003.

Present results were plotted together with earlier estimates from Daskalov 1998a in order to examine long-term evolution of the stock. They indicate that after the collapse in 1990 it took about a decade for the stock to recover to a level comparable with the 1980s. During the 1990s the fishing mortality has been held quite high – often higher than 0.5-0.6 which was previously considered as limit F over which the stock has a great probability to collapse as indeed happened in 1990. This high level of F may be due to a relatively low stock size, but could also result from an over-estimating F by assuming selection at age 4 too high (see Fig. 3.4.6.1.2.1.& Fig. 3.4.6.1.2.2). Indeed the WG discussed that the state of the fisheries and the effort applied in the 1990s was much lower compared to the 1980 when the Soviet fisheries was in full power and reached maximum landings by employing larger fishing vessels and fleets.

In the recent period SSB has again decreased due to lower recruitment and high fishing mortality. Landings have initially (in 2001-2005) reached levels comparable to the 1980s but dropped again in 2006-2007.

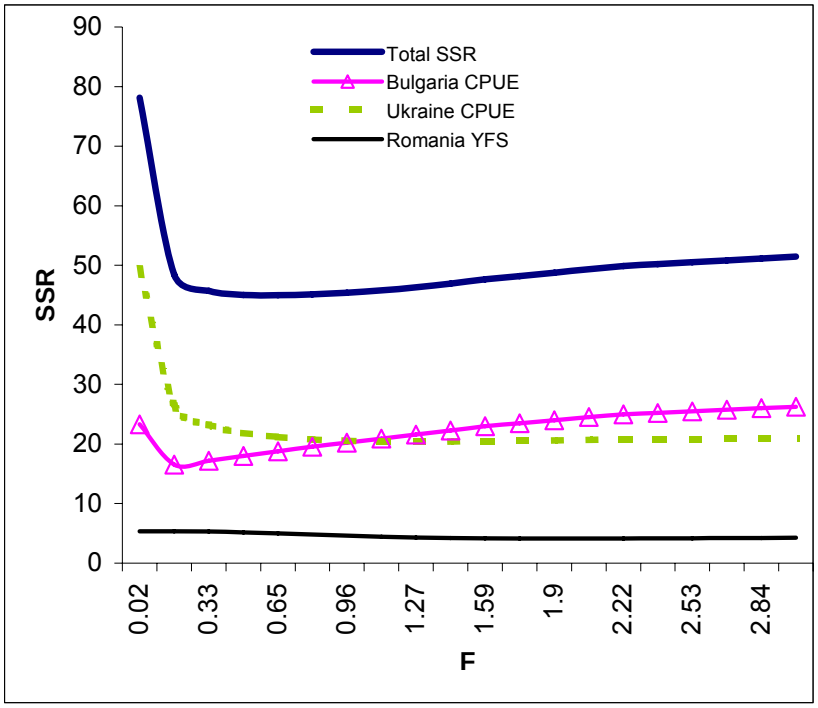

Fig. 3.4.6.1.2.1. Trajectories of the total Sum of Squared Residuals (SSR) and the partial SSRs of the two tuning fleets as functions of the reference F.

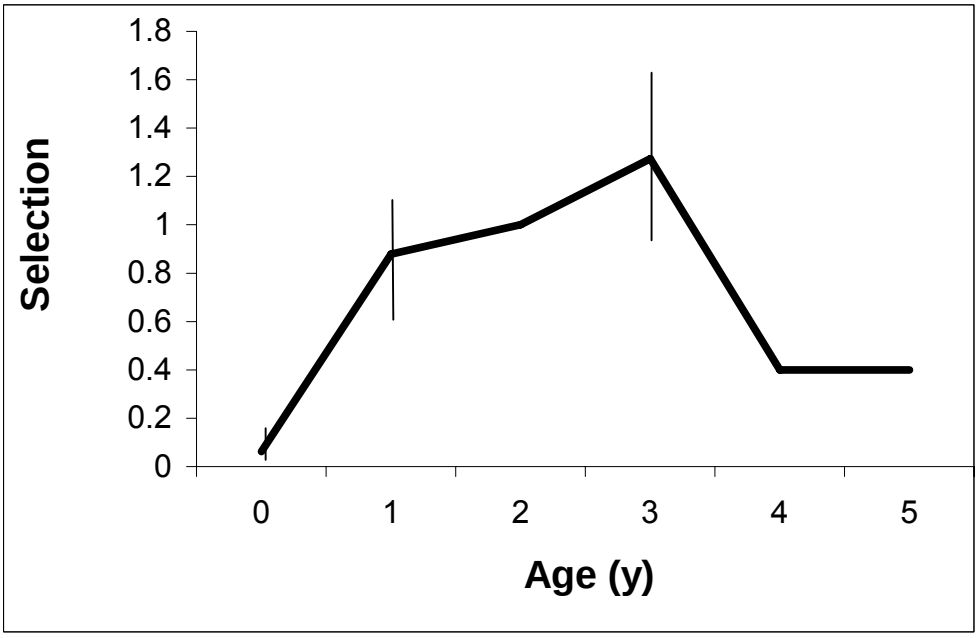

Fig. 3.4.6.1.2.2. Selection pattern estimated by the separable model

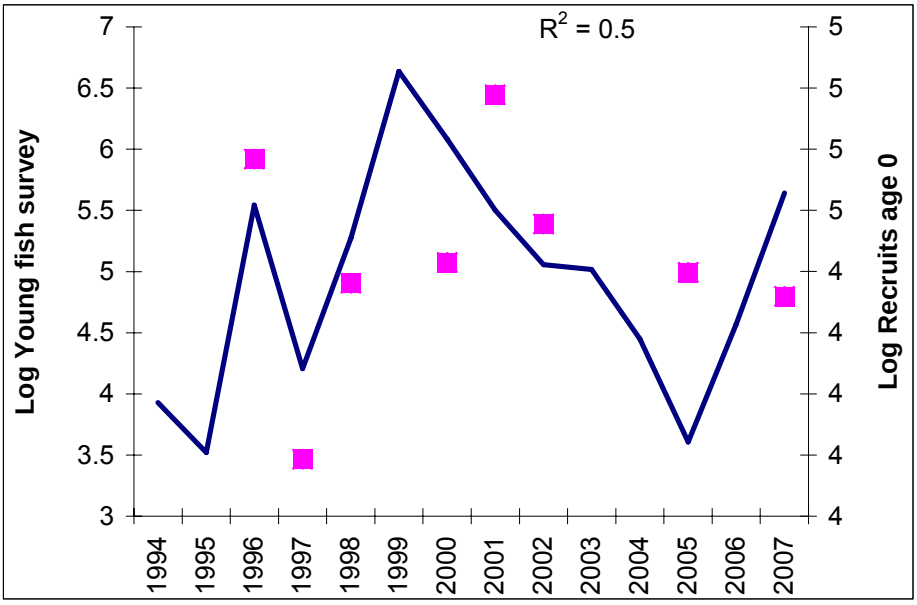

Fig. 3.4.6.1.2.3. Adjustment of ICA: (a) time-series of estimated recruitment (line) and young fish research survey index (diamonds), (b) scatterplot of survey vs. recruitment estimates (diamonds) and best fit (line) given by a power relationship (the equation and r^2 are shown).

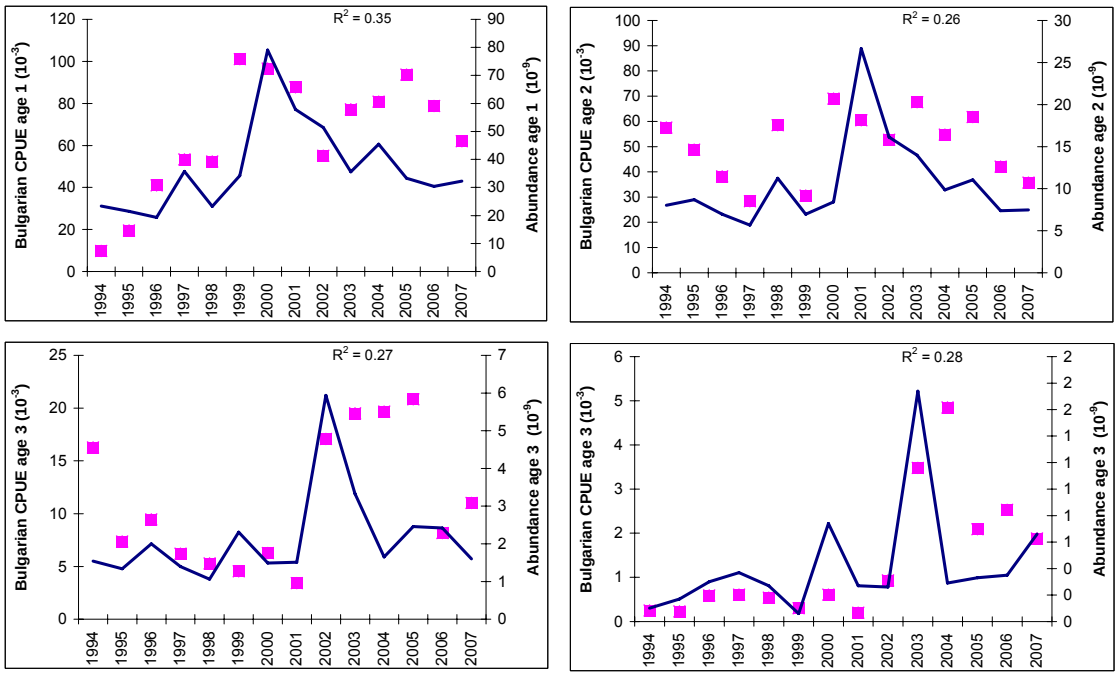

Fig. 3.4.6.1.2.4Adjustment of ICA: time-series of estimated abundance-at-age and age-structured research survey indices (best fit is given by linear relationships and r^2 are displayed): (a) Age 2, (b) Age 3, (c) Age 4, (d) Age 5.

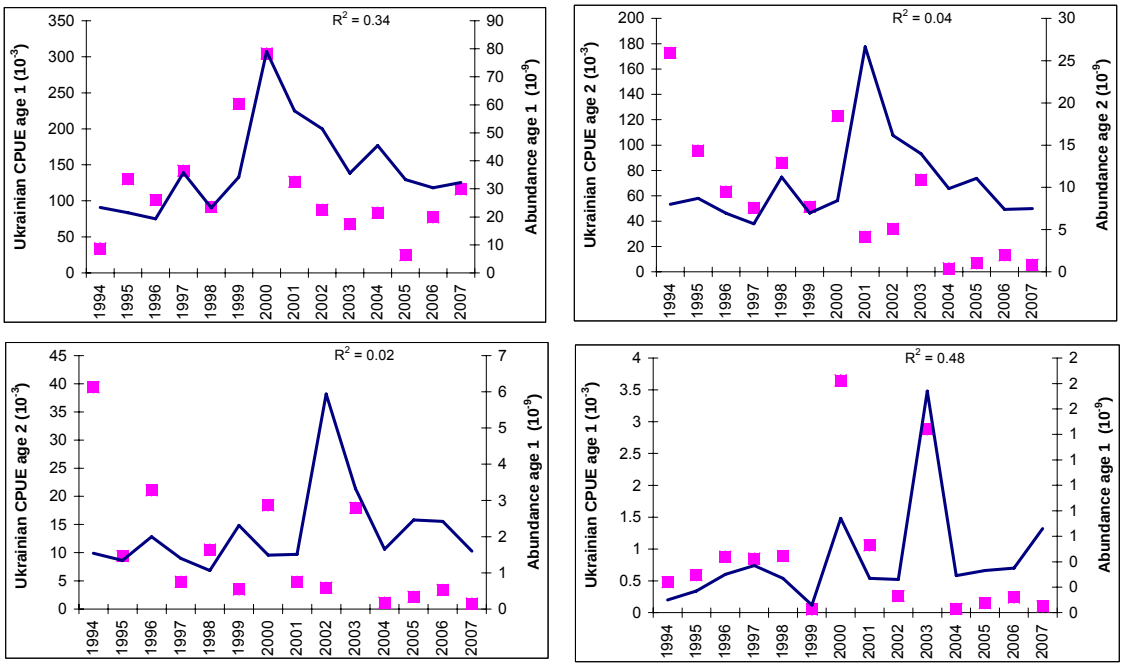

Fig. 3.4.6.1.2.3. 5. Adjustment of ICA: time-series of estimated abundance-at-age and age-structured research survey indices (best fit is given by linear relationships and r^2 are displayed): (a) Age 2, (b) Age 3, (c) Age 4, (d) Age 5.

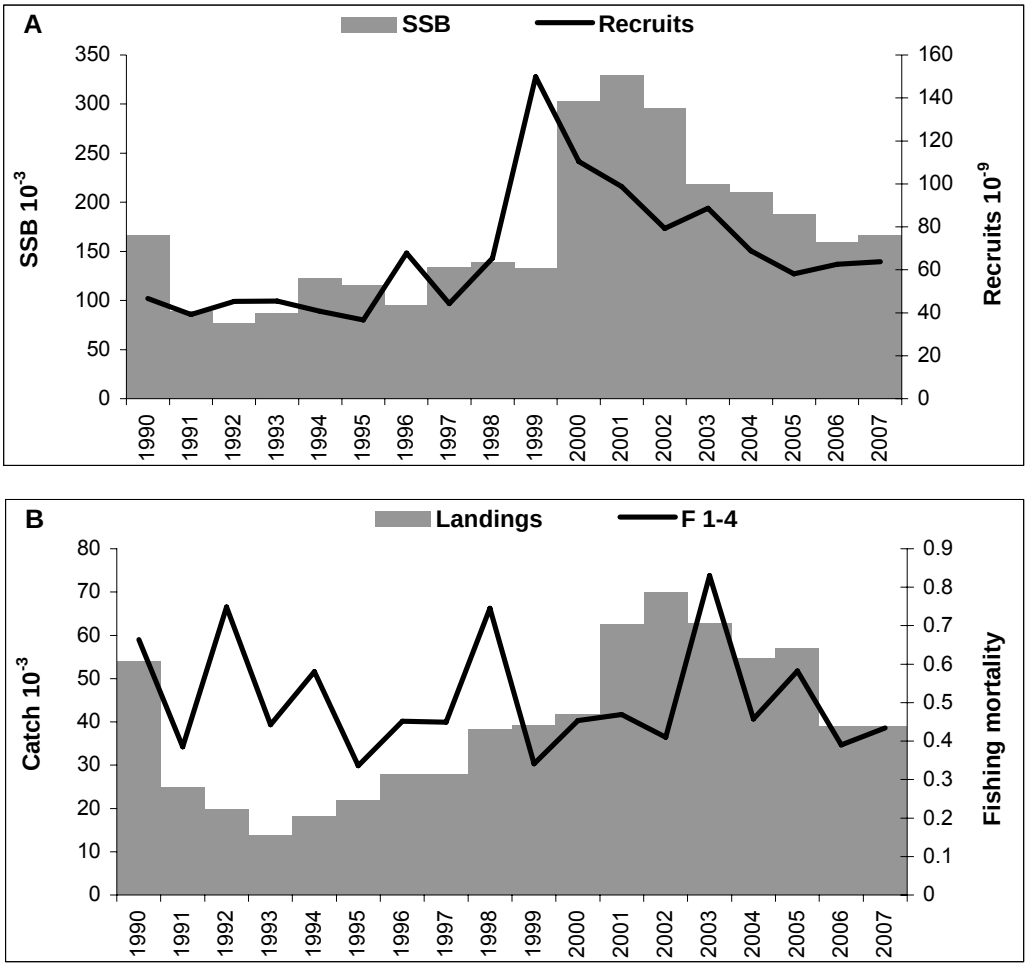

Fig. 3.4.6.1.2.3.6. Time-series of sprat population estimates: A. recruitment (line) and SSB (grey); B. landings (grey) and average fishing mortality (ages 2–4, line).

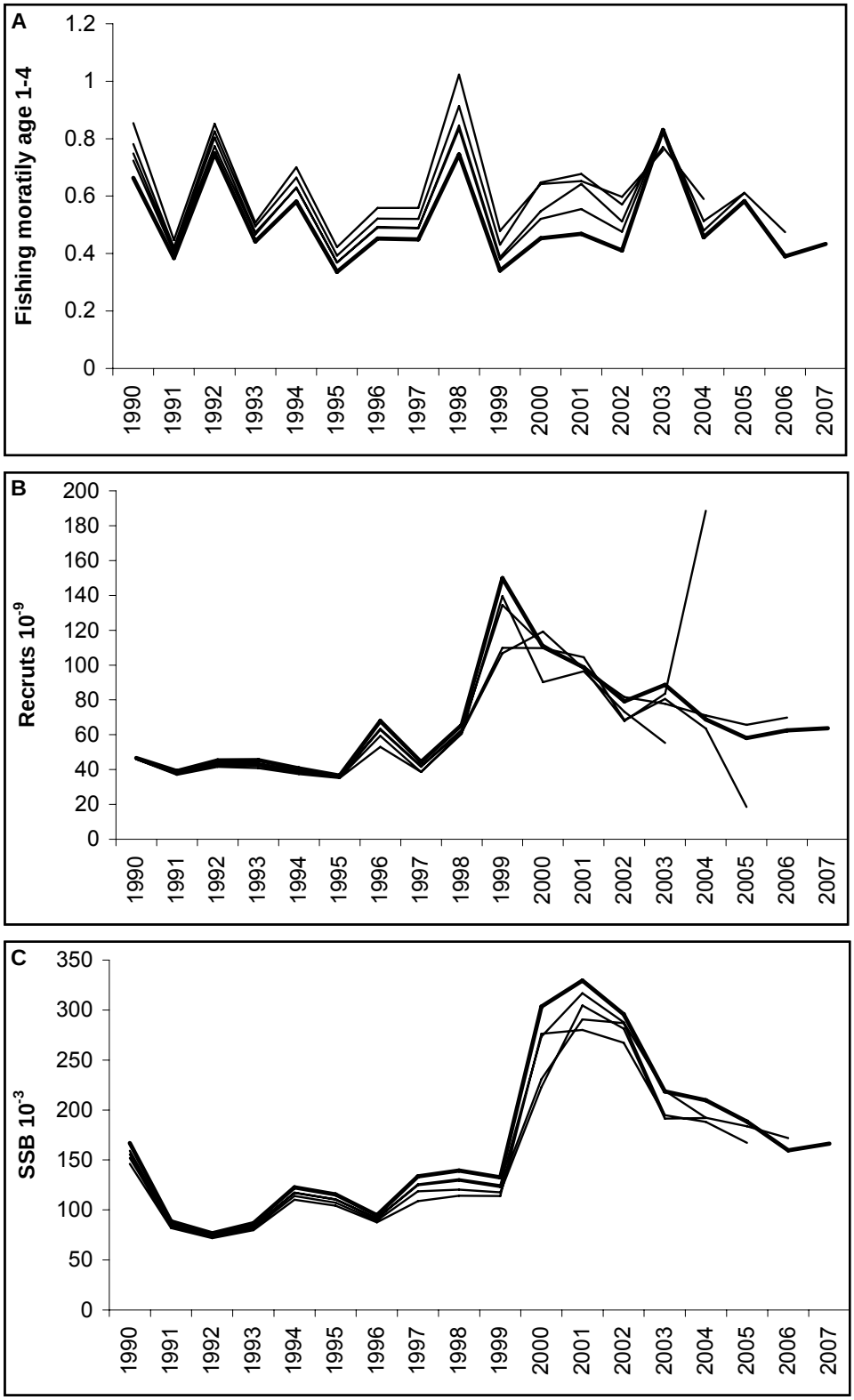

Fig. 3.4.6.1.2.3.7. Retrospective analyses of ICA on sprat

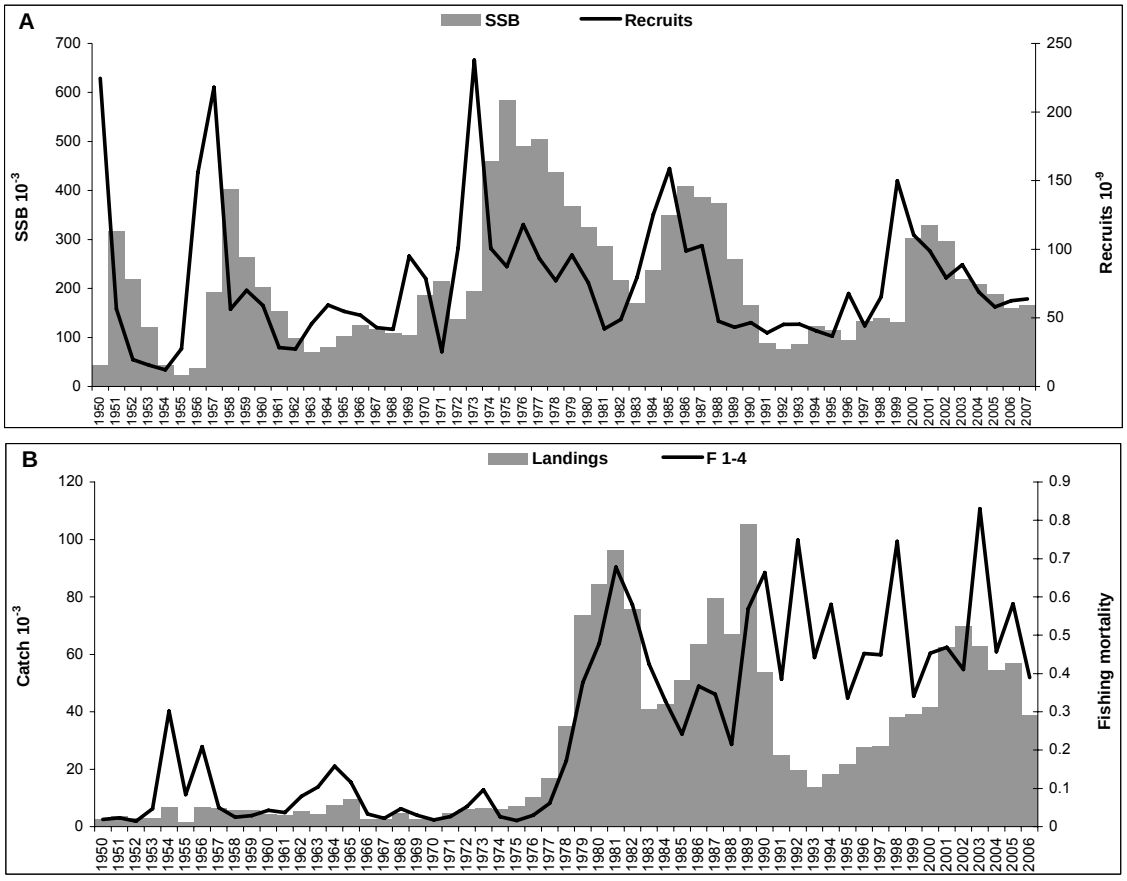

Fig. Fig. 3.4.6.1.2.3.8. Time-series of sprat population estimates – present results combined with historical estimates from Daskalov 1998a: A. recruitment (line) and SSB (grey); B. landings (grey) and average fishing mortality (ages 2–4, line).

Fig. 3.4.6.1.2.3.1. Sprat in the Black Sea 1990-2007: ICA results and diagnostics.

Output Generated by ICA Version 1.4

Fishing Mortality (per year)

AGE	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	0.0193	0.0181	0.0017	0.0263	0.0003	0.0015	0.0003	0.0058	0.0067	0.0006	0.0058	0.0123	0.1551	0.0357	0.0331	0.0456	0.0349	0.0287
1	0.5277	0.7003	0.2385	0.153	0.0417	0.1889	0.2778	0.215	0.2545	0.3827	0.1422	0.3277	0.3492	0.3225	0.4699	0.6474	0.4961	0.408
2	0.8052	0.6244	1.1062	0.4943	0.9544	0.5748	0.7167	0.7452	0.6658	0.5952	0.5809	0.5843	0.628	1.1632	0.5351	0.7372	0.5649	0.4646
3	1.3284	0.1229	1.654	1.2619	1.5467	0.6948	0.8815	0.8436	2.0205	0.2062	0.7505	0.4842	0.3028	1.4811	0.6813	0.9387	0.7193	0.5916
4	0.3266	0.2024	0.3569	0.2213	0.2955	0.1781	0.23	0.2203	0.339	0.159	0.1776	0.1784	0.1684	0.3591	0.214	0.2949	0.226	0.1858
5	0.3266	0.2024	0.3569	0.2213	0.2955	0.1781	0.23	0.2203	0.339	0.159	0.1776	0.1784	0.1684	0.3591	0.214	0.2949	0.226	0.1858

Population Abundance (1 January) x 10 ^ 9

AGE	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	45.37	37	41.9	42.07	38.43	36.03	65.53	44.21	75.36	144.06	110.43	99.57	81.6	70.04	70.4	63.06	63.32	63.78
1	19	23.47	19.16	22.06	21.61	20.26	18.97	34.54	23.18	39.47	75.92	57.9	51.86	36.85	35.64	35.92	31.77	32.24
2	8.15	4.33	4.51	5.84	7.32	8.01	6.49	5.56	10.77	6.95	10.41	25.47	16.13	14.15	10.32	8.61	7.27	7.48
3	4.44	1.41	0.9	0.58	1.38	1.09	1.74	1.22	1.02	2.14	1.48	2.25	5.49	3.33	1.71	2.34	1.59	1.6
4	1.95	0.45	0.48	0.07	0.06	0.11	0.21	0.28	0.2	0.05	0.67	0.27	0.54	1.57	0.29	0.33	0.35	0.3
5	0	0	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Weighting factors for the catches in number

AGE	2004	2005	2006	2007
0	0.1	0.1	0.1	0.1
1	0.5	0.5	0.5	0.5
2	1	1	1	1
3	1	1	1	1
4	0.1	0.1	0.1	0.1

Predicted Age-Structured Index Values

Bul Predicted x 10 ^ 3

AGE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	40.8	35.54	31.83	59.82	39.35	62.85	136.34	94.77	83.98	60.47	54.33	50.1	47.8	50.7
2	32.75	43.35	32.68	27.6	55.69	37.21	56.14	137.11	84.98	57.01	56.95	42.97	39.52	42.76
3	5.09	6.17	8.99	6.43	2.97	15.46	8.15	14.15	37.78	12.71	9.73	11.7	8.91	9.52
4	0.19	0.36	0.66	0.88	0.6	0.17	2.17	0.87	1.73	4.61	0.92	1.01	1.11	0.96

Ukr Predicted x 10 ^ 3

AGE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	70.16	61.11	54.73	102.85	67.66	108.07	234.43	162.94	144.4	103.97	93.41	86.15	82.19	87.17
2	22.85	30.24	22.8	19.25	38.85	25.96	39.16	95.64	59.28	39.77	39.73	29.97	27.57	29.83
3	3.21	3.88	5.66	4.05	1.87	9.74	5.14	8.92	23.8	8.01	6.13	7.37	5.61	6

4	0.1	0.19	0.34	0.45	0.31	0.09	1.12	0.45	0.89	2.37	0.48	0.52	0.57	0.5	

RI Predicted

AGE	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007			
0		1395.3	610.1	1855.7	*******	4124.1	3300	1876.6	*******	*******	1228.3	*******	1280.1		

Fitted Selection Pattern

AGE	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	0.0239	0.0291	0.0015	0.0531	0.0003	0.0026	0.0005	0.0077	0.0101	0.001	0.0099	0.021	0.247	0.0307	0.0618	0.0618	0.0618	0.0618
1	0.6554	1.1215	0.2156	0.3095	0.0437	0.3286	0.3876	0.2885	0.3822	0.643	0.2448	0.5609	0.556	0.2773	0.8783	0.8783	0.8783	0.8783
2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	1.6499	0.1968	1.4953	2.5531	1.6206	1.2087	1.23	1.132	3.035	0.3464	1.292	0.8287	0.4822	1.2733	1.2734	1.2734	1.2734	1.2734
4	0.4056	0.3242	0.3226	0.4477	0.3097	0.3098	0.321	0.2957	0.5092	0.2672	0.3058	0.3053	0.2682	0.3088	0.4	0.4	0.4	0.4
5	0.4056	0.3242	0.3226	0.4477	0.3097	0.3098	0.321	0.2957	0.5092	0.2672	0.3058	0.3053	0.2682	0.3088	0.4	0.4	0.4	0.4

STOCK SUMMARY

Year	Recruits Age 0 ³ thousands	Total Biomass ³ tonnes	Spawning Biomass tonnes	Landings ³ tonnes	Yield /SSB ratio	Mean F Ages 1-4	SoP (%)
1990	4.5E+07	220669	152612	53900	0.3532	1.0668	99
1991	3.7E+07	138127	82630	24900	0.3013	0.3737	99
1992	4.2E+07	142349	71114	19700	0.277	1.3801	100
1993	4.2E+07	151640	80129	13800	0.1722	0.8781	99
1994	3.8E+07	151090	112663	18219	0.1617	1.2505	100
1995	3.6E+07	143232	107207	21746	0.2028	0.6348	99
1996	6.6E+07	155871	90345	27778	0.3075	0.7991	99
1997	4.4E+07	172489	128283	27963	0.218	0.7944	99
1998	7.5E+07	211916	136557	38117	0.2791	1.3431	99
1999	1.4E+08	288414	144351	39152	0.2712	0.4007	99
2000	1.1E+08	412324	301892	41769	0.1384	0.6657	99
2001	1E+08	427786	328216	62587	0.1907	0.5342	99
2002	8.2E+07	378368	296767	69894	0.2355	0.4654	99
2003	7E+07	292494	222453	62716	0.2819	1.3221	99
2004	7E+07	249351	178946	54574	0.305	0.6082	99
2005	6.3E+07	248714	185659	56854	0.3062	0.8379	99
2006	6.3E+07	222824	159508	39048	0.2448	0.6421	99
2007	6.4E+07	227350	163575	39008	0.2385	0.5281	99

No of years	for	separable	analysis	4	
Age range	in	the	analysis	0	5
Year range	in	the	analysis	1990	2007
Number of indices	of	SSB	0		

Number of age-structured indices : 3

Parameters to estimate : 25
Number of observations : 140

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 Param. Distrib.
Separable model : F by year								
1	2004	0.5351	24	0.3285	0.8716	0.4172	0.6863	0.5519
2	2005	0.7371	23	0.4643	1.1704	0.5823	0.9332	0.7579
3	2006	0.5649	27	0.3268	0.9764	0.4273	0.7468	0.5873
4	2007	0.4646	35	0.2315	0.9324	0.3256	0.6628	0.4949
Separable Model: Selection (S) by age								
5	0	0.0618	60	0.0189	0.202	0.0338	0.1131	0.0742
6	1	0.8783	28	0.5021	1.5361	0.6603	1.1682	0.9147
2	1 Fixed :			Reference	Age			
7	3	1.2734	25	0.778	2.0841	0.9903	1.6373	1.3142
4	0.4 Fixed :			Last	TRUE age			
Separable model: Populations in year 2007								
8	0	6.4E+07	18	4.4E+07	9.2E+07	5.3E+07	7.7E+07	6.5E+07
9	1	3.2E+07	38	1.5E+07	6.8E+07	2.2E+07	4.7E+07	3.5E+07
10	2	7480704	22	4835012	1.2E+07	5987367	9346502	7668485
11	3	1598217	28	920700	2774300	1206238	2117574	1662757
12	4	300296	32	157311	573245	215918	417648	317087
Separable model: Populations at age								
13	2004	292829	48	112509	762148	179747	477052	329864
14	2005	334480	36	162489	688520	231419	483441	357959
15	2006	353614	35	177489	704507	248769	502646	376171

Age-structured index catchabilities
Bul
Linear model fitted. Slopes at age :

16	1 Q	3.10E-03	19	2.56E-03	5.59E-03	3.10E-03	4.62E-03	3.86E-03	
17	2 Q	1.16E-02	19	9.58E-03	2.09E-02	1.16E-02	1.73E-02	1.44E-02	
18	3 Q	1.29E-02	20	1.06E-02	2.34E-02	1.29E-02	1.93E-02	1.61E-02	
19	4 Q	5.65E-03	20	4.63E-03	1.04E-02	5.65E-03	8.56E-03	7.10E-03	

Ukr

Linear model fitted. Slopes at age :

20	1 Q	5.33E-03	19	4.40E-03	9.62E-03	5.33E-03	7.94E-03	6.64E-03
21	2 Q	8.09E-03	194	1.25E-03	2.554	8.09E-03	0.395	0.3741
22	3 Q	8.11E-03	194	1.25E-03	2.564	8.11E-03	0.3964	0.3756
23	4 Q	2.91E-03	20	2.39E-03	5.39E-03	2.91E-03	4.41E-03	3.66E-03

RI

Power model fitted. Slopes (Q) and exponents (K) at age

24	0 Q	8.062	49	5.004	35.09	8.062	21.78	14.99
25	0 K	1.32E-13	884	2.70E-17	3.11E-02	1.32E-13	6.38E-06	9.08E+07

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	2004	2005	2006	2007
0	0.899	-1.644	-0.434	1.124
1	0.23	-0.193	-0.126	-0.157
2	-0.217	0.054	0.038	-0.215
3	-0.075	0.088	-0.149	0.076
4	0.835	0.335	0.169	0.774

AGE-STRUCTURED INDEX RESIDUALS

Bul

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	-1.428	-0.596	0.255	-0.115	0.286	0.475	-0.346	-0.078	-0.422	0.244	0.397	0.626	0.5	0.202
2	0.563	0.118	0.155	0.027	0.05	-0.195	0.205	-0.819	-0.479	0.171	-0.04	0.362	0.061	-0.18
3	1.163	0.177	0.05	-0.035	0.574	-1.225	-0.261	-1.417	-0.793	0.427	0.704	0.576	-0.086	0.146
4	0.252	-0.443	-0.117	-0.37	-0.111	0.56	-1.274	-1.465	-0.627	-0.279	1.658	0.722	0.825	0.669

Ukr

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	-0.724	0.754	0.615	0.322	0.302	0.775	0.262	-0.252	-0.499	-0.429	-0.11	-1.239	-0.063	0.286
2	2.023	1.152	1.024	0.965	0.796	0.684	1.143	-1.243	-0.558	0.605	-2.682	-1.481	-0.752	-1.675
3	2.509	0.883	1.315	0.179	1.73	-1.026	1.278	-0.613	-1.836	0.807	-1.698	-1.22	-0.507	-1.802
4	1.591	1.136	0.953	0.626	1.053	-0.643	1.183	0.859	-1.238	0.192	-1.992	-1.242	-0.877	-1.601

RI

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	0.9825	-0.6454	-0.3189	*******	-0.9468	0.6466	0.1526	*******	*******	0.183	*******	-0.0538

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable	model	fitted	from	2004 to	2007
Variance				0.1689	
Skewness	test	stat.		-0.67	
Kurtosis	test	statistic		0.0977	
Partial	chi-square			0.062	
Significance	in	fit		0	
Degrees	of	freedom		5	

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR Bul

Linear catchability relationship assumed

Age				1	2	3	4
Variance				0.0766	0.0295	0.1339	0.1803
Skewness	test	stat.		-1.8983	-1.2815	-0.8755	0.0738
Kurtosis	test	statisti		0.8362	0.5434	-0.3029	-0.3382
Partial	chi-square			0.0927	0.0343	0.1871	0.3402
Significance	in	fit		0	0	0	0
Number	of	observations		14	14	14	14
Degrees	of	freedom		13	13	13	13
Weight	in	the	analysis	0.25	0.25	0.25	0.25

DISTRIBUTION STATISTICS FOR Ukr

Linear catchability relationship assumed

Age				1	2	3	4
Variance				0.0858	0.0048	0.0052	0.3691
Skewness	test	stat.		-0.7713	-0.7154	0.2623	-0.4551
Kurtosis	test	statisti		-0.3661	-0.7217	-0.9647	-1.1131
Partial	chi-square			0.006	0.0078	0.8194	
Significance	in	fit		0	0	0	0
Number	of	observations		14	14	14	14
Degrees	of	freedom		13	13	13	13
Weight	in	the	analysis	0.25	0.0025	0.0025	0.25

DISTRIBUTION STATISTICS FOR RI

Power catchability relationship assumed

Age				0
Variance				0.4763
Skewness	test	stat.		0.053
Kurtosis	test	statisti		-0.5468
Partial	chi-square			0.3793
Significance	in	fit		0.001
Number	of	observations		8
Degrees	of	freedom		6
Weight	in	the	analysis	1

ANALYSIS OF VARIANCE

Unweighted Statistics

			SSQ	Data	Parameters		d.f.	Variance
Total	for	model	106.61	140	25	115	0.927	
Catches	at	age	6.6705	20	15	5	1.3341	
Aged	Indices							
Bul			21.8527	56	4	52	0.4202	
Ukr			75.2292	56	4	52	1.4467	
RI			2.8579	8	2	6	0.4763	

Weighted Statistics

			SSQ	Data	Parameters	d.f.	Variance
Total	for	model	6.5468	140	25	115	0.0569
Catches	at	age	0.8443	20	15	5	0.1689
Aged	Indices						
Bul			1.3658	56	4	52	0.0263
Ukr			1.4788	56	4	52	0.0284
RI			2.8579	8	2	6	0.4763

Conventional VPA with Fishing Mortality Shrinkage

Fs shrunk over 10 years
Minimum CV of the mean taken as 0.2

Shrinkage Diagnostics

F from	model fit	Historic	Mean F	Wt for F from model	Shrunk	estimate
Estimate	Variance	Estimate	Variance			

0.029	0.428	0.019	0.276	0.392	0.023	
0.408	0.18	0.368	0.04	0.182	0.375	
0.465	0.126	0.628	0.04	0.241	0.584	
0.592	0.126	0.594	0.04	0.241	0.593	
0.186	0.126	0.21	0.04	0.241	0.184	
*****	0.154	0.21	0.04	0.206	0.184	

Fishing Mortality (per year)

AGE	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	0.0187	0.0171	0.0015	0.0243	0.0003	0.0015	0.0003	0.0058	0.0077	0.0006	0.0058	0.0124	0.1601	0.0281	0.0852	0.0094	0.0228	0.0225
1	0.5172	0.674	0.2239	0.1409	0.0385	0.1776	0.2731	0.2071	0.254	0.4532	0.1364	0.3277	0.3527	0.3357	0.4627	0.5563	0.4499	0.375
2	0.6607	0.6032	1.0148	0.4526	0.8373	0.5189	0.6541	0.7252	0.63	0.5936	0.7704	0.5515	0.628	1.1865	0.4349	0.569	0.5808	0.5843
3	1.2247	0.0908	1.5066	0.9966	1.2594	0.5317	0.7269	0.7035	1.847	0.1895	0.7466	0.8197	0.2772	1.4811	0.6461	0.991	0.355	0.5931
4	0.2514	0.1719	0.2478	0.1789	0.1875	0.1163	0.1541	0.1607	0.2495	0.1268	0.1605	0.1769	0.3838	0.3186	0.2847	0.2133	0.174	0.1841
5	0.2514	0.1719	0.2478	0.1789	0.1875	0.1163	0.1541	0.1607	0.2495	0.1268	0.1605	0.1769	0.3838	0.3186	0.2847	0.2133	0.174	0.1841

Population Abundance (1 January) x 10 ^ 9

AGE	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	46.66	39.14	45.27	45.39	40.68	36.58	67.79	44.28	65.47	149.86	110.43	98.73	79.22	88.62	68.8	58.07	62.55	63.78
1	19.3	24.15	20.29	23.83	23.36	21.44	19.26	35.73	23.21	34.26	78.97	57.9	51.42	35.59	45.44	33.31	30.33	32.24
2	9.42	4.45	4.76	6.27	8.01	8.69	6.94	5.67	11.23	6.96	8.42	26.65	16.13	13.98	9.84	11.06	7.39	7.48
3	4.65	1.88	0.94	0.67	1.54	1.34	2	1.4	1.06	2.31	1.49	1.51	5.94	3.33	1.65	2.46	2.42	1.6
4	2.46	0.53	0.66	0.08	0.1	0.17	0.3	0.37	0.27	0.06	0.74	0.27	0.26	1.74	0.29	0.33	0.35	0.66
5	0	0	0.05	0	0	0.01	0.01	0	0	0	0	0	0	0	0	0	0	0

STOCK SUMMARY

Year	Recruits Age 0 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 1-4	SoP (%)
1990	4.7E+07	237001	167008	53900	0.3227	0.6635	99
1991	3.9E+07	147341	88629	24900	0.2809	0.38498	99
1992	4.5E+07	153590	76639	19700	0.257	0.74828	100
1993	4.5E+07	163940	86784	13800	0.159	0.44225	99
1994	4.1E+07	163282	122605	18219	0.1486	0.58068	100
1995	3.7E+07	152138	115562	21746	0.1882	0.33613	99
1996	6.8E+07	162635	94844	27778	0.2929	0.45205	99
1997	4.4E+07	177938	133659	27963	0.2092	0.44913	99
1998	6.5E+07	205062	139589	38117	0.2731	0.74513	99
1999	1.5E+08	282357	132496	39152	0.2955	0.34078	99
2000	1.1E+08	413859	303427	41769	0.1377	0.45348	99
2001	9.9E+07	428284	329550	62587	0.1899	0.46895	99
2002	7.9E+07	375044	295829	69894	0.2363	0.41043	99
2003	8.9E+07	307203	218580	62716	0.2869	0.83048	99

2004	6.9E+07	278576	209781	54574	0.2601	0.4571	99
2005	5.8E+07	246387	188321	56854	0.3019	0.5824	99
2006	6.3E+07	222146	159595	39048	0.2447	0.38993	99
2007	6.4E+07	230059	166284	39008	0.2346	0.43413	99

3.4.6.1.3. Short term prediction for 2008 and 2009 based on ICA results

3.4.6.1.3.1. Justification

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

3.4.6.1.3.2. Input parameters

The input parameters are listed in the Tabl.3.4.6.2.1.3.2.1 below. They do represent short term averages of the ICA inputs. The exploitation pattern used is the 2007 estimated vector rescaled to the average exploitation patters estimated for the years 2005-2007. Due to the poor recruitment recently seen, age 0 was set at the average level from 2004-2006.

As the fishery for sprat in the Black Sea is not constrained by an international TAC, the intermediate year 2008 was defined as a status quo effort year with unchanged fishing mortality.

Table 3.4.6.2.1.3.2.1.1 Sprat in the Black Sea. Input to short term prediction.

2008						
age	stock size (000)	M	maturity	weight in stock (kg)	exploitation pattern	weight in catch (kg)
0	63140000	0.6400	0.0000	0.0010	0.0169	0.0019
1	32880000	0.9500	1.0000	0.0036	0.4263	0.0034
2	8570000	0.9500	1.0000	0.0046	0.5353	0.0046
3	1610000	0.9500	1.0000	0.0060	0.5985	0.0065
4	340000	0.9500	1.0000	0.0075	0.1764	0.0079
5	210000	0.9500	1.0000	0.0100	0.1764	0.0100
2009						
age	stock size (000)	M	maturity	weight in stock (kg)	exploitation pattern	weight in catch (kg)
0	63140000	0.6400	0.0000	0.0010	0.0169	0.0019
1		0.9500	1.0000	0.0036	0.4263	0.0034
2		0.9500	1.0000	0.0046	0.5353	0.0046
3		0.9500	1.0000	0.0060	0.5985	0.0065
4		0.9500	1.0000	0.0075	0.1764	0.0079
5		0.9500	1.0000	0.0100	0.1764	0.0100
2010						
age	stock size (000)	M	maturity	weight in stock (kg)	exploitation pattern	weight in catch (kg)
0	63140000	0.6400	0.0000	0.0010	0.0169	0.0019
1		0.9500	1.0000	0.0036	0.4263	0.0034
2		0.9500	1.0000	0.0046	0.5353	0.0046
3		0.9500	1.0000	0.0060	0.5985	0.0065
4		0.9500	1.0000	0.0075	0.1764	0.0079
5		0.9500	1.0000	0.0100	0.1764	0.0100

3.4.6.1.3.3. Input parameters

The following table Tabl. 3.4.6.1.3.3.1 lists the single option status quo results of the prediction with stock parameters at age for 2008 to 2010.

Tabl. 3.4.6.1.3.3.2 list the management option table for the period 2008-2010.

All results of the short term predictions are conditional to the acceptance of the ICA results.

The status quo fishing in 2008 would result in a slightly increased landing around 42,000 t, as compared to the 39,000 t landed in 2007. The SSB would increase from 166,000 t in 2007 to 172,000 t in 2008. Status quo fishing in 2009 and 2010 stabilize around 42,000 t and a the SSB – around 171,000. The short-term forecast indicates that status quo fishing would halt the decreasing trend in SSB and stabilises the landings and SSB even under the assumed low recruitment.

Table 3.4.6.1.3.3.1 Sprat in the Black Sea. Single option (status quo) short term prediction.

2008 F-factor:	1	reference F	0.4341		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	0.0169	781488	1485	63140000	63140	0	0
1	0.4263	7613165	25885	32880000	118368	32880000	118368
2	0.5353	2389104	10990	8570000	39422	8570000	39422
3	0.5985	490019	3185	1610000	9660	1610000	9660
4	0.1764	35978	284	340000	2550	340000	2550
5	0.1764	22222	222	210000	2100	210000	2100
		11331976	42051	106750000	235240	43610000	172100
2009 F-factor:	1	reference F	0.4341		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	0.0169	781488	1485	63140000	63140	0	0
1	0.4263	7579785	25771	32735836	117849	32735836	117849
2	0.5353	2314478	10647	8302307	38191	8302307	38191
3	0.5985	590647	3839	1940621	11644	1940621	11644
4	0.1764	36213	286	342220	2567	342220	2567
5	0.1764	11664	117	110230	1102	110230	1102
		11314275	42145	106571214	234493	43431214	171353
2010 F-factor:	1	reference F	0.4341		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	0.0169	781488	1485	63140000	63140	0	0
1	0.4263	7579785	25771	32735836	117849	32735836	117849
2	0.5353	2304330	10600	8265905	38023	8265905	38023
3	0.5985	572197	3719	1880003	11280	1880003	11280
4	0.1764	43650	345	412496	3094	412496	3094
5	0.1764	11741	117	110950	1110	110950	1110
		11293191	42037	106545190	234496	43405190	171356

Table 3.4.6.1.3.3.2 Sprat in the Black Sea. Management option table for the term prediction based on ICA output.

2008					2009					2010	
F-factor	reference F	stock biomass	sp. stock biomass	catch in weight	F-factor	reference F	stock biomass	sp. stock biomass	catch in weight	stock biomass	sp. stock biomass
1.0000	0.4341	235240	172100	42051	0.0000	0.0000	235174	172034	0	268140	205000
					0.1000	0.0434	235174	172034	4966	264145	201005
					0.2000	0.0868	235174	172034	9748	260325	197185
					0.3000	0.1302	235174	172034	14347	256668	193528
					0.4000	0.1737	235174	172034	18778	253171	190031
					0.5500	0.2388	235174	172034	25116	248206	185066
					0.6000	0.2605	235174	172034	27152	246623	183483
					0.7000	0.3039	235174	172034	31110	243555	180415
					0.8000	0.3473	235174	172034	34924	240619	177479
					0.9000	0.3907	235174	172034	38599	237808	174668
					1.0000	0.4341	235174	172034	42145	235116	171976
					1.1000	0.4775	235174	172034	45561	232536	169396
					1.2000	0.5210	235174	172034	48858	230066	166926
					1.3000	0.5644	235174	172034	52039	227698	164558
					1.4000	0.6078	235174	172034	55108	225429	162289
					1.5000	0.6512	235174	172034	58070	223253	160113

3.4.6.1.4. Medium term prediction based on ICA results

SGMED 09-01 did not undertake medium term projections.

3.4.6.1.5. Long term prediction

3.4.6.1.5.1. Method 1: YpR based on ICA results

3.4.6.1.5.1.1. Input parameters

Table 3.4.6.1.5.1.1.1 represents the input parameters to the YPR analysis. They are derived from long term means of the XSA input data except the exploitation pattern, which was estimated as the 2007 exploitation pattern rescaled to the average of the years 2005-2007.

Table 3.4.6.1.5.1.1.1 Sprat in the Black Sea. Input parameters to YPR analysis.

age min	age group	stock weight	catch weight	maturity	F	M
0	0	0.002	0.002	0	0.0169	0.64
age max	1	0.003	0.003	1	0.4263	0.95
5	2	0.005	0.005	1	0.5353	0.95
Fref	3	0.007	0.007	1	0.5985	0.95
0.4341	4	0.008	0.008	1	0.1764	0.95
	5	0.011	0.011	1	0.1764	0.95

3.4.6.1.5.1.2. Results

The results of the YpR analysis given below are conditional to the acceptance of the XSA results.

Fmax was could not be estimated due to shape to the YpR curve, which has a maximum well outside any 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 (Fig. 3.4.6.1.5.1.2.1). Due to such effects, SGMED 09-01 also refused to propose the estimated $F_{0.1}$=1.30 as an appropriate management reference point.

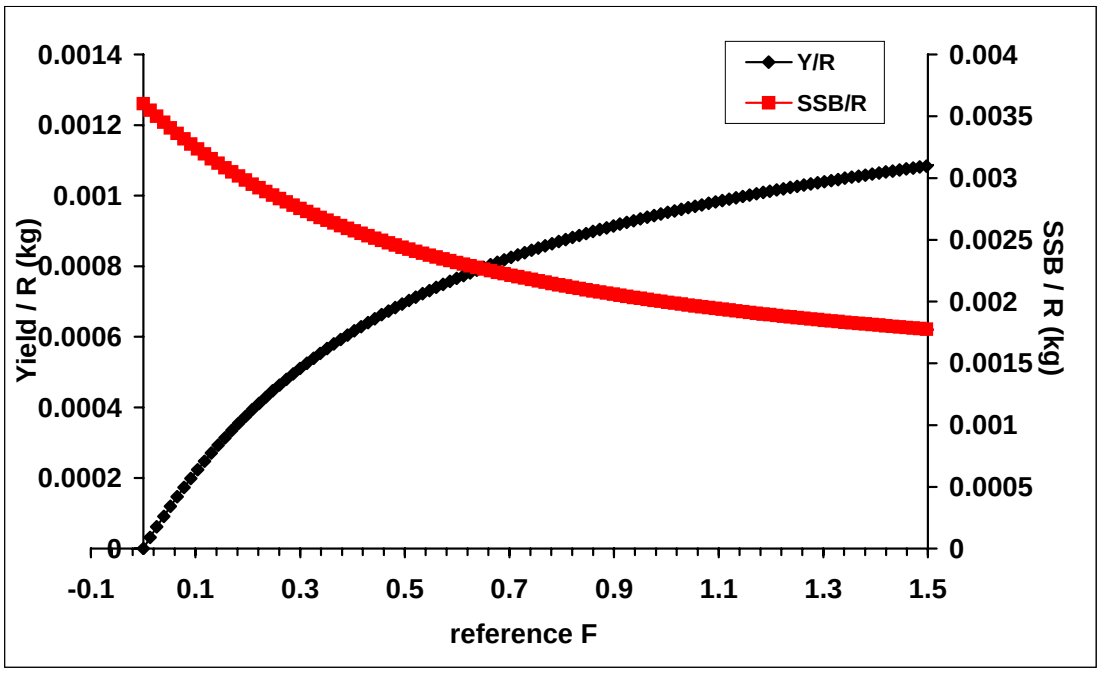

Fig. 3.4.6.1.5.1.2.1 Sprat in the Black Sea. YpR and SSBpR with increasing fishing mortality (average of ages 1-4).

3.4.6.1.5.2. Method 2: Production Model with ICA inputs

3.4.6.1.5.2.1. Input parameters

Table 3.4.6.5.2.1.1 lists all input parameters used to estimate MSY, Fmsy and Bmsy. Such parameters were derived from the ICA assessment described in the previous sections and present long term means with the exception of the exploitation pattern which represents the 2007 exploitation pattern rescaled to the mean exploitation pattern over the years 2005-2007. The recruitment was estimated applying the Ricker function shown in Fig. 3.4.6.5.2.1.1. A reasonably close relationship between the SSB and recruitment appears apparent.

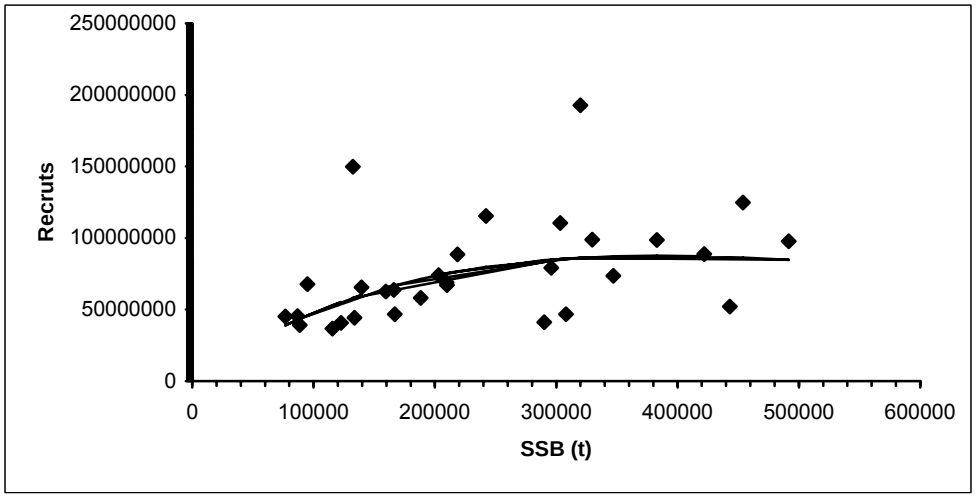

Fig. *3.4.6.5.2.1.1*. Sprat in the Black Sea. Spawning stock recruitment relationship expressed as the Ricker function. Parameters are given in Tab. *3.4.6.5.2.1.1*.

Table *3.4.6.5.2.1.1* Sprat in the Black Sea. Input parameters to the production model.

age min	age group	stock weight	catch weight	maturity	F	M	R=a*SSB*exp(-SSB/k)	
0	0	0.002	0.002	0	0.0169	0.64	a=	619.039
age max	1	0.003	0.003	1	0.4263	0.95	k=	384478
5	2	0.005	0.005	1	0.5353	0.95		
Fref	3	0.007	0.007	1	0.5985	0.95		
0.4341	4	0.008	0.008	1	0.1764	0.95		
	5	0.011	0.011	1	0.1764	0.95		

3.4.6.1.5.2.2. Results

The results of the production model analysis given below are conditional to the acceptance of the XSA results.

According to the results of the production model the MSY is indicated to be in the range of 45,800 t.

Fmsy (ages 1-4) amounts to 0.6. Bmsy appears to be in the range of 140,000 t.

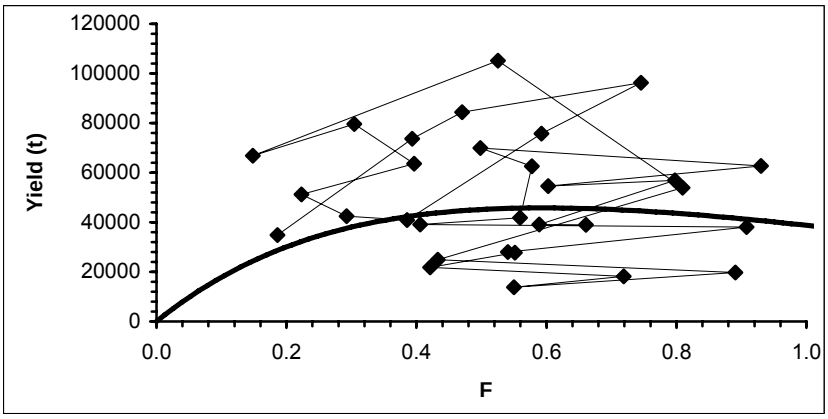

Fig. *3.4.6.1.5.2.2*.1 Sprat in the Black Sea. Relation between yield and fishing mortality (F1-4) observed (linked dots) and its estimated sustainable levels.

3.4.7.Method 2: XSA

3.4.7.1. Justification

The time series available for the period 1978 to 2007 of catch, catch at ages 0-5, weights at age in the stock and weights at age in the catch, maturity at age and natural mortality were considered appropriate for the application of the XSA. Earlier data were considered unreliable.

3.4.7.1.1. Input parameters

The following tables list (Tabl. 3.4.7.1.1.1 & 3.4.7.1.1.2) the input parameters of the XSA.

Historic and recent catch at age were corrected to the official landings (SOP corrections). They do represent officially reported landings and do not include any discards.

The mean weights at ages in the stock 1978-1993 were adopted as catch weights at age in the catch due to lack of data. This approach was considered appropriate as the mean weights at age during the period 1978-1993 had undergone significant increases compared to the more recent years.

Natural mortality M is defined to amount to 0.64 at age 0 and 0.95 at ages 1 and older over the entire assessment. This choice is consistent with setting in earlier assessments but lacks a clear explanation.

The maturity ogive was also defined as constant and represents a knife-edged shape with 0 at age 0 and 1 at ages 1 and older.

The XSA was tuned with 2 commercial catch rates series from Bulgarian and Ukraine fleets, ages 1-4 over 1994-2007.

The trends in these CPUE series are shown below in Fig *3.4.7.1.1.1* and Fig *3.4.7.1.1.*2. Both series indicate that the recent estimates of the most important age groups 1 and 2 are currently at a low level.

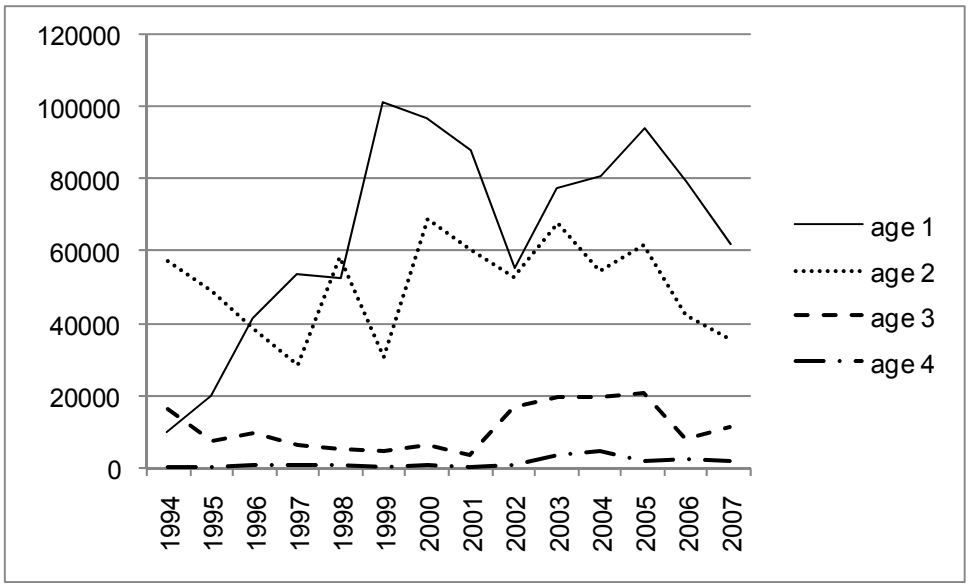

Fig. *3.4.7.1.1.1*. Sprat in the Black Sea. Trends in the Bulgarian commercial CPUE series at age.

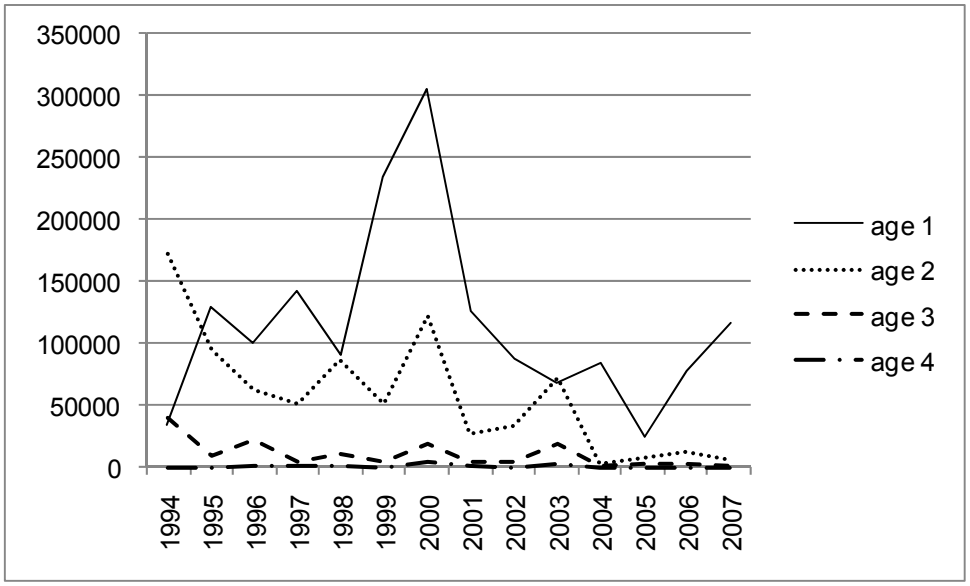

Fig. *3.4.7.1.1.*2. Sprat in the Black Sea. Trends in the Ukraine commercial CPUE series at age.

Table *3.4.7.1.1.1*. Sprat in the Black Sea 1978-2007. XSA input tables 1-7.

1

Run title : S

At 24/03/20

Table
numbers
Numbers*10**

YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
AGE										
0	31454	59139	9174	23253	8292	3748	4141	7415	7638	10024
1	252319	603220	1115948	1105916	1022285	660645	795082	899092	1137172	806365
2	180384	478280	533270	583005	325667	96485	105121	234764	317537	676550
3	118980	191285	89119	132654	42861	46066	22427	30162	130471	141819
4	26121	37251	48884	39922	14670	19829	10006	3896	23164	11385
+gp	4240	816	12713	26755	9567	7013	1035	0	0	0
0 TOTALNU	613497	1369991	1809107	1911505	1423341	833786	937812	1175330	1615982	1646144
TONSLAND	34900	73700	84400	96300	75800	40900	42500	51200	63600	79600
SOPCOF %	100	100	100	100	100	100	100	100	100	100

Table
numbers
Numbers*10**

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
0	913	14398	64004	49172	5131	80644	829	4017	1632	18765
1	1196830	1115869	523570	804665	267315	204422	57189	228369	303396	438560
2	186886	628726	309312	136286	211369	152631	312239	236363	226204	199425
3	115549	259409	232222	10624	52801	29286	78282	37160	70509	48030
4	34300	107627	35928	5464	9600	866	1067	1211	2842	3628
+gp	0	0	0	0	662	0	46	47	47	0
0 TOTALNU	1534477	2126030	1165036	1006211	546877	467848	449651	507167	604630	708408
TONSLANI	66900	105200	53900	24900	19700	13800	18219	21746	27778	27963
SOPCOF %	100	100	100	100	100	100	100	100	100	100

1

Run title : S

At 24/03/20

Table
numbers
Numbers*10**

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE										
0	37324	6454	46915	89953	873092	181650	416660	40167	104184	410801
1	342831	834513	656919	1071163	1013677	672298	1125737	957478	734322	615043
2	355703	210586	309556	760754	509539	684525	231646	323704	219642	150057
3	65818	26168	53466	57919	94809	185023	53260	107699	48013	52028
4	3883	503	7177	2894	5442	31415	8535	7887	5566	7232
+gp	0	0	0	0	0	0	0	0	0	0
0 TOTALNU	805559	1078223	1074034	1982683	2496559	1754910	1835838	1436936	1111727	1235161
TONSLANI	38117	39152	41769	62587	69894	62716	54574	56854	39048	39008
SOPCOF %	100	100	100	100	100	100	100	100	100	100

1

Run title : S

At 24/03/20

Table
weights at age

	YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
	AGE										
0		0.0026	0.0024	0.0024	0.0022	0.0023	0.002	0.0017	0.0018	0.0019	0.002
1		0.0041	0.0042	0.0038	0.0039	0.0044	0.0042	0.0041	0.0035	0.0029	0.0032
2		0.0066	0.0062	0.0056	0.0062	0.0075	0.007	0.0068	0.0071	0.0057	0.0062
3		0.0077	0.0074	0.0074	0.0075	0.0088	0.0082	0.0077	0.0085	0.0078	0.0075
4		0.0086	0.0082	0.0083	0.0092	0.0096	0.0092	0.0085	0.0094	0.0095	0.0089
	+gp	0.01	0.0101	0.0099	0.0108	0.0107	0.0103	0.0102	0.011	0.0105	0.0107
0	SOPCOFA	1	1	1	1	1	1	1	1	1	1

Table 2
weights at age

	YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
	AGE										
0		0.0019	0.0026	0.0015	0.0015	0.0017	0.0017	0.0023	0.0025	0.0025	0.0023
1		0.0036	0.0036	0.003	0.0021	0.0021	0.0025	0.0034	0.0038	0.0038	0.0033
2		0.006	0.0056	0.0058	0.0044	0.0045	0.0036	0.004	0.0046	0.0052	0.0049
3		0.0081	0.0077	0.0069	0.0071	0.0068	0.006	0.0047	0.0054	0.006	0.0063
4		0.0094	0.0088	0.0091	0.0094	0.0086	0.0077	0.0077	0.0069	0.0074	0.0072
	+gp	0.0106	0.0105	0.0109	0.0108	0.0108	0.0108	0.01	0.01	0.01	0.01
0	SOPCOFA	1	1	1	1	1	1	1	1	1	1
1											

Run title : S

At 24/03/20

Table 2
weights at age

	YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
	AGE										
0		0.0024	0.0028	0.0023	0.0017	0.0018	0.0017	0.0019	0.0021	0.002	0.0017
1		0.004	0.0032	0.0035	0.0025	0.0027	0.0028	0.0029	0.0035	0.0033	0.0033
2		0.0051	0.005	0.0045	0.004	0.0041	0.004	0.0044	0.0047	0.0043	0.0049
3		0.0076	0.0065	0.006	0.0063	0.0058	0.0061	0.006	0.0062	0.006	0.0072
4		0.0094	0.0073	0.0078	0.0069	0.0077	0.0068	0.0073	0.0077	0.0073	0.0087
	+gp	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0	SOPCOFA	1	1	1	1	1	1	1	1	1	1
1											

Run title : S

At 24/03/20

Table 3
weights at age

	YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
	AGE										
0		0.0026	0.0024	0.0024	0.0022	0.0023	0.002	0.0017	0.0018	0.0019	0.002
1		0.0041	0.0042	0.0038	0.0039	0.0044	0.0042	0.0041	0.0035	0.0029	0.0032
2		0.0066	0.0062	0.0056	0.0062	0.0075	0.007	0.0068	0.0071	0.0057	0.0062
3		0.0077	0.0074	0.0074	0.0075	0.0088	0.0082	0.0077	0.0085	0.0078	0.0075
4		0.0086	0.0082	0.0083	0.0092	0.0096	0.0092	0.0085	0.0094	0.0095	0.0089
	+gp	0.01	0.0101	0.0099	0.0108	0.0107	0.0103	0.0102	0.011	0.0105	0.0107

Table 3
weights at age

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
0	0.0019	0.0026	0.0015	0.0015	0.0017	0.0017	0.001	0.001	0.001	0.001
1	0.0036	0.0036	0.003	0.0021	0.0021	0.0025	0.0035	0.0033	0.0028	0.0027
2	0.006	0.0056	0.0058	0.0044	0.0045	0.0036	0.0041	0.0043	0.0043	0.0047
3	0.0081	0.0077	0.0069	0.0071	0.0068	0.006	0.0048	0.0048	0.0047	0.0057
4	0.0094	0.0088	0.0091	0.0094	0.0086	0.0077	0.0062	0.0055	0.0053	0.0069
+gp	0.0106	0.0105	0.0109	0.0108	0.0108	0.0108	0.01	0.01	0.01	0.01

1

Run title : S

At 24/03/20

Table 3
weights at age

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE										
0	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
1	0.0034	0.0025	0.0032	0.0035	0.0036	0.0035	0.0034	0.0036	0.0036	0.0036
2	0.0046	0.0047	0.0044	0.0044	0.0045	0.0044	0.0044	0.0046	0.0046	0.0047
3	0.0064	0.0059	0.0056	0.0052	0.0061	0.0059	0.006	0.0061	0.0057	0.0063
4	0.0082	0.0073	0.0072	0.0067	0.0074	0.0074	0.0072	0.0074	0.0074	0.0076
+gp	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

1

Run title : S

At 24/03/20

Table 4
Mortality (M) a

YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
AGE										
0	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64
1	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
2	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
3	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
4	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
+gp	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95

Table 4
Mortality (M) a

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
0	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64
1	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
2	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
3	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
4	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
+gp	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95

1

Run title : S

At 24/03/20

Table 4
Mortality (M) a

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007

AGE										
0	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64
1	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
2	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
3	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
4	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
+gp	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95

1

Run title : S

At 24/03/20

Table 5
mature at age

YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
AGE										
0	0	0	0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1	1	1
3	1	1	1	1	1	1	1	1	1	1
4	1	1	1	1	1	1	1	1	1	1
+gp	1	1	1	1	1	1	1	1	1	1

Table 5
mature at age

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
0	0	0	0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1	1	1
3	1	1	1	1	1	1	1	1	1	1
4	1	1	1	1	1	1	1	1	1	1
+gp	1	1	1	1	1	1	1	1	1	1

1

Run title : S

At 24/03/20

Table 5
mature at age

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE										
0	0	0	0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1	1	1
3	1	1	1	1	1	1	1	1	1	1
4	1	1	1	1	1	1	1	1	1	1
+gp	1	1	1	1	1	1	1	1	1	1

1

Run title : S

At 24/03/20

Table 6
M before Spav

YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
AGE										
0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0

+gp	0	0	0	0	0	0	0	0	0	0

Table 6
M before Spaw

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0	0

1

Run title : S

At 24/03/20

Table 6
M before Spaw

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE										
0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0	0

1

Run title : S

At 24/03/20

Table 7
F before Spaw

YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
AGE										
0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0	0

Table 7
F before Spaw

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0

4	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0	0

1

Run title : S

At 24/03/20

Table 7
F before Spaw

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE										
0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
+gp	0	0	0	0	0	0	0	0	0	0

1

Table *3.4.7.1.1*.2. Sprat in the Black Sea 1978-2007. Tuning series used in the XSA.

```
BLACK  SEA  SPRAT.
DATA
102
Bul CPUE
1994                    2007
1                       1           0           1
1                       4
1                       9782        57490       16272       246
1                       19586       48766       7363        234
1                       41059       38163       9446        586
1                       53323       28370       6210        607
1                       52358       58518       5276        541
1                       101062      30605       4544        297
1                       96508       68946       6278        606
1                       87640       60470       3431        201
1                       55086       52657       17088       926
1                       77194       67634       19488       3484
1                       80828       54708       19673       4852
1                       93685       61730       20826       2088
1                       78818       42022       8175        2532
1                       62030       35728       11017       1876
Ukr CPUE
1994                    2007
1                       1           0           1
1                       4
1                       34013       172777      39393       484
1                       129933      95685       9390        585
1                       101190      63447       21090       881
1                       141882      50524       4846        848
1                       91546       86142       10565       893
1                       234509      51423       3491        46
1                       304504      122882      18435       3646
1                       126654      27600       4833        1058
1                       87690       33919       3797        259
1                       67673       72797       17954       2877
1                       83724       2717        1123        65
1                       24963       6815        2178        151
1                       77178       13000       3381        238
1                       115990      5586        989         100
```

3.4.7.1.2. Results

The tuning of the XSA is defined according to the default settings of the program. Catchability is set dependent on stock size for ages <1 and independent of age for ages >=3. As the tuning considered only commercial trends, the tuning put more weight to the more recent values (tapered time weighting applied).

The Bulgarian fleet gets the majority of the weight for the calculation of the survivors of ages 1-4 and the corresponding fishing mortality. This is confirmed from the tuning diagnostics, which indicate standard errors of the log transformed catchabilities and regression parameters (slopes and r-squared) at acceptable levels. However, the diagnostics of the Ukraine CPUE are poor and explain the low weight it gets in the calculation of survivors and terminal fishing mortality (Table 3.4.7.1.2.1).

Figure 3.4.7.1.2.1 illustrates the retrospective behavior of the assessment parameters fishing mortality (average over ages 1-4), SSB and recruitment. Such retrospective assessments do not indicate any significant bias in the estimations of such stock parameters.

All XSA outputs are listed in the Tables 3.4.7.1.2.1 &3.4.7.1.2.2. Estimates of average fishing mortality (ages 1-4), of landings, SSB and recruits are shown in Figure 3.4.7.1.2.2 and 3.4.7.1.2.3, respectively.

Since 2000, the estimated fishing mortality is quite variable and ranged without a trend at a level of 0.8. The constant exploitation goes along with a recent declining trend in landings and spawning stock biomass. The stock size in 2006 and 2007 was low compared to 1980s and slightly exceeds the lowest level estimated for the 1990s.

However, the majority of the experts of SGMED 09-01 criticized the XSA results with the argument that the exploitation rates of the oldest age groups 4 and 5 would be overestimated. The fisheries patterns would have changed towards inshore regions and thus not select such oldest ages. There were no data presented to SGMED 09-01 to demonstrate such changes in the fishing patterns in addition to those used in the present assessment.

The selection patterns estimated by the XSA indeed indicate some lower selection of the age groups 4 and 5 since 1990 by about 30%, but not to the extent assumed by most of the experts, who argued for a much higher reduction from the estimated level (see ICA assessment of this stock in this report). The following Figure 3.4.7.1.2.4 shows the average selection patterns for certain periods as estimated by the XSA.

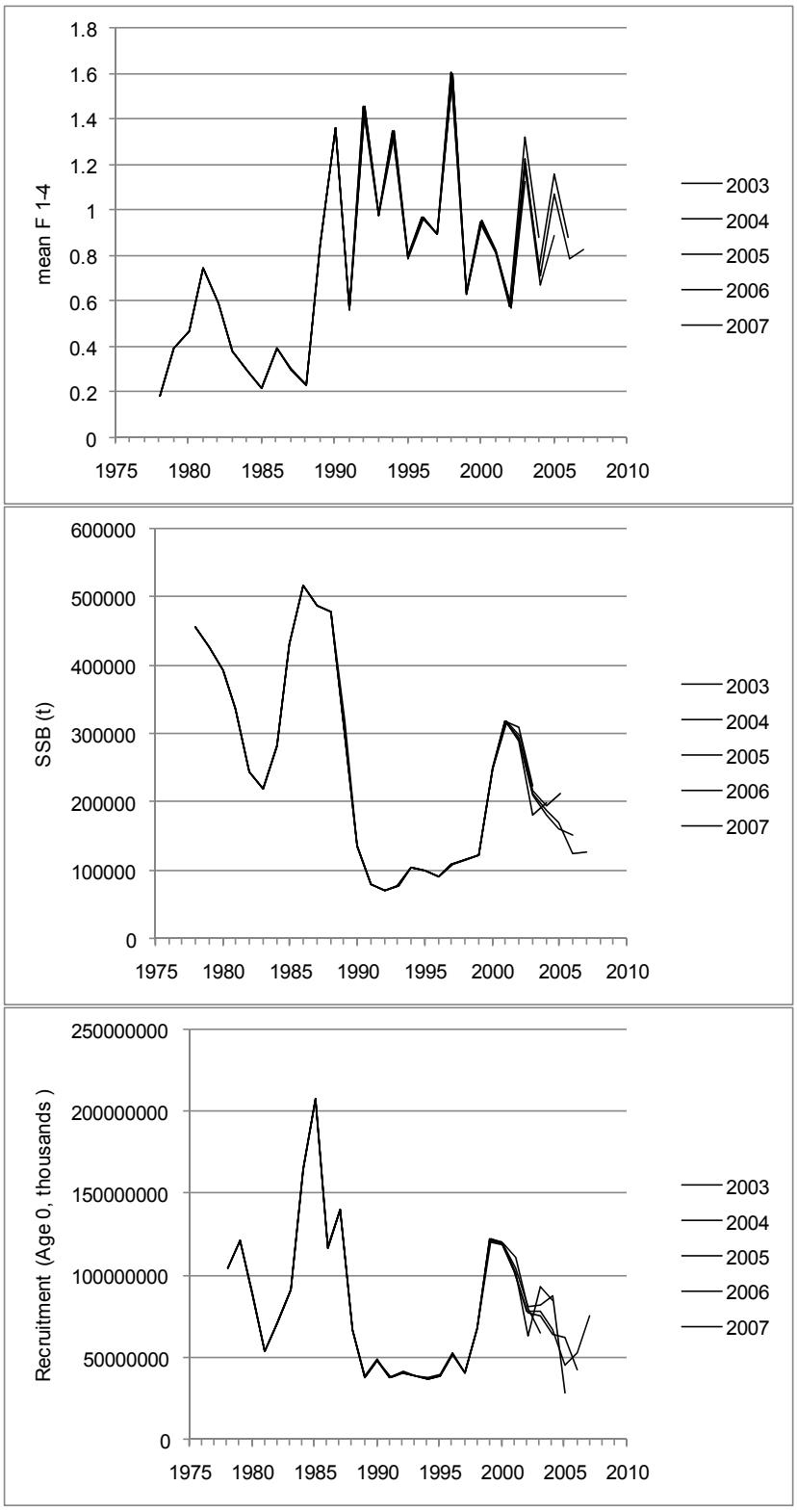

Fig. 3.4.7.1.2.1. Sprat in the Black Sea. Retrospective trends of the assessment parameters fishing mortality (average over ages 1-4), SSB and recruitment.

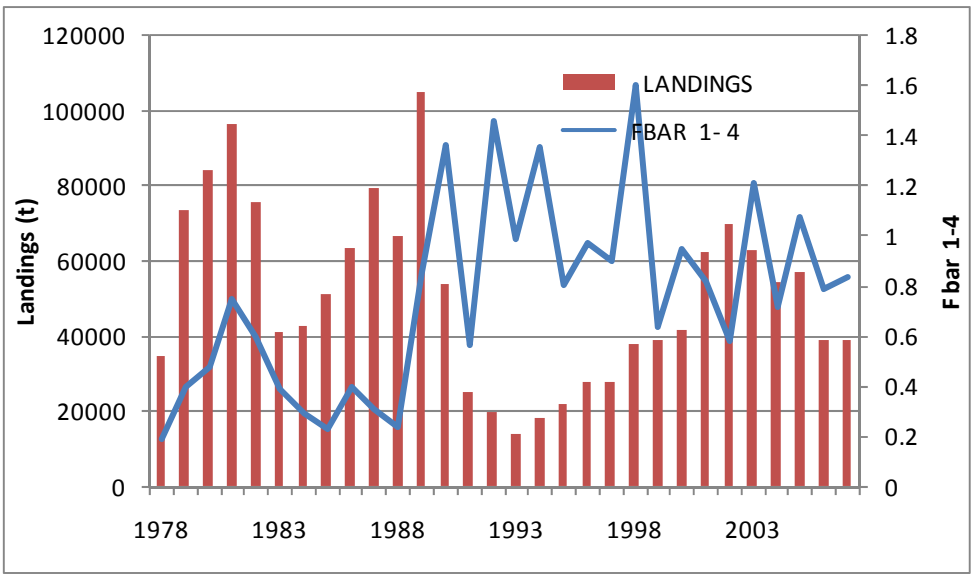

Fig. 3.4.7.1.2.2. Sprat in the Black Sea. Trends in official landings and mean fishing mortality.

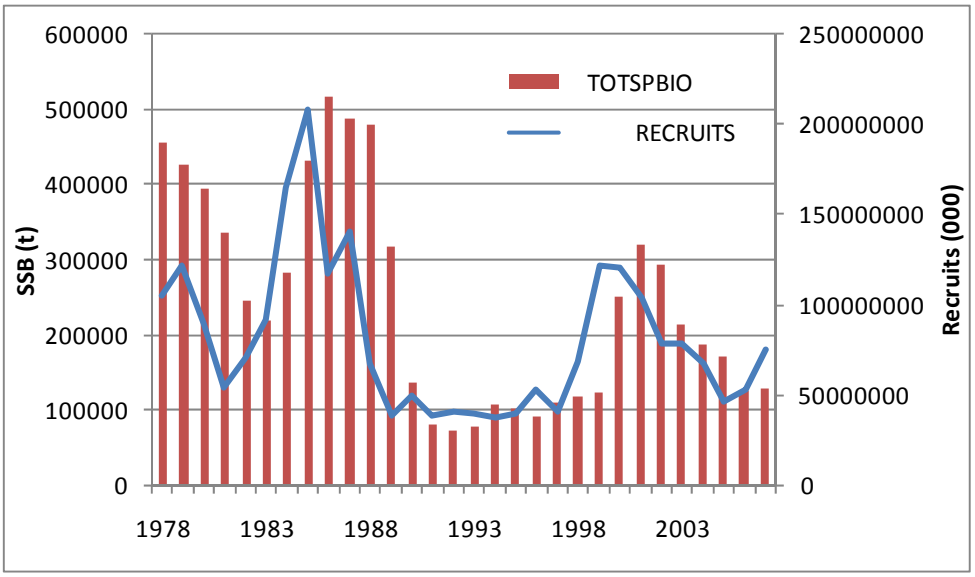

Fig. 3.4.7.1.2.3. Sprat in the Black Sea. Trends in SSB and recruits at age 0.

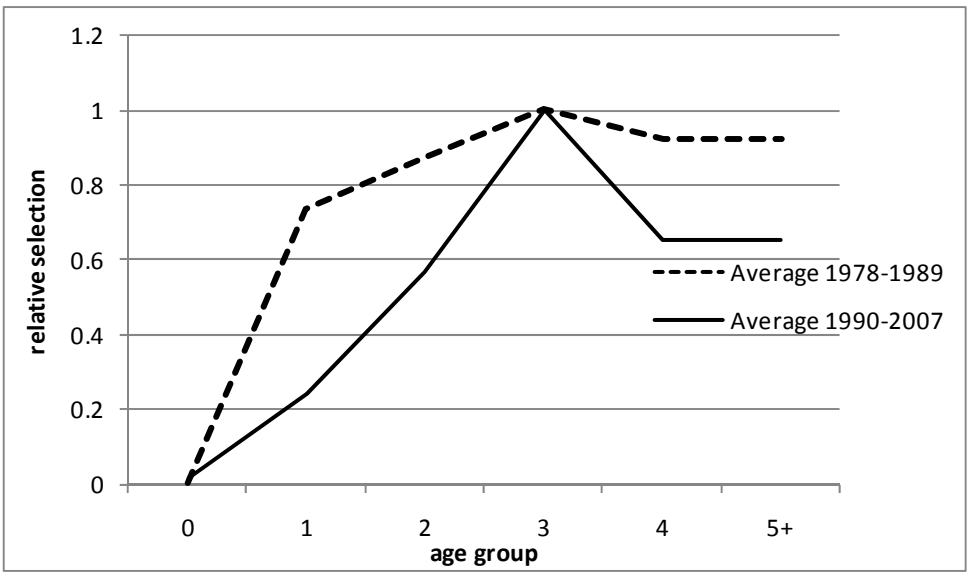

Fig. 3.4.7.1.2.4. Sprat in the Black Sea. Estimated relative selection patterns for the period 1978-1989 and 1990-2007.

Table 3.4.7.1.2.1. Sprat in the Black Sea. XSA tuning settings and diagnostics.

```
Lowestoft VPA Version 3.1

 24/03/2009  11:37

Extended Survivors Analysis

SPRAT 2007

CPUE data from file tune07.csv

Catch data for  30 years. 1978 to 2007. Ages  0 to   5.

    Fleet,           First, Last, First, Last, Alpha,  Beta
                ,    year, year,  age ,  age
Bul CPUE            ,   1994, 2007,   1,     4,   .000,  1.000
Ukr CPUE            ,   1994, 2007,   1,     4,   .000,  1.000


Time series weights :

    Tapered time weighting applied
    Power =    3 over  20 years


Catchability analysis :

    Catchability dependent on stock size for ages <    1

      Regression type = C
      Minimum of   5 points used for regression
      Survivor estimates shrunk to the population mean 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   3 oldest ages.

    S.E. of the mean to which the estimates  are shrunk =    .500

    Minimum standard error for population
    estimates derived from each fleet =    .300

    Prior weighting not applied

Tuning converged after   20 iterations
```

1

Regressio

.751	.820	.877	.921	.954	.976	.990	.997	1.000	1.000

Fishing m

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0	.008	.001	.005	.012	.167	.032	.089	.012	.028	.078
1	.299	.474	.180	.320	.361	.371	.600	.645	.683	.455
2	1.259	.806	.871	.894	.623	1.424	.510	.944	.771	.730
3	3.173	.654	1.681	1.117	.627	1.673	1.007	1.612	.921	1.245
4	1.670	.601	1.062	.946	.691	1.373	.726	1.095	.768	.889

1
XSA
numbers
(Thousand

AGE

YEAR	0	1	2	3	4
1998	6.79E+0	2.13E+07	7.99E+06	1.10E+06	7.69E+04
1999	1.22E+0	3.55E+07	6.12E+06	8.77E+05	1.79E+04
2000	1.20E+0	6.41E+07	8.56E+06	1.06E+06	1.76E+05
2001	1.03E+0	6.29E+07	2.07E+07	1.38E+06	7.61E+04
2002	7.82E+0	5.38E+07	1.77E+07	3.27E+06	1.75E+05
2003	7.86E+0	3.49E+07	1.45E+07	3.66E+06	6.77E+05
2004	6.72E+0	4.01E+07	9.32E+06	1.35E+06	2.66E+05
2005	4.58E+0	3.24E+07	8.52E+06	2.16E+06	1.91E+05
2006	5.28E+0	2.39E+07	6.57E+06	1.28E+06	1.67E+05
2007	7.52E+0	2.71E+07	4.66E+06	1.18E+06	1.97E+05

Estimated
population
abundance
Jan 2008

0.00E+0	3.66E+07	6.64E+06	8.69E+05	1.31E+05

Taper
geometric
the
population

6.65E+0	3.29E+07	8.59E+06	1.42E+06	1.23E+05

Standard
the
Log(VPA
population

.3891	.4073	.4630	.5074	.9971

1

Log c
residuals.

Fleet : Bul

Age	1994	1995	1996	1997

1	-1.50	-.72	.00	-.03
2	.51	.12	.12	-.22
3	.98	.37	.14	.03
4	.50	-.16	.07	-.18

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	.21	.43	-.32	-.34	-.64	.14	.13	.51	.66	.21
2	.41	-.13	.37	-.64	-.72	.01	-.08	.29	.10	.27
3	.16	-.49	-.01	-1.07	-.50	-.13	.67	.45	-.19	.31
4	.15	.65	-.76	-1.06	-.46	-.25	.79	.41	.62	.20

Mean
catchability
standard
ages
catchability
independe
class stre
constant w

Age	1	2	3	4
Mean Log	-5.6630	-4.4131	-4.0713	-4.0713
S.E(Log q	.5052	.3718	.5129	.5817

Regressio
statistics :

Ages
independe
class stre
constant w

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	1.40	-.726	.95	.26	14	.73	-5.66
2	2.23	-2.860	-9.88	.36	14	.64	-4.41
3	1.17	-.412	2.37	.39	14	.62	-4.07
4	1.06	-.307	3.55	.71	14	.65	-4.04

1

Fleet : Uki

Age	1994	1995	1996	1997
1	-.66	.76	.49	.54
2	2.19	1.37	1.20	.94
3	2.53	1.27	1.61	.45
4	1.84	1.42	1.14	.82

Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1	.36	.86	.42	-.38	-.58	-.40	-.24	-1.22	.23	.42
2	1.37	.97	1.53	-.84	-.58	.66	-2.50	-1.34	-.49	-1.01
3	1.52	-.09	1.73	-.06	-1.34	.46	-1.53	-1.14	-.41	-1.44
4	1.32	-.55	1.70	1.26	-1.07	.22	-2.86	-1.55	-1.08	-2.07

Mean
catchability
standard
ages
catchability
independe
class stre
constant w

Age	1	2	3	4
Mean Log	-5.2543	-4.9938	-4.7358	-4.7358
S.E(Log q	.6227	1.3530	1.2787	1.5841

Regressio
statistics :

Ages
independe
class stre
constant w

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	1.86	-.967	-5.16	.12	14	1.16	-5.25
2	2.33	-.605	-9.64	.02	14	3.25	-4.99
3	6.56	-1.015	-47.84	.00	14	8.37	-4.74
4	2.86	-1.337	-7.63	.05	14	4.32	-4.96

1

Terminal
survivor
summaries

Age 0 C
dependent
and yea
strength

Year class

Fleet	F S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Bul CPUE	1.	.000	.000	.00	0	.000	.000
Ukr CPUE	1.	.000	.000	.00	0	.000	.000
P shrinka	32920950	.41					.087
F shrinka	43071540	.50					.067

Weighted
:

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
3664587(	.32	17.42	2	55.158	.078

Age 1 C
constant v

and depe
age

Year class

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Bul CPUE	8163045.	.527	.000	.00	1	.293	.384
Ukr CPUE	10143440	.649	.000	.00	1	.193	.320
F shrinka	5037344.	.50					.565

Weighted
:

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
6644055	.32	.29	3	.902	.455

1
Age 2 C
constant \
and depe
age

Year class

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Bul CPUE	1234217.	.325	.160	.49	2	.459	.563
Ukr CPUE	757539.	.619	.564	.91	2	.092	.803
F shrinka	624082.	.50					.914

Weighted
:

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
868551.	.28	.24	5	.854	.730

Age 3 C
constant \
and depe
age

Year class

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Bul CPUE	167280.	.304	.096	.32	3	.328	1.076
Ukr CPUE	39947.	.657	.233	.35	3	.060	2.208
F shrinka	129018.	.50					1.255

Weighted
:

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
130898.	.32	.14	7	.432	1.245

1
Age 4 C

constant
and age (fi
value for a

Year class

Fleet	E S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Bul CPUE	35080.	.342	.105	.31	4	.339	.825
Ukr CPUE	9887.	.803	.480	.60	4	.054	1.714
F shrinka	32674.	.50					.866

Weighted
:

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
31376.	.33	.13	9	.389	.889

1

Table 3.4.7.1.2.2. Sprat in the Black Sea 1978-2007. XSA result tables 8-17. Note that SSB estimates indicated as B1+ are based on a knife-edged maturity at age 1. TOTSSB estimates consider a maturity of 0.5 at age 0.

1

Run tit
2007

At 24/03

Table 8
mortality (F

YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
AGE										
0	0.0041	0.0067	0.0014	0.006	0.0016	0.0006	0.0003	0.0005	0.0009	0.001
1	0.0781	0.1942	0.3323	0.4768	0.8792	0.3356	0.3079	0.1816	0.1827	0.2358
2	0.1266	0.5081	0.6731	0.7605	0.6258	0.4214	0.1792	0.322	0.2008	0.3686
3	0.3476	0.4619	0.3843	0.9616	0.2441	0.3828	0.3783	0.1574	0.7895	0.2967
4	0.193	0.4102	0.4909	0.7824	0.62	0.4015	0.3038	0.2314	0.4133	0.3164
+gp	0.193	0.4102	0.4909	0.7824	0.62	0.4015	0.3038	0.2314	0.4133	0.3164
0 FBAR 1	0.1863	0.3936	0.4702	0.7453	0.5923	0.3853	0.2923	0.2231	0.3965	0.3044

Table
mortality (F

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
0	0.0002	0.0052	0.0182	0.018	0.0017	0.0289	0.0003	0.0014	0.0004	0.0064
1	0.3024	0.7085	0.5415	0.7175	0.2468	0.1657	0.0471	0.2078	0.2709	0.2938
2	0.1736	0.6531	1.3431	0.661	1.2474	0.5331	1.2448	0.7252	0.8954	0.7527
3	0.2192	1.1406	2.1204	0.2896	2.7857	2.1977	2.716	1.4303	1.7232	1.5858
4	0.2434	0.8921	1.4367	0.5909	1.5361	1.035	1.4016	0.8317	0.9912	0.9477
+gp	0.2434	0.8921	1.4367	0.5909	1.5361	1.035	1.4016	0.8317	0.9912	0.9477
0 FBAR 1	0.2346	0.8486	1.3604	0.5647	1.454	0.9829	1.3524	0.7987	0.9702	0.895

1

Run tit
2007

At 24/03

Table
mortality (F

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	FBAR '		Rescaled
AGE													
0	0.0076	0.0007	0.0054	0.0121	0.1669	0.0323	0.0893	0.0122	0.0276	0.0783	0.0393	0.0438	0.0363
1	0.299	0.474	0.1801	0.32	0.3611	0.3706	0.5997	0.6451	0.6832	0.4547	0.5943	0.663	0.55
2	1.2592	0.8063	0.8714	0.894	0.6233	1.4243	0.5103	0.9437	0.7712	0.7297	0.8149	0.9091	0.7542
3	3.1726	0.6536	1.681	1.1165	0.6266	1.6727	1.007	1.6115	0.9212	1.2447	1.2591	1.4046	1.1653
4	1.6697	0.6007	1.0618	0.946	0.6913	1.3725	0.7258	1.0946	0.7677	0.8893	0.9172	1.0232	0.8488
+gp	1.6697	0.6007	1.0618	0.946	0.6913	1.3725	0.7258	1.0946	0.7677	0.8893	0.9172	1.0232	0.8488
0 FBAR 1	1.6001	0.6336	0.9486	0.8191	0.5756	1.21	0.7107	1.0737	0.7858	0.8296	0.8964	0.999975	0.829575

1

Run tit
2007

At 24/03

Table
F at age

YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987

	AGE										
0		0.0223	0.0171	0.003	0.008	0.0027	0.0015	0.0012	0.0022	0.0023	0.0032
1		0.4194	0.4933	0.7069	0.6397	1.4845	0.871	1.0534	0.8141	0.4606	0.7746
2		0.6792	1.291	1.4317	1.0203	1.0565	1.0935	0.6132	1.4433	0.5063	1.2109
3		1.8656	1.1735	0.8173	1.2902	0.4121	0.9935	1.2942	0.7056	1.9909	0.9749
4		1.0357	1.0422	1.0441	1.0497	1.0469	1.0419	1.0392	1.037	1.0422	1.0396
	+gp	1.0357	1.0422	1.0441	1.0497	1.0469	1.0419	1.0392	1.037	1.0422	1.0396
0	REFM	0.1863	0.3936	0.4702	0.7453	0.5923	0.3853	0.2923	0.2231	0.3965	0.3044

Table
F at age

	YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
	AGE										
0		0.0008	0.0061	0.0134	0.0319	0.0012	0.0294	0.0002	0.0018	0.0004	0.0071
1		1.2887	0.835	0.398	1.2705	0.1697	0.1686	0.0349	0.2602	0.2793	0.3282
2		0.7398	0.7696	0.9873	1.1704	0.8579	0.5424	0.9205	0.9079	0.923	0.841
3		0.9342	1.3441	1.5586	0.5128	1.9159	2.236	2.0083	1.7907	1.7761	1.7719
4		1.0374	1.0513	1.0561	1.0463	1.0565	1.053	1.0364	1.0413	1.0217	1.0589
	+gp	1.0374	1.0513	1.0561	1.0463	1.0565	1.053	1.0364	1.0413	1.0217	1.0589
0	REFM	0.2346	0.8486	1.3604	0.5647	1.454	0.9829	1.3524	0.7987	0.9702	0.895
1											

Run tit
2007

At 24/03

Table
F at age

	YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	MEAN
	AGE											
0		0.0047	0.0012	0.0057	0.0147	0.2899	0.0267	0.1257	0.0113	0.0351	0.0943	0.0469
1		0.1869	0.7481	0.1899	0.3906	0.6273	0.3063	0.8438	0.6008	0.8694	0.5481	0.6728
2		0.7869	1.2725	0.9186	1.0914	1.0829	1.1771	0.718	0.8789	0.9814	0.8796	0.9133
3		1.9827	1.0315	1.7721	1.3631	1.0887	1.3824	1.4169	1.5008	1.1723	1.5003	1.3912
4		1.0435	0.948	1.1194	1.1548	1.2011	1.1343	1.0212	1.0194	0.9769	1.072	1.0228
	+gp	1.0435	0.948	1.1194	1.1548	1.2011	1.1343	1.0212	1.0194	0.9769	1.072	
0	REFM	1.6001	0.6336	0.9486	0.8191	0.5756	1.21	0.7107	1.0737	0.7858	0.8296	
1												

Run tit
2007

At 24/03

Table
number at
year)
Numbers*1

	YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
	AGE										
0		1046627	1211692	890607	536211	707736	915388	1651308	2078250	1171717	1400169
1		539747	549594	634622	468944	281051	372582	482405	870421	1095307	617283
2		244014	193051	175037	176035	112585	45120	103008	137121	280715	352881
3		65163	83152	44917	34531	31824	23288	11449	33300	38431	88817
4		23935	17802	20263	11829	5105	9642	6142	3033	11003	6749
	+gp	3687	364	4888	7197	3059	3185	598	0	0	0
0	TOT/	1923172	2055656	1770334	1234747	1141360	1369205	2254910	3122126	2597172	2465899

Table
number at
year)
Numbers*1

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
0	670471	383848	488043	379558	408847	389923	371271	390394	525642	407138
1	737571	353468	201355	252694	196568	215209	199747	195708	205560	277049
2	188582	210820	67306	45312	47686	59397	70518	73694	61486	60631
3	94400	61310	42433	6795	9049	5297	13479	7854	13801	9712
4	25530	29323	7579	1969	1967	216	228	345	727	953
+gp	0	0	0	0	117	0	9	12	11	0
0 TOT/	1716553	1038769	806717	686328	664233	670042	655251	668007	807228	755482
1										

Run tit
2007

At 24/03

Table
number at
year)
Numbers*1

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	GMST 78-**	
AGE													
0	679302	1216259	1199346	1032377	782261	786189	671560	457923	527718	751555	0	719880	816073
1	213318	355480	640856	628999	537832	349081	401361	323853	238542	270697	366459	384857	435631
2	79873	61179	85582	206992	176646	144963	93195	85215	65703	46588	66441	109307	129952
3	11046	8769	10564	13847	32742	36629	13493	21637	12825	11751	8686	22130	30990
4	769	179	1764	761	1753	6767	2660	1906	1670	1974	1309	2985	7175
+gp	0	0	0	0	0	0	0	0	0	0	314		
0 TOT/	984308	1641867	1938112	1882976	1531235	1323628	1182269	890533	846459	1082565	443207		
1													

Run tit
2007

At 24/03

Table
Spawning
at age (sp
Numbers*1

YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
AGE										
0	523313	605846	445303	268105	353868	457694	825654	1039125	585858	700084
1	539747	549594	634622	468944	281051	372582	482405	870421	1095307	617283
2	244014	193051	175037	176035	112585	45120	103008	137121	280715	352881
3	65163	83152	44917	34531	31824	23288	11449	33300	38431	88817
4	23935	17802	20263	11829	5105	9642	6142	3033	11003	6749
+gp	3687	364	4888	7197	3059	3185	598	0	0	0

Table
Spawning
at age (sp
Numbers*1

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
0	335236	191924	244022	189779	204423	194961	185636	195197	262821	203569
1	737571	353468	201355	252694	196568	215209	199747	195708	205560	277049
2	188582	210820	67306	45312	47686	59397	70518	73694	61486	60631

3	94400	61310	42433	6795	9049	5297	13479	7854	13801	9712
4	25530	29323	7579	1969	1967	216	228	345	727	953
+gp	0	0	0	0	117	0	9	12	11	0

1

Run tit
2007

At 24/03

Table
Spawning
at age (sp
Numbers*1

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE										
0	339651	608130	599673	516188	391130	393095	335780	228961	263859	375778
1	213318	355480	640856	628999	537832	349081	401361	323853	238542	270697
2	79873	61179	85582	206992	176646	144963	93195	85215	65703	46588
3	11046	8769	10564	13847	32742	36629	13493	21637	12825	11751
4	769	179	1764	761	1753	6767	2660	1906	1670	1974
+gp	0	0	0	0	0	0	0	0	0	0

1

Run tit
2007

At 24/03

Table
biomass a
year)

YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
AGE										
0	272123	290806	213746	117966	162779	183078	280722	374085	222626	280034
1	221296	230830	241156	182888	123663	156484	197786	304648	317639	197531
2	161049	119692	98021	109142	84438	31584	70046	97356	160007	218786
3	50175	61533	33239	25898	28005	19096	8816	28305	29976	66613
4	20584	14598	16818	10883	4901	8871	5221	2851	10453	6007
+gp	3687	367	4840	7773	3273	3281	610	0	0	0
0 TOTAL	728915	717825	607819	454550	407059	402394	563200	807245	740701	768970

Table
biomass a
year)

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
0	127390	99801	73207	56934	69504	66287	37127	39039	52564	40714
1	265525	127249	60406	53066	41279	53802	69912	64584	57557	74803
2	113149	118059	39038	19937	21459	21383	28912	31688	26439	28496
3	76464	47209	29279	4824	6153	3178	6470	3770	6487	5536
4	23998	25804	6897	1851	1692	166	141	190	385	657
+gp	0	0	0	0	126	0	9	12	11	0
0 TOTAL	606526	418121	208826	136612	140213	144817	142571	139283	143443	150207

1

Run tit
2007

At 24/03

Table
biomass a
year)

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007

AGE										
0	67930	121626	119935	103238	78226	78619	67156	45792	52772	75156
1	72528	88870	205074	220150	193620	122178	136463	116587	85875	97451
2	36741	28754	37656	91077	79491	63784	41006	39199	30223	21896
3	7070	5174	5916	7201	19973	21611	8096	13198	7310	7403
4	631	131	1270	510	1298	5007	1915	1411	1236	1500
+gp	0	0	0	0	0	0	0	0	0	0
0 TOTAL	184900	244555	369851	422174	372607	291199	254635	216187	177417	203406
1										

Run tit
2007

At 24/03

Table
Spawning biomass (spawning
Tonnes

YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
AGE										
0	136062	145403	106873	58983	81390	91539	140361	187042	111313	140017
1	221296	230830	241156	182888	123663	156484	197786	304648	317639	197531
2	161049	119692	98021	109142	84438	31584	70046	97356	160007	218786
3	50175	61533	33239	25898	28005	19096	8816	28305	29976	66613
4	20584	14598	16818	10883	4901	8871	5221	2851	10453	6007
+gp	3687	367	4840	7773	3273	3281	610	0	0	0
0 TOTSF	592853	572422	500946	395567	325670	310855	422839	620202	629388	628953
B1+	456791	427020	394074	336584	244280	219316	282479	433160	518075	488937

Table
Spawning biomass (spawning
Tonnes

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
0	63695	49900	36603	28467	34752	33143	18564	19520	26282	20357
1	265525	127249	60406	53066	41279	53802	69912	64584	57557	74803
2	113149	118059	39038	19937	21459	21383	28912	31688	26439	28496
3	76464	47209	29279	4824	6153	3178	6470	3770	6487	5536
4	23998	25804	6897	1851	1692	166	141	190	385	657
+gp	0	0	0	0	126	0	9	12	11	0
0 TOTSF	542831	368221	172223	108145	105461	111673	124007	119764	117161	129850
B1+	479136	318321	135620	79678	70709	78529	105444	100244	90879	109492

Run tit
2007

At 24/03

Table
Spawning biomass (spawning
Tonnes

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE										
0	33965	60813	59967	51619	39113	39309	33578	22896	26386	37578
1	72528	88870	205074	220150	193620	122178	136463	116587	85875	97451
2	36741	28754	37656	91077	79491	63784	41006	39199	30223	21896
3	7070	5174	5916	7201	19973	21611	8096	13198	7310	7403
4	631	131	1270	510	1298	5007	1915	1411	1236	1500
+gp	0	0	0	0	0	0	0	0	0	0
0 TOTSF	150935	183742	309883	370556	333494	251890	221057	193291	151031	165828
B1+	116970	122929	249916	318938	294382	212580	187480	170395	124644	128250

Run tit

2007

At 24/03

Table
biomass
SOP (sta
Tonnes

YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
AGE										
0	272123	290806	213746	117966	162779	183078	280722	374085	222626	280034
1	221296	230830	241156	182888	123663	156484	197786	304647	317639	197531
2	161049	119692	98021	109142	84438	31584	70046	97356	160007	218786
3	50175	61533	33239	25898	28005	19096	8816	28305	29976	66613
4	20584	14598	16818	10883	4901	8871	5221	2851	10453	6007
+gp	3687	367	4840	7773	3273	3281	610	0	0	0
0 TOTAL	728915	717825	607819	454550	407059	402394	563200	807245	740701	768970

Table
biomass
SOP (sta
Tonnes

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
0	127389	99801	73206	56934	69504	66287	37127	39039	52564	40714
1	265525	127249	60406	53066	41279	53802	69912	64584	57557	74803
2	113149	118059	39038	19937	21459	21383	28912	31688	26439	28496
3	76464	47209	29279	4824	6153	3178	6470	3770	6487	5536
4	23998	25804	6897	1851	1692	166	141	190	385	657
+gp	0	0	0	0	126	0	9	12	11	0
0 TOTAL	606526	418121	208826	136612	140213	144817	142571	139283	143443	150207

1

Run tit
2007

At 24/03

Table
biomass
SOP (sta
Tonnes

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE										
0	67930	121626	119935	103238	78226	78619	67156	45792	52772	75156
1	72528	88870	205074	220150	193620	122178	136463	116587	85875	97451
2	36741	28754	37656	91077	79491	63784	41006	39199	30223	21896
3	7070	5174	5916	7201	19973	21611	8096	13198	7310	7403
4	631	131	1270	510	1298	5007	1915	1411	1236	1500
+gp	0	0	0	0	0	0	0	0	0	0
0 TOTAL	184900	244555	369851	422174	372607	291199	254635	216187	177417	203406

1

Run tit
2007

At 24/03

Table
Spawning
biomass
(spawning
Tonnes

YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
AGE										
0	136062	145403	106873	58983	81390	91539	140361	187042	111313	140017

1		221296	230830	241156	182888	123663	156484	197786	304647	317639	197531
2		161049	119692	98021	109142	84438	31584	70046	97356	160007	218786
3		50175	61533	33239	25898	28005	19096	8816	28305	29976	66613
4		20584	14598	16818	10883	4901	8871	5221	2851	10453	6007
	+gp	3687	367	4840	7773	3273	3281	610	0	0	0
0	TOTSF	592853	572422	500946	395567	325670	310855	422839	620202	629388	628953

Table
Spawning biomass (spawning
Tonnes

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
0	63695	49900	36603	28467	34752	33143	18564	19520	26282	20357
1	265525	127249	60406	53066	41279	53802	69912	64584	57557	74803
2	113149	118059	39038	19937	21459	21383	28912	31688	26439	28496
3	76464	47209	29279	4824	6153	3178	6470	3770	6487	5536
4	23998	25804	6897	1851	1692	166	141	190	385	657
+gp	0	0	0	0	126	0	9	12	11	0
0 TOTSF	542831	368221	172223	108145	105461	111673	124007	119764	117161	129850
1										

Run tit
2007

At 24/03

Table
Spawning biomass (spawning
Tonnes

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE										
0	33965	60813	59967	51619	39113	39309	33578	22896	26386	37578
1	72528	88870	205074	220150	193620	122178	136463	116587	85875	97451
2	36741	28754	37656	91077	79491	63784	41006	39199	30223	21896
3	7070	5174	5916	7201	19973	21611	8096	13198	7310	7403
4	631	131	1270	510	1298	5007	1915	1411	1236	1500
+gp	0	0	0	0	0	0	0	0	0	0
0 TOTSF	150935	183742	309883	370555	333494	251890	221057	193291	151031	165828
1										

Run tit
2007

At 24/03

Table 16
(without SC

	RE(Ag	TOTALB	TOTSPB B1+	LANDIN(	YIELD/SS	FBAR 1-
1978	10466268	728915	456791	34900	0.0589	0.1863
1979	12116923	717825	427020	73700	0.1288	0.3936
1980	89060656	607819	394074	84400	0.1685	0.4702
1981	53621096	454550	336584	96300	0.2434	0.7453
1982	70773608	407059	244280	75800	0.2328	0.5923
1983	91538832	402394	219316	40900	0.1316	0.3853
1984	16513078	563200	282479	42500	0.1005	0.2923
1985	20782496	807245	433160	51200	0.0826	0.2231
1986	11717168	740701	518075	63600	0.1011	0.3965
1987	14001688	768970	488937	79600	0.1266	0.3044
1988	67047112	606526	479136	66900	0.1232	0.2346
1989	38384848	418121	318321	105200	0.2857	0.8486
1990	48804332	208826	135620	53900	0.313	1.3604
1991	37955820	136612	79678	24900	0.2302	0.5647
1992	40884684	140213	70709	19700	0.1868	1.454
1993	38992264	144817	78529	13800	0.1236	0.9829

1994	37127100	142571	105444	18219	0.1469	1.3524
1995	39039380	139283	100244	21746	0.1816	0.7987
1996	52564220	143443	90879	27778	0.2371	0.9702
1997	40713808	150207	109492	27963	0.2153	0.895
1998	67930176	184900	116970	38117	0.2525	1.6001
1999	12162592(	244555	122929	39152	0.2131	0.6336
2000	11993462	369851	249916	41769	0.1348	0.9486
2001	10323765	422174	318938	62587	0.1689	0.8191
2002	78226096	372607	294382	69894	0.2096	0.5756
2003	78618920	291199	212580	62716	0.249	1.21
2004	67155976	254635	187480	54574	0.2469	0.7107
2005	45792272	216187	170395	56854	0.2941	1.0737
2006	52771828	177417	124644	39048	0.2585	0.7858
2007	75155544	203406	128250	39008	0.2352	0.8296
Arith. Mean	80431095	372208	307691	50891	0.1894	0.7546
0 Units	(Thousan	(Tonnes)	(Tonnes)	(Tonnes)		
1						

Run tit
2007

At 24/03

Table 17
(with SOP

	RE(	TOTALB	TOTSPB	LANDIN(	YIELD/S	SOPCOF	FBAR 1-
	Age 0						
1978	10466268	728915	592853	34900	0.0589	1	0.1863
1979	12116923	717825	572422	73700	0.1288	1	0.3936
1980	89060656	607819	500946	84400	0.1685	1	0.4702
1981	53621096	454550	395567	96300	0.2434	1	0.7453
1982	70773608	407059	325670	75800	0.2328	1	0.5923
1983	91538832	402394	310855	40900	0.1316	1	0.3853
1984	16513078	563200	422839	42500	0.1005	1	0.2923
1985	20782496(	807245	620202	51200	0.0826	1	0.2231
1986	11717168	740701	629388	63600	0.1011	1	0.3965
1987	14001688(	768970	628953	79600	0.1266	1	0.3044
1988	67047112	606526	542831	66900	0.1232	1	0.2346
1989	38384848	418121	368221	105200	0.2857	1	0.8486
1990	48804332	208826	172223	53900	0.313	1	1.3604
1991	37955820	136612	108145	24900	0.2302	1	0.5647
1992	40884684	140213	105461	19700	0.1868	1	1.454
1993	38992264	144817	111673	13800	0.1236	1	0.9829
1994	37127100	142571	124007	18219	0.1469	1	1.3524
1995	39039380	139283	119764	21746	0.1816	1	0.7987
1996	52564220	143443	117161	27778	0.2371	1	0.9702
1997	40713808	150207	129850	27963	0.2153	1	0.895
1998	67930176	184900	150935	38117	0.2525	1	1.6001
1999	12162592(	244555	183742	39152	0.2131	1	0.6336
2000	11993462	369851	309883	41769	0.1348	1	0.9486
2001	10323765	422174	370555	62587	0.1689	1	0.8191
2002	78226096	372607	333494	69894	0.2096	1	0.5756
2003	78618920	291199	251890	62716	0.249	1	1.21
2004	67155976	254635	221057	54574	0.2469	1	0.7107
2005	45792272	216187	193291	56854	0.2941	1	1.0737
2006	52771828	177417	151031	39048	0.2585	1	0.7858
2007	75155544	203406	165828	39008	0.2352	1	0.8296
Arith. Mean	80431095	372208	307691	50891	.1894		
					.7546		
0 Units	(Thousan	(Tonnes)	(Tonnes)	(Tonnes)			
1							

3.4.7.1.3. Short term prediction for 2008 and 2009 based on XSA results

3.4.7.1.3.1. Justification

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

3.4.7.1.3.2. Input parameters

The input parameters are listed in the Table 3.4.7.1.3.2.1 below. They do represent short term averages of the XSA inputs. The exploitation pattern used is the 2007 estimated vector rescaled to the average exploitation patters estimated for the years 2005-2007. Due to the poor recruitment recently seen, age 0 was set at the average level from 2004-2006.

As the fishery for sprat in the Black Sea is not constrained by an international TAC, the intermediate year 2008 was defined as a status quo effort year with unchanged fishing mortality.

Table 3.4.7.1.3.2.1. Sprat in the Black Sea. Input to short term prediction.

2008

age	stock size (000)	M	maturity	weight in stock (kg)	exploitation pattern	weight in catch (kg)
0	55000000	0.6400	0.0000	0.0010	0.0363	0.0019
1	28220000	0.9500	1.0000	0.0036	0.5500	0.0034
2	6210000	0.9500	1.0000	0.0046	0.7542	0.0046
3	850000	0.9500	1.0000	0.0060	1.1653	0.0065
4	140000	0.9500	1.0000	0.0075	0.8488	0.0079
5	90000	0.9500	1.0000	0.0100	0.8488	0.0100
6	0	0.9500	1.0000	0.0100	0.0000	0.0100
7	0	0.9500	1.0000	0.0100	0.0000	0.0100
8	0	0.9500	1.0000	0.0100	0.0000	0.0100
9	0	0.9500	1.0000	0.0100	0.0000	0.0100
10	0	0.9500	1.0000	0.0100	0.0000	0.0100
11	0	0.9500	1.0000	0.0100	0.0000	0.0100
12	0	0.9500	1.0000	0.0100	0.0000	0.0100
13	0	0.9500	1.0000	0.0100	0.0000	0.0100
14	0	0.9500	1.0000	0.0100	0.0000	0.0100
15	0	0.9500	1.0000	0.0100	0.0000	0.0100
16	0	0.9500	1.0000	0.0100	0.0000	0.0100
17	0	0.9500	1.0000	0.0100	0.0000	0.0100
18	0	0.9500	1.0000	0.0100	0.0000	0.0100
19	0	0.9500	1.0000	0.0100	0.0000	0.0100

2009

age	stock size (000)	M	maturity	weight in stock (kg)	exploitation pattern	weight in catch (kg)
0	55000000	0.6400	0.0000	0.0010	0.0363	0.0019
1		0.9500	1.0000	0.0036	0.5500	0.0034
2		0.9500	1.0000	0.0046	0.7542	0.0046
3		0.9500	1.0000	0.0060	1.1653	0.0065
4		0.9500	1.0000	0.0075	0.8488	0.0079
5		0.9500	1.0000	0.0100	0.8488	0.0100
6		0.9500	1.0000	0.0100	0.0000	0.0100
7		0.9500	1.0000	0.0100	0.0000	0.0100
8		0.9500	1.0000	0.0100	0.0000	0.0100
9		0.9500	1.0000	0.0100	0.0000	0.0100
10		0.9500	1.0000	0.0100	0.0000	0.0100
11		0.9500	1.0000	0.0100	0.0000	0.0100
12		0.9500	1.0000	0.0100	0.0000	0.0100
13		0.9500	1.0000	0.0100	0.0000	0.0100
14		0.9500	1.0000	0.0100	0.0000	0.0100
15		0.9500	1.0000	0.0100	0.0000	0.0100
16		0.9500	1.0000	0.0100	0.0000	0.0100
17		0.9500	1.0000	0.0100	0.0000	0.0100
18		0.9500	1.0000	0.0100	0.0000	0.0100
19		0.9500	1.0000	0.0100	0.0000	0.0100

2010

age	stock size (000)	M	maturity	weight in stock (kg)	exploitation pattern	weight in catch (kg)
0	55000000	0.6400	0.0000	0.0010	0.0363	0.0019
1		0.9500	1.0000	0.0036	0.5500	0.0034
2		0.9500	1.0000	0.0046	0.7542	0.0046
3		0.9500	1.0000	0.0060	1.1653	0.0065
4		0.9500	1.0000	0.0075	0.8488	0.0079
5		0.9500	1.0000	0.0100	0.8488	0.0100
6		0.9500	1.0000	0.0100	0.0000	0.0100
7		0.9500	1.0000	0.0100	0.0000	0.0100
8		0.9500	1.0000	0.0100	0.0000	0.0100
9		0.9500	1.0000	0.0100	0.0000	0.0100
10		0.9500	1.0000	0.0100	0.0000	0.0100
11		0.9500	1.0000	0.0100	0.0000	0.0100
12		0.9500	1.0000	0.0100	0.0000	0.0100
13		0.9500	1.0000	0.0100	0.0000	0.0100
14		0.9500	1.0000	0.0100	0.0000	0.0100
15		0.9500	1.0000	0.0100	0.0000	0.0100
16		0.9500	1.0000	0.0100	0.0000	0.0100
17		0.9500	1.0000	0.0100	0.0000	0.0100
18		0.9500	1.0000	0.0100	0.0000	0.0100
19		0.9500	1.0000	0.0100	0.0000	0.0100

3.4.7.1.3.3. Results

The following table Table 3.4.7.1.3.3.1 lists the single option status quo results of the prediction with stock parameters at age for 2008 to 2010.

Table 3.4.7.1.3.3.2 list the management option table for the period 2008-2010.

All results of the short term predictions are conditional to the acceptance of the XSA results.

The status quo fishing in 2008 would result in a slightly increased landing around 44000 t, as compared to the 39000 t landed in 2007. The SSB would increase from 128000 t in 2007 to 137,000 t in 2008. Status quo fishing in 2009 would imply stable landings of 44000 t and a SSB of 138000 t in 2009 and 2010. Thus, status quo fishing would halt the decreasing trend in SSB and stabiles the landings even under the assumed low recruitment

Table 3.4.7.1.3.3.1 Sprat in the Black Sea. Single option (status quo) short term prediction.

2008	F-factor:	1	reference F	0.8296		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	0.0363	1450968	2757	55000000	55000	0	0
1	0.5500	8038531	27331	28220000	101592	28220000	101592
2	0.7542	2248301	10342	6210000	28566	6210000	28566
3	1.1653	411787	2677	850000	5100	850000	5100
4	0.8488	55129	436	140000	1050	140000	1050
5	0.8488	35440	354	90000	900	90000	900
6	0.0000	0	0	0	0	0	0
7	0.0000	0	0	0	0	0	0
8	0.0000	0	0	0	0	0	0
9	0.0000	0	0	0	0	0	0
10	0.0000	0	0	0	0	0	0
11	0.0000	0	0	0	0	0	0
12	0.0000	0	0	0	0	0	0
13	0.0000	0	0	0	0	0	0
14	0.0000	0	0	0	0	0	0
15	0.0000	0	0	0	0	0	0
16	0.0000	0	0	0	0	0	0
17	0.0000	0	0	0	0	0	0
18	0.0000	0	0	0	0	0	0
19	0.0000	0	0	0	0	0	0
		12240156	43897	90510000	192208	35510000	137208
2009	F-factor:	1	reference F	0.8296		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	0.0363	1450968	2757	55000000	55000	0	0
1	0.5500	7966527	27086	27967222	100682	27967222	100682
2	0.7542	2279702	10487	6296733	28965	6296733	28965
3	1.1653	547294	3557	1129710	6778	1129710	6778
4	0.8488	40365	319	102508	769	102508	769
5	0.8488	9124	91	23170	232	23170	232
6	0.0000	0	0	14895	149	14895	149
7	0.0000	0	0	0	0	0	0
8	0.0000	0	0	0	0	0	0
9	0.0000	0	0	0	0	0	0
10	0.0000	0	0	0	0	0	0
11	0.0000	0	0	0	0	0	0
12	0.0000	0	0	0	0	0	0
13	0.0000	0	0	0	0	0	0
14	0.0000	0	0	0	0	0	0
15	0.0000	0	0	0	0	0	0
16	0.0000	0	0	0	0	0	0
17	0.0000	0	0	0	0	0	0
18	0.0000	0	0	0	0	0	0
19	0.0000	0	0	0	0	0	0
		12293980	44297	90534238	192575	35534238	137575
2010	F-factor:	1	reference F	0.8296		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	0.0363	1450968	2757	55000000	55000	0	0
1	0.5500	7966527	27086	27967222	100682	27967222	100682
2	0.7542	2259282	10393	6240331	28706	6240331	28706
3	1.1653	554938	3607	1145488	6873	1145488	6873
4	0.8488	53648	424	136240	1022	136240	1022
5	0.8488	6680	67	16965	170	16965	170
6	0.0000	0	0	3835	38	3835	38
7	0.0000	0	0	5761	58	5761	58
8	0.0000	0	0	0	0	0	0
9	0.0000	0	0	0	0	0	0
10	0.0000	0	0	0	0	0	0
11	0.0000	0	0	0	0	0	0
12	0.0000	0	0	0	0	0	0
13	0.0000	0	0	0	0	0	0
14	0.0000	0	0	0	0	0	0
15	0.0000	0	0	0	0	0	0
16	0.0000	0	0	0	0	0	0
17	0.0000	0	0	0	0	0	0
18	0.0000	0	0	0	0	0	0
19	0.0000	0	0	0	0	0	0
		12292043	44334	90515842	192549	35515842	137549

Table 3.4.7.1.3.3.2. Sprat in the Black Sea. Management option table for the term prediction.

2008					2009					2010	
F-factor	reference F	stock biomass	sp. stock biomass	catch in weight	F-factor	reference F	stock biomass	sp. stock biomass	catch in weight	stock biomass	sp. stock biomass
1.0000	0.8296	192208	137208	43897	0.0000	0.0000	192575	137575	0	227590	172590
					0.1000	0.0830	192575	137575	5526	223087	168087
					0.2000	0.1659	192575	137575	10767	218850	163850
					0.3000	0.2489	192575	137575	15737	214856	159856
					0.4000	0.3318	192575	137575	20458	211093	156093
					0.5500	0.4563	192575	137575	27100	205846	150846
					0.6000	0.4977	192575	137575	29205	204196	149196
					0.7000	0.5807	192575	137575	33259	201032	146032
					0.8000	0.6637	192575	137575	37119	198045	143045
					0.9000	0.7466	192575	137575	40794	195221	140221
					1.0000	0.8296	192575	137575	44297	192549	137549
					1.1000	0.9125	192575	137575	47638	190018	135018
					1.2000	0.9955	192575	137575	50826	187622	132622
					1.3000	1.0784	192575	137575	53869	185352	130352
					1.4000	1.1614	192575	137575	56778	183198	128198
					1.5000	1.2444	192575	137575	59557	181154	126154

3.4.7.1.4. Medium term prediction

SGMED 09-01 did not undertake medium term projections.

3.4.7.1.5. Long term prediction

In order to estimate and propose reference points to fisheries management consistent with high long term yields, SGMED applied Yield per Recruit and Production models.

3.4.7.1.5.1. Method 1: Yield per Recruit with XSA exploitation pattern

3.4.7.1.5.1.1. Input parameters

Table 3.4.7.1.5.1.1.1 represents the input parameters to the YPR analysis. They are derived from long term means of the XSA input data except the exploitation pattern, which was estimated as the 2007 exploitation pattern rescaled to the average of the years 2005-2007.

Table 3.4.7.1.5.1.1.1 Sprat in the Black Sea. Input parameters to YPR analysis.

age min	age group	stock weight	catch weight	maturity	F	M
0	0	0.002	0.002	0	0.0363	0.64
age max	1	0.003	0.003	1	0.5500	0.95
5	2	0.005	0.005	1	0.7542	0.95
Fref	3	0.007	0.007	1	1.1653	0.95
0.8296	4	0.008	0.008	1	0.8488	0.95
	5	0.011	0.011	1	0.8488	0.95

3.4.7.1.5.1.2. Results

The results of the YpR analysis given below are conditional to the acceptance of the XSA results.

F_{max} was could not be estimated due to shape to the YpR curve, which has a maximum well outside any reasonable range. The skewed shape of the YpR curve results from the high natural mortality chosen and the sort life span of sprat in the Black Sea (Fig. X1). Due to such effects, SGMED 09-01 also refused to propose the estimated $F_{0.1}$=1.54 as an appropriate management reference point.

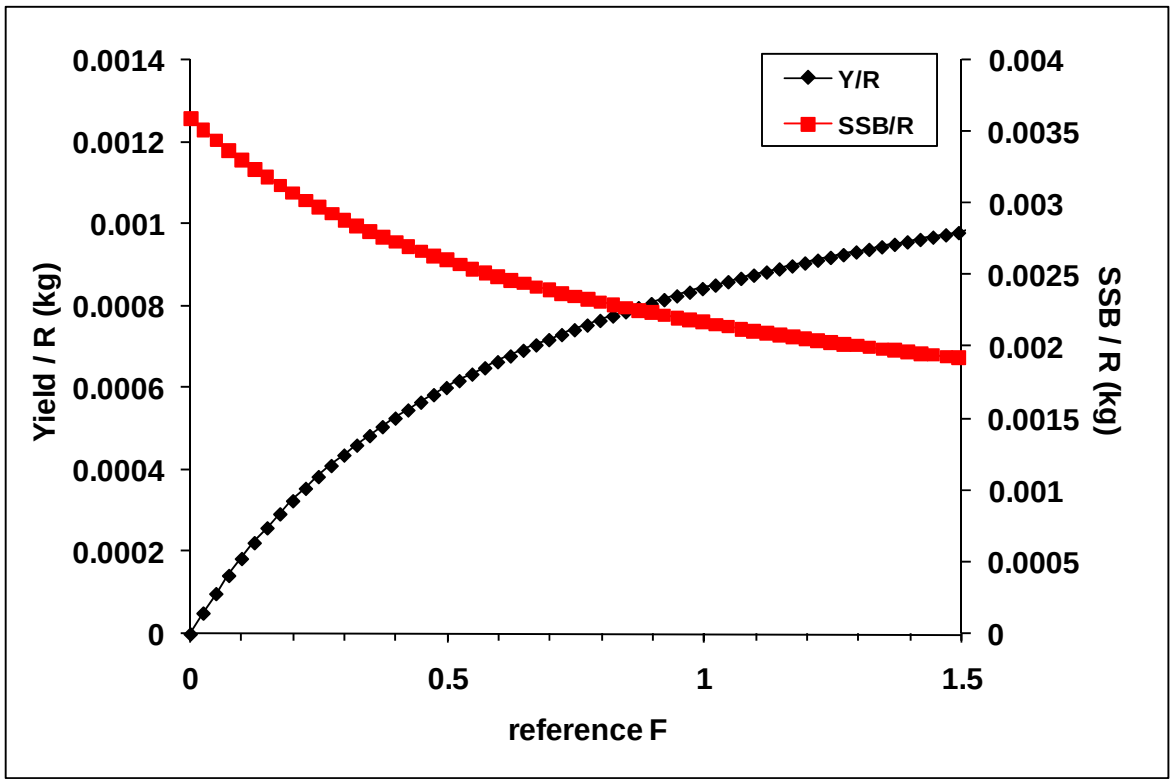

Fig. 3.4.7.1.5.1.1.1 Sprat in the Black Sea. YpR and SSBpR with increasing fishing mortality (average of ages 1-4).

3.4.7.1.5.2. Method 2: Production model with XSA inputs

3.4.7.1.5.2.1. Input parameters

Table 3.4.7.1.5.2.1.1 lists all input parameters used to estimate MSY, Fmsy and Bmsy. Such parameters were derived from the XSA assessment described in the previous sections and present long term means with the exception of the exploitation pattern which represents the 2007 exploitation pattern rescaled to the mean exploitation pattern over the years 2005-2007. The recruitment was estimated applying the Ricker function shown in Fig. 3.4.7.1.5.2.1.1. A reasonably close relationship between the SSB and recruitment appears apparent.

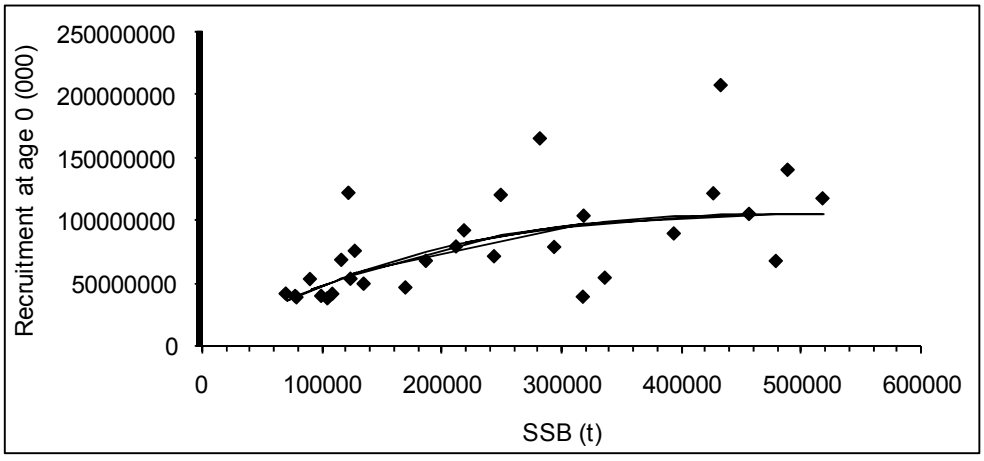

Fig. *3.4.7.1.5.2.1.1*. Sprat in the Black Sea. Spawning stock recruitment relationship expressed as the Ricker function. Parameters are given in Tab. *3.4.7.1.5.2.1.1*.

Table *3.4.7.1.5.2.1.1*. Sprat in the Black Sea. Input parameters to the production model.

age min	age group	stock weight	catch weight	maturity	F	M	Ricker parameters	
0	0	0.002	0.002	0	0.0363	0.64	a=	581.656918
age max	1	0.003	0.003	1	0.5500	0.95	k=	486033.624
5	2	0.005	0.005	1	0.7542	0.95		
Fref	3	0.007	0.007	1	1.1653	0.95		
0.8296	4	0.008	0.008	1	0.8488	0.95		
	5	0.011	0.011	1	0.8488	0.95		

3.4.7.1.5.2.2. Results

The results of the production model analysis given below are conditional to the acceptance of the XSA results.

According to the results of the production model the MSY is indicated to be in the range of 50000 t.

F_{msy} (ages 1-4) amounts to 0.67.

B_{msy} appears to be in the range of 170000 t.

According to such references, the stock would appear to be actually over fished. Due to the reduced state of the stock size, the estimated short term landings in the range of 37000 t and 44000 t are to be considered below the maximum sustainable yield.

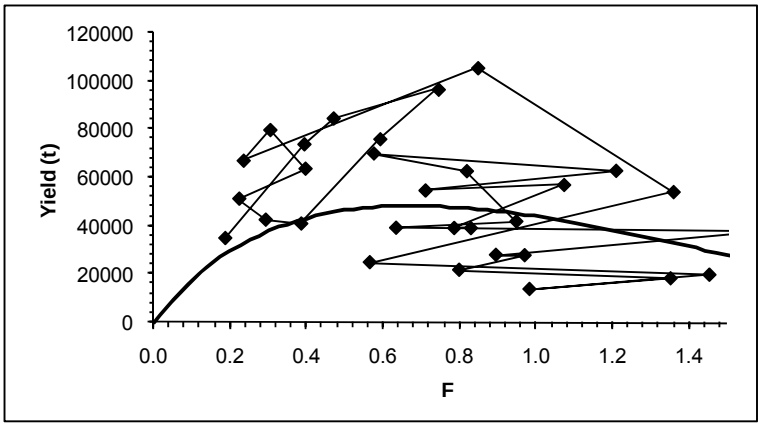

Fig. 3.4.7.1.5.2.2.1. Sprat in the Black Sea. Relation between yield and fishing mortality (F1-4) observed (linked dots) and its estimated sustainable levels.

3.5. Comparing XSA and ICA assessments

Recruitment, biomass and mean fishing mortality F 1-4 from ICA and XSA runs were compared to previous estimates obtained applying XSA to 1993 data (Daskalov 1998, Fig. 3.4.8.1). While SSB and recruitment estimates show consistent trajectories, estimates of mean F exhibit more discrepancies. XSA estimates of F show a regime like stepwise shift after 1988 which the WG interpret as an artefact due to the model misspecification – XSA does not account for the low selection at age 4 after 1988 (Fig. 3.4.8.1). Fishing mortalities estimated by the present version of ICA may also be overestimated compared to the levels observed in the 1980s knowing the state and dynamics of the fisheries since the 1980s, but the WG has accepted this more conservative option till an objective method of estimating the selection pattern is found and comparisons with other methods (e.g. Mesnil) are performed.

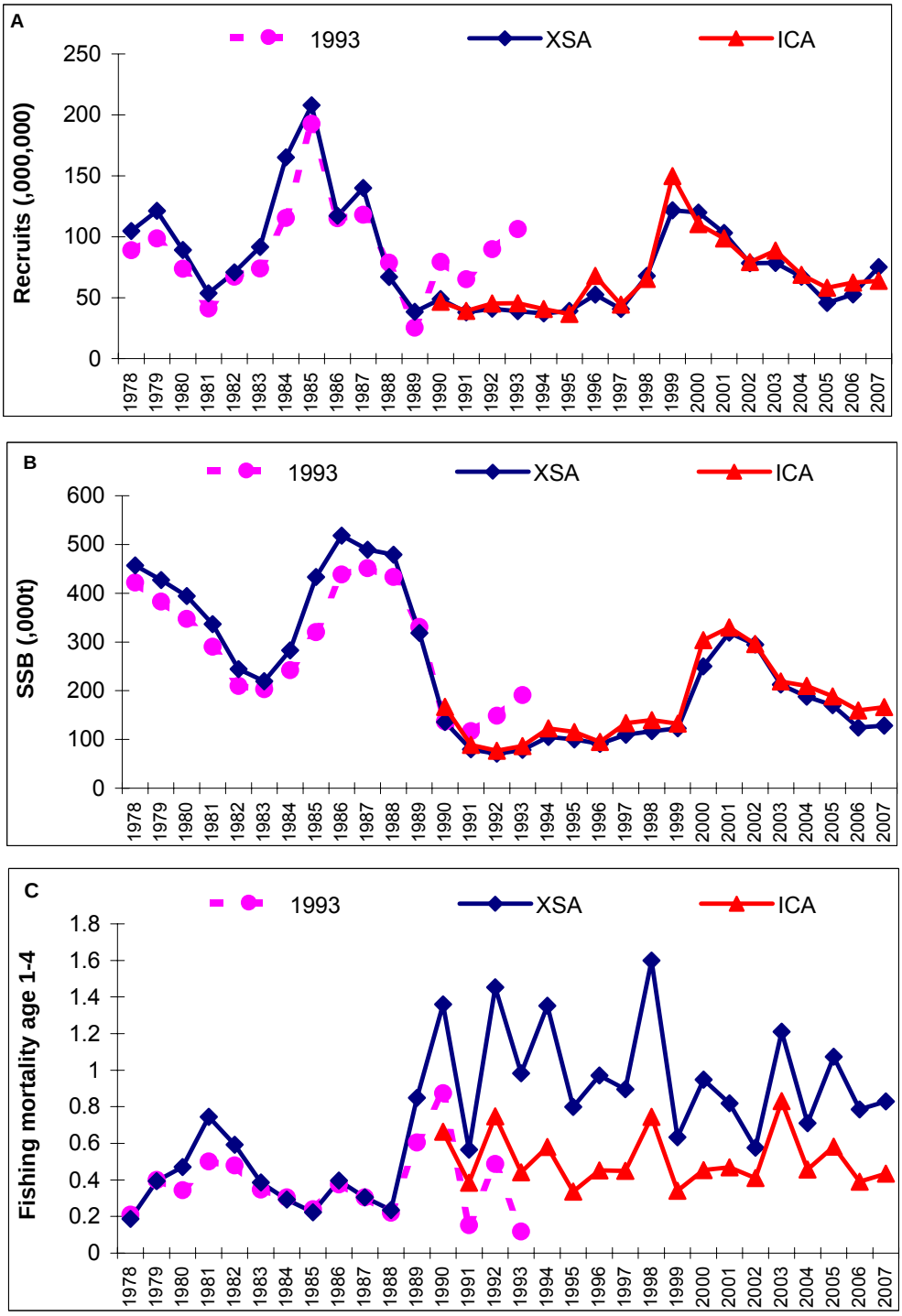

Fig. 3.5.1 Comparing sprat population parameters estimated using 1993 XSA, 2007 XSA and 2007 ICA: A Recruitment, B SSB, C. F1-4

3.6. Scientific advice

3.6.1.Justification

The WG accepted ICA assessment as closer to the real state of the stock at the present development of the fisheries.

3.6.2. State of the spawning stock size

According to both ICA and XSA assessments in recent years the SSB is decreasing. In the last two years it stabilises in the range of 150-170,000 t. Under constant recruitment scenarion and status quo F it is expected to increase to 190,000 by 2010.

3.6.3. State of recruitment

After a positive trend in 1999-2001 the recruitment has decreased. Over the last 3 years its downward trend has stopped and the recruitment ramains about 60 billions.

3.6.4. State of exploitation

Over the last few years the fishing mortality has piqued in 2003 and 2005 and since then has decreased. Landings have also decreased in 2006-2007 to about 40,000 t. Current catch levels for sprat should not be allowed to increased in 2009 and in the near future.

3.6.5. 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. Due to low recruitment and relatively strong exploitation stock is now at a medium level but if a higher recruitment appears it could possibly quickly recover to a higher level.

4. STOCK ASSESSMENT OF TURBOT IN THE BLACK SEA

4.1. Stock identification and biological features

4.1.1. Stock Identification

Turbot (*Psetta maxima*) occurs all over the shelf area of all Black Sea coastal states at depths of about 100 m - 140 m and makes grouped local shoals. Turbot inhabits sandy, mixed bottoms or mussel beds. In all Black Sea countries turbot is important target for the fisheries. Major fishing gear are gillnets, demersal trawls in Turkey and turbot also caught as a by-catch of sprat fisheries, long-lines and purse seines. In order to protect turbot stock in EU waters and improve the stock reproductive capacity, the mesh size of gillnets have been synchronised between Bulgaria and Romania.

4.1.2. Growth

Turbot is the long lived species with slow growth rate. The parameters in VBGF for turbot by countries are given on the following tables (Tabl. 4.1.2.1, 4.1.2.2, 4.1.2.3):

Table *4.1.2.*1. Growth parameters of turbot in Bulgarian waters.

Parameters	2006	2007	2008
L_∞ (cm)	90.37	79.26	77.80
k	0.160	0.173	0.242
t_0	-2.114	-1.561	0.1518
a	0.00003	0.000008	0.0004
b	2.900	3.173	2.205

Table *4.1.2.*2. Growth parameters of turbot in Romanian waters.

Parameters	2003	2004	2005	2006	2007	2008
L_∞ (cm)	76.110	76.800	80.000	85.14	73.4	72.500
k	0.198	0.117	0.200	0.145	0.210	0.213
t_0	-1.646	-1.355	-1.143	-2.010	-1.428	- 1.410
a	0.035	0.03501	0.01032	0.01078	0.00838	0.00806
b	2.833	2.8328	3.1558	3.1459	3.2104	3.2162

Table *4.1.2.*3. Growth parameters of turbot in Ukrainian and Turkish waters.

Parameters	Ukraine 2000 -2006	Turkey 1990 - 1991	Turkey 1990 - 1996	Turkey 1998 - 2000
L_∞ (cm)	74	82.57	96.24	95.9
k	0.106	0.17	0.119	0.104
t_0	-1.73	-0.93	-0.01	-1.55
a	1	0.0085		0.0106
b	3	3.18		3.14

4.1.3. Maturity

Maturity ogive for Bulgaria and Romania is given on the Fig. 4.1.3.1

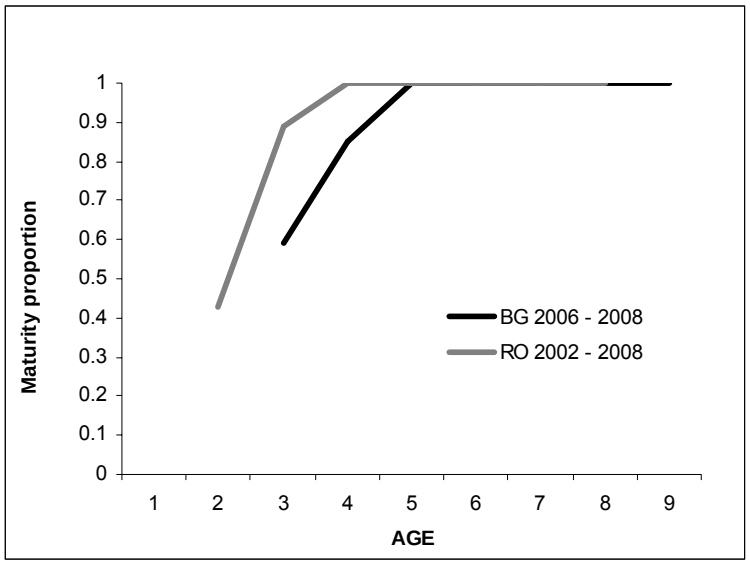

Fig. 4.1.3.1 Maturity ogive of turbot in Bulgarian and Romanian waters.

According to Ivanov, Beverton (1985), along Bulgarian Black Sea coast most fishes become mature between three and five years of age. According to Popova (1954, 1967), the turbot along former USSR coast reaches sexual maturity later and most of the females become mature at 6 to 8 years old. According to Ivanov, Beverton (1985), these differencies are due not only to real differencies in the biology of local groups of turbot, but also to discrepancies in the age readings of otoliths.Intercalibration procedures are necessary to be applied in order to reduce the bias due to age misreading.

4.2. Fisheries

4.2.1.General description of fisheries

The WG noted that the Turbot (*Psetta maxima*) is the one of the most important demersal fish species in the Black Sea with high market demand and prices. Main fishing gear for all coastal states are gillnets, but in Turkey, the bottom trawling is also permitted. The turbot is often caught as a by-catch of sprat fishery, long lines and purse seine fishery.

4.2.2.Management regulations applicable in 2007 and 2008

The TACs for turbot catches in 2007 and 2008 and quotas allocation was introduced regarding to Council Regulations (EC) No 1579/2007 and No 1139/2008. Both for Bulgaria and Romania quotas of 50 t for each country were permitted. Also mesh size of gillnets was regulated.

4.2.3.Catches

4.2.3.1. Landings

The data set of landings was compiled for the period 1989 – 2008 (Tabl. 4.2.3.1.1). The WG used only official landings statistics for the pointed period. The Turkish landings statistics for 2008 will be presented during the next meeting, because they are still not published.

Table 4.2.3.1.1. Landings of turbot in the Black Sea during the period 1989 – 2008.

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	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	17	99	5.47	193	142	15	11	617.97	444.5
2003	40.8	24	118	5.876	126	93	15	1	423.676	308.8
2004	16.2	42	126	7.157	118	116	2	7	434.357	302.2
2005	12.69	37	123	6	273	275	15	6	747.69	445.69
2006	14.81	35.108	154	8	266	481	7		962.81	466.81
2007	66.85	48.064	205	10.58	346	353	7		1036.696	666
2008	54.621	49.112	239	12.353	Not published		5			360.086

Landing figures show different trends (Fig. 4.2.3.1.1 & Tab. 4.2.3.1.1) and the WG agreed that in all countries landings are misreported. Major trends in landings in Bulgaria and Turkey and in Romania and Ukraine (Fig. 4.2.3.1.1) look consistent.

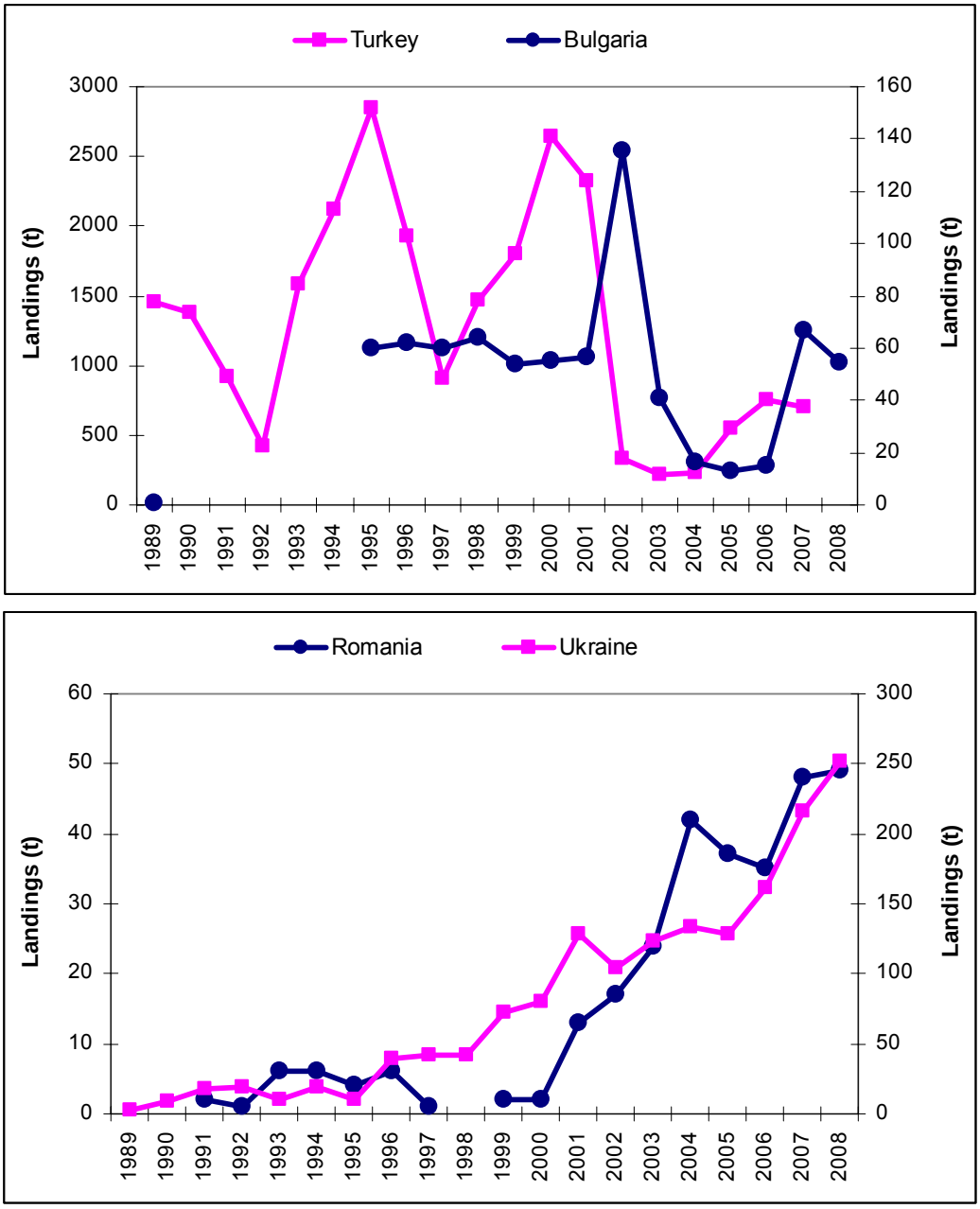

Fig. 4.2.3.1.1 Landings of turbot in the Black Sea by countries during the period 1989 – 2008.

4.2.3.2. Discards

The WG was not discussing the discards due to lack of data.

4.2.4.Fishing effort and CPUE

Commercial CPUE

The total number of vessels involved in Romanian turbot fishery in 2008 is 4 trawlers and 134 boats, which operate with about 4450 gillnets and 10 beach seines. The CPUE data from commercial landings is given on Tabl. 4.2.4.1.

Table 4.2.4.1.Turbot catches (t), fishing effort and CPUE for the fisheries along the Romanian coast.

Years	Catch (t)	*E F F O R T* Number gill net	Number days	Number hours	*CPUE* t /gill net	t / day	t / hour
2001	13.00	980	100	2400	0.018	0.131	0.005
2002	17.00	1267	125	3000	0.013	0.136	0.005
2003	24.00	2765	150	3600	0.009	0.160	0.006
2004	42.00	4350	225	5400	0.009	0.186	0.007
2005	37.00	3856	205	4920	0.009	0.193	0.007
2006	35.108	3794	192	4560	0.018	0.184	0.0076
2007	48.064	3789	250	6608	0.025	0.250	0.0104
2008	49.112	4450	185	4440	0.022	0.265	0.0099

Ukrainian data for effort and CPUE are given on Tabl. 4.2.4.2.

Table 4.2.4.2. Effort (number of gill nets) and CPUE (kg/gill net) of Ukrainian fishing fleet in Crimean waters working on turbot fishery.

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
CPUE	2.1	4.2	8.6	11.6	6.2	27.3	25.6	20.5	32.1	24.6	24.8	23.3	20.9	21.8	15.9	23	27.2	36.4
Effort	950	2140	1066	1482	1571	1331	1500	1792	2000	1937	4728	3006	3913	3840	8097	7044	5100	4861

In Bulgaria, 9963 gillnets were registered for 2008 (NAFA, 2009). The Bulgarian fishing effort for 2007 and 2008, according to national statistics (NAFA, 2009) is given on Tabl. 4.2.4.3 & 4.2.4.4 :

Table 4.2.4.3 Fishing effort along the Bulgarian Black Sea coast in 2007.

Vessel length	**number of vessels**	**days at sea**	**KW**	**GT**	**KW*days at sea**	**GT*days at sea**	**fishing gear**
< 6meters without engine	8	10	0.00	6.10	0	61	GNS
< 6м.with engine	32	66	340.53	32.71	22474.98	2158.86	GNS
from 6 to 12 meters	86	177	2 685.20	278.43	475280.4	49282.11	GNS
from 12 to 24 meters	26	208	3 631.40	714.27	755331.2	148568.16	OTM, GNS
over 24 meters	3	6	732.47	333.00	4394.82	1998	OTM GNS

Table 4.2.4.4. Fishing effort along the Bulgarian Black Sea coast in 2008.

Vessel length	number of vessels	days at sea	KW	GT	KW*days at sea	GT*days at sea	fishing gear
< 6meters without engine	9	27	0.00	9.30	0	251.1	GNS
< 6м.with engine	55	99	421.97	54.79	41775.03	5424.21	GNS
from 6 to 12 meters	107	290	3 266.01	368.05	947142.9	106734.5	GNS
from 12 to 24 meters	28	267	3 691.66	733.64	985673.2	195881.88	OTM GNS
over 24 meters	2	4	432.47	216.00	1729.88	864	OTM

In Turkey, the data about number of fishing vessels, operating in Black Sea and corresponding effort for the period 1984 – 2007 are presented on Fig. 4.2.4.1.

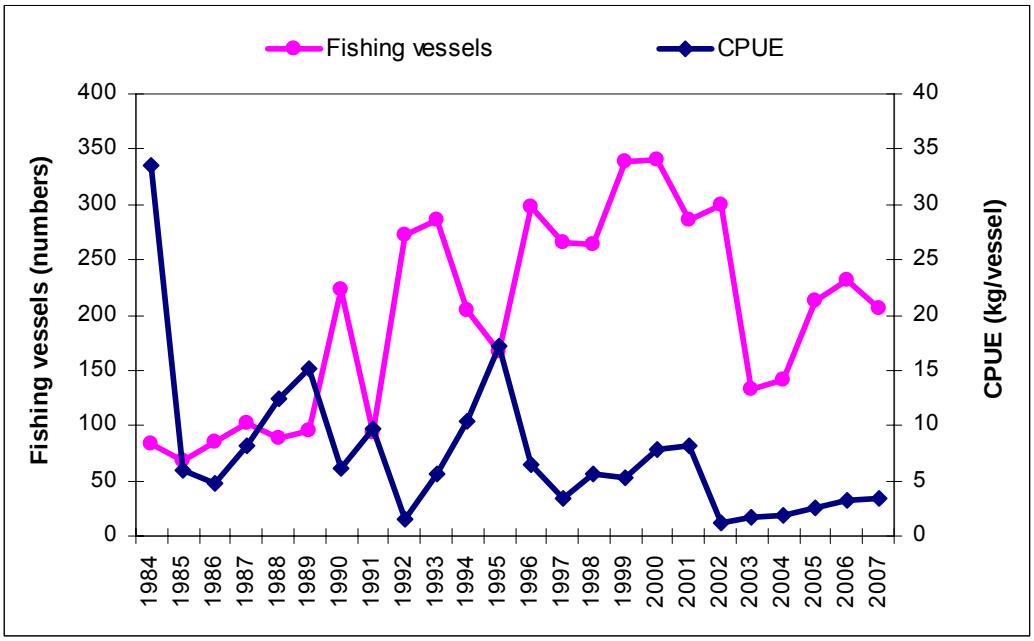

Fig. 4.2.4.1. Number of fishing vessels and CPUE in Turkey during the period 1984 – 2007.

The existing data for CPUE from research surveys are presented on Fig. 4.2.4.2.

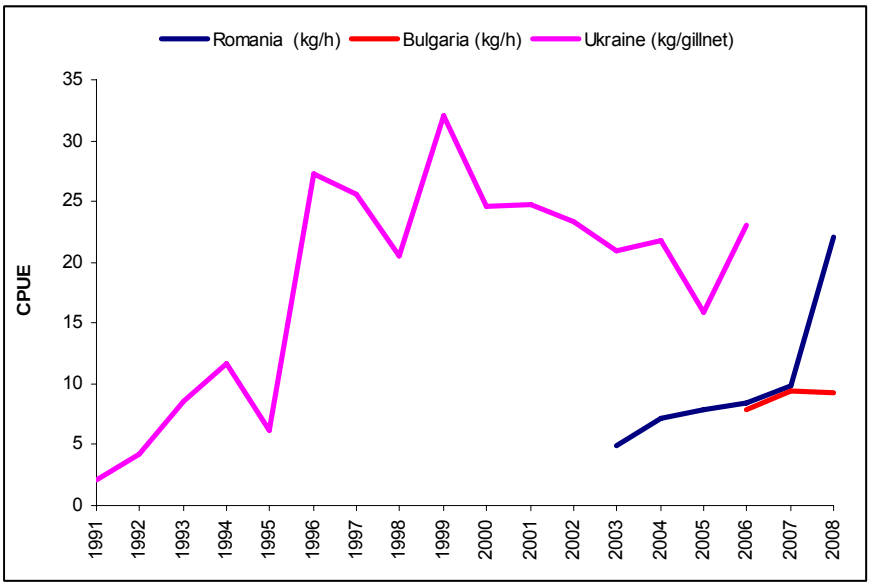

Fig. 4.2.4.2. CPUE for turbot from research surveys.

4.3. Scientific surveys

The WG discussed trend in CPUE, obtained from national research surveys data.

4.3.1.Bulgarian turbot survey, 2008

To establish the exploited turbot stock in front of the Bulgarian Black Sea coast swept area method and standard methodology for stratified sampling was employed (Gulland, 1966; Sparre, Venema, 1998; Sabatella,Franquesa, 2004). The region was divided in three strata according to depth – stratum 1 (35 – 50 m), stratum 2 (50 – 75 m) and stratum 3 (75 – 100 m). The study area was partitioned into 128 equal in size, but not overlying fields situated at depth 15 - 100 m, of which 70 in the Northern region and 58 in the Southern region. In the Northern region for the aims of the study additional forth stratum was introduced, which covered depths between 15 and 35 m because is this area the bottom structure allows bottom trawling in shallow waters as distinguished from Southern region. At 44 of the fields chosen at random, sampling by means of bottom trawling is carried out .

The seabed area covered during a single haul represents a basic measurement unit, which is very small compared to the total study area, nevertheless deemed representative since turbots do not aggregate in dense assemblages (Martino, Karapetkova, 1957). Each field is a rectangle with sides 5' Lat × 5' Long and area around 62.58 km^2 (measured by application of GIS), large enough for a standard lug extent in meridian direction to fit within the field boundaries. The fields are grouped in larger sectors – so called strata, which geographic and depth boundaries are selected according to the density distribution of the species under study. As a result of the trawling survey a biomass index was calculated. The time for a haul is between 1.5 – 2 hours with velocity 1.6 – 1.8 knots. The trawl employed has horizontal opening of 12 m an vertical opening – 1.5 m, mesh size – 10 cm.

The trawl survey, carried out during spring season (April – May) of 2008 in front of Bulgarian Black Sea coast, estimated that turbot the turbot abundance is 1966.18 tons (Tabl. 4.5.1.1). The average CPUE is 9.32 kg/hour and correspondingly CPUA – 233.06 kg/km^2. (Panayotova et. al., 2008).

Table 4.3.1.1. Biomass of turbot exploitation stock in the Bulgarian Black Sea, spring, 2008.

Region	Stratum	Fields	Area km^2	$\overline{CPUA}$ kg/km^2	Biomass (tons)
North	1	14	876.11	277.87	243.44
	2	24	1501.91	323.27	485.52

		3	17	1063.85	333.51	354.80
		4	15	938.69	178.74	167.78
	Total		**70**	**4380.56**		**1251.55**
South		1	15	938.69	104.60	98.18
		2	20	1251.59	172.28	215.62
		3	23	1439.33	278.49	400.83
	Total		**58**	**3629.61**		**714.63**
GRAND TOTAL			**128**	**8010.16**		**1966.18**

4.3.2.Romanian turbot survey, 2008

The swept area method was applied by using of demersal trawl gear. Investigated area includes Romanian shelf aquatory between depths 20 – 75 m. In 2008, two surveys were accomplished during the spring (April) and autumn (October) seasons with total number of hauls 28 and 29, respectively. Surveys were conducted by the research vessel "Star of the Sea 1" (ROU P-CT-040254), of the National Institute for Marine Research and Development "*Grigore Antipa*" Constanta, by demersal and pelagic trawl gears. The characteristics of trawl are: vertical opening - 3 m, horizontal opening - 57 m and mesh size of the codend 50 – 100 mm. The trawling speed was 2.5 - 3 knots.

During the spring survey in April 2008, the covered area has a surface of 2702 Nm^2 and encloses depths between 20 and 66 m. The estimated turbot abundance was 2661 tons. The average values of the turbot catches varied between 0.001 kg/Nm^2 and 1.782 kg/Nm^2. Significant catches were recorded between 35 and 55 m isobates, in front of Cap Midia - Tuzla (the change of abundance 0.535 – 0.891), Eforie Sud-Vama Veche (1.069–1.782) and Corbu-Sf. Gheorghe (0.143–0.257)(Tabl. 4.3.2.1).

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Table 4.3.2.1. Turbot agglomerations along Romanian Black Sea coast in April 2008.

Nr. polygon	Researched area (Nm^2)	Limits of variation of abundance (t/Nm^2)	Average (t/Nm^2)	Total (t)	Total platform (t)
1	90	0	0	0	
2	195	0	0	0	
3	92.3	0	0	0	
4	73.5	0	0	0	
5	112	0	0	0	**2661**
6	802	1.069 – 1.782	1.340	1.075	
7	660	0.535 – 0.891	0.758	500	
8	677.2	0.143 – 0.257	0.202	137	
Total	**2702**	**0.143 – 1.782**		**1712**	

During the autumn survey in October 2008, 29 hauls with pelagic trawl have been carried out. In the investigated area of 2702 Nm^2, the distribution of turbot agglomerations was different compared to spring survey. The average values of turbot catches, were situated in the limits between 0.185 and 2.224 t/Nm^2. Some significant catches have been recorded between 30 and 45 m isobaths in Corbu - Sulina (limits of variation of the abundance of 1.112 – 2.224 and between 45 and 65 m isobates in the area that lies between Constanta - Vama Veche (0.927 – 1.668 t/Nm) (Tabl. 4.3.2.2).

Table 4.3.2.2 Turbot agglomerations along Romanian Black Sea coast in October, 2008.

Nr. polygon	Researched area (Nm^2)	Limits of variation of abundance (t/Nm^2)	Average (t/Nm^2)	Total (t)	Total platform (t)
1	625	0.185 – 0.371	260	162.50	
2	350	0.556 – 0.964	828	289.80	
3	100	0	0	0	
4	550	1.112 – 2.224	1179	985.05	**3581**

5	550	0.185 – 0.556	432	237.60
6	588	0.927 – 1.668	1159	681.49
Total	**2763**	**0 – 2.224**		**2356.44**

During another surveys in 2008, some assessments on turbot biomass were made and the results are given on Tabl. 4.3.2.3.

Table 4.3.2.2.3.Turbot agglomerations along Romanian Black Sea coast obtained during the scientific surveys in 2008

Researched area (Nm^2)	Estimated biomass in researched area (t)	Estimated biomass on Romanian platform (t)
	April	
2702	**1.722**	**2661**
	August	
2222	**161,1***	**411,1**
	September	
2069	**187,6***	**426**
	Octomber	
2763	**2356,44**	**3581**

* pelagic trawl survey

4.3.2.1. *Methods*

The swept area method was applied during scientific surveys for the estimation of turbot abundance. According to this method, the trawl sweeps a well defined path, the area of which is the length of the path multiplied by the width of the trawl, called the "swept area" or the "effective path swept". The swept area, a, can be estimated from:

(1) a = D*hr*X2

$D = V*t$

where: a - swept area, V - velocity of the trawl over the ground when trawling, X2 is that fraction of the head-rope length hr, which is equal to the width of the path swept by the trawl, the "wing spread", t - is the time spent trawling , D- distance covered.

For the estimation of turbot abundance, the catch per unit of area (CPUA) was used:

(2) $\frac{C_{w/t}}{a/t} = \frac{Cw}{a} kg/km^2$

where: Cw/t – catch in weight per unit of area, a/t – the area swept per hour.

The biomass of the investigated species for each stratum is obtained from:

(3) $B = \left(\overline{C_{w/a}}\right) * A$

where: $\overline{C_{w/a}}$ - the mean catch per unit area of all hauls, A – the total size of the area under investigation in stratum.

The total area of survey region, equal to the sum of all strata areas, becomes:

A = A1+A2+A3+…+An

The mean catch for the entire survey area is obtained from – equation 5:

(5) $\overline{Ca}(A) = \frac{Ca1*A1 + Ca2*A2 + Ca3*A3 + ... + Can*An}{A}$

where: Ca1- catch per unit area of stratum 1 and etc., A1 – area of stratum 1 and etc., A – total area of survey region.

The total biomass in the survey area is estimated by:

(6) $B = \overline{Ca}(A) * A$

where: $\overline{Ca}(A)$ - mean catch for the entire survey area, A – total area of survey region.

4.3.2.2. Geographical distribution patterns

The SGMED 09-01 agreed to prepare common maps of geografic distribution patterns of CPUE and fishing areas for turbot along Bulgarian and Romanian Black Sea coast during the next meeting. The necessary data will be collected under DCR, scientific surveys and VMS data. The distribution of CPUE in 2008 by countries is presented on Figs 4.3.2.2.1, 4.3.2.2.2, 4.3.2.2.3.

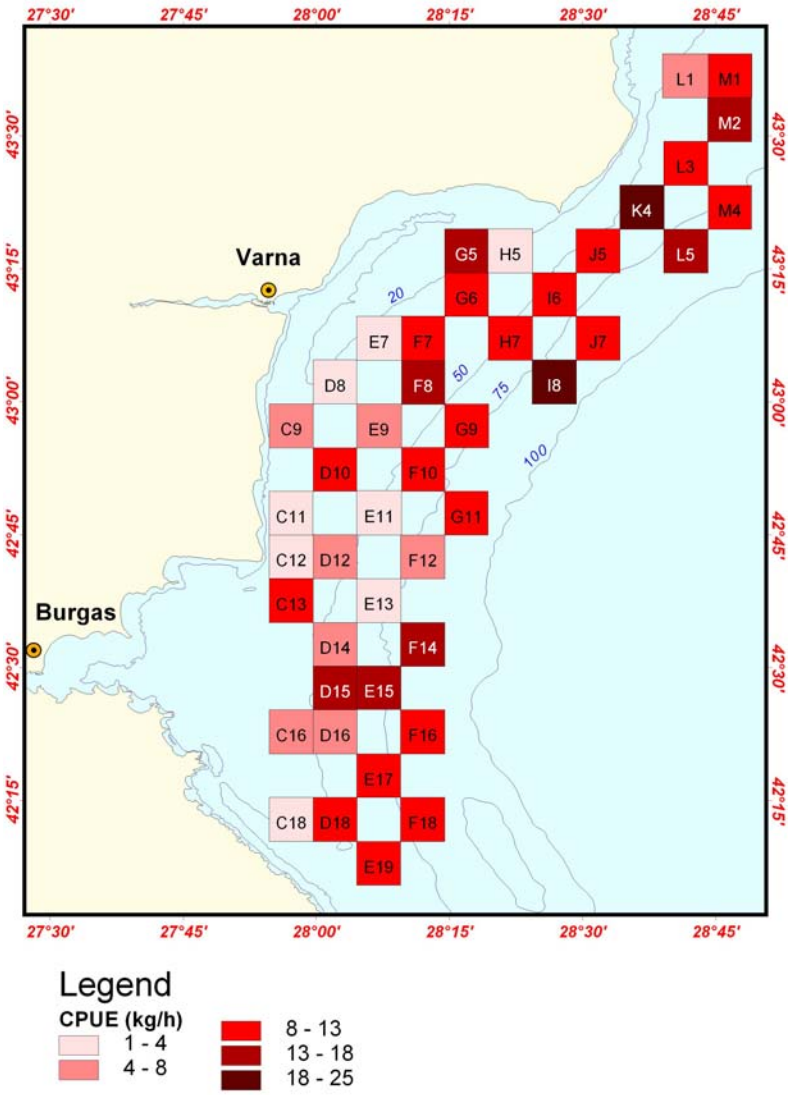


Fig. *4.3.2.2.1*. Distribution of CPUE in the Bulgarian Black Sea during spring scientific survey for turbot in 2008.

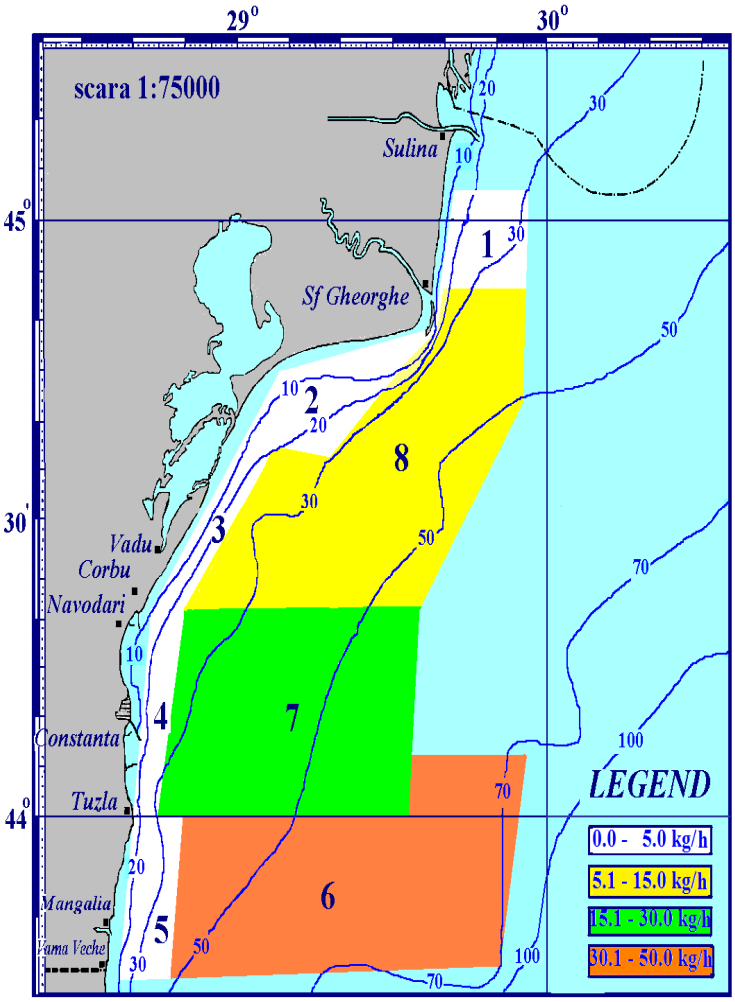


Fig. *4.3.2.2.*2. Distribution and abundance of turbot agglomerations in April 2008, Romania

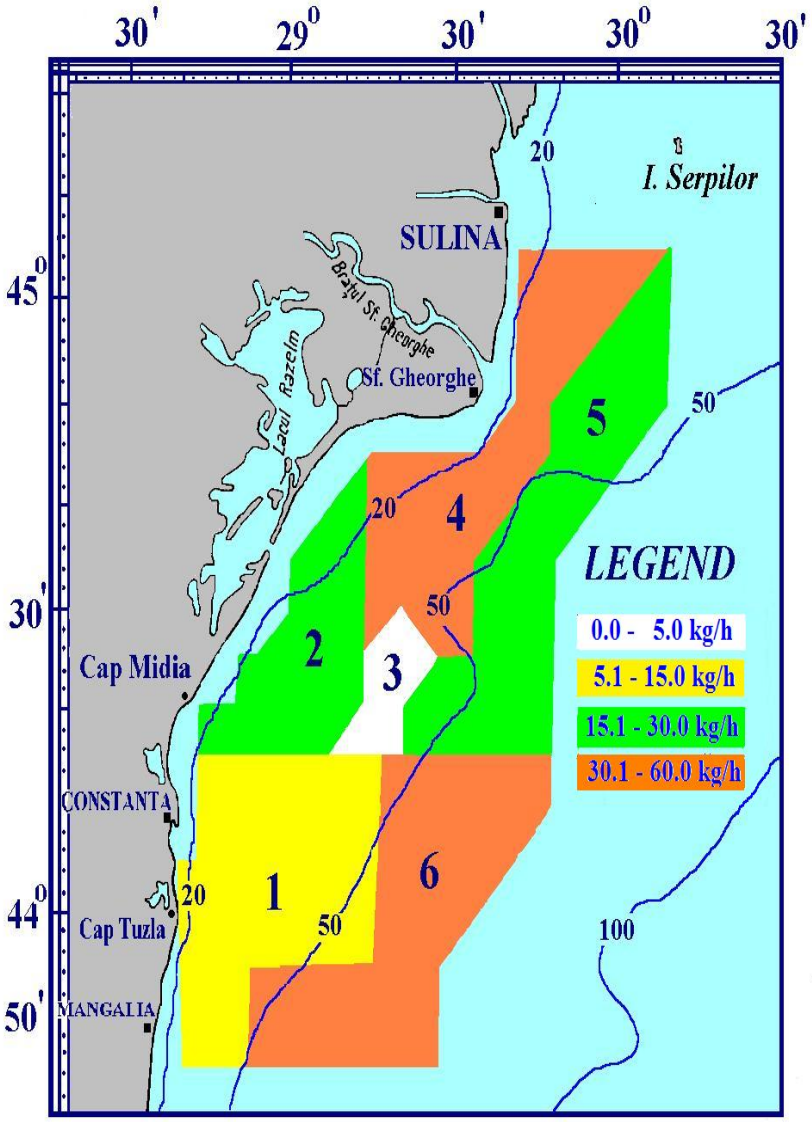


Fig. *4.3.2.2.*3. Distribution and abundance of turbot agglomerations during October 2008, Romania

4.3.2.3. Trends in abundance and biomass

SGMED 09-01 collect fishery independent information regarding the trend of turbot stock, derived from national scientific surveys. The analysis of abundance indices shows slight increase of turbot stock (Fig. 4.3.2.3.1).

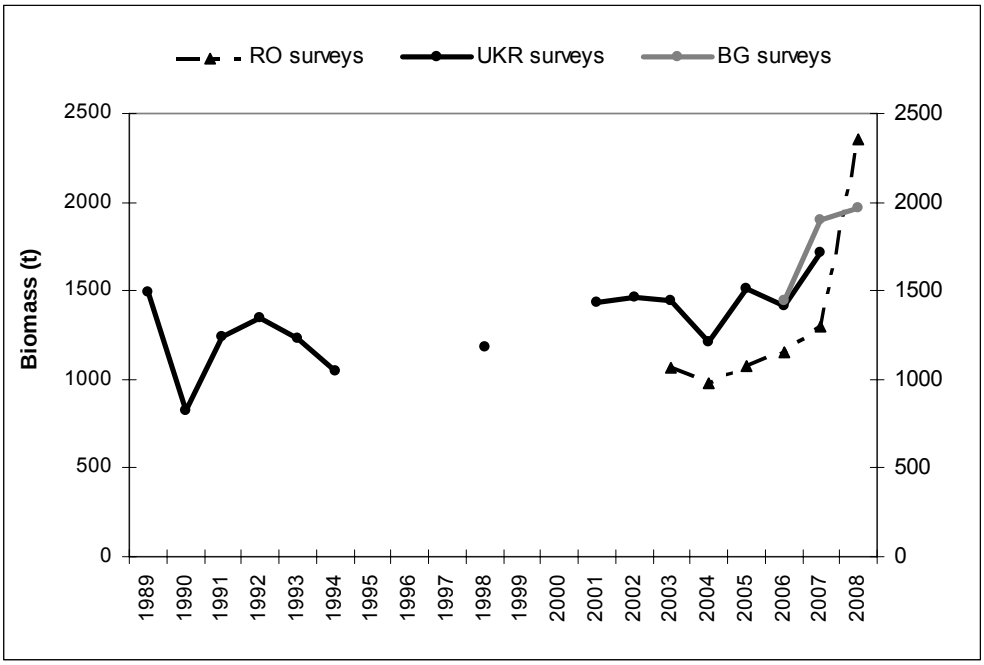
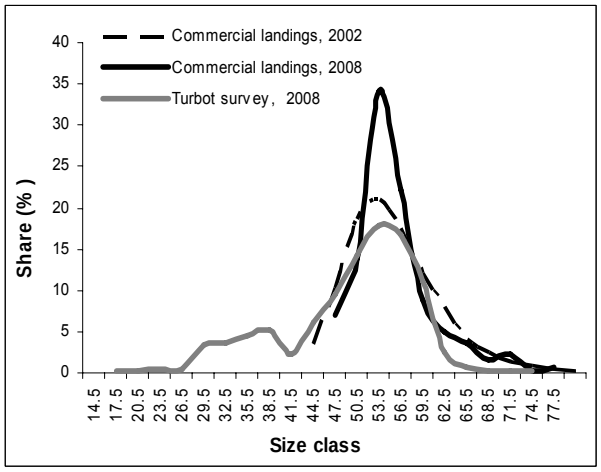


Fig. *4.3.2.3.1* Turbot abundance during scientific surveys in Bulgaria, Romania and Ukraine.

4.3.2.4. Trends in abundance by length or age

SGMED 09-01 analyze the available data for size composition of landings in Bulgaria and Romania, which show close conformity in most abundant size classes in 2008 (Fig. 4.3.2.4.1 A, B). Bulgarian data for length composition of landings and survey data in 2008 present very similar trend, which allow the usage of survey data in analyses, in case if commercial data are not available.

A



B

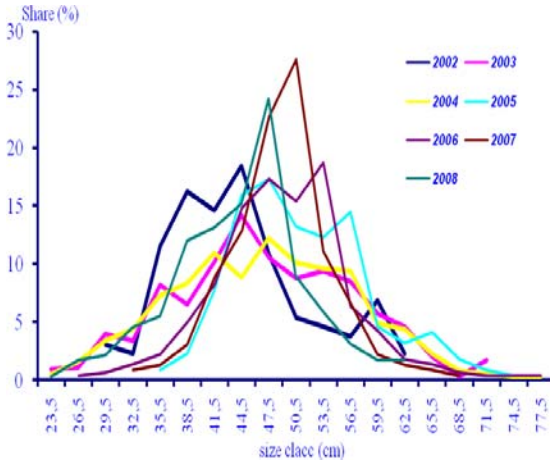


Fig. . 4.3.2.4.1 Size composition of Bulgarian (A) and Romanian (B) landings.

The size structure of catches during scientific surveys in both countries also show consistency (Fig. . 4.5.2.4.2).

A B

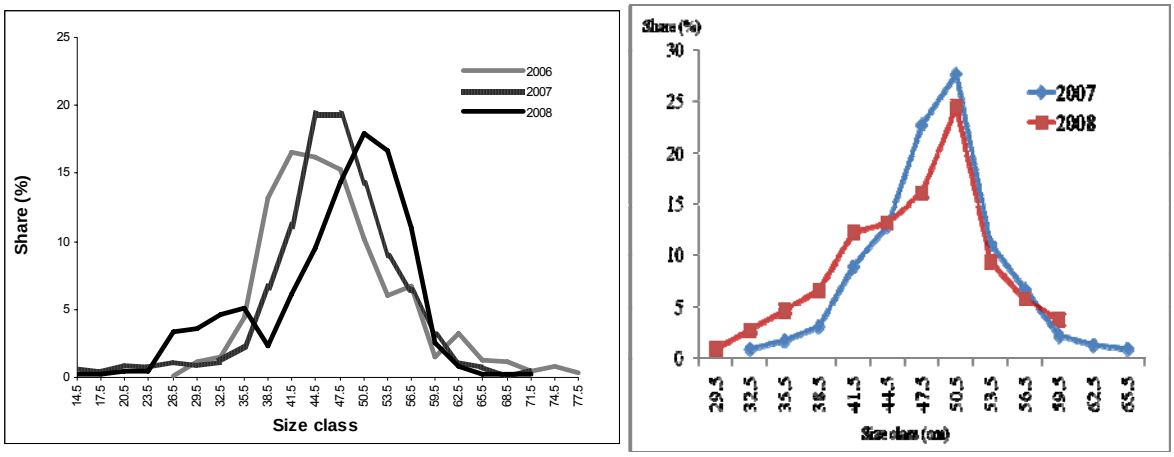


Fig. . 4.3.2.4.2. The lenght frequency (%) of turbot catches during Bulgarian (A) and Romanian surveys, during the period 2007-2008.

Age structure of Romanian landings show maximum of 4-5 old fish, but for Bulgaria such information is not available (Fig. . 4.3.2.4.3).

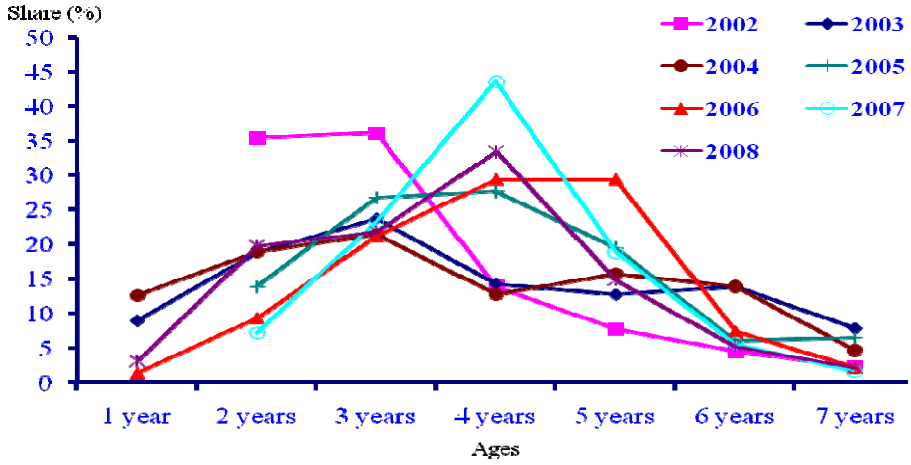


Fig. . 4.3.2.4.3. Age structure of landings in Romanian waters.

Scientific surveys in 2008 presented maximum of 4 – 5-years old fish in Bulgarian and Romanian Black Sea area (Fig. . 4.3.2.4.4).

A B

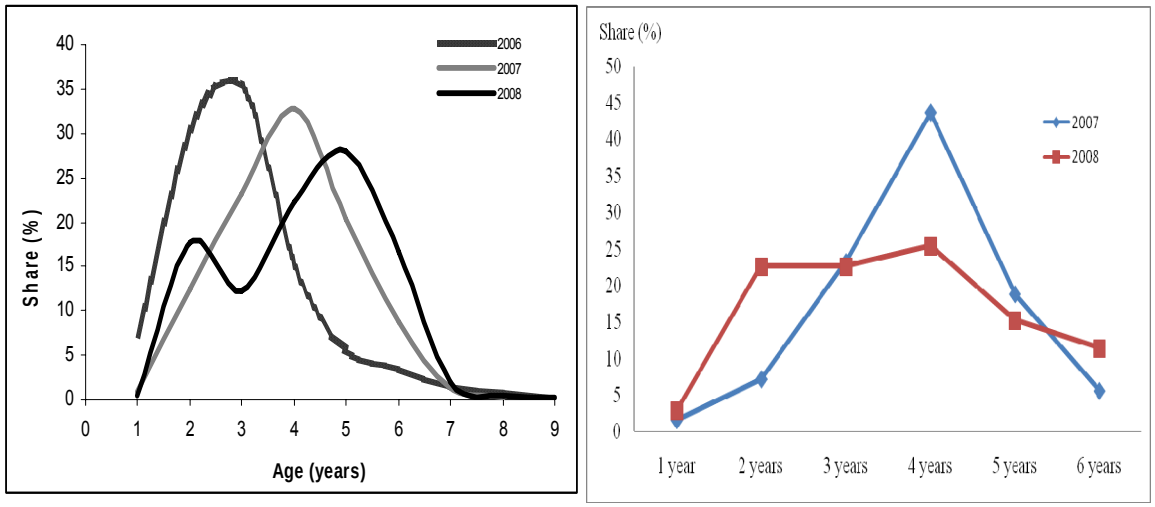


Fig. . 4.3.2.4.4. Age composition of catches during scientific surveys in Bulgarian (A) and Romanian waters (B).

4.3.2.5. Trends in growth

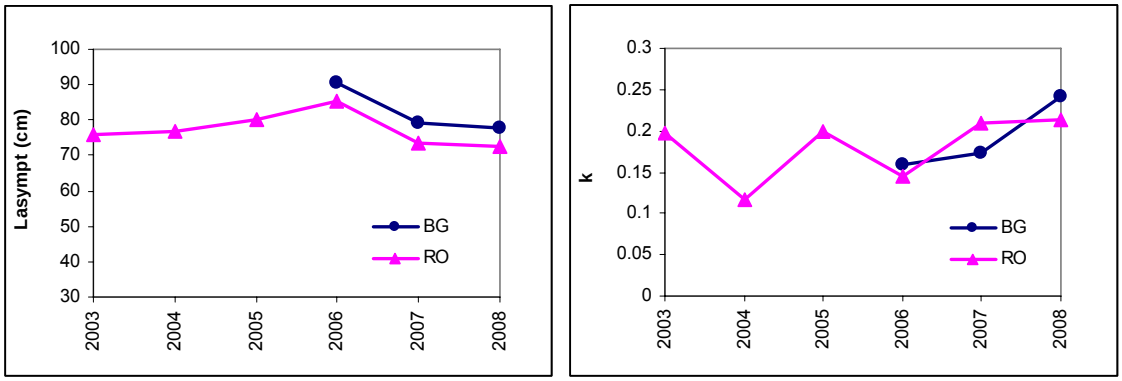


Fig. 4.3.2.5.1. Growth parameters of turbot in Bulgarian and Romanian waters.

4.3.2.6. Trends in maturity

SGMED 09-01 agreed to use the following proportion of turbot maturity at age in the total Black Sea area for the analytical methods – Fig. 4.5.2.6.1

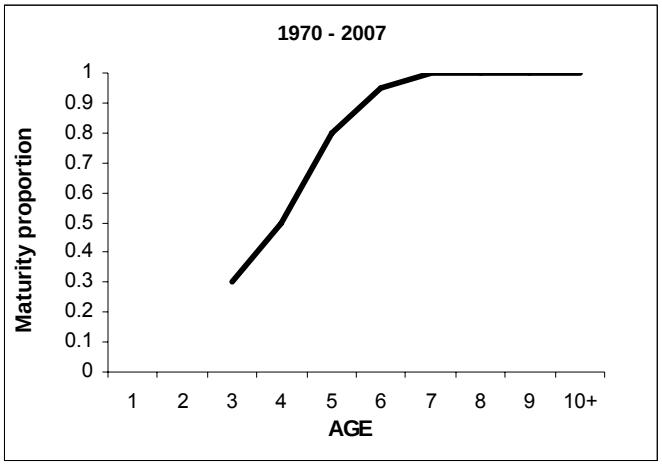


Fig. *4.3.2.6.1* Maturity ogive of turbot.

4.4. Assessment of historic stock parameters

The SGMED 09-01 performed assessment of historic stock parameters for the period 1970 – 2007 using XSA (VPA 3.1, Lowestoft), based on landings at age data of turbot from Bulgaria, Romania, Ukraine and Turkey, which were agreed as representative for the total Black Sea area. Data for the period after 1988 processed by the WG during the previous two meetings were combined with landings at age data from Prodanov et.al (1997).

During the meeting the WG discussed concerns that the official landings are misreported to a unknown extent, and decided to interpret the assessment results from the performed XSA should be applied only as relative and indicative only for the trends in the turbot stock.

During the next meeting the WG will update dataset with Turkish landings and perform new runs of XSA, including 2008.

4.4.1.Method 1: XSA

4.4.2.Justification

The time series available for the period 1970 to 2007 of landings, catch at ages 1-10+, weights at age in the stock and weights at age in the landings, maturity at age and natural mortality were considered appropriate for the application of the XSA. Tunning series from Ukranian and Romanian surveys were used for the XSA.

4.4.3.Input parameters

Historic and recent catch at age data were compiled by using the catch at age data from Prodanov et al (1997) for the period 1970 – 1988 and national statistics by countries after 1988. The catch at age data were corrected to the official landings (SOP corrections). They do represent officially reported landings and do not include any discards.

The mean weights at ages in the stock 1989-1997 were adopted as catch weights at age in the catch due to lack of data. For the mean weights at age during the period 1970 – 1988 were accepted theoretical weights (according to Ivanov, Karapetkova, 1979) due to lack of data.

Natural mortality M is defined to amount to 0.19 at age over the entire assessment.

The maturity ogive was also defined and agreed between WG.

The XSA was tuned with 2 commercial catch rates series from Romania and Ukraine fleets, ages 2-10+ over 1970-2007.

The trends in these CPUE series are shown below in Fig. 4.4.3.1 and Fig. 4.4.3.2. Both series indicate that the recent estimates of the most important age groups 2-5 slightly increase in recent years.

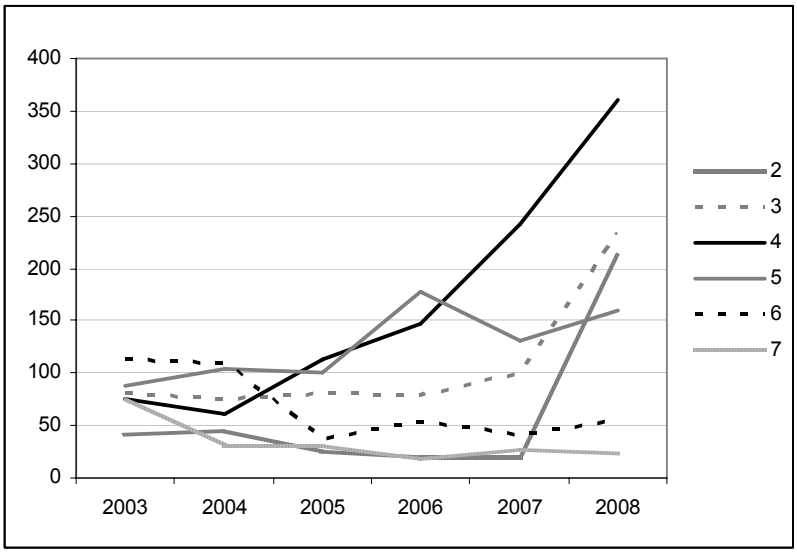


Fig. 4.4.3.1.Turbot in the Black Sea. Trends in the Romanian commercial CPUE series at age.

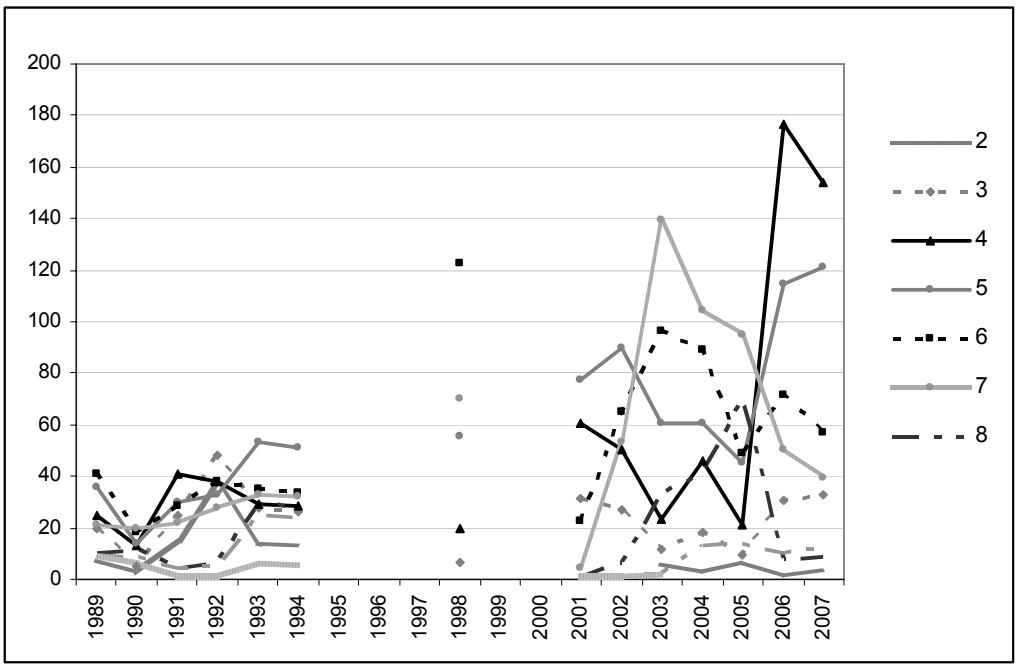


Fig. 4.4.3.2.Turbot in the Black Sea. Trends in the Ukrainean commercial CPUE series at age.

The following tables list (Tabl. *4.4.3.1*, *4.4.3.*2) the input parameters of the XSA.

Table 4.4.3.1 Turbot in the Black Sea 1970-2007. XSA input tables 1-7.

Run title : BLACK SEA TURBOT Total 2009 COMBSEX PLUSGROUP

At 31.3.2009 01:11

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1970	1971	1972	1973	1974	1975	1976	1977
AGE								
1	0	0	0	0	0	0	0	0
2	65	2	2	3	2	0	27	22
3	319	42	70	45	6	10	84	51
4	155	384	48	60	9	28	34	24
5	487	177	194	267	47	132	101	78
6	280	167	200	229	108	91	90	99
7	212	126	168	201	107	58	63	94
8	76	37	69	75	38	18	19	31
9	34	15	27	33	23	7	12	26
#NAME?	37	14	31	48	42	9	33	68
TOTALNUM	1665	964	808	961	382	353	463	493
TONSLAND	5273	3052	3049	3705	1696	1273	1584	2012
SOPCOF %		100	100	100	100	100	100	100

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
AGE										
1	0	0	0	0	0	0	0	0	0	0
2	21	3	13	19	0	0	0	0	0	0
3	61	145	75	80	124	161	62	1	0	1
4	47	103	41	26	74	101	57	3	0	10
5	185	396	160	81	216	383	52	5	6	15
6	127	324	190	145	184	217	86	10	7	55
7	94	246	145	178	185	196	92	19	15	16
8	29	76	48	97	82	79	76	9	0	16
9	18	50	25	54	76	72	52	15	3	10
#NAME?	30	105	51	89	169	153	138	33	39	49
TOTALNUM	612	1449	747	770	1110	1363	615	95	72	171
TONSLAND	2160	5447	2843	3276	4662	5307	2852	527	428	849
SOPCOF %		100	100	100	100	100	100	100	100	100	100

Run title : BLACK SEA TURBOT Total 2009 COMBSEX PLUSGROUP

At 31.3.2009 01:11

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
1	0	4	20	55	18	201	1	19	76	0

2		0	12	56	71	43	436	123	67	38	0
3		0	33	69	121	29	366	283	47	40	62
4		0	41	106	88	30	151	224	309	129	48
5		23	59	96	60	17	63	204	483	167	43
6		35	68	37	47	13	26	63	245	208	50
7		29	35	30	36	15	15	45	86	96	68
8		45	17	21	8	10	15	39	19	42	32
9		10	16	13	6	2	11	34	2	10	13
#NAME?		66	52	36	6	2	3	10	2	0	3
TOTALNUM		209	335	484	498	180	1287	1026	1280	808	319
TONSLAND		1116	1452	1392	935	438	1601	2139	2924	2031	1014
SOPCOF	%		100	100	99	98	100	100	100	100	101	100

Table 1 Catch numbers at age Numbers*10**-3

YEAR		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE											
1		0	0	4	0	0	1	4	2	11	14
2		0	0	109	28	30	9	10	27	52	55
3		9	69	98	42	59	15	20	81	70	104
4		26	113	131	131	45	14	21	83	93	197
5		73	75	107	244	53	23	25	58	68	95
6		175	182	78	319	37	33	30	28	42	49
7		96	145	196	103	26	35	21	23	36	18
8		54	25	110	22	2	6	11	15	7	2
9		11	13	56	3	0	0	1	1	9	2
#NAME?		0	6	17	8	1	0	0	0	0	0
TOTALNUM		444	628	906	900	252	136	144	318	388	537
TONSLAND		1574	1933	2776	2522	592	408	425	727	956	1027
SOPCOF	%		100	100	103	100	105	104	105	99	100	96

Run title : BLACK SEA TURBOT Total 2009 COMBSEX PLUSGROUP

At 31.3.2009 01:11

Table 2 Catch weights at age (kg)

YEAR		1970	1971	1972	1973	1974	1975	1976	1977
AGE									
1		0.614	0.614	0.614	0.614	0.614	0.614	0.614	0.614
2		1.083	1.083	1.083	1.083	1.083	1.083	1.083	1.083
3		1.646	1.646	1.646	1.646	1.646	1.646	1.646	1.646
4		2.292	2.292	2.292	2.292	2.292	2.292	2.292	2.292
5		3.004	3.004	3.004	3.004	3.004	3.004	3.004	3.004
6		3.731	3.731	3.731	3.731	3.731	3.731	3.731	3.731
7		4.456	4.456	4.456	4.456	4.456	4.456	4.456	4.456
8		5.17	5.17	5.17	5.17	5.17	5.17	5.17	5.17
9		5.876	5.876	5.876	5.876	5.876	5.876	5.876	5.876
#NAME?		7.458	7.458	7.458	7.458	7.458	7.458	7.458	7.458
SOPCOFAC		0.9999	1.0001	0.9999	1.0001	0.9998	1.0001	1.0003	1.0002

Table	2	Catch	weights	at	age	(kg)				
YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
AGE										
1	0.614	0.614	0.614	0.614	0.614	0.614	0.614	0.614	0.614	0.614
2	1.083	1.083	1.083	1.083	1.083	1.083	1.083	1.083	1.083	1.083
3	1.646	1.646	1.646	1.646	1.646	1.646	1.646	1.646	1.646	1.646
4	2.292	2.292	2.292	2.292	2.292	2.292	2.292	2.292	2.292	2.292
5	3.004	3.004	3.004	3.004	3.004	3.004	3.004	3.004	3.004	3.004
6	3.731	3.731	3.731	3.731	3.731	3.731	3.731	3.731	3.731	3.731
7	4.456	4.456	4.456	4.456	4.456	4.456	4.456	4.456	4.456	4.456
8	5.17	5.17	5.17	5.17	5.17	5.17	5.17	5.17	5.17	5.17
9	5.876	5.876	5.876	5.876	5.876	5.876	5.876	5.876	5.876	5.876
#NAME?	7.458	7.458	7.458	7.458	7.458	7.458	7.458	7.458	7.458	7.458
SOPCOFAC	1.0001	1	1.0001	1.0002	0.9999	1.0001	1.0001	1.0002	0.9991	0.9995

Run	title	:	BLACK	SEA	TURBOT	Total	2009	COMBSEX	PLUSGROUP
At	31.3.2009	01:11							

Table	2	Catch	weights	at	age	(kg)				
YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
1	0.614	0.5	0.457	0.383	0.727	0.453	0.6	0.09	0.417	0.417
2	1.083	1	0.73	0.777	0.947	0.893	0.76	0.72	0.822	0.822
3	1.646	1.4	1.247	1.153	1.427	1.1	1.07	0.953	1	1
4	2.292	1.8	1.777	1.71	1.997	1.543	1.593	1.57	1.6	1.6
5	3.004	2.2	2.16	2.12	2.647	2.087	2.083	2.22	2.1	2.1
6	3.731	3.3	3.243	3.03	3.907	2.963	2.597	2.993	2.8	2.8
7	4.456	4	3.9	4.257	5.283	4.443	4.2	4.423	4.3	4.3
8	5.17	5.3	5.447	5.467	6.3	5.82	5.9	6	6	6
9	5.876	6.6	6.5	6.6	8.8	8.34	8.3	8.5	9.5	9.5
#NAME?	7.458	12.117	12.278	12.352	9.537	9.369	9.473	9.5	10.314	10.5
SOPCOFAC	1.0004	1.0001	0.9875	0.982	0.9999	1.0002	1.0001	1	1.0124	1

Table	2	Catch	weights	at	age	(kg)				
YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE										
1	0.417	0.417	0.18	0.417	0.417	0.477	0.486	0.16	0.621	0.291
2	0.822	0.822	0.43	0.822	0.852	0.793	0.973	0.843	0.999	0.794
3	1.3	1.3	1.227	1.3	1.283	1.292	1.429	1.321	1.507	1.4
4	1.7	1.7	1.567	1.7	1.938	1.975	1.953	1.938	2.114	1.891
5	2.2	2.2	2.223	2.3	2.532	2.4	2.517	2.545	2.68	2.441
6	3.1	3.1	2.87	3.1	3.197	3.116	3.183	3.436	3.501	3.119
7	4.3	4.3	3.913	4.1	4.117	4.078	4.238	4.388	4.467	4.706
8	6	6	5.233	5.7	5.4	5.4	5.796	5.78	5.828	6.06
9	7	7	6.62	9.5	6.6	6.6	6.8	7.5	7.4	7.5
#NAME?	10.314	9.5	8.321	12.667	10.25	10	10.314	9.842	10.314	9

SOPCOFAC	0.9999	1	1.0309	1.0011	1.0457	1.0445	1.0516	0.9891	1.0004	0.963

Run title : BLACK SEA TURBOT Total 2009 COMBSEX PLUSGROUP

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Table 3 Stock weights at age (kg)

YEAR	1970	1971	1972	1973	1974	1975	1976	1977
AGE								
1	0.614	0.614	0.614	0.614	0.614	0.614	0.614	0.614
2	1.083	1.083	1.083	1.083	1.083	1.083	1.083	1.083
3	1.646	1.646	1.646	1.646	1.646	1.646	1.646	1.646
4	2.292	2.292	2.292	2.292	2.292	2.292	2.292	2.292
5	3.004	3.004	3.004	3.004	3.004	3.004	3.004	3.004
6	3.731	3.731	3.731	3.731	3.731	3.731	3.731	3.731
7	4.456	4.456	4.456	4.456	4.456	4.456	4.456	4.456
8	5.17	5.17	5.17	5.17	5.17	5.17	5.17	5.17
9	5.876	5.876	5.876	5.876	5.876	5.876	5.876	5.876
#NAME?	7.458	7.458	7.458	7.458	7.458	7.458	7.458	7.458

Table 3 Stock weights at age (kg)

YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
AGE										
1	0.614	0.614	0.614	0.614	0.614	0.614	0.614	0.614	0.614	0.614
2	1.083	1.083	1.083	1.083	1.083	1.083	1.083	1.083	1.083	1.083
3	1.646	1.646	1.646	1.646	1.646	1.646	1.646	1.646	1.646	1.646
4	2.292	2.292	2.292	2.292	2.292	2.292	2.292	2.292	2.292	2.292
5	3.004	3.004	3.004	3.004	3.004	3.004	3.004	3.004	3.004	3.004
6	3.731	3.731	3.731	3.731	3.731	3.731	3.731	3.731	3.731	3.731
7	4.456	4.456	4.456	4.456	4.456	4.456	4.456	4.456	4.456	4.456
8	5.17	5.17	5.17	5.17	5.17	5.17	5.17	5.17	5.17	5.17
9	5.876	5.876	5.876	5.876	5.876	5.876	5.876	5.876	5.876	5.876
#NAME?	7.458	7.458	7.458	7.458	7.458	7.458	7.458	7.458	7.458	7.458

Run title : BLACK SEA TURBOT Total 2009 COMBSEX PLUSGROUP

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Table 3 Stock weights at age (kg)

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
1	0.614	0.5	0.457	0.383	0.727	0.453	0.6	0.09	0.614	0.614
2	1.083	1	0.73	0.777	0.947	0.893	0.76	0.72	1.083	1.083
3	1.646	1.4	1.247	1.153	1.427	1.1	1.07	0.953	1	1
4	2.292	1.8	1.777	1.71	1.997	1.543	1.593	1.57	1.6	1.6

5	3.004	2.2	2.16	2.12	2.647	2.087	2.083	2.22	2.1	2.1
6	3.731	3.3	3.243	3.03	3.907	2.963	2.597	2.993	2.8	2.8
7	4.456	4	3.9	4.257	5.283	4.443	4.2	4.423	4.3	4.3
8	5.17	5.3	5.447	5.467	6.3	5.82	5.9	6	6	6
9	5.876	6.6	6.5	6.6	8.8	8.34	8.3	8.5	9.5	9.5
#NAME?	7.458	12.117	12.278	12.352	9.537	9.369	9.473	9.5	7.458	10.5

Table 3 Stock weights at age (kg)

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE										
1	0.614	0.614	0.18	0.614	0.614	0.614	0.486	0.16	0.621	0.291
2	1.083	1.083	1.083	1.083	0.852	0.793	0.973	0.843	0.999	0.794
3	1.3	1.3	1.227	1.3	1.283	1.292	1.429	1.321	1.507	1.4
4	1.7	1.7	1.567	1.7	1.938	1.975	1.953	1.938	2.114	1.891
5	2.2	2.2	2.223	2.3	2.532	2.4	2.517	2.545	2.68	2.441
6	3.1	3.1	2.87	3.1	3.197	3.116	3.183	3.436	3.501	3.119
7	4.3	4.3	3.913	4.1	4.117	4.078	4.238	4.388	4.467	4.706
8	6	6	5.233	5.7	5.4	5.4	5.796	5.78	5.828	6.06
9	7	7	6.62	9.5	6.6	6.6	6.8	7.5	7.4	7.5
#NAME?	10.314	9.5	8.321	12.667	10.25	10	7.458	9.842	7.458	9

Run title : BLACK SEA TURBOT Total 2009 COMBSEX PLUSGROUP

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Table 4 Natural Mortality (M) at age

YEAR	1970	1971	1972	1973	1974	1975	1976	1977
AGE								
1	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
2	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
3	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
4	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
5	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
6	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
7	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
8	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
9	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
#NAME?	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19

Table 4 Natural Mortality (M) at age

YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
AGE										
1	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
2	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
3	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
4	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
5	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19

6	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
7	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
8	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
9	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
#NAME?	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19

Run title : BLACK SEA TURBOT Total 2009 COMBSEX PLUSGROUP

At 31.3.2009 01:11

Table 4 Natural Mortality (M) at age

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
1	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
2	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
3	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
4	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
5	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
6	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
7	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
8	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
9	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
#NAME?	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19

Table 4 Natural Mortality (M) at age

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE										
1	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
2	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
3	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
4	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
5	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
6	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
7	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
8	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
9	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
#NAME?	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19

Run title : BLACK SEA TURBOT Total 2009 COMBSEX PLUSGROUP

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Table 5 Proportion mature at age

YEAR	1970	1971	1972	1973	1974	1975	1976	1977
AGE								

1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
5	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
6	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
7	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1
#NAME?	1	1	1	1	1	1	1	1

Table 5 Proportion mature at age

YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
AGE										
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
5	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
6	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
7	1	1	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1	1	1
#NAME?	1	1	1	1	1	1	1	1	1	1

Run title : BLACK SEA TURBOT Total 2009 COMBSEX PLUSGROUP

At 31.3.2009 01:11

Table 5 Proportion mature at age

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
5	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
6	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
7	1	1	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1	1	1
#NAME?	1	1	1	1	1	1	1	1	1	1

Table 5 Proportion mature at age

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE										
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0

3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
5	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
6	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
7	1	1	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1	1	1
#NAME?	1	1	1	1	1	1	1	1	1	1

Run title : BLACK SEA TURBOT Total 2009 COMBSEX PLUSGROUP

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Table 6 Proportion of M before Spawning

YEAR	1970	1971	1972	1973	1974	1975	1976	1977
AGE								
1	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
2	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
3	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
4	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
5	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
6	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
7	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
8	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
9	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
#NAME?	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25

Table 6 Proportion of M before Spawning

YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
AGE										
1	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
2	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
3	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
4	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
5	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
6	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
7	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
8	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
9	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
#NAME?	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25

Run title : BLACK SEA TURBOT Total 2009 COMBSEX PLUSGROUP

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Table	6	Proportion	of	M	before	Spawning				
YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
1	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
2	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
3	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
4	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
5	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
6	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
7	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
8	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
9	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
#NAME?	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25

Table	6	Proportion	of	M	before	Spawning				
YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE										
1	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
2	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
3	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
4	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
5	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
6	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
7	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
8	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
9	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
#NAME?	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25

Run	title	:	BLACK	SEA	TURBOT	Total	2009	COMBSEX	PLUSGROUP
At	31.3.2009	01:11							

Table	7	Proportion	of	F	before	Spawning			
YEAR	1970	1971	1972	1973	1974	1975	1976	1977	
AGE									
1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
2	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
3	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
7	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
8	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
9	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
#NAME?	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	

Table	7	Proportion	of	F	before	Spawning				
YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987

AGE										
1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
2	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
3	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
7	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
8	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
9	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
#NAME?	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5

Run title : BLACK SEA TURBOT Total 2009 COMBSEX PLUSGROUP

At 31.3.2009 01:11

Table 7 Proportion of F before Spawning

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
2	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
3	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
7	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
8	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
9	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
#NAME?	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5

Table 7 Proportion of F before Spawning

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE										
1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
2	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
3	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
7	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
8	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
9	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
#NAME?	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5

Table 4.4.3.1.2 Turbot in the Black Sea 1970-2007. Tuning series used in the XSA.

BLACK SEA TURBOT Total 2009 COMBSEX TUNING DATA(effort nos at age)
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RO	Trawl	fleet							
2003	2007								
1	1	0.25	0.8						
2	7								
1	42.128	79.962	75.329	87.249	112.536	75.571			
1	44.134	75.775	60.611	103.477	108.773	30.69			
1	25.087	81.031	113.648	99.979	37.855	30.366			
1	18.894	78.997	146.391	177.682	54.103	18.398			
1	19.205	100.181	242.311	131.348	41.724	26.786			
UKR	Trawl	survey							
1989	2007								
1	1	0.25	0.8						
2	10								
1	7.107	19.901	24.774	35.74	41.019	20.916	10.153	9.544	8.935
1	2.862	5.128	13.117	13.833	18.126	19.676	11.686	8.705	5.843
1	15.301	24.842	41.044	29.703	28.803	21.602	4.68	4.14	0.9
1	36.745	48.051	37.772	33.147	38.029	28.008	6.424	5.396	1.028
1	14.045	27.579	29.367	53.371	34.729	33.197	29.367	25.026	5.618
1	13.487	26.484	28.201	51.252	33.35	31.879	28.201	24.032	5.395
1	-9	-9	-9	-9	-9	-9	-9	-9	-9
1	-9	-9	-9	-9	-9	-9	-9	-9	-9
1	-9	-9	-9	-9	-9	-9	-9	-9	-9
1	-9	6.453	19.359	55.497	122.932	70.339	37.105	10.97	-9
1	-9	-9	-9	-9	-9	-9	-9	-9	-9
1	-9	-9	-9	-9	-9	-9	-9	-9	-9
1	10.23	31.56	60.944	77.703	22.854	4.571	0.653	0.653	0.653
1	-9	27.166	50.198	89.765	64.962	53.151	6.791	1.476	0.886
1	5.976	11.578	23.53	60.505	95.986	139.684	33.24	1.867	1.12
1	3.219	18.509	45.968	60.233	89.022	104.555	40.844	12.845	-9
1	6.397	9.5	20.993	45.174	49.18	95.172	70.173	13.611	3.23
1	1.389	30.567	176.456	114.858	71.323	50.482	7.873	10.189	-9
1	3.445	33.159	153.739	121.441	56.845	39.619	9.043	12.058	1.292

4.4.4.Results

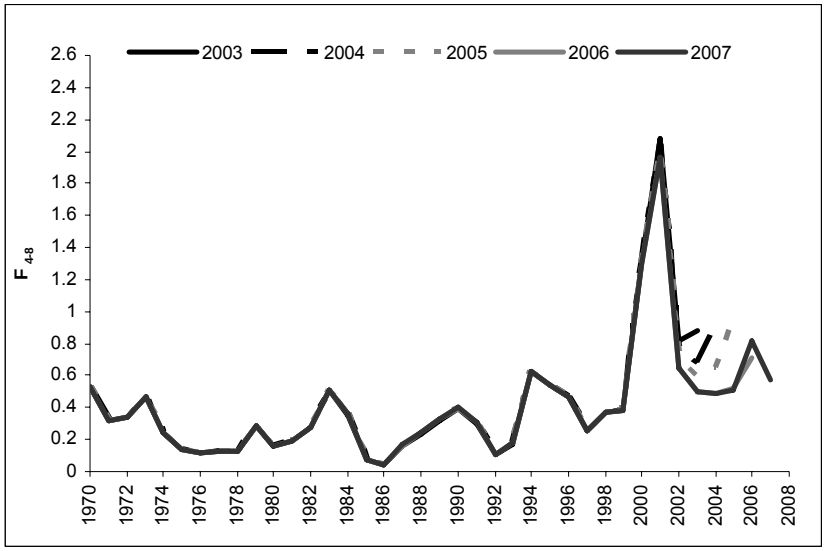
SGMED 09-01 applied Extended Survivors Analysis (XSA) (Shepherd, 1992) and the technique "shrinkage to the mean" was used in order to stabilize the analysis. It takes into account the mean F (or N) over the recent years in the calculation of the last year F's or N's, which means an additional constraint on the last year estimates. In XSA two shrinkage options are available: shrinkage to the population mean or N shrinkage applied to recruitment and shrinkage to the mean F (F shrinkage) which is applied to all last year F's as well as to the oldest age F's.

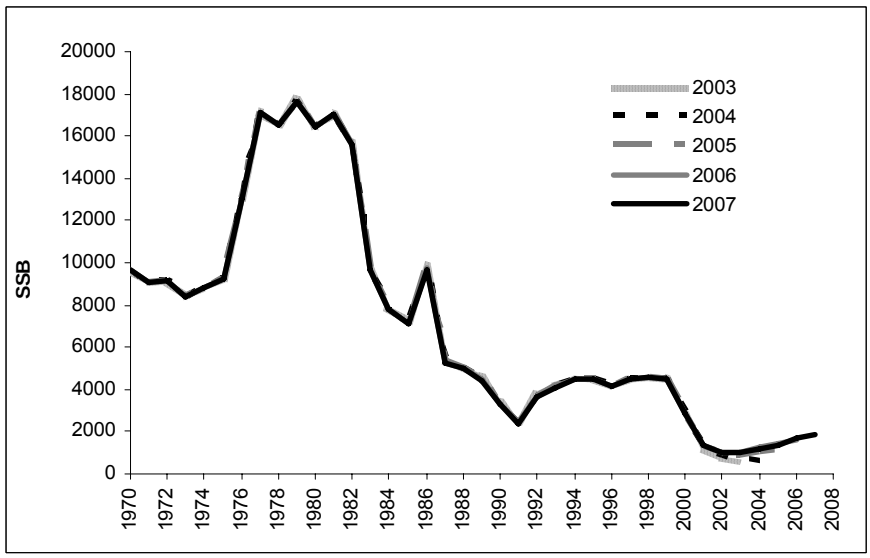
The tuning of the XSA is defined according to the default settings of the program. Catchability is set dependent on stock size for ages <3 and independent of age for ages >=5.

The Romanian fleet gets the majority of the weight for the calculation of the survivors of ages 3-5 and the corresponding fishing mortality. This is confirmed from the tuning diagnostics, which indicate standard errors of the log transformed catchabilities and regression parameters (slopes and r-squared) at acceptable levels. Diagnostics of the Ukraine CPUE are poor and explain the low weight it gets in the calculation of survivors and terminal fishing mortality (Tabl. 4.6.4.1).

Fig. 4.4.4.1 illustrates the retrospective behaviour of the assessment parameters fishing mortality (average over ages 4-8), SSB and recruitment. These retrospective assessments do not indicate any significant bias in the

estimations of such stock parameters. However, it seems that XSA over-estimate F and under-estimate recruitment and SSB in 2003-2005 but not in 2006.





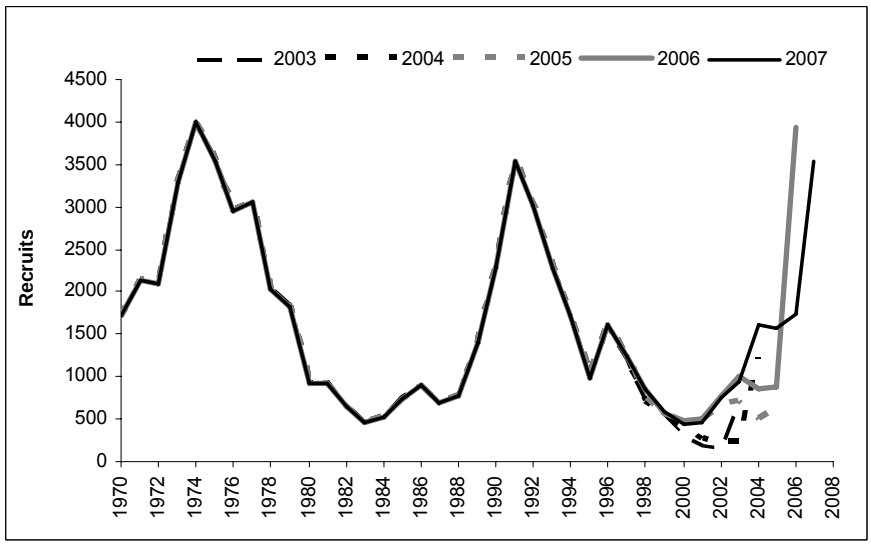


Fig. 4.4.4.1 Turbot in the Black Sea. Retrospective trends of the assessment parameters fishing mortality (average over ages 4-8), SSB and recruitment.

XSA outputs are listed in the Tabl. 4.4.4.1

Table 4.6.4.1 Turbot in the Black Sea. XSA tuning settings and diagnostics, shrinkage option.

Run	title	:	BLACK	SEA	TURBOT	Total	2009	COMBSEX	PLUSGROUP		
At	31.3.2009	03:42									
Terminal	Fs	derived	using	XSA	(With	F	shrinkage)				
Table	8	Fishing	mortality	(F)	at	age					
YEAR	1970	1971	1972	1973	1974	1975	1976	1977			
AGE											
1	0	0	0	0	0	0	0	0			
2	0.0349	0.0012	0.0011	0.0021	0.0009	0.0001	0.0102	0.0098			
3	0.1656	0.0282	0.0677	0.035	0.0045	0.005	0.0344	0.0236			
4	0.1344	0.3039	0.0397	0.0756	0.0088	0.0264	0.0205	0.0121			
5	0.472	0.2222	0.2444	0.3203	0.0768	0.166	0.1246	0.0591			
6	0.5209	0.2871	0.415	0.5033	0.2039	0.2076	0.1614	0.1717			
7	0.7768	0.4668	0.5195	0.9801	0.4596	0.1592	0.2153	0.2499			
8	0.7567	0.2878	0.5021	0.4577	0.4767	0.1247	0.0691	0.1563			
9	0.5362	0.3153	0.3462	0.4707	0.2463	0.1373	0.1186	0.1303			
#NAME?	0.5362	0.3153	0.3462	0.4707	0.2463	0.1373	0.1186	0.1303			
FBAR	-3	7	0.4139	0.2616	0.2573	0.3828	0.1507	0.1128	0.1112	0.1033	

Table	8	Fishing	mortality	(F)	at	age					
YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	
AGE											
1	0	0	0	0	0	0	0	0	0	0	
2	0.0093	0.0023	0.0092	0.0281	0.0001	0.0001	0.0002	0.0002	0.0001	0.0001	
3	0.0341	0.0801	0.0613	0.074	0.2504	0.3283	0.167	0.0033	0.0002	0.003	
4	0.0273	0.0739	0.0287	0.0268	0.09	0.3267	0.1803	0.0099	0.0012	0.0368	
5	0.1208	0.3287	0.1545	0.0728	0.3222	0.8816	0.2781	0.0227	0.0279	0.0782	
6	0.1273	0.3173	0.2557	0.2036	0.2324	0.6172	0.4855	0.0799	0.0393	0.3555	
7	0.2419	0.3846	0.2261	0.4	0.4257	0.4126	0.5792	0.1784	0.1579	0.1118	
8	0.1109	0.3116	0.1184	0.2297	0.3222	0.3217	0.272	0.0952	0.0036	0.2442	
9	0.1261	0.2847	0.1573	0.1873	0.2799	0.5158	0.3612	0.0774	0.0461	0.1659	
#NAME?	0.1261	0.2847	0.1573	0.1873	0.2799	0.5158	0.3612	0.0774	0.0461	0.1659	
FBAR	-3	7	0.1103	0.2369	0.1453	0.1554	0.2641	0.5133	0.338	0.0589	0.0453 0.1171

Run	title	:	BLACK	SEA	TURBOT	Total	2009	COMBSEX	PLUSGROUP		
At	31.3.2009	03:42									
Terminal	Fs	derived	using	XSA	(With	F	shrinkage)				
Table	8	Fishing	mortality	(F)	at	age					

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997		
AGE												
1	0	0.0029	0.0098	0.0173	0.0065	0.1021	0.0004	0.0211	0.0534	0		
2	0.0001	0.0204	0.0552	0.0426	0.0165	0.215	0.0826	0.0534	0.0539	0		
3	0.0001	0.0806	0.1587	0.1586	0.0219	0.1893	0.2089	0.0405	0.0409	0.1148		
4	0.0007	0.0936	0.396	0.3066	0.0523	0.1493	0.1677	0.3664	0.1486	0.0623		
5	0.1158	0.2138	0.3246	0.4078	0.0891	0.1498	0.3071	0.6462	0.342	0.0669		
6	0.27	0.5705	0.202	0.2588	0.146	0.1856	0.215	0.7361	0.642	0.1587		
7	0.3165	0.4615	0.5209	0.3051	0.1226	0.2323	0.5532	0.5095	0.7273	0.4391		
8	0.5139	0.3018	0.5628	0.268	0.1248	0.1653	1.8885	0.4673	0.4967	0.5604		
9	0.2446	0.3328	0.4041	0.3097	0.1057	0.2057	0.6883	0.5412	0.4838	0.2847		
#NAME?	0.2446	0.3328	0.4041	0.3097	0.1057	0.2057	0.6883	0.5412	0.4838	0.2847		
FBAR	-3	7	0.1406	0.284	0.3204	0.2874	0.0864	0.1813	0.2904	0.4598	0.3802	0.1684

Table 8 Fishing mortality (F) at age

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	FBAR	**-**
AGE												
1	0	0	0.0092	0	0	0.0016	0.0026	0.0011	0.0071	0.0044	0.0042	
2	0	0	0.2886	0.0892	0.0916	0.0152	0.014	0.0226	0.0453	0.0435	0.0372	
3	0.0094	0.0945	0.2035	0.1692	0.2703	0.0583	0.0441	0.1502	0.0741	0.1181	0.1142	
4	0.0629	0.1572	0.2586	0.4584	0.2704	0.0922	0.1094	0.2595	0.2566	0.3061	0.2741	
5	0.125	0.2635	0.2162	1.0901	0.3304	0.2165	0.2396	0.4795	0.3493	0.446	0.4249	
6	0.4138	0.5148	0.4732	2.0559	0.4435	0.3494	0.4858	0.4462	0.7686	0.447	0.5539	
7	0.5135	0.7195	2.08	3.295	1.1161	1.0397	0.39	0.8396	2.0718	0.8989	1.2701	
8	0.7595	0.2382	3.4556	2.9245	1.0769	0.8202	1.2262	0.5419	0.6489	0.7801	0.657	
9	0.3795	0.3832	1.3125	1.9818	0.6085	0.4441	0.41	0.4194	0.7156	0.4472	0.5274	
#NAME?	0.3795	0.3832	1.3125	1.9818	0.6085	0.4441	0.41	0.4194	0.7156	0.4472		
FBAR	-3	7	0.2249	0.3499	0.6463	1.4137	0.4861	0.3512	0.2538	0.435	0.7041	0.4432

Run title : BLACK SEA TURBOT Total 2009 COMBSEX PLUSGROUP

At 31.3.2009 03:42

Terminal Fs derived using XSA (With F shrinkage)

Table 9 Relative F at age

YEAR	1970	1971	1972	1973	1974	1975	1976	1977
AGE								
1	0	0	0	0	0	0	0	0
2	0.0843	0.0048	0.0044	0.0055	0.0059	0.0006	0.0913	0.0946
3	0.4	0.1078	0.2632	0.0914	0.03	0.0443	0.3094	0.2281
4	0.3247	1.1614	0.1543	0.1974	0.0585	0.2341	0.1843	0.1168
5	1.1403	0.8492	0.9501	0.8366	0.5093	1.4713	1.1203	0.5727
6	1.2583	1.0975	1.613	1.3146	1.353	1.8394	1.4507	1.6627
7	1.8767	1.7841	2.0194	2.56	3.0491	1.4109	1.9352	2.4196
8	1.828	1.0998	1.9517	1.1956	3.1628	1.105	0.6212	1.5137
9	1.2955	1.2051	1.3456	1.2295	1.6343	1.2163	1.0657	1.2613
#NAME?	1.2955	1.2051	1.3456	1.2295	1.6343	1.2163	1.0657	1.2613
REFMEAN	0.4139	0.2616	0.2573	0.3828	0.1507	0.1128	0.1112	0.1033

Table	9	Relative	F	at	age					
YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
AGE										
1	0	0	0.0001	0.0001	0	0	0	0.0002	0.0002	0.0001
2	0.0841	0.0097	0.0633	0.181	0.0004	0.0003	0.0006	0.003	0.0029	0.0009
3	0.3091	0.3381	0.422	0.476	0.9481	0.6397	0.4941	0.0569	0.0049	0.026
4	0.2476	0.312	0.1976	0.1722	0.3406	0.6364	0.5334	0.1681	0.027	0.3144
5	1.0956	1.3874	1.0637	0.4683	1.22	1.7177	0.8228	0.386	0.6155	0.6679
6	1.1545	1.3391	1.7603	1.3098	0.8798	1.2024	1.4363	1.3576	0.8672	3.037
7	2.1932	1.6234	1.5564	2.5737	1.6115	0.8038	1.7134	3.0314	3.4855	0.9547
8	1.0052	1.3153	0.8153	1.4781	1.22	0.6268	0.8047	1.6182	0.0805	2.0865
9	1.143	1.2017	1.0826	1.2053	1.0598	1.0049	1.0685	1.3157	1.0173	1.4175
#NAME?	1.143	1.2017	1.0826	1.2053	1.0598	1.0049	1.0685	1.3157	1.0173	1.4175
REFMEAN	0.1103	0.2369	0.1453	0.1554	0.2641	0.5133	0.338	0.0589	0.0453	0.1171

Run title : BLACK SEA TURBOT Total 2009 COMBSEX PLUSGROUP

At 31.3.2009 03:42

Terminal Fs derived using XSA (With F shrinkage)

Table	9	Relative	F	at	age					
YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
1	0.0001	0.0102	0.0307	0.0603	0.075	0.5634	0.0015	0.046	0.1405	0.0001
2	0.0009	0.072	0.1721	0.1483	0.191	1.1861	0.2844	0.1162	0.1418	0.0001
3	0.0009	0.2838	0.4951	0.5518	0.254	1.0442	0.7193	0.0881	0.1077	0.6816
4	0.0051	0.3294	1.2358	1.067	0.6054	0.8236	0.5775	0.797	0.3909	0.37
5	0.8237	0.7529	1.0131	1.4192	1.0315	0.8266	1.0576	1.4055	0.8996	0.3974
6	1.9197	2.009	0.6303	0.9005	1.6899	1.024	0.7405	1.6012	1.6887	0.9425
7	2.2506	1.6249	1.6256	1.0615	1.4192	1.2816	1.9052	1.1082	1.9131	2.6085
8	3.6541	1.0628	1.7562	0.9324	1.4449	0.9121	6.5034	1.0165	1.3065	3.3285
9	1.7389	1.1717	1.261	1.0776	1.2237	1.1347	2.3702	1.1772	1.2727	1.6909
#NAME?	1.7389	1.1717	1.261	1.0776	1.2237	1.1347	2.3702	1.1772	1.2727	1.6909
REFMEAN	0.1406	0.284	0.3204	0.2874	0.0864	0.1813	0.2904	0.4598	0.3802	0.1684

Table	9	Relative	F	at	age							
YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	MEAN	**-**
AGE												
1	0.0001	0.0001	0.0142	0	0	0.0044	0.0102	0.0025	0.0101	0.0098	0.0075	
2	0	0	0.4465	0.0631	0.1884	0.0434	0.0551	0.052	0.0644	0.0982	0.0715	
3	0.0418	0.2702	0.3149	0.1197	0.5561	0.1659	0.1737	0.3454	0.1053	0.2665	0.239	
4	0.2797	0.4493	0.4001	0.3243	0.5561	0.2625	0.4311	0.5964	0.3645	0.6907	0.5505	
5	0.5556	0.7531	0.3345	0.7711	0.6797	0.6165	0.9442	1.1022	0.4962	1.0063	0.8682	
6	1.8399	1.4712	0.7321	1.4542	0.9122	0.9949	1.9143	1.0258	1.0916	1.0084	1.0419	
7	2.283	2.0562	3.2184	2.3307	2.2959	2.9601	1.5367	1.9301	2.9425	2.0281	2.3002	
8	3.3769	0.6808	5.3468	2.0687	2.2152	2.3352	4.8313	1.2459	0.9216	1.7601	1.3092	
9	1.6871	1.0952	2.0308	1.4019	1.2517	1.2643	1.6154	0.9641	1.0163	1.0091	0.9965	

#NAME?	1.6871	1.0952	2.0308	1.4019	1.2517	1.2643	1.6154	0.9641	1.0163	1.0091
REFMEAN	0.2249	0.3499	0.6463	1.4137	0.4861	0.3512	0.2538	0.435	0.7041	0.4432

Run title : BLACK SEA TURBOT Total 2009 COMBSEX PLUSGROUP

At 31.3.2009 03:42

Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1970	1971	1972	1973	1974	1975	1976	1977
AGE								
1	1714	2129	2090	3281	4002	3536	2947	3048
2	2098	1418	1761	1728	2713	3309	2924	2437
3	2298	1676	1171	1454	1426	2242	2736	2394
4	1355	1610	1347	905	1161	1174	1844	2186
5	1423	979	983	1071	694	952	946	1494
6	758	734	649	636	643	531	667	690
7	431	373	456	354	318	434	357	469
8	157	164	193	224	110	166	306	238
9	91	61	102	97	117	56	121	236
#NAME?	98	56	114	139	210	77	328	613
TOTAL	10424	9199	8865	9889	11395	12478	13176	13806

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
AGE										
1	2021	1828	928	926	643	457	516	724	891	683
2	2520	1672	1512	767	766	532	378	427	599	737
3	1996	2065	1379	1239	617	633	440	313	353	495
4	1933	1595	1576	1073	952	397	377	308	258	292
5	1786	1556	1225	1267	864	719	237	260	252	213
6	1165	1309	926	868	974	517	246	148	211	203
7	481	848	788	593	586	638	231	125	113	167
8	302	312	477	520	329	316	349	107	87	80
9	168	224	189	351	342	197	190	220	80	71
#NAME?	280	464	385	570	755	414	499	489	958	350
TOTAL	12654	11873	9386	8174	6826	4823	3463	3122	3801	3291

Run title : BLACK SEA TURBOT Total 2009 COMBSEX PLUSGROUP

At 31.3.2009 03:42

Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
1	771	1403	2274	3528	3016	2277	1707	986	1610	1232

2	565	638	1157	1862	2867	2478	1700	1411	798	1262
3	609	467	517	906	1476	2332	1653	1294	1106	625
4	408	504	356	365	639	1194	1596	1109	1028	878
5	233	337	379	198	222	502	850	1116	636	733
6	163	171	225	227	109	168	357	517	484	373
7	117	103	80	152	145	78	115	238	205	210
8	124	71	54	39	93	106	51	55	118	82
9	52	61	43	25	25	68	74	6	28	60
#NAME?	332	202	118	25	27	19	22	6	0	14
TOTAL	3374	3957	5204	7327	8618	9221	8127	6739	6013	5470

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	GMST
AGE												
1	852	579	442	462	748	947	1607	1572	1743	3527	0	1324
2	1019	704	479	362	382	619	782	1326	1299	1431	2904	1102
3	1044	843	583	297	274	288	504	638	1072	1026	1133	901
4	461	855	634	393	207	173	225	399	454	823	754	700
5	682	358	604	405	206	131	130	167	254	290	501	531
6	567	498	227	402	113	122	87	85	85	148	154	357
7	264	310	246	117	43	60	71	44	45	33	78	215
8	112	130	125	25	4	12	17	40	16	5	11	105
9	39	43	85	3	1	1	4	4	19	7	2	50
#NAME?	0	22	25	9	1	1	0	1	0	1	4	
TOTAL	5039	4342	3450	2476	1978	2353	3429	4276	4987	7292	5542	

Run title : BLACK SEA TURBOT Total 2009 COMBSEX PLUSGROUP

At 31.3.2009 03:42

Terminal Fs derived using XSA (With F shrinkage)

Table 11 Spawning stock number at age (spawning time) Numbers*10**-3

YEAR	1970	1971	1972	1973	1974	1975	1976	1977
AGE								
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	605	473	324	409	407	640	769	677
4	604	659	630	415	551	553	870	1036
5	858	669	663	696	509	668	678	1107
6	529	576	477	448	526	434	557	574
7	279	281	335	207	241	382	306	395
8	102	135	143	170	83	149	282	210
9	67	49	81	73	99	50	109	211
#NAME?	72	45	92	104	177	69	295	548

Table 11 Spawning stock number at age (spawning time) Numbers*10**-3

YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
AGE										

1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	561	568	383	342	156	154	116	89	101	141
4	909	733	741	505	434	161	164	146	123	137
5	1283	1007	865	932	561	353	157	196	190	156
6	990	1012	738	710	785	344	175	129	187	154
7	406	667	671	463	451	495	165	109	100	151
8	273	255	429	442	267	257	291	97	83	67
9	151	185	167	305	283	145	151	202	75	63
#NAME?	251	384	339	495	626	305	397	449	893	307

Run title : BLACK SEA TURBOT Total 2009 COMBSEX PLUSGROUP

At 31.3.2009 03:42

Terminal Fs derived using XSA (With F shrinkage)

Table 11 Spawning stock number at age (spawning time) Numbers*10**-3

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	174	128	137	239	418	607	426	363	310	169
4	195	229	139	149	297	528	700	440	455	406
5	168	231	246	123	162	355	556	616	409	541
6	129	117	184	181	92	139	290	324	318	313
7	96	78	59	125	130	66	83	176	136	161
8	91	58	39	33	83	93	19	41	88	59
9	44	49	34	21	23	58	50	5	21	49
#NAME?	280	163	92	20	24	16	15	5	0	12

Table 11 Spawning stock number at age (spawning time) Numbers*10**-3

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE										
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	297	230	151	78	68	80	141	169	295	277
4	213	377	266	149	86	79	102	167	190	337
5	489	239	414	179	133	90	88	100	163	177
6	417	349	163	130	82	93	62	61	53	107
7	194	206	83	22	23	34	56	28	15	20
8	73	110	21	6	2	7	9	29	11	3
9	30	34	42	1	1	1	3	3	13	5
#NAME?	0	17	13	3	1	0	0	1	0	1

Run title : BLACK SEA TURBOT Total 2009 COMBSEX PLUSGROUP

At 31.3.2009 03:42

Terminal Fs derived using XSA (With F shrinkage)

Table	12	Stock	biomass	at	age	(start	of	year)	Tonnes
YEAR	1970	1971	1972	1973	1974	1975	1976	1977	
AGE									
1	1053	1307	1283	2014	2457	2171	1810	1871	
2	2273	1535	1907	1872	2938	3584	3167	2640	
3	3782	2758	1927	2394	2348	3690	4504	3940	
4	3105	3690	3088	2074	2662	2691	4228	5011	
5	4276	2942	2952	3217	2084	2859	2841	4489	
6	2829	2739	2420	2374	2398	1983	2488	2576	
7	1919	1660	2030	1578	1418	1932	1591	2091	
8	809	847	999	1159	568	859	1581	1231	
9	536	357	597	568	689	332	713	1386	
#NAME?	733	414	853	1034	1568	577	2444	4575	
TOTALBIO	21315	18250	18055	18283	19130	20677	25365	29809	

Table	12	Stock	biomass	at	age	(start	of	year)	Tonnes	
YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
AGE										
1	1241	1123	570	569	395	281	317	444	547	419
2	2729	1810	1638	831	830	576	410	462	648	798
3	3285	3399	2270	2039	1015	1043	724	515	581	815
4	4431	3656	3613	2459	2181	910	865	705	591	669
5	5366	4673	3681	3805	2594	2160	711	783	757	640
6	4346	4884	3455	3239	3634	1931	919	553	786	756
7	2143	3779	3512	2643	2610	2845	1029	558	505	746
8	1562	1614	2468	2688	1700	1636	1807	553	448	413
9	989	1314	1111	2061	2008	1157	1115	1294	473	420
#NAME?	2090	3459	2869	4254	5632	3089	3718	3650	7143	2607
TOTALBIO	28184	29712	25186	24586	22597	15628	11614	9518	12479	8284

Run title : BLACK SEA TURBOT Total 2009 COMBSEX PLUSGROUP

At 31.3.2009 03:42

Terminal Fs derived using XSA (With F shrinkage)

Table	12	Stock	biomass	at	age	(start	of	year)	Tonnes	
YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
1	474	702	1039	1351	2192	1031	1024	89	988	757
2	612	638	845	1447	2715	2213	1292	1016	864	1367
3	1003	654	645	1044	2106	2566	1768	1234	1106	625
4	935	907	633	624	1276	1842	2543	1741	1645	1405
5	699	742	820	420	588	1047	1771	2478	1335	1539
6	607	566	730	687	426	498	927	1548	1354	1046
7	523	411	312	648	765	346	484	1053	881	905
8	640	375	292	215	584	616	301	329	710	491
9	304	404	281	167	219	565	616	54	270	566
#NAME?	2477	2447	1452	310	255	179	213	60	0	148

TOTALBIO	8275	7845	7049	6913	11127	10902	10941	9602	9154	8848

Table 12 Stock biomass at age (start of year) Tonnes

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE										
1	523	356	79	284	459	582	781	252	1083	1026
2	1104	763	519	392	326	491	761	1118	1297	1137
3	1357	1095	715	386	351	372	720	843	1615	1437
4	784	1453	993	668	402	341	439	773	960	1556
5	1501	788	1343	931	520	314	328	424	682	709
6	1757	1544	653	1248	360	381	277	291	299	463
7	1133	1332	963	480	175	244	302	194	200	154
8	673	782	653	145	19	62	101	230	92	28
9	271	304	563	31	7	7	29	32	142	51
#NAME?	0	205	211	120	14	6	0	13	0	7
TOTALBIO	9102	8622	6692	4685	2634	2799	3739	4170	6370	6568

Run title : BLACK SEA TURBOT Total 2009 COMBSEX PLUSGROUP

At 31.3.2009 03:42

Terminal Fs derived using XSA (With F shrinkage)

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR	1970	1971	1972	1973	1974	1975	1976	1977
AGE								
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	996	778	533	673	670	1053	1267	1114
4	1384	1512	1443	952	1263	1266	1995	2375
5	2576	2009	1993	2091	1530	2008	2036	3325
6	1976	2150	1782	1672	1962	1619	2079	2142
7	1241	1253	1493	922	1074	1701	1362	1760
8	529	699	741	879	427	770	1456	1086
9	391	291	479	428	581	295	640	1239
#NAME?	535	337	684	779	1322	514	2197	4087
TOTSPBIO	9627	9029	9147	8396	8830	9226	13033	17126

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
AGE										
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	924	934	630	562	256	253	191	147	166	233
4	2084	1680	1698	1157	994	369	377	335	282	313
5	3854	3025	2599	2799	1685	1061	472	590	570	469
6	3694	3776	2755	2650	2931	1285	653	482	698	574
7	1811	2973	2991	2063	2012	2207	734	487	445	673
8	1410	1317	2218	2285	1380	1328	1504	503	427	349
9	886	1087	979	1789	1665	853	887	1187	440	368

#NAME?	1871	2861	2529	3694	4669	2276	2960	3349	6657	2289
TOTSPBIO	16534	17653	16399	17000	15590	9631	7778	7079	9684	5267

Run title : BLACK SEA TURBOT Total 2009 COMBSEX PLUSGROUP

At 31.3.2009 03:42

Terminal Fs derived using XSA (With F shrinkage)

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	287	180	170	276	596	668	456	346	310	169
4	446	413	248	255	593	815	1115	691	728	649
5	503	509	532	261	429	741	1159	1368	858	1135
6	481	385	598	547	359	411	754	971	890	875
7	426	311	230	530	686	294	350	779	584	693
8	472	308	210	179	524	541	112	248	528	354
9	257	326	219	136	198	486	417	40	202	468
#NAME?	2091	1976	1131	253	231	154	144	44	0	122
TOTSPBIO	4962	4407	3338	2438	3615	4110	4507	4486	4101	4466

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE										
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	386	299	185	101	88	104	202	224	445	388
4	362	641	416	253	167	155	198	324	402	637
5	1076	527	920	412	337	215	222	255	437	433
6	1294	1081	467	404	261	289	197	211	184	335
7	836	887	325	88	96	138	237	122	68	94
8	439	662	111	32	11	39	52	168	64	18
9	213	239	278	11	5	5	22	25	95	39
#NAME?	0	161	104	42	10	5	0	10	0	5
TOTSPBIO	4607	4497	2805	1345	974	950	1130	1337	1695	1948

Run title : BLACK SEA TURBOT Total 2009 COMBSEX PLUSGROUP

At 31.3.2009 03:42

Terminal Fs derived using XSA (With F shrinkage)

Table 14 Stock biomass at age with SOP (start of year) Tonnes

YEAR	1970	1971	1972	1973	1974	1975	1976	1977
AGE								

1	1052	1307	1283	2015	2456	2171	1810	1872
2	2272	1535	1906	1872	2938	3584	3168	2640
3	3782	2759	1927	2394	2347	3690	4506	3940
4	3105	3691	3088	2074	2661	2692	4229	5012
5	4275	2943	2951	3217	2084	2860	2842	4490
6	2829	2740	2420	2374	2398	1983	2488	2576
7	1919	1660	2030	1578	1417	1932	1592	2091
8	809	847	998	1159	568	859	1581	1231
9	536	357	597	568	689	332	713	1387
#NAME?	733	414	853	1034	1567	577	2445	4575
TOTALBIO	21313	18253	18053	18285	19126	20679	25373	29814

Table 14 Stock biomass at age with SOP (start of year) Tonnes

YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
AGE										
1	1241	1123	570	569	395	281	317	445	547	419
2	2730	1810	1638	831	830	576	410	463	648	798
3	3286	3399	2270	2040	1015	1043	724	515	581	814
4	4432	3656	3613	2459	2181	910	865	706	590	669
5	5367	4673	3681	3805	2594	2161	712	783	756	639
6	4346	4884	3456	3240	3633	1931	919	553	785	756
7	2143	3779	3513	2643	2610	2845	1029	559	504	746
8	1563	1614	2468	2688	1699	1636	1807	553	448	413
9	990	1314	1111	2061	2008	1157	1115	1294	472	420
#NAME?	2090	3459	2869	4254	5631	3089	3718	3651	7137	2606
TOTALBIO	28188	29711	25188	24590	22596	15629	11615	9520	12467	8280

Run title : BLACK SEA TURBOT Total 2009 COMBSEX PLUSGROUP

At 31.3.2009 03:42

Terminal Fs derived using XSA (With F shrinkage)

Table 14 Stock biomass at age with SOP (start of year) Tonnes

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
1	474	702	1026	1327	2192	1032	1024	89	1001	757
2	612	638	834	1421	2715	2213	1292	1016	875	1367
3	1003	654	636	1025	2106	2566	1768	1234	1120	625
4	936	907	625	612	1276	1843	2543	1741	1665	1405
5	699	742	809	413	587	1047	1771	2478	1352	1539
6	608	566	721	675	426	498	927	1548	1371	1046
7	524	411	308	636	765	346	484	1053	892	905
8	640	375	288	211	584	617	301	329	719	491
9	304	404	278	164	219	565	616	54	273	566
#NAME?	2478	2447	1434	304	255	179	213	60	0	148
TOTALBIO	8278	7845	6961	6788	11126	10904	10941	9603	9268	8848

Table 14 Stock biomass at age with SOP (start of year) Tonnes

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007

AGE										
1	523	356	82	284	480	608	821	249	1083	988
2	1103	763	535	392	340	513	800	1106	1298	1095
3	1357	1095	737	386	367	389	757	833	1616	1384
4	784	1453	1024	669	420	356	462	764	960	1499
5	1501	788	1384	932	544	328	345	420	682	683
6	1757	1544	673	1249	376	398	292	288	299	446
7	1133	1332	993	481	183	254	317	192	200	148
8	673	782	673	145	20	65	106	228	92	27
9	271	304	580	31	8	7	30	31	142	49
#NAME?	0	205	217	120	14	6	0	13	0	6
TOTALBIO	9102	8622	6898	4690	2754	2924	3931	4125	6372	6325

Run title : BLACK SEA TURBOT Total 2009 COMBSEX PLUSGROUP

At 31.3.2009 03:42

Terminal Fs derived using XSA (With F shrinkage)

Table 15 Spawning stock biomass with SOP (spawning time) Tonnes

YEAR	1970	1971	1972	1973	1974	1975	1976	1977
AGE								
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	996	778	533	673	670	1053	1267	1114
4	1384	1512	1443	952	1263	1266	1996	2375
5	2576	2009	1992	2091	1530	2008	2037	3325
6	1975	2150	1781	1672	1962	1619	2080	2142
7	1241	1254	1493	922	1074	1701	1363	1760
8	528	699	741	879	427	770	1457	1086
9	391	291	479	428	581	295	641	1239
#NAME?	535	337	684	779	1321	514	2197	4088
TOTSPBIO	9627	9030	9146	8397	8828	9227	13037	17129

Table 15 Spawning stock biomass with SOP (spawning time) Tonnes

YEAR	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
AGE										
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	924	934	630	562	256	253	191	147	166	233
4	2084	1680	1698	1157	994	369	377	335	281	313
5	3854	3025	2599	2799	1685	1061	472	590	569	469
6	3695	3776	2755	2651	2930	1285	653	482	697	573
7	1811	2973	2992	2064	2012	2207	734	487	444	673
8	1410	1317	2218	2286	1379	1328	1504	503	426	349
9	886	1087	979	1790	1665	853	887	1187	440	368
#NAME?	1872	2861	2529	3694	4669	2276	2960	3349	6651	2288
TOTSPBIO	16536	17653	16400	17002	15589	9632	7778	7080	9675	5265

Run title : BLACK SEA TURBOT Total 2009 COMBSEX PLUSGROUP

At 31.3.2009 03:42

Terminal Fs derived using XSA (With F shrinkage)

Table 15 Spawning stock biomass with SOP (spawning time) Tonnes

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE										
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	287	180	168	271	596	668	456	346	314	169
4	446	413	244	251	593	815	1115	691	737	649
5	503	509	525	257	429	741	1159	1368	869	1135
6	481	385	591	537	359	411	754	971	901	875
7	426	311	227	521	686	294	350	779	591	693
8	472	308	207	176	523	541	112	248	535	354
9	257	326	216	134	198	486	417	40	205	468
#NAME?	2091	1976	1117	248	231	154	144	44	0	122
TOTSPBIO	4964	4407	3296	2394	3615	4110	4507	4487	4152	4466

Table 15 Spawning stock biomass with SOP (spawning time) Tonnes

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AGE										
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	386	299	190	102	92	108	212	221	445	373
4	362	641	429	254	175	162	209	320	403	613
5	1076	527	948	412	352	224	233	252	437	417
6	1294	1081	481	405	273	302	207	209	184	323
7	836	887	335	88	100	144	249	121	68	90
8	439	662	114	32	11	41	55	166	64	18
9	213	239	287	11	5	5	23	24	95	38
#NAME?	0	161	107	43	10	5	0	10	0	5
TOTSPBIO	4607	4497	2892	1346	1019	993	1188	1323	1696	1876

Run title : BLACK SEA TURBOT Total 2009 COMBSEX PLUSGROUP

At 31.3.2009 03:42

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

Age	RECRUITS 1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR -3	7
1970	1714	21315	9627	5273	0.5477	0.4139	
1971	2129	18250	9029	3052	0.338	0.2616	
1972	2090	18055	9147	3049	0.3333	0.2573	
1973	3281	18283	8396	3705	0.4413	0.3828	
1974	4002	19130	8830	1696	0.1921	0.1507	

1975	3536	20677	9226	1273	0.138	0.1128
1976	2947	25365	13033	1584	0.1215	0.1112
1977	3048	29809	17126	2012	0.1175	0.1033
1978	2021	28184	16534	2160	0.1306	0.1103
1979	1828	29712	17653	5447	0.3086	0.2369
1980	928	25186	16399	2843	0.1734	0.1453
1981	926	24586	17000	3276	0.1927	0.1554
1982	643	22597	15590	4662	0.299	0.2641
1983	457	15628	9631	5307	0.551	0.5133
1984	516	11614	7778	2852	0.3667	0.338
1985	724	9518	7079	527	0.0744	0.0589
1986	891	12479	9684	428	0.0442	0.0453
1987	683	8284	5267	849	0.1612	0.1171
1988	771	8275	4962	1116	0.2249	0.1406
1989	1403	7845	4407	1452	0.3295	0.284
1990	2274	7049	3338	1392	0.4171	0.3204
1991	3528	6913	2438	935	0.3835	0.2874
1992	3016	11127	3615	438	0.1212	0.0864
1993	2277	10902	4110	1601	0.3896	0.1813
1994	1707	10941	4507	2139	0.4746	0.2904
1995	986	9602	4486	2924	0.6518	0.4598
1996	1610	9154	4101	2031	0.4952	0.3802
1997	1232	8848	4466	1014	0.2271	0.1684
1998	852	9102	4607	1574	0.3416	0.2249
1999	579	8622	4497	1933	0.4299	0.3499
2000	442	6692	2805	2776	0.9896	0.6463
2001	462	4685	1345	2522	1.8756	1.4137
2002	748	2634	974	592	0.6077	0.4861
2003	947	2799	950	408	0.4293	0.3512
2004	1607	3739	1130	425	0.376	0.2538
2005	1572	4170	1337	727	0.5436	0.435
2006	1743	6370	1695	956	0.564	0.7041
2007	3527	6568	1948	1027	0.5271	0.4432
Arith.						
Mean	1675	13282	7072	2052	0.3929	0.3075
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Run title : BLACK SEA TURBOT Total 2009 COMBSEX PLUSGROUP

At 31.3.2009 03:42

Table 17 Summary (with SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

RECRUITS	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	SOPCOFAC	FBAR	-3	7
Age	1							
1970	1714	21313	9627	5273	0.5478	0.9999	0.4139	
1971	2129	18253	9030	3052	0.338	1.0001	0.2616	
1972	2090	18053	9146	3049	0.3334	0.9999	0.2573	
1973	3281	18285	8397	3705	0.4412	1.0001	0.3828	
1974	4002	19126	8828	1696	0.1921	0.9998	0.1507	
1975	3536	20679	9227	1273	0.138	1.0001	0.1128	
1976	2947	25373	13037	1584	0.1215	1.0003	0.1112	

1977	3048	29814	17129	2012	0.1175	1.0002	0.1033
1978	2021	28188	16536	2160	0.1306	1.0001	0.1103
1979	1828	29711	17653	5447	0.3086	1	0.2369
1980	928	25188	16400	2843	0.1734	1.0001	0.1453
1981	926	24590	17002	3276	0.1927	1.0002	0.1554
1982	643	22596	15589	4662	0.2991	0.9999	0.2641
1983	457	15629	9632	5307	0.551	1.0001	0.5133
1984	516	11615	7778	2852	0.3667	1.0001	0.338
1985	724	9520	7080	527	0.0744	1.0002	0.0589
1986	891	12467	9675	428	0.0442	0.9991	0.0453
1987	683	8280	5265	849	0.1613	0.9995	0.1171
1988	771	8278	4964	1116	0.2248	1.0004	0.1406
1989	1403	7845	4407	1452	0.3295	1.0001	0.284
1990	2274	6961	3296	1392	0.4223	0.9875	0.3204
1991	3528	6788	2394	935	0.3905	0.982	0.2874
1992	3016	11126	3615	438	0.1212	0.9999	0.0864
1993	2277	10904	4110	1601	0.3895	1.0002	0.1813
1994	1707	10941	4507	2139	0.4746	1.0001	0.2904
1995	986	9603	4487	2924	0.6517	1	0.4598
1996	1610	9268	4152	2031	0.4892	1.0124	0.3802
1997	1232	8848	4466	1014	0.2271	1	0.1684
1998	852	9102	4607	1574	0.3417	0.9999	0.2249
1999	579	8622	4497	1933	0.4299	1	0.3499
2000	442	6898	2892	2776	0.9599	1.0309	0.6463
2001	462	4690	1346	2522	1.8736	1.0011	1.4137
2002	748	2754	1019	592	0.5812	1.0457	0.4861
2003	947	2924	993	408	0.4109	1.0445	0.3512
2004	1607	3931	1188	425	0.3576	1.0516	0.2538
2005	1572	4125	1323	727	0.5496	0.9891	0.435
2006	1743	6372	1696	956	0.5638	1.0004	0.7041
2007	3527	6325	1876	1027	0.5474	0.963	0.4432
Arith. Mean	1675	13289	7075	2052	0.3912	0.3075	
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)			

XSA runs were performed by the SGMED 09- using VPA 3.1 (Lowestoft) on the total catch at age under different adjustments. Two versions of the assessment model were produced during the meeting. Estimates of average fishing mortality (ages 4-8), of landings, SSB and recruits are shown in Fig. 4.4.4.1.2 and Fig. 4.4.4.1.3, respectively.

The first version was produced by tuning the model using Romanian and Ukrainian age disaggregated research survey CPUE without shrinkage to the mean terminal Fs. According to this version recruitment has peaks in 1973 - 1976, 1989-1992, and 2002-2005 (Fig. 2.1.4.1.3.2). The SSB increases from 1975 to 1981 then drops in 1985, and increases again in up to ~11 000 t during the period 1988 -1999. After 2001, the SSB start to increase. During the period 1970 – 2007, the average fishing mortality F_{4-8} has a high range between 0.3 and 0.9 with peaks in 1983 – 1984 and 2000 – 2001.

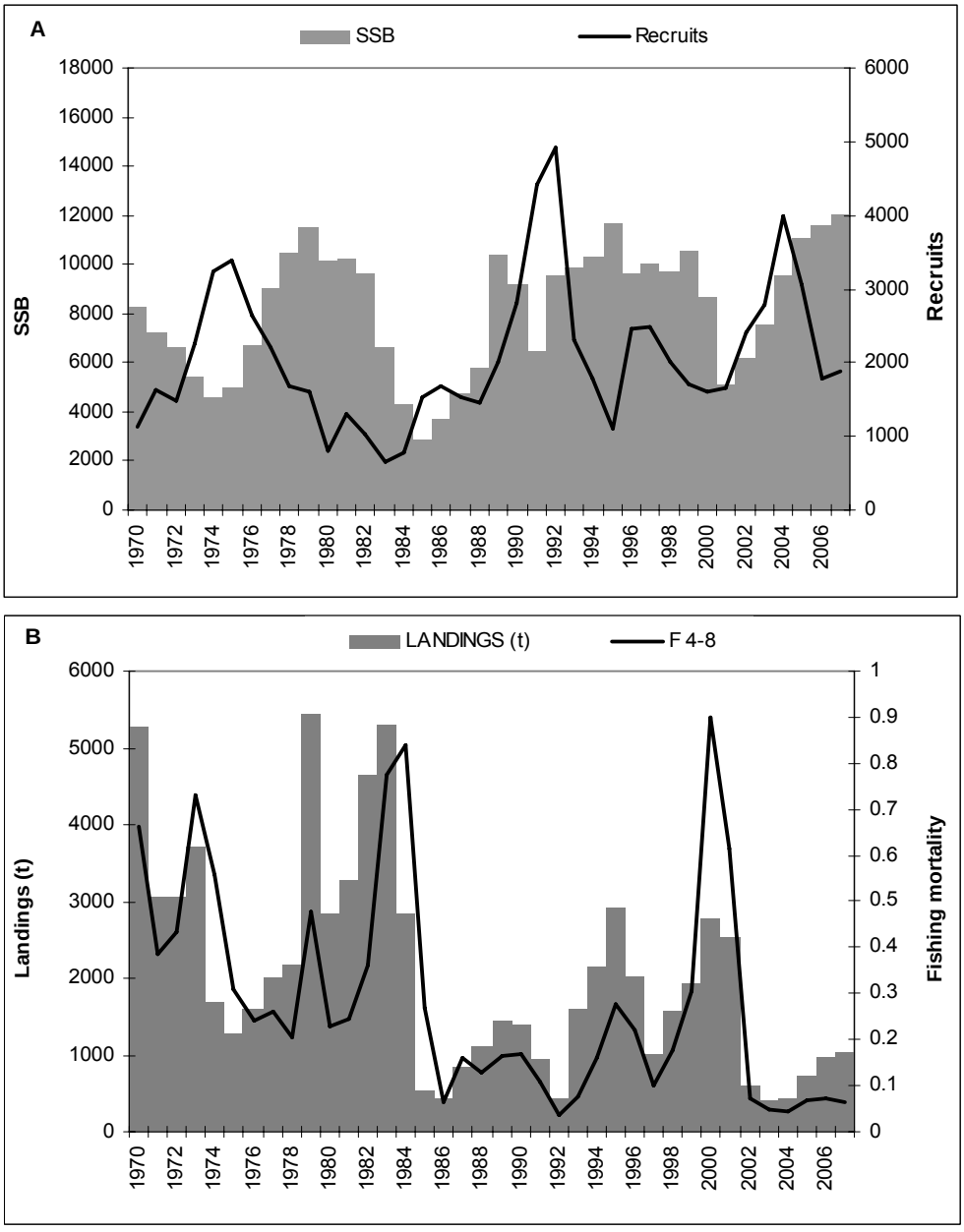


Fig. 4.4.4.1.2 . Time-series of turbot population estimates of total stock in the Black Sea (XSA version without terminal F shrinkage): A. recruitment (line) and SSB (grey); B. landings (grey) and average fishing mortality (ages 4–8, line).

Under the second option (Fig. 4.6.4.1.3), SGMED 09-01 applied shrinkage to the mean terminal Fs. The results are different from the version without shrinkage. In this version recruitment has two peaks in 1971 – 1978 and 1988 – 1994 and increase of recruitment after 2001, but the absolute values of maximums are lower than in version without shrinkage. But the SSB attained higher values up to 17,500 t during the period 1976 – 1983 and very low values after 2000. Fishing mortality F_{4-8} is also ~ 2 time greater but follows a similar trajectory with a peak in 2000-2001.

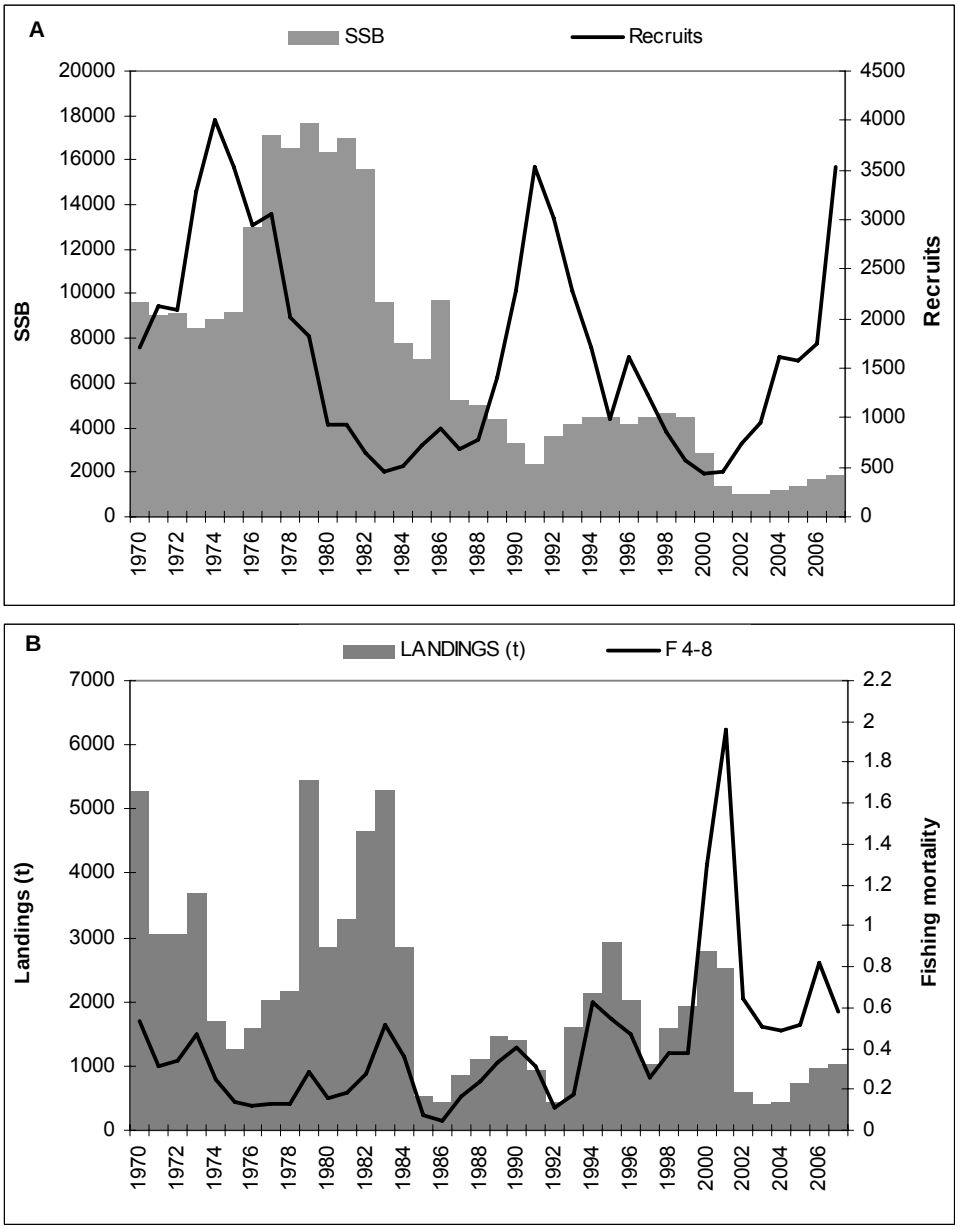
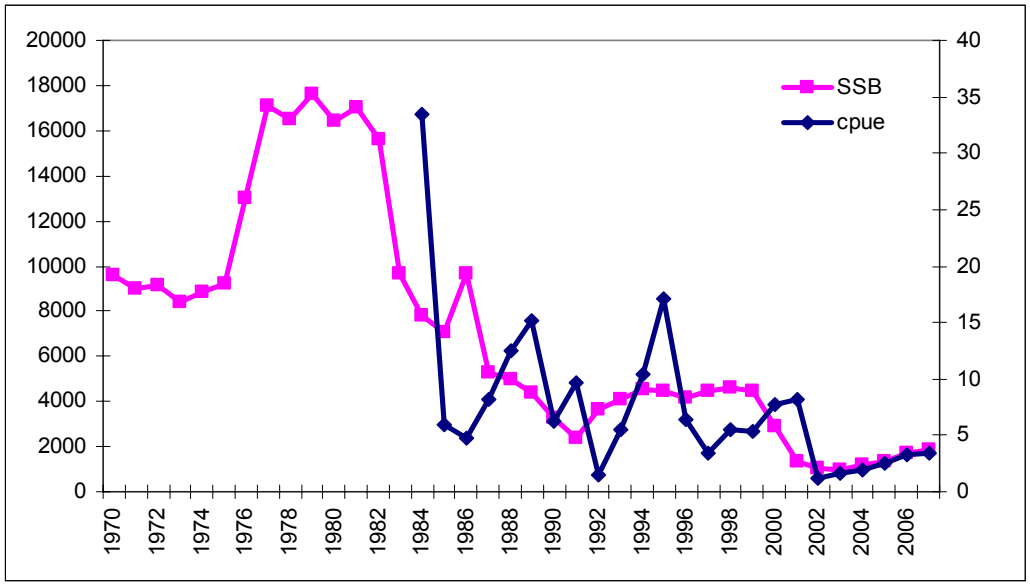


Fig. 4.4.4.1.3. Time-series of turbot population estimates of total stock in the Black Sea (XSA version with terminal F shrinkage): A. recruitment (line) and SSB (grey); B. landings (grey) and average fishing mortality (ages 4–8, line).

SGMED 09-01 accepted the results produced with the shrinkage option as more realistic (Fig. 4.6.4.1.4), because SSB correlates with Turkish CPUE (r^2=0.48). Also the estimated average F_{4-8} show good correlation with Turkish effort (r^2=0.45), especially since 2000 (r^2=0.65).

A



B

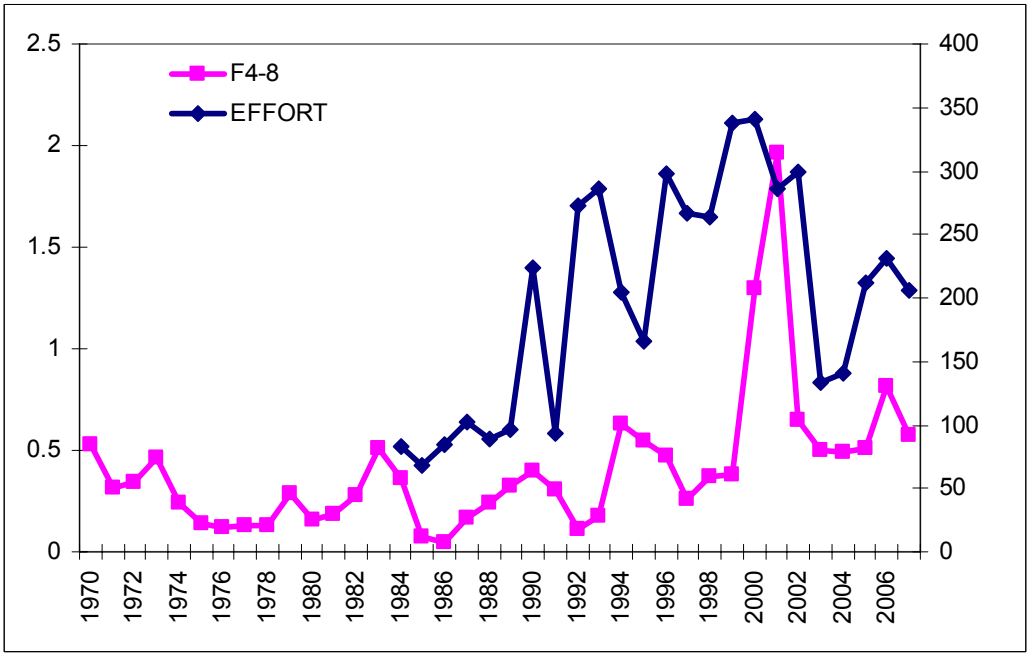


Fig. 4.4.4.1.4. Correlation between estimated SSB (shrinkage option) and Turkish CPUE (A) and estimated mean F_{4-8} (shrinkage option) and Turkish effort – number of vessels (B).

The difference between the two assessment versions (Fig. 4.4.4.1.2 & 4.6.4.1.3) is considerable, and does not allow to assess the state of the stock in absolute values. It seems the difference is mainly due to the estimation of the last year terminal Fs, which for such a long lived species substantially influence the estimates of stock size in the previous ~10 years, and if a constant exploitation pattern is assumed (as in XSA) will influence also the last age terminal Fs. Major uncertainties in landings (due to misreporting), and possibly in the tuning data make these assessment even more uncertain.

The SGMED 09-01 consider these results as a useful and indicative of trends in turbot abundance in the Black Sea. Slight recovery of turbot stock from historic low levels was noted. However the present results cannot be used for the aims of the management advice and prediction of stock size.

4.5. Short term prediction for 2008 and 2009

SGMED 09-01 did not undertake the short term prediction of stock size.

4.6. Medium term prediction

SGMED 09-01 did not undertake medium term projections.

4.7. Long term prediction

SGMED 09-01 did not undertake long term projections.

4.8. Scientific advice

4.8.1. Short term considerations

SGMED 09-01 is not in the position to give advice on the specific precise catches, consistent with the high long-term years due to uncertainty in the recent landings levels.

In order to safeguard the recovery potential of the actual stock, SGMED 09-01 recommends landings should be kept at the low levels in 2009 and in the near future.

4.8.2. State of the spawning stock size

The turbot SSB during recent years is at low level compared to historical abundance. In 2002 and 2003 the SSB has been at the absolute minimum since 1970. Relative abundance estimates are confirmed by CPUE data. Catches have also dropped since 2002. A garduate recovery in SSB and catches is observed since 2004.

4.8.3. State of recruitment

Recruitment was at minimum in 2000-2001 and started to increase since 2002. The high value estimated for 2007 is quite uncertain and need to be confirmed by subsequent analyses. The increase in recruitment since 2002 has positively influenced the SSB but given that many small and immature turbots are caught by the fisheries such a positive influence may not propagate in the next years.

4.8.4. State of exploitation

Fishing mortality has peeked in 2000-2001 due to relatively high catches provided the low biomass of the stock. The catches decreased since 2002 but fishing mortality stayed quite high because of the low exploitable biomass.

4.8.5. Medium term considerations

The exploitation needs to be kept at the lowest possible level in order to allow the stock to recover.

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ANNEX EXPERT DECLARATIONS

Declarations of invited experts are published on the STECF web site on https://stecf.jrc.ec.europa.eu/home together with the final report.

European Commission

EUR 23848 EN **– Joint Research Centre – Institute for the Protection and Security of the Citizen**
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Author(s): G. Daskalov, V. Raykov, M. Panayotova, G. Radu, V. Maximov, V. Shlyakhov, E. Duzgunez and H.-J. Rätz

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Abstract
SGMED-09-01 was held during 23–27 March 2009 in Ranco, Italy. The meeting was convened to focus on a assessments of the sprat and turbot stocks in the Black Sea and a review of the scientific advice for 2009. STECF reviewed the report during its plenary meeting during 20-24 April 2009 with some major revisions of the advice provided by the working group.

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