ANALYSIS OF THE EVOLUTION OF FISHING AND BIOLOGICAL CHARACTERISTICS OF MAIN FISH FROM THE ROMANIAN PONTIC BASIN, BETWEEN 2000 AND 2008

V. MAXIMOV, G. RADU, E. ANTON, Tania ZAHARIA
National Institute for Marine Research and Development
"Grigore Antipa", Constanta, Romania
e-mail: maxi@alpha.rmri.ro

ABSTRACT

In the Romanian marine area, the structure on species of the catches reflects partially the composition of the Black Sea ichthyofauna, because the ratio between the captured species is conditioned, basically, by the following factors: type of fishing gear and seasonal conditions of fishing agglomarations.

The research concerned the fish populations in the Romanian sector of the Black Sea, carried out in the period between 2000 and 2008, including both the quantitative structure and the qualitative component of the catches and the biological parameters of the main exploitable fish species in the Romanian marine area, under the specific hydroclimatic conditios for the analysed period.

The paper mentions the data and information regarding the catches, fishing effort, CPUE, mass and lenght, class, structure, age, relation between sexes, maturity, the establishment of the length/mass ratio for the fish species: *Spratus spratus* (sprat), *Engraulis encrasicolus* (anchovie), *Trachurus mediterraneus ponticus* (horse mackerel), *Merlangius merlangus euxinus* (whiting), *Psetta maxima maeotica* (turbot), *Squalus acanthias* (picked dogfish), *Mullus barbatus ponticus* (striped mullet) *Pomatomus saltatrix* (bluefish), *Gobiidae* (gobie).

KEY WORDS: Black Sea, catches, active fishing, stationary fishing, species, fishing effort, length, mass, age, length/mass ratio, growth parameters, estimation of mortality rates

INTRODUCTION

From ancient times, fishing has been a major food source for humans, ensuring jobs and economic advantages for those who practiced it. But, as the knowledge improved and the sector dynamically developed after World War Two, this myth vanished, discovering that these living marine resources, although renewable, are not infinite and must be managed properly if we want to maintain their contribution to the nutritional, economical and social wellbeing of a growing world population.

The most important resource, commercially exploited and with traditional implications, is represented by fish. The marine biological resources are essential for the survival of humanity, but, as we all know, they are renewable, but not neverending. That is why they must be managed properly.

Fishery resources are influenced by the changes of the natural environment conditions, as well as by the changes in the environment produced by human activities.

During the past years, the anthropic causes that determined severe mutations among the fish populations on the Romanian littoral were partly preserved, but some manifested at a lower intensity, as follows:

- environmental conditions in the littoral area are still precarious, demonstrated by the movement of the fish banks towards the pelagic area during the warm season;
- the influence of the systematization of the Danube and of the hydrotechnical constructions is still affecting the migration of sturgeons and mackerels;
- the use of inappropriate fishing tools and techniques;
- excessive fishing of the anchovy and horse mackerel wintering agglomerations;
- illegal fishing of the turbot and piked dogfish breeding agglomerations.

Man can have a more decisive role in a negative way in unbalancing the interrelational system of the populations than predators and parasites, through uncontrolled exploitation, having in view the maximization of productivity of the ecosystem, through fishing. But we forget the following: the fewer the species that represent the exploited system, the more instable it is by its own nature.

MATERIALS AND METHODS

The methodology and techniques used for collecting, verifying, processing and data analysing, as well as for the assessment of fish stocks are generally those accepted in the entire
Black Sea basin and in accordance with the international standard.

The qualitative and quantitative composition of the fish catches were obtained from the fishing statistics after centralization, the temporal data were obtained from the fishing companies and after interviews with fishermen. The fishing effort (vessels no. / pound nets no / trawls no. / no of hours per trawl / nets no. / fishing days) was also obtained from companies, collected by the National Agency for Fishing and Aquaculture (***NAFA***) inspectors.

For the study of the biological parameters of the main fish species, samples were collected from the relevant catches, for each species, which were analyzed in the laboratory, observing especially: *the structure according to length, mass and age classes*, elements required for the estimation of the growth parameters. The biometric measurements were made for the total length (L_t), being read at 5 mm (sprat) and 30 mm (turbot) intervals and the centralizations at inferior centimeter, The mass was obtained in grams, with a ±1 g precision. The age readings were made according to otolyths and radia.

In order to measure the total length (L_t)/weight relation (W), we used the relation (Carlander, 1977):

$$\mathbf{W = a \times L_t^b} \quad (1);$$

where: W is the weight of the fish's body; L_t - total length of the fish; a and b - regression constants.

The values for *a* and *b* constants were determined using the method of the smallest squares (Snedecor, 1968), included in the FISHPARM program (Prager *et al.*, 1994).

In order to estimate the growth parameters (L_∞, k, t_o), the following equations were used (Von Bertalanffy, 1938):

$$Lt = L\infty\left[1 - e^{-k(t-to)}\right] \quad (2); \qquad Wt = W\infty\left[1 - e^{-k(t-to)}\right]^3 \quad (3);$$

$$to = t + \frac{1}{k}\ln\left(1 - \frac{Lt}{L\infty}\right) \quad (4);$$

where: L_t is the length for age t (in cm); W_t - weight at age (in gr); L_∞/W_∞ - length/weight maximum value; k - growth parameter; t - age (years); t_0 - hypothetical age when L = W = 0; e - natural logarithm base.

For the evaluation of the L_∞, k, t_o parameters was used the FISHPARM program (Prager *et al.*, 1987, 1989, 1994) and the following equations (Pauly, 1984):

$L_{t+1} = a + b\,L_t$ (5); $L\infty = \frac{a}{1-b}$ (6); $k = -\ln b$ (7); $L\infty = -\frac{a}{b}$ (8).

where: L_t and L_{t+1} are the medium length in consecutive years; a and b - regression coefficients.

For the estimation of the mortality coefficients, the following ecuations were used:

* The estimation of the natural mortality coefficient (M) with Pauly's empirical relationship (1980):

$$\ln M = -0{,}0152 - 0{,}279 \ln L_\infty + 0{,}6543 \ln k + 0{,}4634 \ln T$$

where T - the average water temperature in the distribution area of the stock;

* The estimation of the total mortality (Z) with Pauly's relationship (1982):

$$Z = \frac{nk}{(n+1)\log e\left[\frac{L\infty - Lc}{L\infty - L}\right]}$$

where: Z - total mortality; L_∞, k - growth parameters; L - the average length of the captured individuals; L_c - average length, first catch; n - number of individuals; T - annual water temperature (ºC)

RESULTS AND DISCUSSION

1. The State of fisheries on the Romanian Black Sea littoral

The marine fishing along the Romanian Black Sea shore is carried on in two ways:

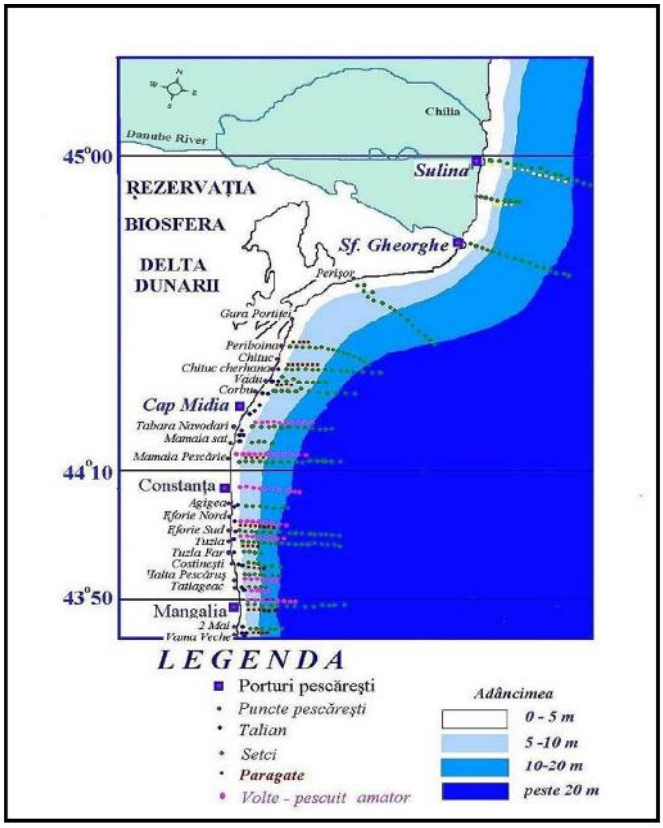
- fishing with coast trawler vessels, *B-410, Baltica* and *T.C.M.N.* types, equipped with *pelagic trawls* and *gill nets*, which activate offshore, at depths below 20 meters;

- fishing along the shore, practiced in 28 fishing points, between *Sulina - Vama Veche*, in shallow waters (3,0 - 11,0 meters), using fixed tools (*trap nets, gill nets, longlines and beach seines*) and at depths of 40 - 60 meters, using turbot gill nets and longlines (Fig. 1).

Stationary fishing

In the coastal area of the shallow Romanian sector, stationary fishing is characterized by the concentration of the activity in the first four/six months of the season (April-September), when the main commercial species come closer to the coast for reproduction and feeding. Stationary fishing is practiced along

the shoreline, in 28 fishing points, situated between Sulina and Vama Veche, with fixed tools (*trap nets, gill nets, longlines and beach seines*) and turbot gill nets and longlines, down to 40-60 m (especially in the Southern sector / Constanţa-Mangalia). Stationary fishing is practiced in 28 fishing points, with a number of 870 boats, of which only 255, under 10 m, and 28, between 10-15 m, have fishing license, by using 21-23 trap nets, 2,500 turbot gill nets, 1,000 shad gills, 200 goby gills, 16 beach seines, 544 longlines (54.400 hooks) şi 1,172 hands (Fig. 1, Table 1) (*Maximov et al. 2007, 2008*).



Total length of the coastline	-	245 Km (6%);
Continental platform	-	30.000 Km^2 (16%);
EEZ	-	25.000 Km^2

Fig 1 - The Romanian coastal sector of the Black Sea

Despite the fact that Romania is a maritime country, with 244 km of coastline, in the past decade, due to the new conditions of fishing practice, the

cease in granting subsidies from the state and the alignment to the principles of market economy, led to the radical change of the conditions of marine traditional fishery. Also, the competition created by the opening of fishery products imports, especially of frozen sprat, the lack of experience in exploiting under the new circumstances, the deterioration of the vessels, as well as the increase of fuel and maintenance costs led to a drastical incolution of active fishing in the Romanian sector of the Black Sea. Year by year, active fishing has reduced gradually, so that in 2008, out of the total of more than 20 vessels recorded in the Ships and Boats File, only two vessels carried out sporadically specialized sprat fishing, *MEDUZA 4* and *CHEFAL 6* , and other four vessels specialized turbot fishing, *DRAGONUL, HENDEM MUSTAFA, MEDUZA 4* şi *CHEFALUL 10* (Table 1, Fig. 2).

2. The Catch, Fishing Effort and Catch Per Unit Effort

In the fishing season between 2000 and 2008, the level of the catches, except the period 2000-2002, when values over 2.000 tones annually (2.476 to/2000, 2.431 to/2001, respectively 2.116 to/2002) were registered, was relatively low, between 1.390 tones/2006 and 1.940 tones/2005, then dropping to 435 t /2007 and 444 t / 2008 (Fig. 3) (Maximov V.).

The level of the catches in 2007 and 2008, the lowest in the past 10 years, was a consequence of the reduction of the fishing effort (the reduction in the number of coastal trawls, seines and, consequently, of the staff involved in the fishing activity), of the growth of production costs, as well as of the influence of hydroclimatic factors on the fish populations.

Photo: V. Maximov

Photo: V. Maximov

Trap nets and fishing point

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Pelagic trawl

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Fig. 2 - Fishing point, pelagic trawl and catches

Active fishing

In the 8-10 months of fishing activity every year (February-November) between 2000 and 2008, the Romanian coastal trawler vessels got different catches, determined by the fishing effort (number of vessels, effective number of days at sea, number of trawling and trawling hours), as well as by the evolution of hydroclimatic conditions, the state of the main fishing species stocks (sprat and whiting) and of the market demand of the fish, varying between 324 t/2008 and 2.008 t/2001, the catch in 2008, by the three operational ships, was 324 tones, the lowest in the history of Romanian fishing, being lower by 24,83% compared to 2007, respectively 77,56% compared to 2006 (Maximov V.). The reduction of catches was caused by the decrease of the fishing effort (number of vessels, fishing days, trawling hours) (Fig. 5). Active fishing was and is determined by the distribution of fish

agglomerations, especially of sprat populations and the market demand of the product.

Table 1 - Vessels and tools used for active fishing between 2006 – 2008

Operator	Vessel	*Activity period*	*Catch*				*Gears used*		*Crew* (*no.*)
			Total	**sprat**	**turbot**	**other**	**trawl**	gillnets	
YEAR 2006									
SC Blue Balena Trading	*Hendem Mustafa*	II - XII	19,056	7,750	5,670	5,636	1	500	10
SC Euromabile	*Meduza 2*	V- X	138,384	133,489	310	4,585	1	50	7
SC Fishing Meridian	*Chefalul 6*	V - XI	107,533	101,091	30	6,412	1	10	6
SC Miadmar	*Meduza 4*	IV - X	133,487	100,345	15,560	17,582	1	70	7
SC Dunaraf Trans	*Chefalul 10*	IX XII	51,037	36,736	6,842	7,459	1	500	6
SC Brivas fish	*Dragonul 1*	IV - IX	13,001	3,989	1,727	7,285	1	450	7
SC *Morunul*	*Morunul*	IX	150	150	-		1	-	7
T O T A L	**7 vessels**	**II - XII**	**462.653**	**383555**	**30.139**	**48.959**	**7**	**1,580**	
YEAR 2007									
SC Blue Balena Trading	*Hendem Mustafa*	II - XI	20,894	-	16,881	4,013	-	500	10
SC Euromabile	*Meduza 2*	III - VII	28,862	27,635	594	633	1	200	6
SC Fishing Meridian	*Chefalul 6*	V - X	64,989	62,575	14	2,400	1	10	5
SC Miadmar	*Meduza 4*	IV – VII	170,000	90,000	6,000	74,000	1	234	7
	Flamengo 4	V – X	5,075	3,613	888	574	1	100	6
SC Dunaraf Trans	*Chefalul 10*	VIII – IX	27,316	10,288	9,200	7,828	1	500	6
	Chefalul 12	VIII	3,000	1,500	388	1,112	1	200	6
SC Brivas fish	*Dragonul 1*	III - VIII	2,556	-	2,542	14	-	250	7
SC Smart Fish	*Yildirimilar 1*	III - VII	1,558	-	1,278	280	-	500	5
T O T A L	**9 vessels**	**II - XI**	**324,250**	**195,611**	**37,785**	**90,854**	**6**	**2,494**	**56**
YEAR 2008									
SC Blue Balena Trading	*Hendem Mustafa*	II – VIII	8,461	-	8,032	429	-	1000	10
SC Fishing Meridian	*Chefalul 6*	VI – VIII	28,790	27,760	-	1,030	1	-	5
SC Brivas fish	*Dragonul 1*	III - VII	2,937	100	2,837	-	1	200	7
SC Miadmar	*Meduza 4*	IV - VIII	127,330	117,930	7,169	2,231	1	250	6
SC Dunaraf Trans	*Chefalul 10*	VIII – IX	25,246	2,050	18,811	4,385	1	500	6
T O T A L	**5 vessels**	**II -IX**	**192,764**	**147,840**	**36,849**	**8,075**	**4**	**1,950**	**34**

Table 2 - Number of vessels, fishing tools and staff involved in stationary fishing in 2008 (private enterprises and associations)

No	Fishing point	**Boats**				**Fishing gears**							*Crew* (*no.*)	
		Total	Licensed	withs smo	withs out	trap net	gill nets	gill shad	gill goby	beach seine	longlaine	volte	P	A
1	*Sulina*	163	163	146	17	2	1310	525	-	2	-	-	163	-
2	*Sf. Gheorghe*	82	82	80	2	1	6375	2640	-	1	-	-	90	-
3	*Perişor-Periteaşca*	100	100	75	25	-	3654	964	-	1	142	-	90	-
4	*Periboina*	102	82	82	20	4	920	364	-			-	92	-
5	*Chituc pichet*	20	18	18	2		108	114	-	-	-	-	21	-
6	*Chituc cherhana*	5	5	2	3	2	340	160	-	4	100	-	6	-
7	*Vadu*	2	2	1	1	2	150	50	10	1	-	-	5	-

8	*Corbu*	2	2	-	2	3	200	50	-	1	30	-	5	-
9	*Cap Midia*	8	8	2	6	2	50	10	-	1	10	-	10	-
10	*Cap Midia cherhana*	6	6	3	3	2	50	20	-	-	-	-	12	-
11	*Tabăra Năvodari*	8	8	5	3	2	60		-	-	-	-	18	-
12	*Mamaia sat*	6	6	-	6	4	50	20	-	1	10	-	15	-
13	*Mamaia Pescărie*	52	2	50	2	-	50	20	-	1	28	220	16	106
14	*Constanţa* (As. *Albatros)*	40	2	40	-	-	50	10	-	-	-	140	5	70
15	*Agigea*	3	3	-	3	3	100	10	10	-	10	-	8	-
16	*Eforie Nord*	3	3	2	1	1	20	10	-	-	-	-	50	-
17	*Eforie Sud*	27	3	22	5	2	50	10	-	2	-	60	20	60
18	*Tuzla* (As. *Delfinul*)	70		56	14	-	20	20	10	1	10	150	14	150
19	*Tuzla far*	3	2	-	3	1	50	30	20	-	20	-	6	-
20	*Costineşti*	6	6	3	3	2	136	10	10	1	-	-	20	-
21	*Golful Francezului*	5		3	2	-	10	10	10	-	-	20	17	12
22	*Halta Pescaruş*	32	8	30	2	-	180	50	160	-	20	200	16	48
23	*Tatlageac (Olimp)*	12	7	8	4	2	150	20	140	-	10	12	12	12
24	*Jupiter Cap Aurora*	4	4	2	2	-	10	-	10	-	-	20	2	8
25	*Saturn*	3	3	-	3	-	10	-	10	-	-	10	2	6
26	*Mangalia*	80	50	73	7	-	200	-	-	-	200	300	20	190
27	*2 Mai*	18	7	12	6	1	30	10	20	-	20	40	9	35
28	*Vama Veche*	8	4	-	8	6	65	20	30	1	10	-	8	-
	T O T A L	**870**	**586**	**715**	**2084**	**42**	**14398**	**5147**	**440**	**18**	**620**	**1172**	**435**	**697**

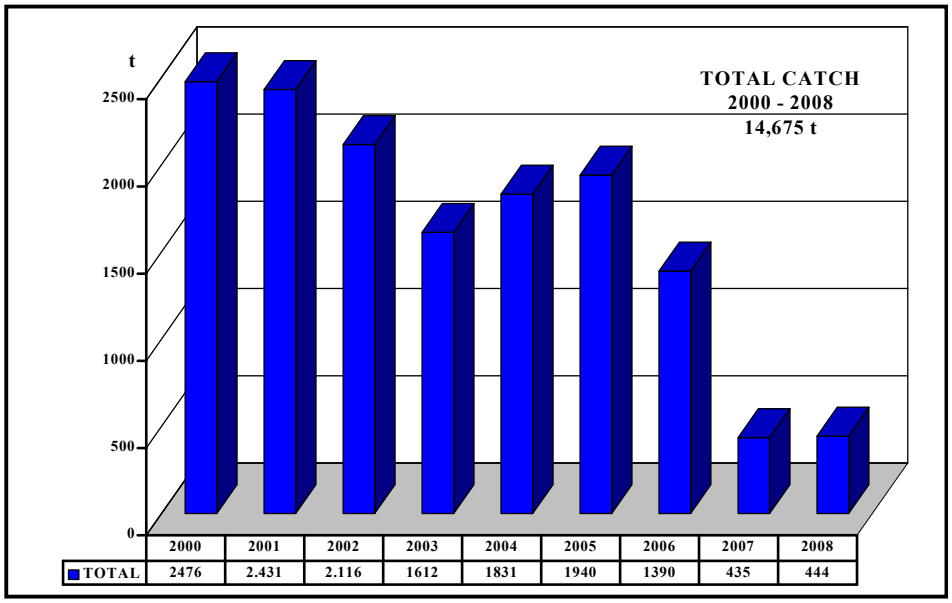


Fig 3 - Total catch (tones) in the Romanian sector between 2000 and 2008

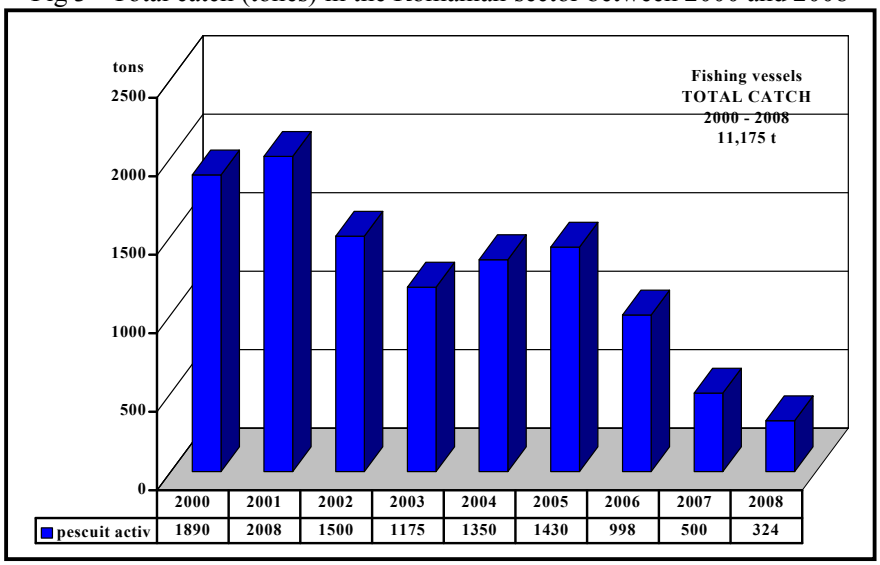


Fig. 4 - The total catch (tones) resulted from active fishing between 2000-2008

During the past years, the vessels fished only when they had clear requests, due to the high cost of fuel. The only sectors where fishing was carried out are Constanţa - Corbu and Zătoane - Sulina. The average productivity obtained by the trawler ships in 2008 was of 74,62 t/vessel, 1,28 t/day, 0,51 t/ trawling and 1,03 t / hour, in about 175 fishing days, 218 trawlings and 435 fishing hours (Table 3) (Maximov et al. 2006, 2007, 2008).

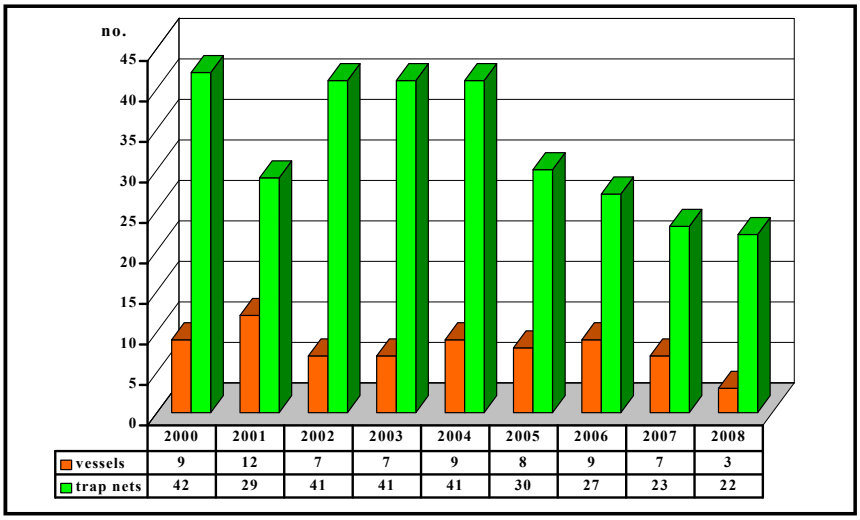


Fig. 5 - The fishing effort with fixed and active tools between 2000 and 2008

Stationary fishing

Generally, on the Romanian littoral, fishing by fixed tools is characterized by the concentration of the activity in the first three/four months of the season (April-July), when most of the species come closer to the coast for feeding and breeding. The levels of the catches and fishing productivity were different from one year to another, depending on the fishing effort (number of trap nets and effective fishing days), the evolution of the hydroclimatic conditions and of the state of the main fishing species and anthropic factors. The catches between 2001 and 2008 varied between 616 tones / 2002 and 101 tones / 2008.

Table 3 - The evolution of catches, fishing effort, CPUE in the fishing carried out on the Romanian littoral between 2000-2008

Years	**Stationary fishing**					**Active fishing**								
	Catches (t)	no. trap nets	no. day	*c. p. u. e* t/trap nets	t/day	Captura (t)	no. Vessel	nr. day	o. hours	no. trul.	*C. P. U. E* t/vessel	t/day	t/hour	t/tr.
2000	**586**	42												
2001	**423**	29	722	14,58	0.58	**2.008**	7	678	3.498	2.422	286,86	2,96	0,57	0,83
2002	**617**	41	3.341	15,02	0.18	**1.500**	7	878	2.922	1.971	214,29	1,71	0,51	0,76
2003	**437**	41	3.573	10,65	0,12	**1.175**	9	743	2.067	2.848	130,56	1,58	0,57	0,41
2004	**481**	41	3.125	11,73	0,15	**1.350**	8	762	2.035	2.675	168,75	1,77	0,66	0,50
2005	**510**	30	2.750	17,00	0,18	**1.430**	9	788	2.110	2.805	158,89	1,81	0,68	0,51
2006	**392**	27	2.510	14,52	0,16	**998**	8	760	2.020	2.605	124,75	1,31	0,49	0,38
2007	**137**	23	1.560	6,23	0,08	**298**	3	177	500	746	99,33	1,68	0,59	1,33
2008	**120**	22	1.360	5,45	0,09	**324**	3	175	435	218	108	1,85	0,74	1,48

The poor results obtained in 2008 (101 tones) were 36,00% lower than in 2007 and 74,23% lower than in 2006 (Fig. 6), caused by the reduction in the number of trap nets (from 41 to 21 / Fig. 5), as well as by the fact that fish did not approach the shallow water areas (under 10 meters), where trap nets are usually placed.

In 2008, 21 trap nets were placed at depths between 3.0-11.0 m, according to the characteristics of the fishing sector, which generated a total catch of 101,687 kg in 1,310 days of activity, an average monthly productivity of 4,81 t/trap net and an average daily productivity of 0.07 t/day (Table 3). At the 14 professional fishing points where fishing activities were carried out, the average catches and productivity were different, depending on the number of trap nets, turbot seines, fishing rods and days of activity. The best results were registered in 2 Mai - Vama Veche, Tatlageac (Olimp), Costinesti and Cape Midia. At the amateur fishing points (8) a number of 14 authorized persons carried out their activity, using turbot seines (about 240 pieces), hook lines and rods, realized a catch of 6.619 kg, with an average productivity of 121.34 kg / trap net. Along these, 3,900 amateur fishermen licensed by A.G.V.P.S. - Constanţa used fishing rods and obtained a total catch of 30,000 kg, with an average productivity of 3.75 kg/rod.

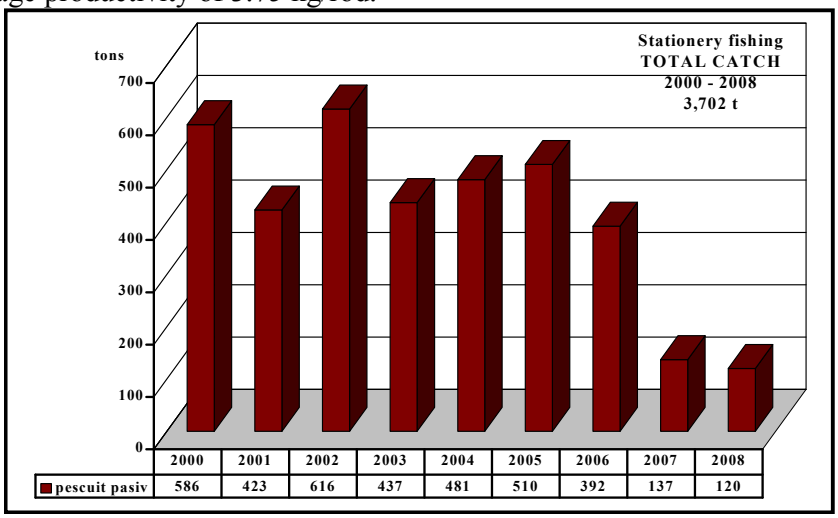


Fig. 6 - The total catch (tones) resulted from stationary fishing between 2000-2008

The structure on species

The main characteristics of the catches on the Romanian littoral is the presence of a large number of species (over 20), out of which the most important are the small sized ones (sprat, anchovy, whiting, goby). The

presence of the valuable species (turbot, piked dogfish, sturgeon, horse mackerel, belone, Danube shad, bluefish) continues to be low and critical, despite a slight tendency of recovery. On the whole Romanian littoral and during the entire fishing period, the dominant share in the catches belonged to sprat/*Spratus spratus,* turbot/*Psetta maeotica* and Danube shad/*Alosa pontica,* along which the traditional species emerged: anchovy/*Engraulis encrasicolus*, whiting/*Merlangius merlangus ponticus*, horse mackerel /*Trachurus mediterraneus ponticus*, goby/*Gobiidae*, bluefish/*Mugidae,* piked dogfish/*Squalus acanthias*, and other species (Fig. 7).

**** Active fishing***

In active fishing, the main species continues to be sprat, which represented, in the period analyzed, 74.8-96.21% of the total catch, along with whiting - 2.2-13.3% and bluefish - 0.1-0.7%. Even though in 2008, during the summer months, horse mackerel was present in the Romanian sector of the Black Sea (the survey trawlings made during the August and September expeditions), the vessels reported catches of about 5.4%. In addition to active fishing, the vessels equipped with fishing gears and turbot seines realized a 33 tone catch of turbot (14,1%) (Table 4).

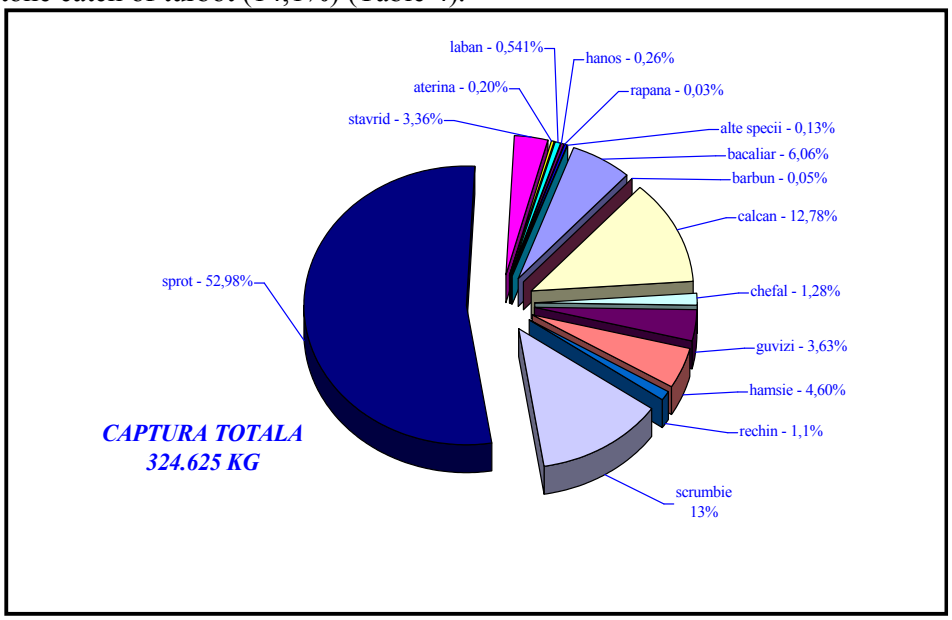


Fig. 7 - The main species strictures (%) of the catches in marine fishing

Table 4 - The structure of catches (%) in active fishing between 2000 and 2008

Species	2000	2001	2002	2003	2004	2005	2006	2007	2008
Sprat	92.7	85.7	96.21	95.7	92.9	89.7	89.9	89.8	74.8
Whiting	6.9	13.3	2.53	3.8	4.9	4.4	5.8	2.2	10.9
Horse mackerel	0.3	0.5	0,95	0.3	0.5	0.7	0.9	1.6	5.4
European anchovy						2.5		0.5	0.9
Bluefish	0.1	0.4	0,13	0.1	0.2	0.1	0.3	0.1	0.7
Turbot					1.4	1.9	2.5	4.1	4.2
Piked dogfish						0.4	0.6	1.45	2.5
Other species	-	0.1	0.17	0.1	0.1	0.3	0.1	0.3	0.6
TOTAL (t)	**1,890**	**2,008**	**1,500**	**1,175**	**1,350**	**1,430**	**998**	**298**	**324**

**** Stationary fishing***

In the catches resulted from stationary fishing, the presence of 27 species was registered, the percentage of which was different from one sector to another and from one season to another. On the entire Romanian sector and the whole fishing period (April-October), the dominant catches were the traditional species: anchovy (5.8-48%), sprat (9.8-76.6%), goby (5.8-15.5%), horse mackerel (0.2-2.3%), turbot (0.1-10%), whiting (4.7-24.8%) and sand smelt (0.1-7.8%)(Table 5).

Table 5 - The structure of catches (%) in stationary fishing between 2000 and 2008

Species	2000	2001	2002	2003	2004	2005	2006	2007	2008
Sturgeon	0.1	0.3	0.1	0.1	0.1	+	Forbid den	Forbid den	Forbid den
Sand smelt	7.1	6.8	1.4	1.6	1.3	0.3	0.1	626	626
Garfish	0.0	0.1	+	+	0.1	+	0.1	205	125
Horse mackerel	0.2	2.0	1.1	1.5	1.8	0.6	2.3	11358	3567
Caspian shad	13.0	5.2	0.4	1.0	1.2	0.2	0.1	461	234
Danube shad	0.9	0.7	0.2	0.2	3.3	0,.2	2.2	47049	52705
Kilka	0.9	2.7	0.7	0.8	1.1	0.1	0.1	325	125
Sprat	9.0	16.6	28.3	21.6	19.7	76.6	55.5	234000	10345
European anchovy	34.9	44.0	48.0	36.9	28.2	7.9	5.8	15000	12354
Whiting	24.8	9.2	7.8	15.6	10.6	4.7	5.8	55173	23453
Goby	7.0	5.8	7.5	10.5	15.5	4.9	12.4	13091	3568
Grey mullet	0.0	0.1	0.3	0.3	0.5	0.5	0.4	7499	5681
Red mullet	0.2	0.6	0.2	0.6	8.3	1.6	1.2	219	342
Bluefish	0.2	0.3	0.1	0.2	0.3	0.1	0.1	345	123
Turbot	0.4	3.0	2.7	5.2	0.1	1.9	10	47111	23467
Flounder	0.0	+	+	0.1	4.9	+	+	Forbidden	Forbidden
Common sole	1.0	2.0	1.0	2.9	2.7	0.1		Forbidden	Forbidden
Dogfish	-	-	-	-	-	-	2.4	10283	9745
Other species	0.3	0.6	0.3	0.4	0.3	0.2	0.9	2143	1653
T O T A L	**586**	**423**	**617**	**437**	**481**	**510**	**392**	**443921**	**148118**

Determination of biological parameters

The determination of biological parameters of the commercially valuable fish species is an important objective in establishing the demographic structure, the growth parameters, as well as of other parameters required for the study of the recruitment, mortality, effective and biomass on age classes. The study of biological parameters of the main fish species, resulted from stationary fishing in the fishing points on the littoral, as well as from the catches of the trawler vessels, was achieved based upon the samples collected on the field and analyzed in the laboratory. The main biological parameters taken into account were: length, mass, age, sex and degree of maturity of the gonads.

Structure on classes: length, mass and age

Out of the total **124,825** gravimetric and biometric measurements, 48.78 % were made upon the species ***Spratus spratus*** (60,873 exp.), 1.56% - ***Psetta maxima maeotica*** (1,951 exp.), 25.21% - ***Engraulis encrasicolus*** (31,462 exp.); 12.28% - ***Merlangius merlangus euxinus*** (15,322 exp.); 7.57% - ***Trachurus mediterraneus ponticus*** (9,446 exp.); 2.56% - ***Mullus barbatus ponticus*** (3,214 exp); 1.71% - ***Neogobius melanostomus*** (2,136 exp.) şi 0.33% - ***Mesogobius batrachocephalus*** (421 exp.) (Table 6).

Table 6 - Biological samples collected between 2000 and 2008

S P E C I E S	Popular name	years									*TOTAL*
		2000	2001	2002	2003	2004	2005	2006	2007	2008	
Spratus spratus	sprat	5009	5739	4567	4590	3632	3064	6703	12572	14997	**60,873**
Psetta maxima maeotica	turbot			130	352	385	220	278	250	336	**1,951**
Engraulis encrasicolus	anchovy	2248	2009	2909	1891	2303	2148	2483	7887	7584	**31,462**
Merlangius merlangus ponticus	whiting	1286	1536	625	2674		1877	2116	2912	2296	**15,322**
Trachurus mediterraneus	horse macherel	209	824	569	428	787	287	330	2119	3893	**9,446**
Mullus barbatus ponticus	red mulet		231					1052	460	1471	**3,214**
Neogobius melanostomus	black spotted goby	347	197					990		602	**2.136**
Mesogobius batrachocephalus	knout goby							222		199	**421**
T O T A L		**9099**	**10536**	**8800**	**9935**	**7107**	**7596**	**14174**	**26200**	**31378**	**124,825**

a. Sprat (*Spratus spratus* Linnaeus, *1758*) - the analysis of length and mass classes of the sprat catches emphasized the presence of mature individuals and a great homogeneity of the fish schools. The length variation of the sprat individuals ranged within the length class limits of 55-130 mm/1.18-12.80 g, the classes of 70-100 mm/2.17-6.44 g (Fig. 8) being dominant. The average body length was 84.132 mm and the average weight 3.655 g. The age structure of the sprat catches indicates the presence of $0;0^{+}$ and $3;3^{+}$ years old individuals, the core fo the catch being represented by $1;1^{+}$

and 2;2^{+} years old individuals (Fig. 9)(Maximov et al. 2006, 2007, 2008). The sex ratio was clearly favorable to females / 55.67%, compared to 44.33%/males.

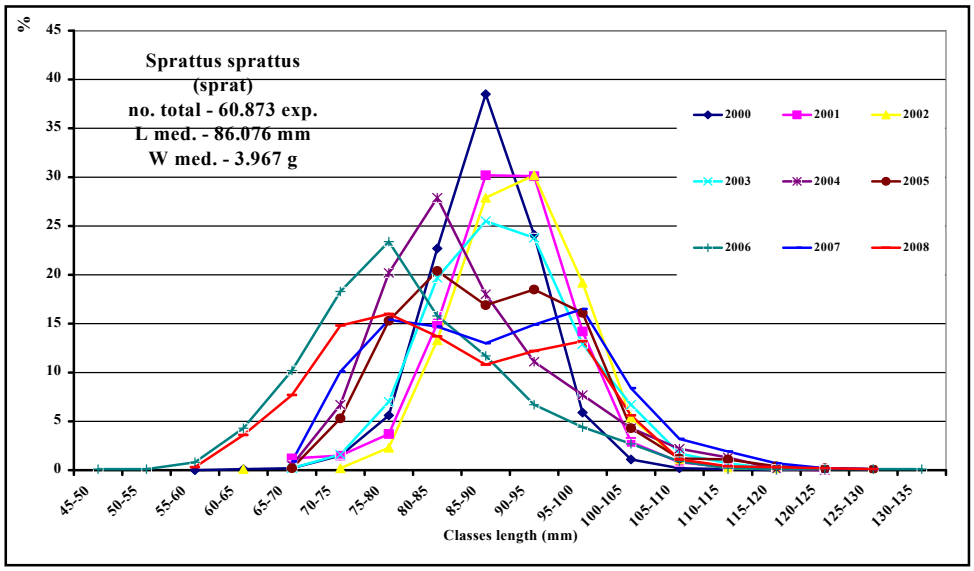
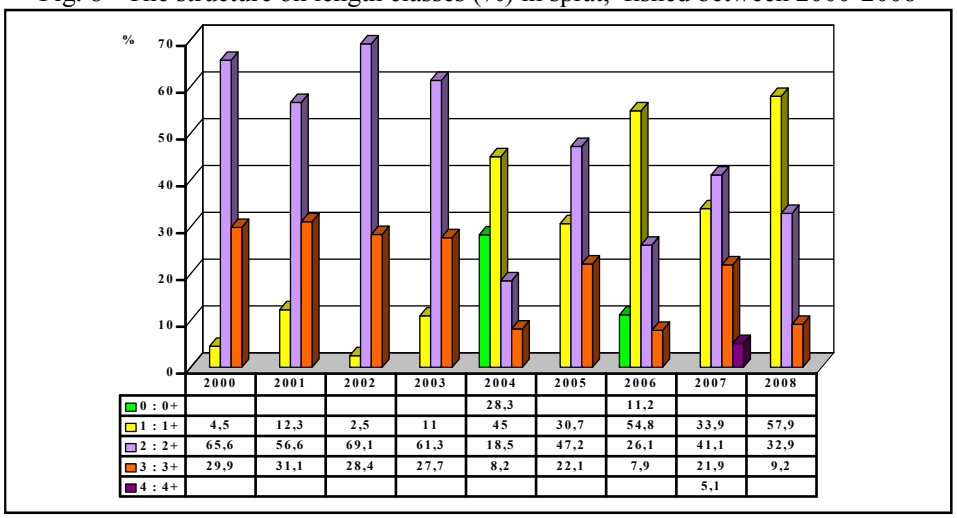


Fig. 8 - The structure on length classes (%) in sprat, fished between 2000-2008



	2000	2001	2002	2003	2004	2005	2006	2007	2008
0 : 0+					28,3		11,2		
1 : 1+	4,5	12,3	2,5	11	45	30,7	54,8	33,9	57,9
2 : 2+	65,6	56,6	69,1	61,3	18,5	47,2	26,1	41,1	32,9
3 : 3+	29,9	31,1	28,4	27,7	8,2	22,1	7,9	21,9	9,2
4 : 4+								5,1	

Fig. 9 - The structure on age classes (%) in sprat, fished between 2000 – 2008

b. ***Turbot*** (*Pseta maxima maeotica* Pallas 1811) - the analysis of length and mass classes of turbot agglomerations emphasized the presence of mature individuals and a great homogeneity of the fish schools. The length variation of the turbot individuals ranged within the length class limits of 26.5-65.5 cm / 310-5,580 g, dominant being the 41.5-50.5 cm / 1,315-2,472 g classes (Fig. 10). The ratio on sexes was clearly favorable to females 57.2%, compared to 42.8%, males. The average body length was 47.06 cm, and the average mass 2,015 g (Maximov et al. 2006, 2007, 2008). The age structure of the turbot catches indicated the presence of 1 to 7 years old individuals, the core of the catch being represented by 5 years old (30.6% of the total number of individuals analyzed) and 4 years old individuals (28.3%), followed closely by 3 years old (18,5%) and 2 years old individuals (9.20%)(Fig. 11).

c. Anchovy (*Engraulis encrasicolus* Linnaeus, 1758) - 31,462 anchovy individuals were examined (59.41% females and 40.59 males), which had a total average length ranging between 106.14 mm and 115.88 mm and an average mass ranging between 6.79 g and 9.56 g. Between May and September, the anchovy schools consisted of 60-160 mm / 1.35-15.59 g individuals, aged between $0;0^{+}$ and $3;3^{+}$ years, dominated by 80-125 mm / 3.55-10.84 g, aged $1;1^{+}$ years (55.8%) individuals, the larger ratio being represented by females (Fig. 12). The catches contained individuals belonging to the $1;1^{+}$ and $4;4^{+}$ age group, the $1;1^{+}$ and $2;2^{+}$ years old groups, as a consequence of the fishing pressure upon the species, especially in the wintering areas (Fig. 13).

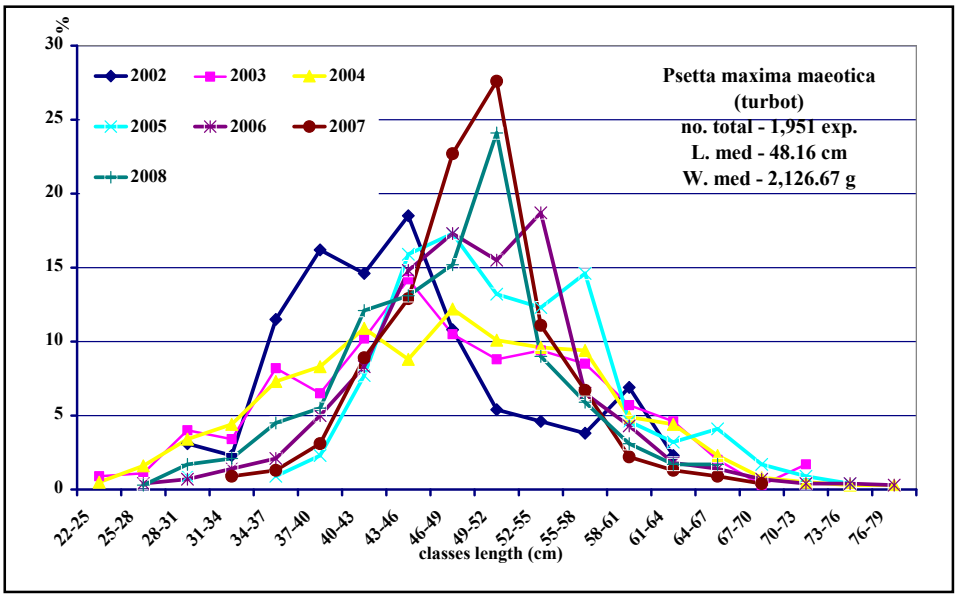
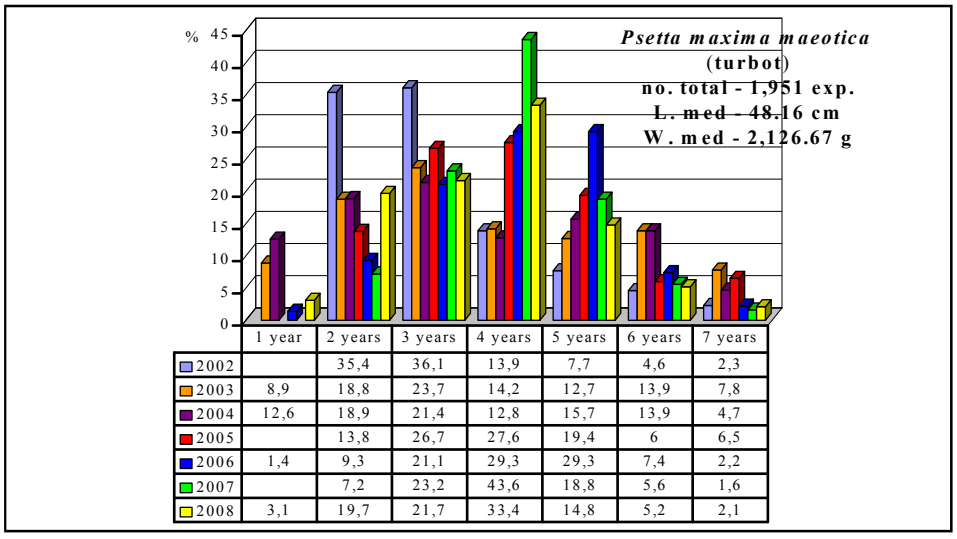


Fig. 10 - The structure on length classes (%) in turbot, fished between 2000–2008



	1 year	2 years	3 years	4 years	5 years	6 years	7 years
2002		35,4	36,1	13,9	7,7	4,6	2,3
2003	8,9	18,8	23,7	14,2	12,7	13,9	7,8
2004	12,6	18,9	21,4	12,8	15,7	13,9	4,7
2005		13,8	26,7	27,6	19,4	6	6,5
2006	1,4	9,3	21,1	29,3	29,3	7,4	2,2
2007		7,2	23,2	43,6	18,8	5,6	1,6
2008	3,1	19,7	21,7	33,4	14,8	5,2	2,1

Fig. 11 - The structure on age classes (%) in turbot, fished between 2000 – 2008

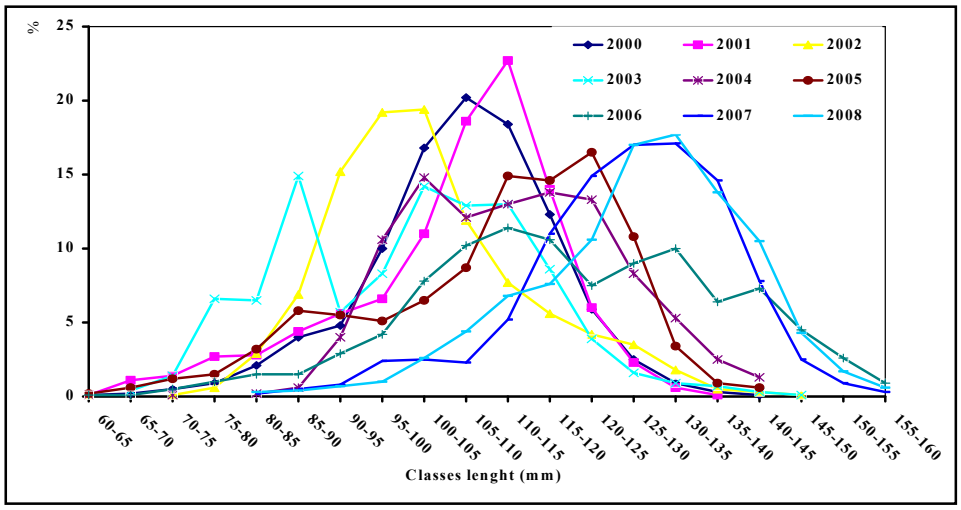
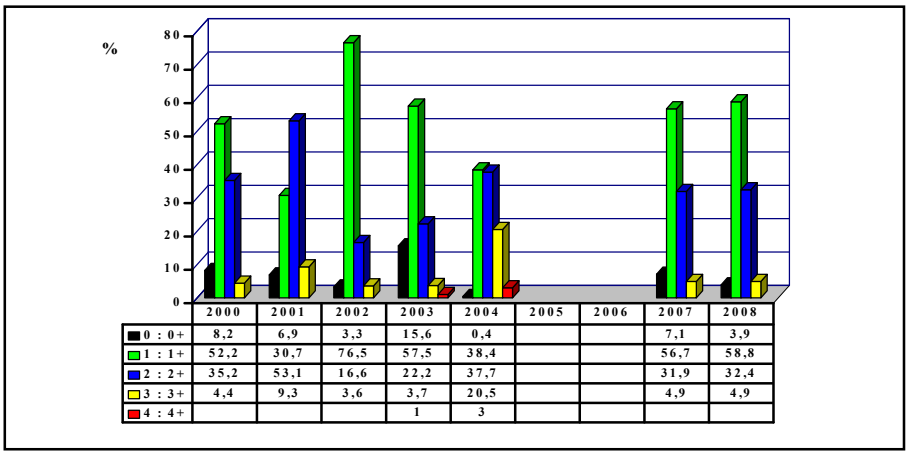


Fig. 12 - The structure on length classes (%) in European anchovy, fished between 2000 - 2008

d. Whiting (*Merlangius merlangus euxinus* Nordmann, 1840) - on the whole, in 2008, the whiting population on the Romanian littoral was homogenous, the length variation ranging between 60-165 mm/2.03-36.50 g, dominant being the 90-125 mm/5.50-13.84 g classes (Fig. 14). The average body length was of 107.45 mm and the average mass 10.58 g. The age distribution analysis during the entire season emphasized the presence of 1;1^+ to 4;4^+ years old individuals, dominant being the 1;1^+ years old (48.62%) and 2;2^+ years old individuals (43.05%)(Fig. 15). The sex ratio indicated a clear domination of females (57.53%)(Maximov et al. 2006, 2007, 2008).



	2000	2001	2002	2003	2004	2005	2006	2007	2008
0 : 0+	8,2	6,9	3,3	15,6	0,4			7,1	3,9
1 : 1+	52,2	30,7	76,5	57,5	38,4			56,7	58,8
2 : 2+	35,2	53,1	16,6	22,2	37,7			31,9	32,4
3 : 3+	4,4	9,3	3,6	3,7	20,5			4,9	4,9
4 : 4+				1	3				

Fig. 13 - The structure on age classes (%) in European anchovy, fished between 2000-2008

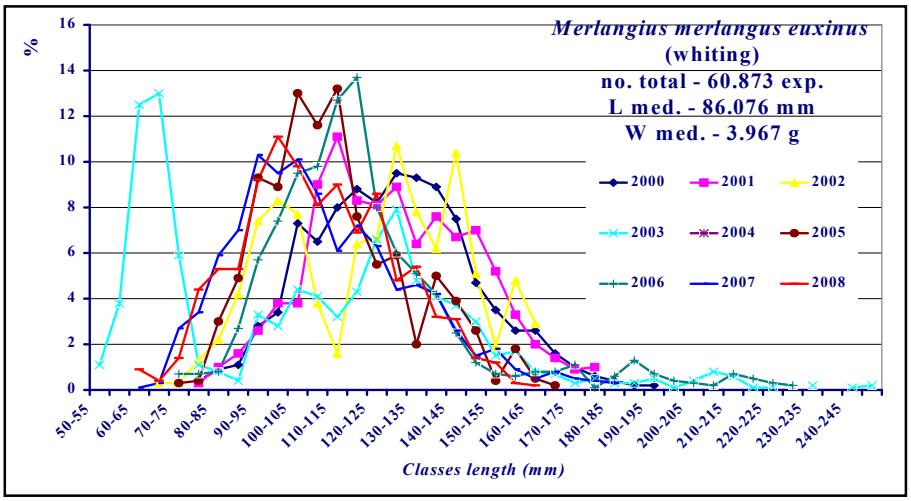
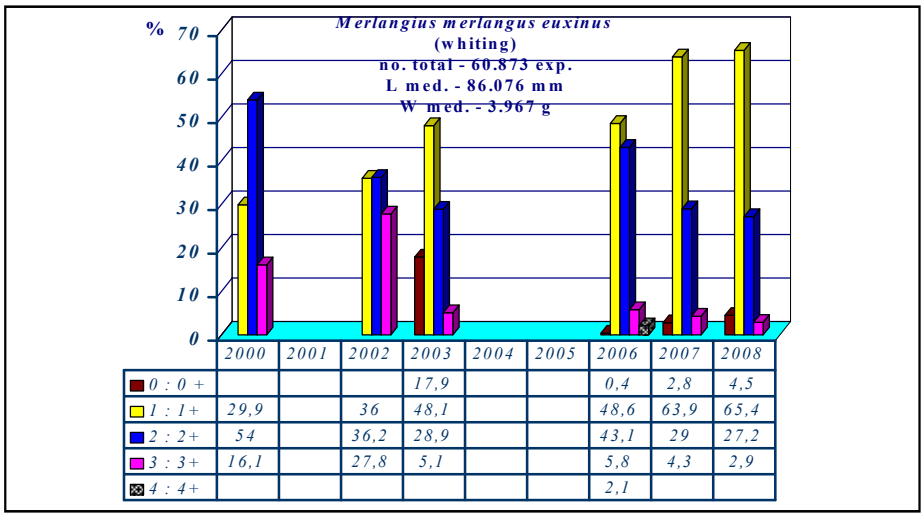


Fig.14 - The structure on length classes (%) in whiting, fished between 2000–2008



	2000	2001	2002	2003	2004	2005	2006	2007	2008
0 : 0 +				17,9			0,4	2,8	4,5
1 : 1+	29,9		36	48,1			48,6	63,9	65,4
2 : 2+	54		36,2	28,9			43,1	29	27,2
3 : 3+	16,1		27,8	5,1			5,8	4,3	2,9
4 : 4+							2,1		

Fig. 15 - The structure on age classes (%) in whiting, fished between 2000-2008

e. Horse mackerel (*Trachurus mediterraneus ponticus* Aleev, 1956) - the Horse mackerel agglomerations were composed of young, as well as mature individuals, the length variation ranging between 85-165 mm / 5.05-39.17 g, with ages between 1;1^+ and 5;5^+ years old, the classes between 115-145 mm / 13.10 -30.30 g, aged 2;2^+ and 3;3^+ years old were dominant (Fig. 16 and 17) (Maximov et al. 2006, 2007, 2008).

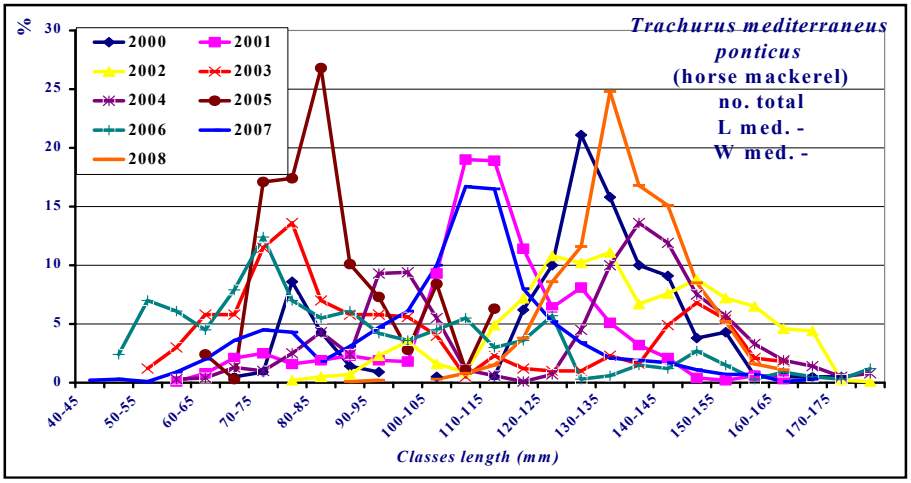
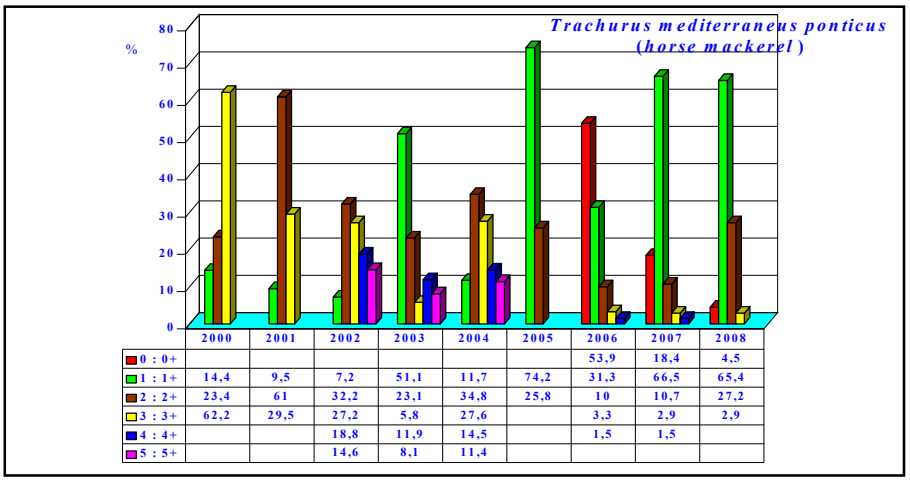


Fig. 16 - The structure on length classes (%) in the horse mackerel, fished between 2000-2008



	2000	2001	2002	2003	2004	2005	2006	2007	2008
0 : 0+							53,9	18,4	4,5
1 : 1+	14,4	9,5	7,2	51,1	11,7	74,2	31,3	66,5	65,4
2 : 2+	23,4	61	32,2	23,1	34,8	25,8	10	10,7	27,2
3 : 3+	62,2	29,5	27,2	5,8	27,6		3,3	2,9	2,9
4 : 4+			18,8	11,9	14,5		1,5	1,5	
5 : 5+			14,6	8,1	11,4				

Fig. 17 - The structure on age classes (%) in the horse mackerel, fished between 2000 – 2008

f. Red mullet (*Mullus barbatus ponticus* Essipov, 1927) - its dimension variations were homogenous, between 60-170 mm / 6.49-55.14 g, with a domination of the 95-125 mm / 11.64-21.16 g classes (Fig. 18). The average body length was 114.08 mm and the average mass 18.20 g. The age distribution indicates the presence of individuals aged between 0^+ and 3^+ years old. The base of the red mullet catches was represented by 1^+year old individuals (26.76%), with an average 115.83 mm si 16.09 g length and weight, followed by the 3^+ years old group, with 15.29% (average length and mass 133.31 mm, respectively 25.42 g). The sex ratio indicates a slight domination of females (56.08%) compared to males (43.92%).

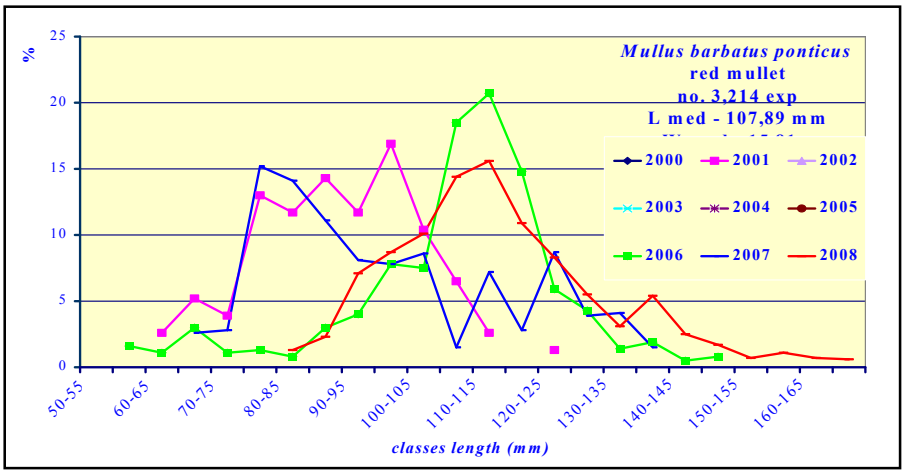


Fig. 18 - The structure on length classes (%) in the red mullet, fished between 2000 – 2008

g. Black spotted goby (*Neogobius melanostomus* Nordmann, 1840) - the Black spotted goby, the most common goby species in the catches, had a wide length variation, ranging between 70-190 mm / 8.26 - 116.69 g, with a domination of the 105-145 mm / 22.26–43.31 g classes, aged 3-4 years old (Fig. 19 and 20). The average body length was 123.88 cm, and the average mass - 31.88 g. The sex ratio indicates a clear domination of females (60.20%, respectively 68.23%) compared to males (39.80%, respectively 31.77%).

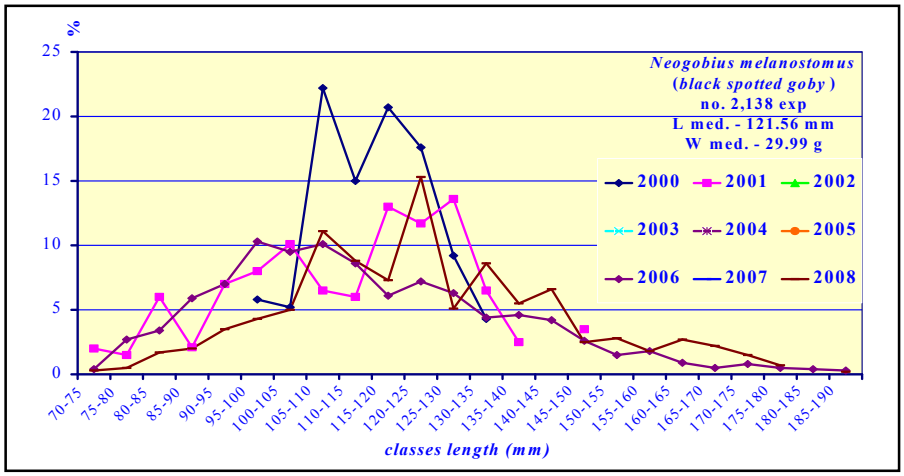


Fig. 19 - The structure on length classes (%) in the the black spotted goby, fished between 2000-2008

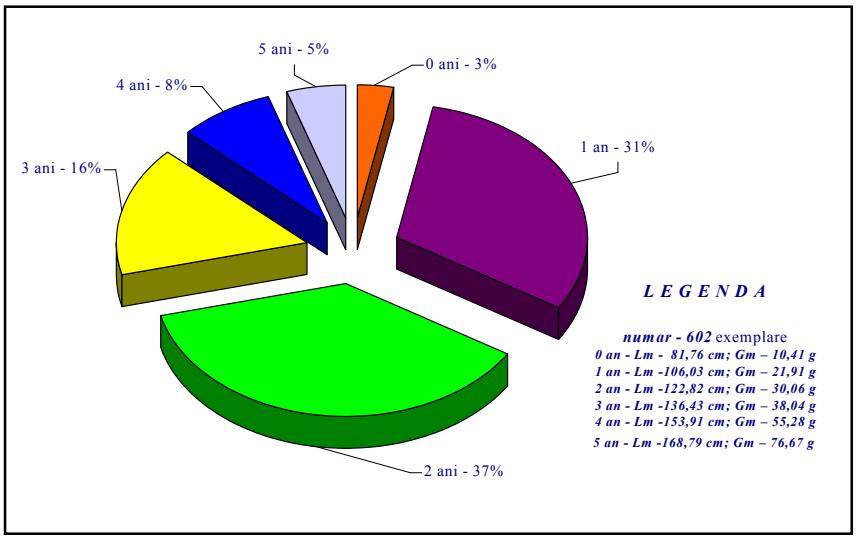


Fig. 20 - The structure on age classes (%) in the the black spotted goby, fished between 2000-2008

Determination of vital parameters

The concept of *stock* is closely related to the values of the length/mass relationship, the growth parameters and mortality data. One method of evaluating fish stocks is the one analyzing the variation of the biomass of a stock, under the influence of the growth and mortality phenomena. Thus, an important stage in evaluating fish stocks is represented by the establishing of the length/mass coefficients, the growth parameters and mortality rates.

a. The length/mass relationship - this relationship expresses the most accuratlelx the changes that occur in the mass of the fish during the growth in length and can be a was of indirectly estimating the growth rythm. The length/mass relationship coefficients, determined annually between 2004 and 2008, established the following equations for sprat and turbot (Table 8) (Maximov 2006, 2007, 2008):

- sprat → $W_t = 0{,}007018 \times L_t^{2{,}949310}$; $r = 0{,}9947$;
- turbot → $W_t = 0{,}014232 \times L_t^{3{,}213099}$; $r = 0{,}9865$;
- anchovy → $W_t = 0{,}007137 \times L_t^{2{,}9867772}$; $r = 0{,}9946$;
- whiting → $W_t = 0.004706 \times Lt^{3.136302}$, $r = 0.9984$;

➢ horse mackerel ⟶ $W_t = 0{,}006638 \times L_t^{3{,}188074}$; r = 0,9989.

Table 8 - Length /weight relationship coefficients for sprat, turbot, European anchovy, horse mackerel and whiting, established between 2004-2008

Year	Parameters			Length interval (mm)	Parameters			Length interval (mm)
	a	b	r		a	b	r	
	sprat				**turbot**			
2004	0,004550	3,112000	0,9991	65 – 125	0,03501	2,8328	0,9377	23.5 – 71.5
2005	0,006760	2,969100	0,9841	65 – 125	0,01032	3,1558	0,9989	29.5 – 71.5
2006	0,000006	3,017600	0,9986	45 – 135	0,01078	3,1459	0,9991	26.5 – 65.5
2007	0,013890	2,664400	0,9954	65 – 130	0,00838	3,2104	0,9992	32.5 – 68.5
2008	0,009854	2,983452	0,9965	55 - 130	0,00665	3,2704	0,9977	23.5 – 68.5
Total	**0,007018**	**2,949310**	**0,9947**	**45 - 135**	**0,01423**	**3,2131**	**0,9865**	**23,5 – 71,5**
	European anchovy				**whiting**			
2004	0,004550	3,112000	0,9991	65 – 125	0,03501	2,8328	0,9377	23.5 – 71.5
2005	0,006760	2,969100	0,9841	65 – 125	0,01032	3,1558	0,9989	29.5 – 71.5
2006	0,000006	3,017600	0,9986	45 – 135	0,01078	3,1459	0,9991	26.5 – 65.5
2007	0,013890	2,664400	0,9954	65 – 130	0,00838	3,2104	0,9992	32.5 – 68.5
2008	0,009854	2,983452	0,9965	55 - 130	0,00665	3,2704	0,9977	23.5 – 68.5
Total	**0,007018**	**2,949310**	**0,9947**	**45 - 135**	**0,01423**	**3,2131**	**0,9865**	**23,5 – 71,5**

b. Growth parameters - growth represents the positive aspect in the dynamics of a fish stock, its study meaning mainly the determination of body size according to age. Thus, all evaluation methods of the stock operate mainly with data structured on ages. The fish becomes longer as it ages, but the growth rate (the increase in length during the time unit) decreases as it gets older, getting close to 0 when it is extremely old. The growth parameters obtained by Romanian calculations, using the classic formulae, between 2004 and 2008, indicate a fast growth rate in the early years, with values of the catabolism coefficient ranging between 0,195-0,220 in sprat, respectively 0,117-0,210 for turbot (Table 9)(Maximov 2006, 2007, 2008).

Table 9 - Growth parameters of the main fish species on the Romanian littoral

Year	Growth parameters				Length interval (mm)	Growth parameters				Length Interval (mm)
	L_∞ (mm)	W_∞ (g)	k	t_0		L_∞ (mm)	W_∞ (g)	k	t_0	
	sprat					**turbot**				
2004	14.45		0.195	- 3.95	65 – 125	76.80		0.117	- 1.355	23.5 – 71.5
2005	14.22		0.178	- 3.30	65 – 125	80.00		0.200	- 1.143	29.5 – 71.5
2006	14.21		0.220	- 2.20	45 – 135	85.14		0.140	- 2.010	26.5 – 65.5
2007	13.68		0.210	- 3.27	65 – 130	73.40		0.210	- 1.428	32.5 – 68.5
2008	13.77		0.224	- 2,86	55 - 130	76.11	8,374	0.193	- 1.646	29.5 – 62.5
	European anchovy					**whiting**				
2004	14.45		0.195	- 3.95	65 – 125	76.80		0.117	- 1.355	23.5 – 71.5
2005	14.22		0.178	- 3.30	65 – 125	80.00		0.200	- 1.143	29.5 – 71.5

2006	14.21		0.220	- 2.20	45 – 135	85.14		0.140	- 2.010	26.5 – 65.5
2007	13.68		0.210	- 3.27	65 – 130	73.40		0.210	- 1.428	32.5 – 68.5
2008	13.77		0.224	- 2,86	55 - 130	76.11	8,374	0.193	- 1.646	29.5 – 62.5

The growth parameters, determined annually, between 2004 and 2008, established the following Von Bertalanffy ecuations, for the species sprat and turbot:

- sprat ⟶ $L_t = 13,77\ [\ 1 - e^{-0,73\,(t+1,71)}\ ]$;
- turbot ⟶ $L_t = 76,84\ [\ 1 - e^{-0,149\,(t+3,81)}\ ]$;

$W_t = 8.374,65\ [1 - e^{-0,149\,(t+3,81)}\ ]^3$

- anchovy ⟶ $L_t = 13,77\ [\ 1 - e^{-0,73\,(t+1,71)}\ ]$;
- whiting ⟶ $L_t = 26.3\ (1 - e^{-0.160\,(t+2.19)})$

$W_t = 8.374,65\ [1 - e^{-0,149\,(t+3,81)}\ ]^3$

- horse mackerel ⟶ $L_t = 13,77\ [\ 1 - e^{-0,73\,(t+1,71)}\ ]$;

c. *Estimation of mortality rates* - the parameters used when describing mortality are called „mortality rates“ and reflect the number of death during the time unit. Using Pauly's relationship, as well as other formulae, the values of M were determined for the main industrial fish species (Table 10)(Maximov 2006, 2007, 2008). In order to preserve the fish stock at the desirable level and with an adequate age structure, the control of mortality due to fishing is required.

Table 10 - Mortality rates for sprat and turbot on the Romanian littoral

Metoda	Z	M
sprat		
Pauly	1,4685	0,6782
turbot		
Beverton şi Holt	0,295	
Pauly		0,22
Richter şi Efanov		0,19
Ault & Ehrhardt	0,225	
anchovy		
Pauly	1,4685	0,6782
whiting		
Beverton şi Holt	0.414	
Pauly		0.680
Powell&Watheral		0.410
Catch-Curve method (B&H)	0.530	

CONCLUSIONS

In the fishing season between 2000 and 2008, the level of the catches, except the period 2000-2002, when values over 2.000 tons annually (2.476 to/2000, 2.431 to/2001, respectively 2.116 to/2002) were registered, was relatively low, between 1.390 tones/2006 and 1.940 tones/2005, then dropping to 435 t /2007 and 444 t / 2008.

The level of the catches in 2007 and 2008, the lowest in the past 10 years, was a consequence of the reduction of the fishing effort (the reduction in the number of coastal trawls, seines and, consequently, of the staff involved in the fishing activity), of the growth of production costs, as well as of the influence of hydroclimatic factors on the fish populations.

Fishing faces a series of problems:

- adverse weather conditions which affect fishing activities;
- aging fishing fleet and increasing fuel costs;
- lack of minimum conditions for safe navigation, hygiene and storage of fish;
- ineffective marketing and poor advertising of fishery products;
- weak organization of producers and fishermen;
- non-standard gears;
- low productivity;
- low training levels;
- low sanitary - veterinary control;
- inadequate vessels for marine fishing;
- lack of almost any mechanization of fishing operations;
- risks of accidents at sea;
- reduced diversity of fishery products;
- species of low interest for local processing;
- limited access to financial resources;
- lack of landing facilities;
- insufficient technical equipment and obsolete installations;
- inadequate working conditions.

The dominant species in the catches were sprat, turbot and Danube shad, along with the traditional species: anchovy, whiting, goby, horse mackerel, piked dogfish, bluefish other species.

The structure on length and mass classes of the sprat catches emphasized the presence of small sized individuals, the length variation of the sprat individuals ranging within 55-135 mm, having the mass between 1.18-12.80 g, with dominant classes of 70-100 mm / 2.17-6.44 g. The average body length was 84.132 mm and the average weight 3.655 g. The sex ratio was clearly favorable to females with a 55.67% percentage;

The anchovy catches revealed 60-160 mm / 1.35-9.56 g individuals, aged from $0;0^+$ years old to $3;3^+$ years old, dominated by the 80-125 mm / 3.55-10.84 g individuals, aged $1;1^+$ (38.4-64.4%) years old, the larger ratio being represented by females (59.41%), compared to the males - (40.59%). The average length and mass were 105.87 mm, respectively 7,641 g.

The length of whiting had wide size variations, ranging between 60-165 mm/2.03-36.50 g, dominated by 90-125 mm/5.50-13.84 g classes. The average body length was 107.45 mm and the average mass 10.58 g. The age distribution analysis emphasized the presence of $1;1^+$ to $4;4^+$ years old individuals, dominated by the $1;1^+$ (48.62%) and $2;2^+$ years old individuals (43.05%). The sex ratio indicated a clear domination of females (57.53%).

The horse mackerel agglomerations were composed of young, as well as mature individuals, the length variation ranging between 85-165 mm / 5.05-39.17 g, with ages between $1;1^+$ and $5;5^+$ years old, the classes between 115-145 mm / 6.33-15.74 g, aged $2;2^+$ and $3;3^+$ years old were dominant. The average length and weight were 13.10 mm and 13.896 g.

The dimensions variations of red mullet ranged between 60-170 mm / 6.49-55.14 g, with a domination of the 95-125 mm / 11.64-21.16 g classes. The average length of the body was 114.08 mm and the average mass 18.20 g. As far as age distribution is concerned, it indicated the presence of individuals aged between $0;0^+$ and $3;3^+$ years old, dominated by the $2;2^+$ years old ones (49.0%);

The growth parameters obtained by Romanian calculations, using the classic formulae, between 2004 and 2008, indicate a fast growth rate in the early years, with values of the catabolism coefficient (k) ranging between 0.195-0.220 in sprat and 0.117-0.210 for turbot.

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