SPRAT AND TURBOT FISHERIES IN THE BULGARIAN AND ROMANIAN BLACK SEA AREA

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ABSTRACT

The first part of the present paper presents a summary description of peculiarities in distribution of the sprat and turbot in the Bulgarian and Romanian Black Sea areas during spawning, fattening and wintering; it also shows two maps including routes and periods of its spawning, feeding and other migrations.
The second part of the paper includes data about evolution of the fishing gears, fishing effort, catch dynamics, volume of catches, structure of the populations, stocks biomass and maps showing geographic density patterns in annual abundance indices for sprat and turbot by fishing gear and seasons.
Sprat - *Sprattus sprattus* L., 1758, marine pelagic species, forms important agglomerations and performs irregular migrations between nutrition areas and spawning places determined by temperature conditions. In the spring there is a tendency of movement of the shoals toward coast and northwards and toward offing in the autumn, but there no specific migrations of spawning or feeding. The sprat wintering offing at depths of 80 to100m; in April - May is

nearing of littoral area in exploitable quantities, while in the summer high water temperature prevents performing of migrations from coast to offing.

Sprat is the second most abundant fish species after the anchovy in the Black Sea and an important fisheries resource and prey species for Bulgaria and Romania. Sprat is an object of both artisanal and commercial mid-water trawl fisheries.

The stock estimates confirm the cyclic nature of the sprat population dynamics. The year with relatively strong recruitment was followed by years of low to medium recruitment which leads to a relative decrease of the Spawning Stock Biomass (SSB).

A quota is allocated in EU waters of the Black Sea (Bulgaria and Romania). No fishery management agreement exists between other Black Sea countries. In the EU Black Sea waters, Total Allowable Catch (TAC) of 12,750 tons is allocated in 2009. This figure is a result of a reduction of the 2008 TAC of 15,000 tons based on the precautionary principle.

Turbot - *Psetta maxima maeotica* Tortonese, 1971, marine species, specific for sandy, rocky or mixed bottoms. In winter, adults are encountered at higher depths than 60 to 70m; in spring (March - April) they are nearing of shore until 18 to 30m for reproduction. After spawning, adults are spreading and moving again towards deeper water. Turbot migrations are relative short and perpendicular on shore.

In all Black Sea countries turbot is one of the most valuable fish species.

The TACs for turbot catches in 2007 and 2008 and quotas allocation was introduced regarding 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 is regulated.

In deeper waters in front of south Romanian shelf and Northern Bulgarian shelf, the high densities of turbot were registered due to preferable habitat for turbot – sandy, sands with gravels bottoms and mussel beds and availability of items from turbot diet.

KEY WORDS: Black Sea, sprat, turbot, catch, fishing effort, biomass

INTRODUCTION

In recent times the Black Sea ecosystem has experienced large-scale human- driven disturbances such as collapses of fish stocks, eutrophication and invasions by alien species. Over the decades, fishing has become a leading anthropogenic stressor, affecting not only fish stocks but also triggered large-scale ecosystem effects such as trophic cascades and regime shifts (Daskalov *et al*., 2007; Daskalov, 2008; Daskalov *et al*., 2009).

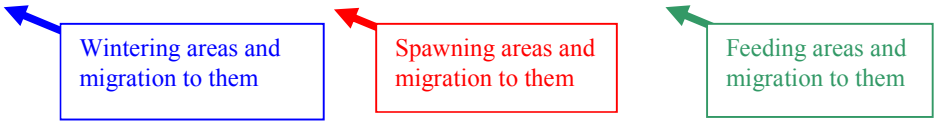
The Black Sea ichthyofauna has undergone major changes concerning both its qualitative and quantitative structure and the behaviour of various species. These changes are consequences of human activities, directly through the fishing pressure and indirectly through the deterioration of the environmental conditions, especially in the western part of the Black Sea.

Interaction between environmental, biological and anthropogenic factors generated feedbacks resulting in hypoxia and hydrogen sulphide production, adversely affecting the ecosystem as a whole and fish stocks in particular. The complex nature of ecosystem responses to human activities calls for more elaborate management approaches than currently provided by traditional environmental and fisheries assessments and regulations.

The two species analysed in the paper represent the main target species in the Bulgarian and Romanian commercial fishing. Also, in the EU Black Sea waters, a Total Allowable Catch (TAC) is allocated for these species.

MATERIAL AND METHODS

In the first part of the paper a summary description of peculiarities in distribution of the two species in the Bulgarian and Romanian Black Sea area during spawning, fattening and wintering is provided. Also, two maps including routes and periods of spawning, feeding and other migrations are shown (Fig.1, 2).



The second part of the paper includes data about evolution of the fishing gears, fishing effort, catch dynamics, volume of catches, structure of the populations, stocks biomass and maps showing geographic density patterns in annual abundance indices for sprat and turbot by fishing gear and seasons.

For assessment of the biomass of the main species the swept area method, using pelagic trawl for sprat and demersal trawl for turbot has been used.

RESULTS AND DISCUSSIONS

Sprat

Marine pelagic species, usually inshore schooling, sometimes entering in the estuaries (especially the juveniles), and tolerating salinities as low as 4‰. In the daytime, it keeps to higher depths and in the night it comes to surface. It forms important agglomerations and performs unregulated migrations between nutrition areas and spawning places determined by temperature conditions. In the spring there is a tendency of movement of the shoals toward coast and northwards and toward offing in the autumn, but there are not specific migrations of spawning or feeding.

Mostly, adults tend to remain under the thermocline, penetrating above only in the spring and autumn. Juveniles occupy a large spread area at surface in the warm water.

The sprat wintering offing at depths of 80 to 100m; in April - May is nearing the littoral area in exploitable quantities, while in the summer it avoids high water temperature performing migrations from coast to offing (Fig. 1).

Sexual maturity is attained at the age of 1 year when it has about 7 cm.

Spawning takes place almost all long year, but with maximum intensity in November – March, laying eggs in portions. Eggs are pelagic, in spherical shape. In winter, eggs are encountered in the surface layer as well as in deeper ones; in summer only at depths below 10m.

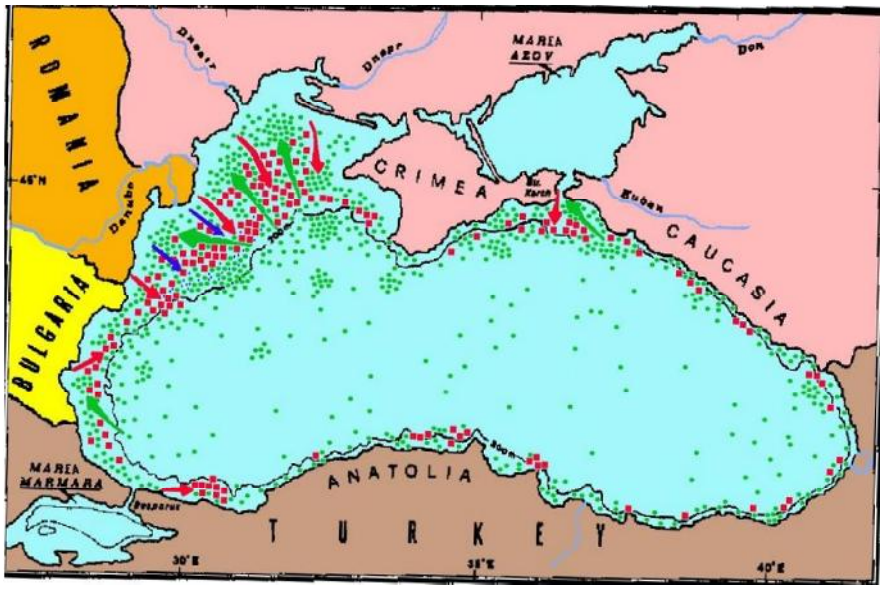


Fig. 1 - Sprat migration routes in the Black Sea area

Turbot

Marine demersal species, specific for sandy, rocky or mixed bottoms; rather common in brackish waters. So, the turbot occurs all over the shelf of the Black Sea. It is a large-sized fish with long life cycle; it reaches length of 85 cm, weight of 12 kg and age of more than 17 years in the Black Sea. Turbot fecundity is very high, up to 12.8 million of eggs per year. Larvae and fries during the first two months inhabit the pelagic zone, feeding on zooplankton. Adults feed on fish mainly, both on demersal (whiting, red mullet and gobies), and pelagic (anchovy, sprat, horse mackerel, shad) species. Diet of turbot also includes crustaceans (shrimps, crabs, etc.), molluscs and polychaetes. Like whiting, it does not undertake distant transboundary migrations. Local migrations (spawning, feeding and wintering) have a general direction from the open sea towards the coast or from the coasts towards offshore.

In various parts of the sea it matures in majority at the age of 3 to 5 years (in the waters of Bulgaria – Ivanov and Beverton, 1985), at the age of 5 to 6 years (in the waters of Ukraine and the Russian Federation). It spawns in spring, from late March till mid and late June at the water temperature 8 to 12ºC. The peak of the spawning falls in May at depths below 20-40 to 60 m. After the spawning turbot moves downwards to the depth 50 to 90 m and till the early autumn it leads low-activity life, feeding poorly. In autumn turbot

reaches the coasts again, where it feeds intensively. For wintering it migrates to the depths below 60 m occurring down to 140m (Fig. 2).

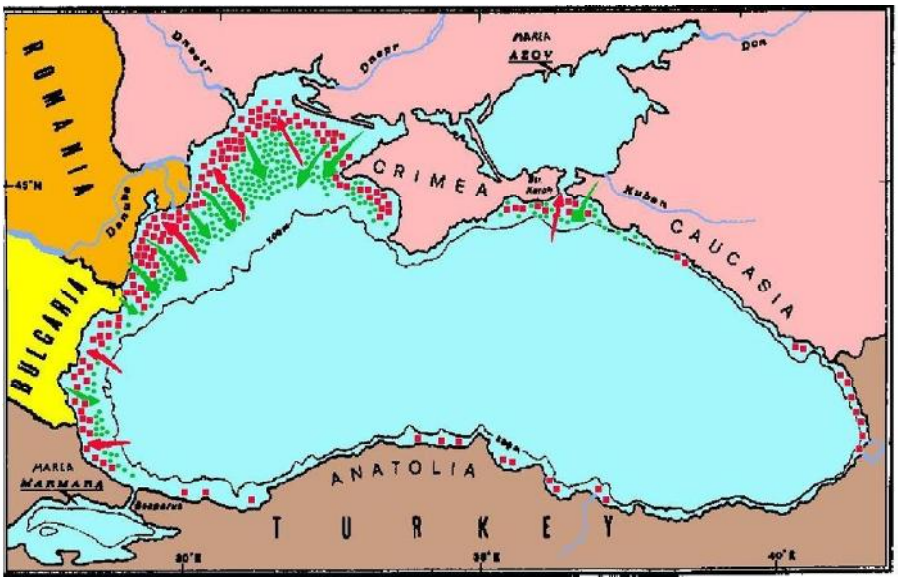


Fig. 2 - Turbot migration routes in the Black Sea area

Some scientists consider that in the Romanian, Bulgarian and Ukrainian waters there is the unique stock, probably endemic subspecies named *Psetta maxima maeotica* or *Psetta maeotica* (Prodanov, 2003; Radu, 2003). Strictly speaking, the above-mentioned populations are the independent units of the stock; it is specially needed to assess their stock and to regulate their fishing. In practice it seems to be impossible due to numerous gaps in information and lack of regional management and regulation of fisheries.

State of fishing fleet and fishery facilities

In 2008, the Bulgarian fleet consisted of 2,547 vessels with an aggregated total of 8,378 GT and 63,860 kW. There are 2,440 fishing boats less than 12m representing approximately 96 % of all Bulgarian vessels and producing 57.28 % of all Bulgarian catches in the Black Sea (Table 1). In 2008 the vessels were operating only in the Black Sea (Panayotova *et al*., 2008; Raykov *et al*., 2008)

Table 1 - Segmentation of the Bulgarian fishing fleet 2008

		<6 m	6 -12 m	12-18 m	18-24 m	24-40 m
Total vessels registered		**842**	**1598**	**68**	**27**	**12**
Active vessels		**213**	**434**	**45**	**13**	**11**
Using 'Active' gears	Pelagic trawlers		3	8	2	11
	Vessels using other gears*	22	115	17	4	
Using 'Passive' gears	Vessels using hooks	14	23	2		
	Drift and/or fixed netters	166	224	8	1	
	Vessels using pots and/or traps	3	33	1		
	Vessels using other passive gears		1			
	Vessels using polyvalent 'passive' gears only	2	10			
Using Polyvalent gears	Vessels using active and passive gears	6	25	9	6	

The Romanian Black Sea fishing fleet capacity consisted in 2008 of 441 vessels, registered in the Fishing Fleet Register (Table 2), out of which:

A) 20 over 12 m long; from the whole figure 20 vessels are over 12m long, not all of them have been fully operating for the past few years. Only 9 vessels are equipped with VMS devices, and just 10 of them have been operational in 2008.

B) 421 boats, smaller than 12m registered, but only 174 active in 2008.

This fleet is in a poor condition and needs improvements of safety on-board, working conditions and facilities for landing. The fisheries of this small fleet are typically artisanal type as multi-species and multi-gear fisheries, fishermen switching from one gear to another several times throughout the year (Radu *et al*., 2008; Staicu *et al*., 2008).

The infrastructure represented by fishery ports with specialized berths and deposit spaces, as well as locations for organizing the first sell of fish is poor.

Table 2 - Segmentation of the Romanian fleet in 2008

		< 6 m	**6 – <12 m**	**12-18 m**	**18 – <24 m**	**24 – <40 m**	**> 40 m**	**Total**
Total vessels registered		50	371	5	4	11	-	**441**
Active vessels		15	159	4	2	4	-	**184**
Midwater otter trawl	Mixed demersal and pelagic species					3		**3**
Pound nets	Small pelagic fish Demersal fish	5	34					**39**
Set gillnets	Demersal species		51	4	2	1		**58**
Artisanal fisheries (Hand lines, Set long lines, Beach seine)	Other finfish	10	74					**84**

Fishing techniques and fishing gears

The Bulgarian and Romanian marine fisheries are mainly structured in four major categories: pelagic trawl fishery (OTM); pound net fishery (FPN); bottom set gillnet fishery (GNS); artisanal fishery (long lines and hand lines fishery) (Maximov *et al*., 2007; Prodanov, 2003; Radu, 2003; Radu *et al*., 2006; 2008) (Table 3).

The fishery gears used by the trawlers are the pelagic trawls, equipped for demersal use. This kind of activity is focussed on small pelagic species as main target is the sprat.

In the pound net fishery, the main species in the catches have a seasonal character, the sprat being the target species in spring period and the beginning of the summer and anchovy and horse mackerel in the summer and autumn periods. The by-catch in the pound net fishery is composed of whiting, turbot, red mullet and others demersal species.

In bottom set gillnet fishery, the bottom species with commercial importance is turbot with by-catch of thornback ray, common stingray, spiny dogfish and cetaceans.

Table 3 - The main fishing techniques for sprat and turbot in the Bulgarian and Romanian areas

Fishing techniques	**Main species captured**	**Target species**	**Space strata**	**Comments**
OTM_MPD_14_0_0	MPD_Mixed pelagic and demersal fish	Sprat	37.4.2	TAC regulated
FPN_MPD_14_0_0	MPD_ Mixed pelagic and demersal fish	Sprat, anchovy, horse mackerel	37.4.2	TAC regulated for sprat
GNS_DEF_400_0_0	DEF_Demersal fish	Turbot	37.4.2	TAC regulated

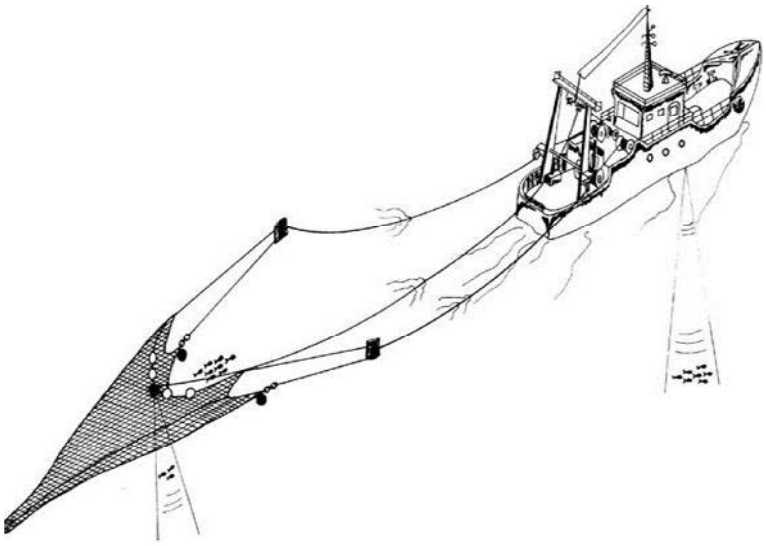


Fig. 3 - Trawler and trawl assembly

OTM_MPD_12-14_0_0

- Spatial distribution of the fishing activity of the metier: shelf; offshore; Bulgarian and Romanian coast of Black Sea.
- Seasonal pattern of the fishing activity of the metier: BG: February – November; RO: April – November.
- Number of vessels involved in metier by LOA group: BG: 3(6-12m), 8(12-18m), 2(18-24m), 11(24-40 m); RO: 3(24-40).
- Detailed gear types and selectivity devices used in metier: BG: bag mesh size 2a=12mm; RO: type 50/35-74m, trawl codent with mesh size of 2a=14mm (Fig. 3).
- Main target and by-catch species for the metier: the target fish species in pelagic trawl fishery is sprat with by-catch of *whiting, turbot, anchovy, shad, horse mackerel* and *red mullet*.

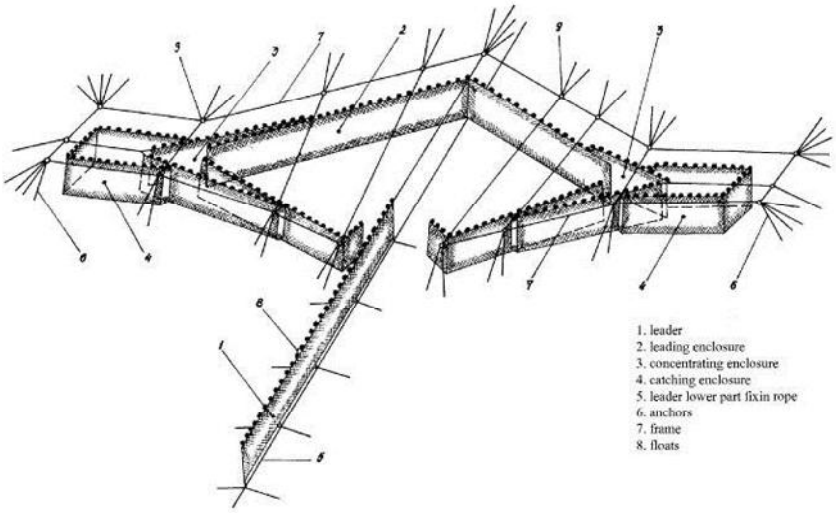


Fig. 4 - Pound net installed at 9-12 m depth

FPN_MPD_12-16_0_0

- Spatial distribution of the fishing activity of the metier: shelf; inshore, Bulgarian and Romanian coast of Black Sea.
- Seasonal pattern of the fishing activity of the metier: BG: March – November; RO: April – September.
- Number of vessels involved in metier by LOA group (Appendix III EC949/2008): BG: 3 (<6m), 33(6-12m), 1(12-18m); RO: 5(<6m), 34(6-12m) (Fig. 4).
- Main target and by-catch species for the metier: In the pound net fishery, the main species in the catches have a seasonal character, the sprat being the target species in spring period and the beginning of the summer and anchovy and horse mackerel in the summer and autumn period. The by-catch in the pound net fishery is composed of *whiting, turbot, red mullet* and *others demersal species.*

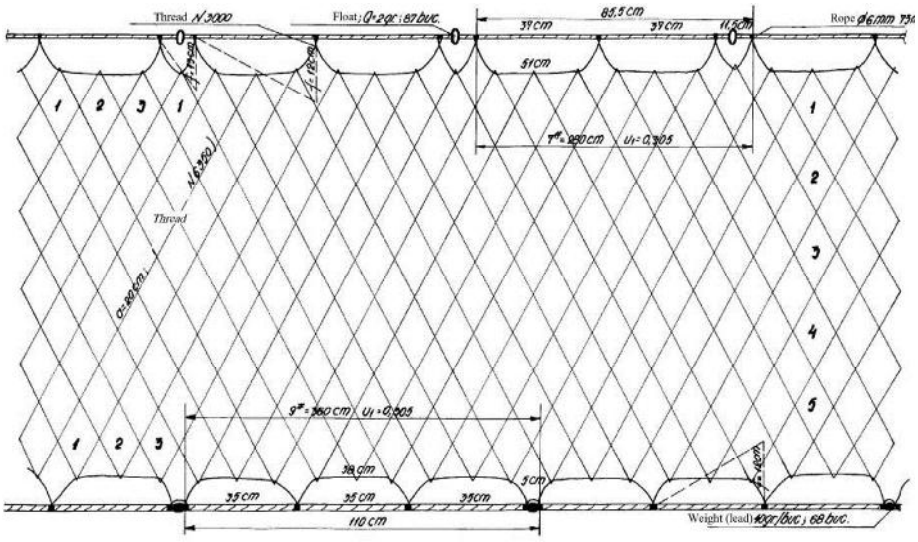


Fig. 5 - Turbot gill net

GNS_DEF_400_0_0

- Spatial distribution of the fishing activity of the metier: shelf; offshore; Bulgarian and Romanian coast of Black Sea.
- Number of vessels involved in metier by LOA group (Appendix III EC949/2008): BG: 166(<6mm), 224(6-12m), 8(12-18m), 1(18-24m); RO: 51(6-12m), 4(12-18m) 2(18-24m), 1(24-40m).
- Detailed gear types and selectivity devices used in metier: Gill nets with mesh size 2a= 400mm (Fig.5).
- Main target and by-catch species for the metier: Main target is turbot with by-catch of *picked dogfish, thornback ray, sturgeons, common stingray* and cetaceans.
- Additional remarks (historical and others): BG: No changes in discard pattern, the number of vessels is limited with the introduction of special permits for turbot catches (target species of the metier). The adopted numbers of vessels for Bulgaria in 2010 are 149. RO: In some years the by-catch and discards of dolphins can be a problem. There is a statistics of the dolphin by-catch and stranding.

Evolution of the sprat and turbot catches

The level of capture and fishing efficiency oscillated from one year to an other, the fishing effort (number of vessels, number of pound nets and gill nets, effective fishing days, etc.), evolution of hydro-climatic conditions and stocks status of the main fish species (Maximov *et al*., 2007; Panayotova *et al*.,

2008; Radu *et al*., 2008; Radu *et al*., 2007; Raykov *et al*., 2008; Staicu *et al*., 2008).

Initially (2001-2005) sprat landings have reached levels comparable to the '80ies but dropped again in 2006-2007. In 2008 the total landing started to increase again due to expending Turkish fisheries that corresponded to a rise in fishing mortality (Fig.6).

However, in 2006-2007 decreasing CPUE and mean size for sprat in Bulgarian and Romanian fisheries are indicating that the fishing pressure might be too strong for the present level of exploited stock biomass, and further catch limitations may be needed.

According to the data of the official statistics between 1995 and 2008 more than 80% of turbot catches in the Black Sea (400-2900 tons) have been realized by Turkey (219 -2850 tons) (Fig.7). However, in all other Black Sea countries non-reported catch of turbot exceeds the official catch for many times, being compared with the Turkish total catches.

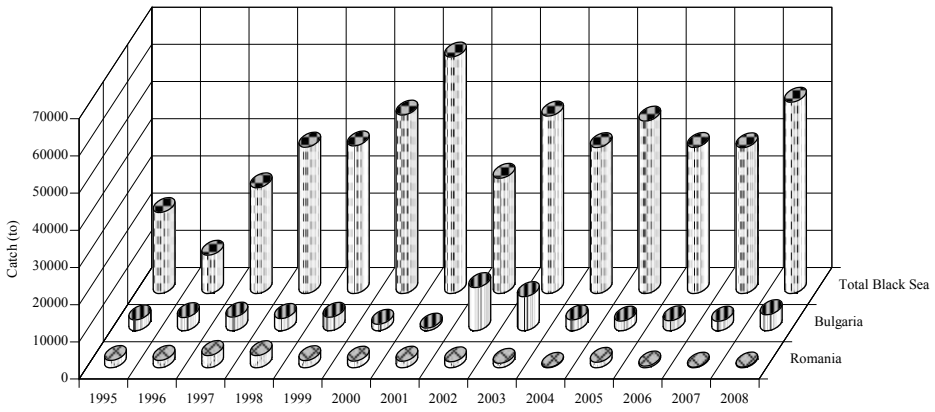


Fig. 6 - Sprat catches between 1995 and 2008

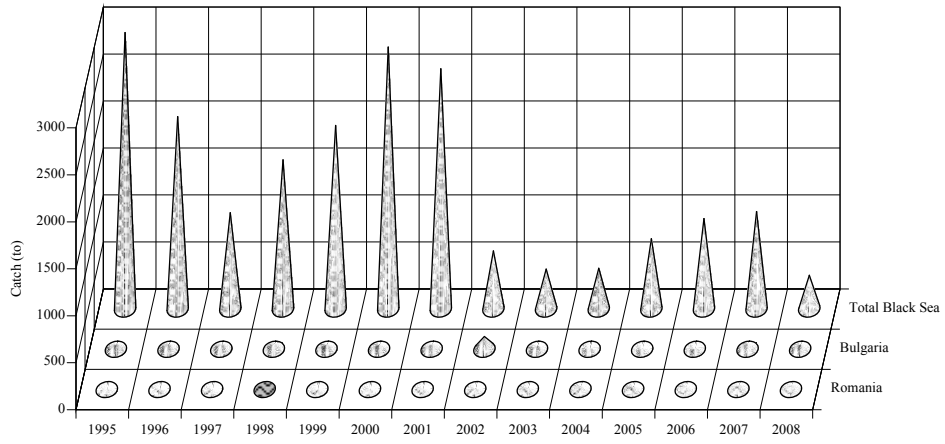


Fig. 7 - Turbot catches between 1995 and 2008

Structure of sprat and turbot populations

Determination of the biological parameters of fish species of economic interest represents an important objective to establish demographic structure, growth parameters as well as others parameters necessary for recruitment study, mortality rate, abundance and biomass (Maximov *et al*., 2007; Radu *et al*., 2008).

The length of sprat individuals ranged between 55 - 130mm / 1.18–12.80g, dominant being the classes of 70 - 100mm / 2.17 – 6.44g. Average length of the body was of 84.132mm and mean weight of 3.655g. The age structure shows the presence of the specimens of 1; 1^+ and 3; 3^+ years, the catch base being the individuals of 1; 1^+ and 2; 2^+ years, pertaining to the 2006 and 2007 generations (Fig.8, 9, 10).

The ration between females and males was favourable for females with 55.67%, against 44.33% for males.

The analysis by length classes of the turbot catches in 2008 evinced the presence of mature specimens and homogeneity of agglomerations. The length of turbot individuals ranged within the limits of 38.5 - 80.5cm. Dominant

classes are the ones of 44.5 - 68.5cm. (Fig.11). The ratio between sexes indicates a clear dominance of females (57.2%) over males (42.8%).

The composition by age of turbot catches reveals the existence of specimens between 2 to 9 years. Most of the individuals are 4 years old (29% of all specimens analyzed) and 5 years old (23%), followed closely by those 3 years old (20%) and 6 years old (120%) (Fig. 12, 13).

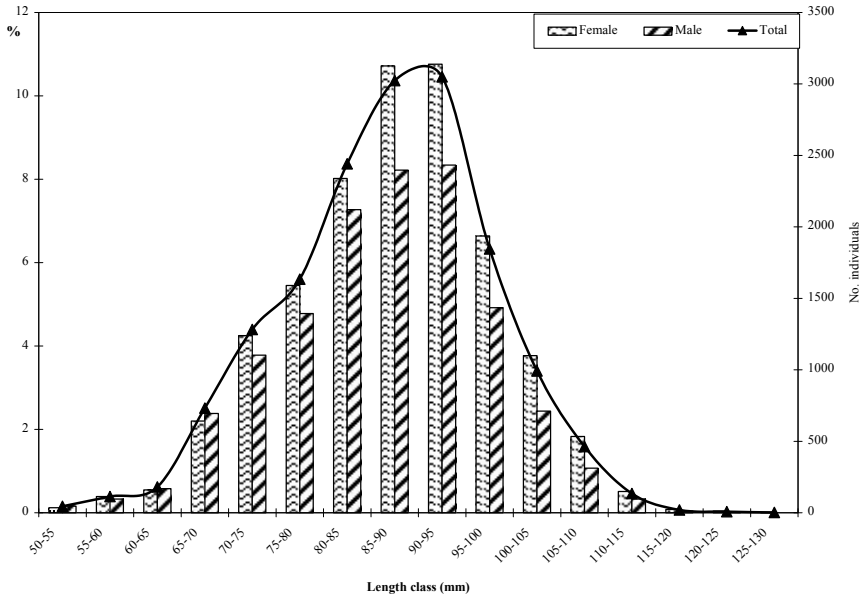


Fig. 8 - Structure on length classes for sprat in the Romanian Black Sea

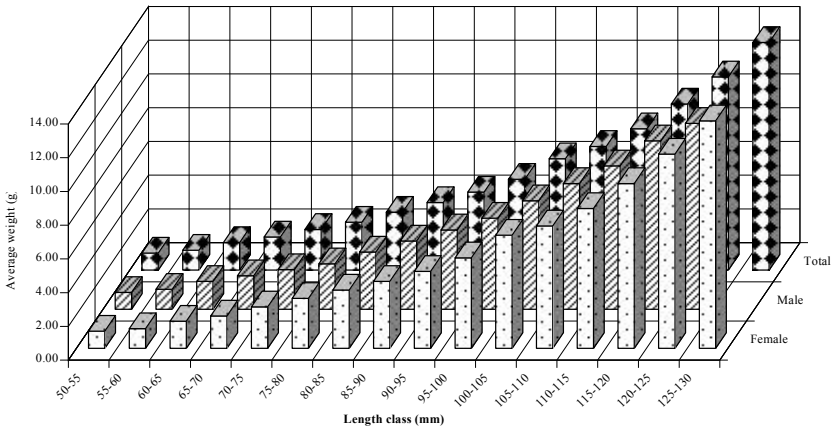


Fig. 9 - Mean weight on length classes for sprat in the Romanian Black Sea

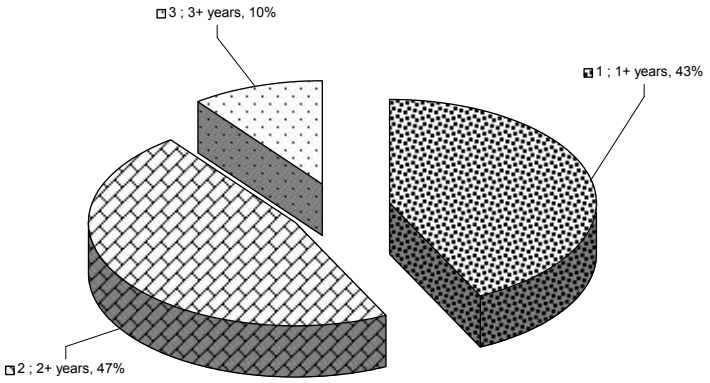


Fig.10 - Percentage on age classes for sprat in the Romanian Black Sea

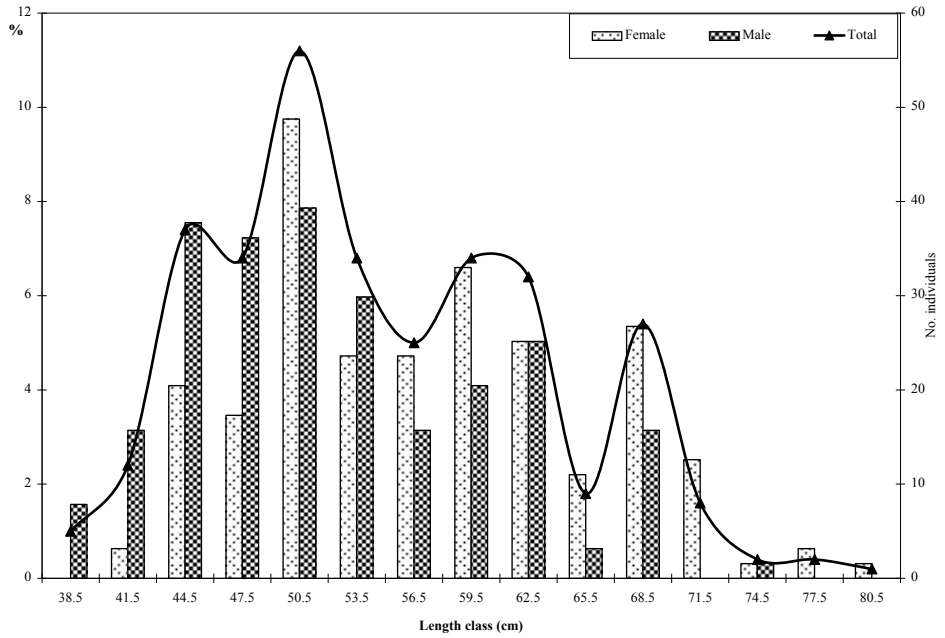


Fig.11 - Structure on length classes for turbot in the Romanian Black Sea

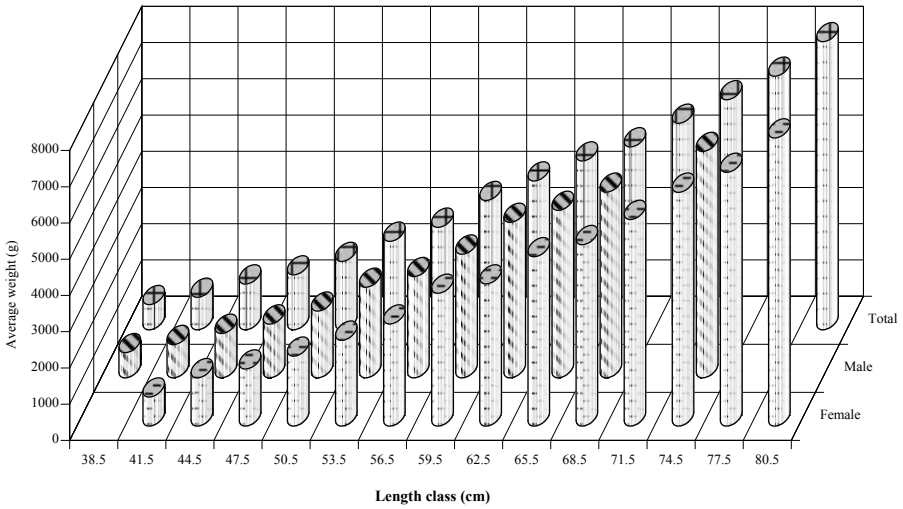


Fig.12 - Mean weight on length classes for turbot in the Romanian Black Sea

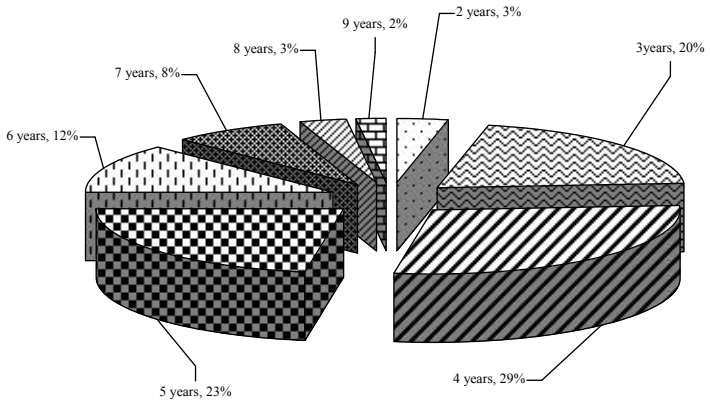


Fig. 13 - Percentage on age classes for turbot in the Romanian Black Sea

Evolution of sprat and turbot biomass

The swept area method is used for evaluation the biomass of fishing agglomerations of sprat, whiting, turbot, dogfish based on the statistic processing of productivity data obtained in sampling trawling and industrial trawling. For sprat sampling the pelagic trawl in demersal variant were used and for turbot sampling the bottom trawl (Panayotova *et al*., 2008; Radu *et al*., 2008; Raykov *et al*., 2008).

The biomass of sprat stock shows cyclic dynamics with lows and highs over decades. Maxima of recruitment and biomass occurred in the mid '70ies and mid '80ies. Maximum catch was recorded in 1989 (>100,000tons), leading to highest fishing mortality after that the stock collapsed. The collapse has been indicated by the drop in catches, abundance indices and commercial catch per unit effort (CPUE), and age and size composition. After the collapse in 1990 recruitment, biomass and catches of sprat started to increase showing a stable recovery by 2005.

The sprat agglomeration biomass ranged between 30,000 - 60,000 tons, function of environmental conditions, at Romanian littoral and about 30,000 - 40,000 tons at Bulgarian littoral (Fig.14).

In the Bulgarian and Romanian waters turbot stocks are in state of stress, and as compared with the previous period, this state is very slightly improved (Fig.15, 16).

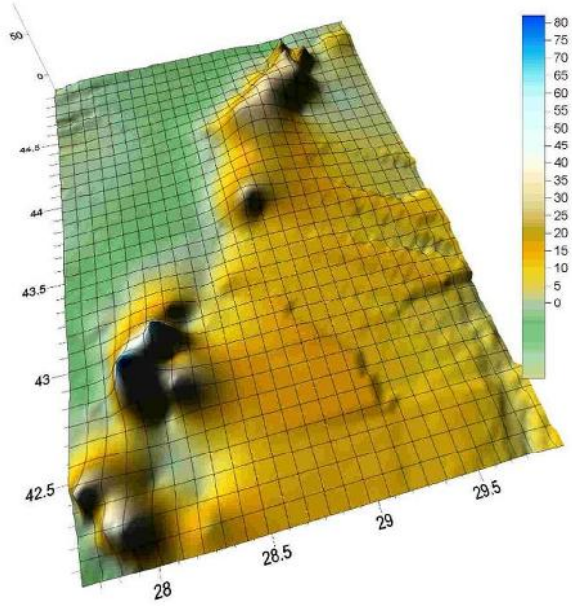


Fig.14 - Distribution of the sprat agglomerations in the spring 2008 (t/Nm^2)

The last assessments of turbot biomass in the Bulgarian waters show values about 1,500 tons. In the Romanian waters the last research by trawl surveys indicated that the biomass of the turbot ranged between 1,066 to 1,500 tons, slightly increasing.

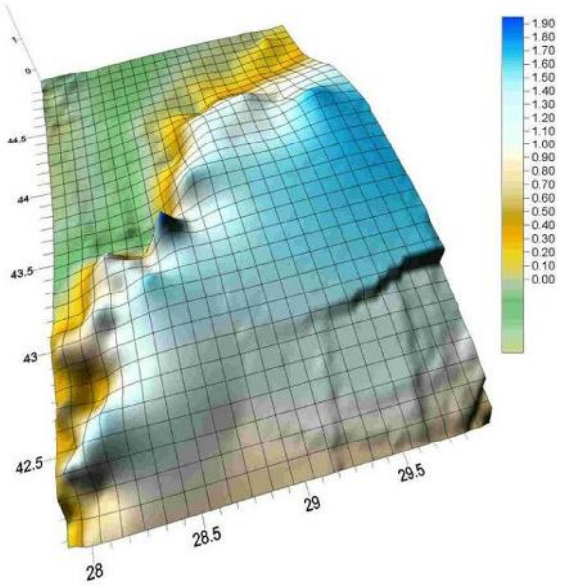


Fig. 15 - Distribution of the turbot agglomerations in the spring 2008 (t/Nm^2)

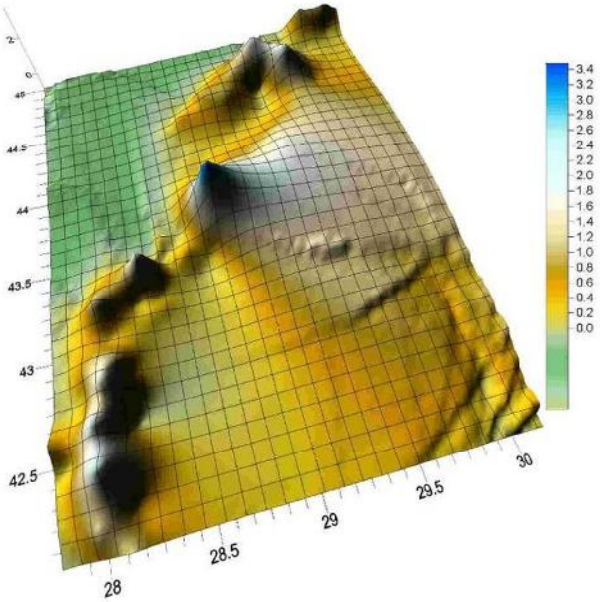


Fig. 16 - Distribution of the turbot agglomerations in the autumn 2008 (t/Nm^2)

CONCLUSIONS

- Sprat is the second most abundant fish species after the anchovy in the Black Sea and an important fisheries resource and prey species for Bulgaria and Romania.
- Sprat is an object of both artisanal and commercial mid-water trawl fisheries.
- In all the Black Sea countries turbot is one of the most valuable fish species.
- The fishery gears used by the trawlers are the pelagic trawls, equipped for demersal use.
- In bottom set gillnet fishery, the bottom species with commercial importance is turbot.
- The level of capture and fishing efficiency oscillated from one year to other, as to fishing effort, evolution of hydro-climatic conditions and stocks status of the main fish species.
- The biomass of sprat stock shows cyclic dynamics with lows and highs over decades.
- The sprat agglomeration biomass ranged between 30,000 - 60,000 tons, as to environmental conditions, in each area.
- In the Bulgarian and Romanian waters turbot stocks are in state of stress, and as compared with the previous period, this state is very slightly improved.
- The last assessments of turbot biomass in the Bulgarian and Romanian waters show values about 1,500 tons in each area.
- The transboundary character of the living resources from the Black Sea imposes the necessity for coordinated efforts at regional level for their exploiting and protection.

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