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Stock Assessment of the Whiting (Merlangius Merlangus) in the Western Part of the Black Sea During 1971-1997

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Introduction

During the last 30 years the Black Sea environmental conditions changed sharply. Major importance had the increased basin's anthropogenic eutrophication, the latter reaching its maximum in the 1980s. That brought to changes in the phytoplankton species composition and provoked blooms, which raised repeatedly their duration and spatial distribution. The changes that has come are determined by the following factors: increased nutrients concentrations, mainly nitrogen and phosphorus; shifts in the sea water temperature in winter months which are in contradiction to the average phytoplankton blooms frequency in the summer months; sun activity influence on the ration of Bacillariophyceae/Dynophyceae biomasses; the excessively intensified fisheries discrepant to the Black Sea environmental conditions. All this is the cause for so called bottom-up/top-down effects as in one hand the basin's productivity enhances and on the other the commercial fishery strongly reduces the fish population abundance and to some cases has even led to complet extinction of some species, that has predetermined the lack of balance between the single links in the food chain. That drove to the invasion and mass development of a number of new for the Black Sea species, among them *Mnemiopsis leidyi* having the most pronounced negative impact. This species has entered the basin in the early 1980s highest biomass however reached in 1989. Ten years later in the basin entered the species *Beroe ovata* that is the predator on *M. leidyi*. The environmental shifts along with the intensified fishery led to the dramatical depletion of many fish stocks in the early 1990s - anchovy, horse mackerel, sprat, whiting, etc.

The accomplishment of reliable stock assessment of whiting in the western part of the basin is complicated task as no specialised fishery is carried on. In Bulgaria and in the countries of the former USSR the whiting is fished as by-catch in the trawl sprat fishery. In Romania the whiting is caught by coastal gears (trap-nets), which extend farther offshore in comparison to Bulgaria where the trap-nets are installed near the shore.

All these predetermine the so-called bottom-up/top-down effects because of the increased productivity of the basin on the one hand and the reduction of fish population caused by the commercial fishery on the other. The latter have even caused in certain cases complete extinction of some fish species like mackerel for instance, causing in its turn imbalance between particular links of the food webs. This promoted the invasion and mass development of a number of new for the Black Sea species, the ctenophore *Mnemiopsis leidyi* having the greatest negative influence on the fish populations as besides being a competitor for the zooplankton it directly finishes off the eggs and larvae of the spawning fish (Georgieva, Konsulov, 1993). This ctenophore entered the Black Sea in the early 80s but the biggest biomass it reached in 1989. Ten years later a new species *Beroe ovata* entered the basin that is a predator on *Mnemiopsis leidyi*. The changes in the environment together with the intensified

fishery brought to catastrophic reduction of many fish species in the yearly 90s – anchovy, sprat, whiting etc. The improvement of the ecological conditions after 1990 as a result of the collapse of the economies of the former socialist countries boarding with the Black Sea and the reduction of the fishing effort on some fish species led to partial recovering of their stocks (Velikova, Petrova, 1999; Velikova, Moncheva, Petrova, 1999; Velikova et al. 2001).

According to the FAO experts the whiting stocks must be protected from overfishing because they are of great importance for the turbot, spiny dogfish, etc. This calls for permanent monitoring on its both biological and exploitation parameters.

Materials and methods

The whiting catches in the western part of the Black Sea during the period 1971-1997 are presented in table 1. It is seen that for the catches of Bulgaria and former USSR there are two columns of data. The first one is according to FAO data and the second one according to the so called "expert estimates". In the first case the catches are strongly underestimated as the whiting appears mainly as by-catch in the sprat fishery. For this reason only the catches where the species occurrence in considerable or predominant are recorded.

Table 1. Whiting catches in the western part of the Black Sea during the period 1971-1997 (in thousand tons)

Years	Bulgaria	Bulgaria	Romania	former USSR	former USSR	Total	Total
	FAO	*	FAO	FAO	*	FAO	*
1971	0.0	0.0	381.0	0.0	0.0	381.0	381.0
1972	0.0	0.0	416.0	0.0	0.0	416.0	416.0
1973	0.0	0.0	329.0	0.0	0.0	329.0	329.0
1974	0.0	0.0	1305.0	0.0	0.0	1305.0	1305.0
1975	454.0	754.0	346.0	0.0	0.0	800.0	1100.0
1976	377.0	1715.1	541.0	22.0	107.4	940.0	2363.5
1977	218.0	2134.6	1495.0	0.0	800.0	1713.0	4429.6
1978	407.0	2912.6	1345.0	583.0	3283.0	2335.0	7540.6
1979	71.0	2563.5	1205.0	11377.0	17877.0	12653.0	21645.5
1980	30.0	3889.8	618.0	2720.0	5500.0	3368.0	9791.8
1981	1.0	2563.5	894.0	2530.0	6500.0	3425.0	9957.5
1982	0.0	2750.3	800.0	1514.0	8200.0	2314.0	11750.3
1983	0.0	1506.5	1080.0	2381.0	7800.0	3461.0	10386.5
1984	0.0	1710.7	1192.0	4759.0	10500.0	5951.0	13402.7
1985	0.0	1500.8	3138.0	2684.0	5000.0	5822.0	9638.8
1986	0.0	1118.2	1949.0	2660.0	4800.0	4609.0	7967.2
1987	0.0	1057.6	615.0	2764.0	4500.0	3379.0	6172.6
1988	0.0	885.9	1009.0	2223.0	4500.0	3232.0	6394.5
1989	0.0	744.5	2738.0	591.0	6000.0	3329.0	9482.5
1990	0.0	359.4	2653.0	322.0	8800.0	2975.0	11812.4
1991	0.0	246.2	59.0	24.0	2600.0	83.0	2905.2
1992	0.0	482.6	1357.0	70.0	900.0	1357.0	2739.6
1993	0.0	619.8	599.0	193.0	500.0	599.0	1718.8
1994	0.0	190.5	432.0	376.0	1176.0	808.0	1798.5
1995	0.0	277.0	327.0	254.0	1250.0	581.0	1854.0
1996	0.0	305.5	372.0	237.0	1800.0	609.0	2477.5
1997	0.0	329.6	441.0	97.0	2100.0	538.0	2870.6
1998	0.0		640.0	227.0		867.0	

Remark: FAO - according to FAO yearbooks of Fisheries statistics;
*** - according to expert assessments**

In fact the fish species almost always accompanies the sprat catches as out of fish species the sprat is of major importance for whiting diet. For establishing the real catch values of whiting it is essential to record permanently their percent in relation to sprat catches. This is in fact the way the expert assessments for the whiting catches have been done.

The age composition of whiting's catches in the western part of the Black Sea are given in table 2.

VPA has been performed using FISAT (F A O, 1996) and SIMUCO (S p a r e, 1987) software. The values of M=0.70 is after P r o d a n o v et al. (1997). The starting values for 6 year olds (F_6=F_{st}) during different years represent 1/5 from those defined for the sprat (I v a n o v, 1994) according to the characteristics in the two species distribution during the seasons as well as the fact that no specialised fishery on whiting exists. As it is well known the establishment of starting values of F by age classes during the last year is very difficult task. That is why for the fully presented age classes in the stock the value of F_{st} for the oldest age group are usually used. For partially presented age groups the value of F_t are established by determining the relationships between the values of their catches (Ct) and the obtained Ft values from VPA during the period 1976-1996. Then on the basis of the level of C_t in 1997 the value of Ft in the same year were calculated.

Results

The results of the performed VPA are presented in table 3 and 4. It is seen from table 3 that the total number of specimens for the

Table 2. Age composition of whiting catches in the western part of the Black Sea during the period 1971-1997 (in million specimens)

Years	0+	1	2	3	4	5	6	CN	CW	W
1971	7.17	11.20	6.57	2.89	1.49	0.70	0.29	30.31	381.0	12.57
1972	5.85	14.57	6.31	2.74	1.40	0.69	0.30	31.86	416.0	13.06
1973	4.03	9.59	6.46	3.51	1.67	0.80	0.23	26.29	329.0	12.51
1974	6.91	32.69	19.33	15.10	6.90	3.30	1.20	85.43	1305.0	15.28
1975	18.68	21.84	16.41	8.09	5.51	2.88	1.20	74.61	1100.0	14.74
1976	30.10	58.62	34.60	19.66	7.40	6.01	2.27	158.66	2363-5	14.90
1977	7.30	116.10	108.83	48.19	16.12	2.59	3.78	302.91	4429.6	14.62
1978	26.73	134.70	192.50	85.02	26.61	3.89	0.91	470.36	7540.6	16.03
1979	32.11	134.33	358.59	246.57	94.59	6.21	1.30	873.70	21645.5	24.77
1980	310.50	220.50	103.71	88.59	75.20	35.66	1.92	836.08	9791.8	11.71
1981	30.29	353.08	184.91	85.79	34.76	18.89	8.92	716.64	9957.5	13.89
1982	626.30	253.31	175.37	98.64	38.98	18.56	7.63	1218.79	11750.3	9.64
1983	113.35	360.48	132.33	86.27	45.68	14.77	6.09	758.97	10386.5	13.68
1984	172.24	303.03	259.97	112.21	48.83	19.12	2.78	918.18	13402.7	14.60
1985	160.08	232.72	133.52	104.75	39.84	15.78	6.86	693.55	9638.8	13.90
1986	105.08	225.82	110.03	54.24	36.94	10.34	9.70	552.15	7967.2	14.43
1987	59.38	205.71	101.04	39.92	19.47	18.58	3.25	447.35	6172.6	13.80
1988	82.96	204.58	83.12	46.28	14.45	5.12	10.25	446.76	6394.5	14.31
1989	215.86	260.63	105.55	46.33	24.91	6.12	2.34	661.74	9482.5	14.33
1990	755.43	157.25	129.97	30.56	14.01	10.36	2.86	1100.44	11812.4	10.73
1991	71.18	90.00	42.90	12.78	4.93	1.79	1.96	225.54	2905.2	12.88
1992	61.85	69.49	40.96	19.05	3.69	0.96	0.55	196.55	2739.6	13.94
1993	41.89	44.91	18.13	15.16	4.65	0.86	0.13	125.73	1718.8	13.67
1994	43.05	46.98	18.81	15.73	4.82	0.89	0.14	130.42	1798.5	13.79
1995	48.01	51.38	22.35	13.01	5.25	0.94	0.16	141.10	1854.0	13.14
1996	53.25	60.65	28.21	20.08	9.47	2.50	0.68	174.84	2477.5	14.17
1997	70.72	74.78	29.89	21.32	9.79	3.74	0.52	210.76	2870.6	13.62
Mean	117.05	138.85	91.50	50.48	22.12	7.85	2.90	429.99	6023.7	14.01

Table 3. Stock assessment of the Black Sea whiting in the western part of the basin (in number: N x 10^9 specimens; in biomass: B x 10^3 tons)

Years	0+	1	2	3	4	5	6	N1+	B1+	B2+
1971	11.000	4.990	1.810	0.985	0.093	0.062	0.037	7.977	137.8	79.5
1972	1.790	5.460	2.470	0.896	0.487	0.045	0.030	9.388	170.2	106.4
1973	1.850	0.885	2.700	1.220	0.443	0.241	0.022	5.511	140.9	130.6
1974	2.860	0.916	0.433	1.340	0.605	0.219	0.119	3.632	113.0	102.3
1975	10.300	1.410	0.432	0.202	0.654	0.296	0.106	3.100	87.0	70.5
1976	11.900	5.120	0.687	0.203	0.095	0.321	0.145	6.571	115.7	54.0
1977	12.300	5.890	2.500	0.317	0.088	0.042	0.155	8.992	159.0	81.4
1978	6.730	6.120	2.840	1.170	0.125	0.033	0.019	10.307	186.3	110.2
1979	11.400	3.320	2.950	1.280	0.522	0.044	0.014	8.130	161.5	125.2
1980	12.900	5.630	1.560	1.220	0.468	0.195	0.018	9.091	163.7	105.8
1981	6.200	6.190	2.640	0.702	0.544	0.181	0.073	10.330	185.9	113.3
1982	14.000	3.060	2.830	1.190	0.290	0.246	0.077	7.693	160.1	126.9
1983	4.180	6.510	1.340	1.290	0.521	0.117	0.110	9.888	177.8	107.2
1984	5.210	2.000	2.980	0.577	0.580	0.227	0.048	6.412	148.0	124.0
1985	7.920	2.470	0.786	1.300	0.210	0.254	0.100	5.122	119.1	90.4
1986	3.390	3.820	1.070	0.300	0.575	0.078	0.115	5.958	117.9	71.8
1987	2.120	1.610	1.740	0.454	0.112	0.260	0.031	4.207	94.9	75.9
1988	2.680	1.010	0.659	0.796	0.198	0.042	0.117	2.822	73.4	61.0
1989	2.340	1.270	0.364	0.270	0.364	0.089	0.018	2.375	54.8	39.6
1990	4.870	1.020	0.455	0.110	0.103	0.164	0.040	1.892	43.1	30.5
1991	3.510	1.910	0.397	0.139	0.034	0.042	0.074	2.596	44.4	21.9
1992	3.880	1.690	0.884	0.168	0.060	0.014	0.019	2.835	52.6	31.7
1993	4.680	1.880	0.792	0.411	0.070	0.027	0.006	3.186	61.9	38.3
1994	4.830	2.300	0.904	0.381	0.194	0.032	0.013	3.824	72.9	46.7
1995	6.990	2.370	1.110	0.435	0.178	0.092	0.015	4.200	86.2	57.2
1996	8.190	3.440	1.140	0.535	0.207	0.084	0.043	5.251	101.6	61.5
1997	7.220	4.030	1.670	0.548	0.252	0.096	0.039	6.635	120.8	74.9
Mean		3.197	1.487	0.683	0.299	0.131	0.059	5.856		
%		54.59	25.39	11.66	5.11	2.24	1.01	100.00		

age groups from 1 to 6 years old during the period 1971-1997 vary from 1.892 (1990) to 10.330 x 10^9 sp. (1981) at average 5.856 x 10^9 sp. In that number the 1 year olds have the greatest share - 54.59 % from the total number. The oldest ages (5 and 6 year olds) represent just about 3.25 %.

In the pointed period the mean weighted values of the fishing mortality coefficient for the ages from 1 to 6 years range from 0.0039 (1972) to 0.3594 (1990). For the spawning biomass (B2+) the mean weighted values of F2+ range from 0.0038 (1973) to 0.5006 (1990) - table 4.

On table 5 and figure 1 the results from the VPA for the biomass (B1+) of the whiting in the western Black Sea during 1971-1997 are shown. It is seen on the table that the biomass has varied from 43.1 (1990) to 186.3 (1978) thousand tons. The spawning biomass (B2+) has varied from 21.9 (1991) to 130.6 (1973) thousand tons, mean value 79.2 thousand tons. The largest share have the 2-, 3- and 4-year old fish - 84.85 % at total. The oldest age groups (5 and 6 years olds) represent 15.15 % of the spawning stock.

The estimates accomplished show that the whiting's biomass in the western part of Black Sea has trend toward decrease after 1985 and in 1990 reaches the lowest level of 43.1 thousand tons.

After 1990 the whiting biomass began to grow up and in 1992 it reached 52.6 thousand tons. This trend is preserved till 1997 when the biomass reached 120.8 thousand tons i.e. slightly over the average annual level - 116.7

Table 4. Fishing mortality of the whiting from the western part of the Black Sea during the period 1971-1997

Years	0+	1	2	3	4	5	6	F1+	F2+
1971	0.0009	0.0031	0.0051	0.0041	0.0224	0.0159	0.0111	0.0040	0.0056
1972	0.0046	0.0037	0.0036	0.0043	0.0040	0.0214	0.0139	0.0039	0.0041
1973	0.0030	0.0152	0.0033	0.0040	0.0053	0.0046	0.0146	0.0056	0.0038
1974	0.0034	0.0508	0.0639	0.0158	0.0160	0.0212	0.0141	0.0307	0.0239
1975	0.0025	0.0217	0.0541	0.0572	0.0118	0.0136	0.0158	0.0255	0.0286
1976	0.0035	0.0160	0.0723	0.1431	0.1144	0.0264	0.0220	0.0279	0.0698
1977	0.0008	0.0278	0.0622	0.2336	0.2901	0.0895	0.0344	0.0476	0.0852
1978	0.0055	0.0310	0.0983	0.1061	0.3436	0.1799	0.0686	0.0624	0.1083
1979	0.0039	0.0577	0.1834	0.3054	0.2852	0.2158	0.1426	0.1579	0.2271
1980	0.0340	0.0558	0.0966	0.1060	0.2486	0.2883	0.1630	0.0852	0.1329
1981	0.0068	0.0822	0.1017	0.1840	0.0926	0.1549	0.1855	0.0967	0.1183
1982	0.0641	0.1215	0.0895	0.1220	0.2041	0.1100	0.1466	0.1128	0.1071
1983	0.0383	0.0798	0.1458	0.0973	0.1290	0.1899	0.0801	0.0949	0.1241
1984	0.0469	0.2332	0.1281	0.3087	0.1237	0.1234	0.0831	0.1762	0.1504
1985	0.0285	0.1394	0.2647	0.1176	0.2993	0.0897	0.0998	0.1564	0.1722
1986	0.0440	0.0852	0.1535	0.2846	0.0930	0.2026	0.1233	0.1105	0.1558
1987	0.0396	0.1933	0.0836	0.1299	0.2720	0.1038	0.1538	0.1374	0.1027
1988	0.0550	0.3228	0.1906	0.0838	0.1062	0.1820	0.1294	0.1992	0.1303
1989	0.1359	0.4304	0.4975	0.2674	0.0995	0.1005	0.2027	0.3574	0.2734
1990	0.2390	0.2386	0.7561	0.4721	0.2074	0.0917	0.1048	0.3594	0.5006
1991	0.0286	0.0676	0.1610	0.2614	0.2217	0.0617	0.0374	0.0993	0.1649
1992	0.0224	0.0586	0.0323	0.1698	0.1916	0.1031	0.0402	0.0599	0.0618
1993	0.0125	0.0337	0.0325	0.0525	0.0958	0.1050	0.0302	0.0378	0.0437
1994	0.0112	0.0287	0.0284	0.0589	0.0501	0.0488	0.0371	0.0329	0.0393
1995	0.0087	0.0303	0.0348	0.0424	0.0580	0.0519	0.0434	0.0344	0.0398
1996	0.0087	0.0248	0.0252	0.0534	0.0655	0.0598	0.0555	0.0312	0.0432
1997	0.0135	0.0261	0.0285	0.0554	0.0554	0.0554	0.0554	0.0308	0.0382

thousand tons. However during the last two years (1996 and 1997) the biomass may prove to be overestimated as the generations that compose it have not yet finished their life span.

The increase of the whiting biomass after 1990 is confirmed also by the data for the percentage share of the whiting in sprat catches. Similar trends toward increase of the biomass are ascertained in the two most abundant fish species in the Black Sea - the sprat and anchovy.

The whiting biomass estimates for the Western Black Sea during the period 1971-1993, in comparative aspects between the Prodanov's et al. (1997) data and ours ones, are shown on figure 2. It is seen on the pointed figure that our estimate agree by trend with those performed by Prodanov et al. (1997). By absolute values it holds intermediate place as in general it is higher than that at Mt variable with age and lower than that at Mt=constant. According to Prodanov et al. (1997) the first assessment is accomplished by tunning of Fst values by add hoc tuning (Sparre, 1987).

Discussion

The trawl fishery for sprat is carried out at depths of 20 to 40 meters in spring (April - June). During these months the largest sprat catches are taken. This is caused by the trophic migrations of the fish species toward the shore after having finished the intense reproduction in winter (November - March) which takes place of at greater depths, primarily in the water layers of 50-75 meters. During spring months considerable part of the oldest age groups of the whiting (5 and 6 years olds) stay at greater depths thus remaining beyond the scope of the sprat trawl fishery

Table 5. Whiting biomass by age groups (in thousand tons) in western part of the Black Sea during the period 1971-1997

Years	1	2	3	4	5	6	B1+	B2+
1971	58.3	36.3	32.6	4.3	3.6	2.7	137.8	79.5
1972	63.8	49.6	29.7	22.3	2.6	2.2	170.2	106.4
1973	10.3	54.2	40.4	20.3	14.1	1.6	140.9	130.6
1974	10.7	8.7	44.4	27.7	12.8	8.7	113.0	102.3
1975	16.5	8.7	6.7	30.0	17.4	7.7	87.0	70.5
1976	61.7	13.8	6.7	4.3	19.0	10.2	115.7	54.0
1977	77.6	53.4	10.8	4.1	2.5	10.6	159.0	81.4
1978	76.1	62.1	39.1	5.7	1.9	1.4	186.3	110.2
1979	36.3	56.9	41.4	23.3	2.6	1.0	161.5	125.2
1980	57.9	30.5	40.8	22.1	11.0	1.4	163.7	105.8
1981	72.6	49.8	22.9	24.4	10.9	5.3	185.9	113.3
1982	33.2	54.1	39.5	13.2	14.5	5.6	160.1	126.9
1983	70.6	25.6	42.8	23.7	6.9	8.2	177.8	107.2
1984	24.0	61.0	19.0	26.9	13.5	3.6	148.0	124.0
1985	28.7	16.4	42.6	9.4	14.8	7.2	119.1	90.4
1986	46.1	22.6	10.0	26.2	4.6	8.4	117.9	71.8
1987	19.0	37.4	15.5	5.2	15.5	2.3	94.9	75.9
1988	12.4	13.8	27.0	9.1	2.5	8.6	73.4	61.0
1989	15.2	7.8	8.9	16.4	5.2	1.3	54.8	39.6
1990	12.6	9.9	3.6	4.6	9.4	3.0	43.1	30.5
1991	22.5	8.3	4.6	1.5	2.4	5.1	44.4	21.9
1992	20.9	21.0	5.8	2.8	0.8	1.3	52.6	31.7
1993	23.6	18.9	14.3	3.2	1.5	0.4	61.9	38.3
1994	26.2	21.6	13.4	9.0	1.8	0.9	72.9	46.7
1995	28.7	27.1	15.5	8.4	5.4	1.1	86.2	57.2
1996	40.1	26.4	18.1	9.3	4.8	2.9	101.6	61.5
1997	45.9	37.5	18.2	11.2	5.4	2.6	120.8	74.9
Mean	37.5	30.9	22.7	13.6	7.7	4.3	116.7	79.2
%	32.13	26.48	19.45	11.65	6.60	3.69	100.00	
%		39.02	28.66	17.17	9.72	5.43		100.00

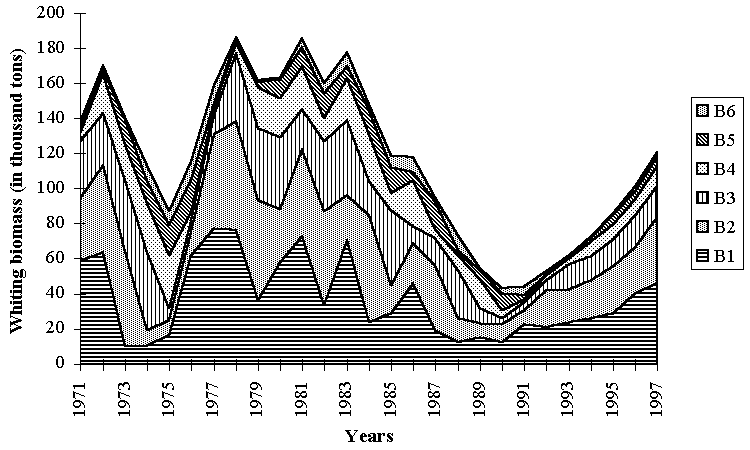

Fig. 1. Whiting biomass by age groups (in thousand tons) in the western part of the Black Sea during the period 1971-1997

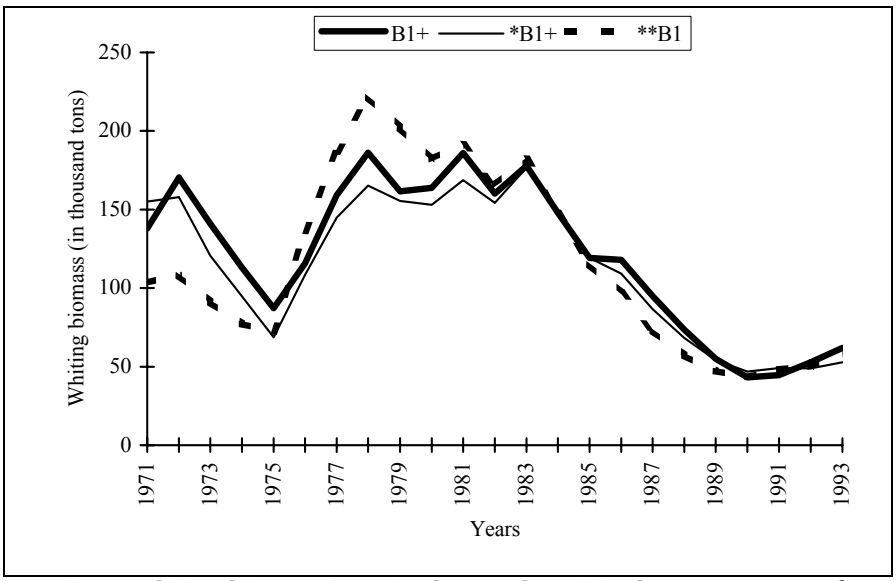

Fig. 2. Whiting biomass (B1+, in thousand tons) in the western part of the Black Sea during the period 1971-1993
B_{1+} - our assessment; *B_{1+} and **B_{1+} - according to P r o d a n o v et al. (1997) at M_t variable with age and M_t = constant, respectively

(P r o d a n o v, 1984; P r o d a n o v et al. 1997). For this reason the fishing effort applied to the sprat oldest age group (4 year olds) radically differs from that applied to whiting - 6 year olds. This is of great importance when using Virtual Population Analysis (VPA) which methodology requires the defining by yeas the values of the fishing mortality coefficient for the oldest age group. That is why the estimated biomasses may prove to be overestimated, especially during last two years, as the generations that compose it have not yet finished their life span. Nevertheless, the trend toward increasing the whiting biomass off the Bulgarian coast is beyond doubt. The prolonged raising of the whiting biomass during the period 1994 – 1997 respond to the improved ecological conditions of the Black Sea environment after 1993 (V e l i k o v a et al. 2001). As noted earlier after 1990 as a result of the reduced pollution of the basin with nutrients and chemical compounds, owing to the collapse of the economies of the former socialist countries bordering with the Black Sea, the conditions of the environment improved. This in its turn brought to increasing the biomass of many fish species. In some species like the anchovy for instance the biomass of their stocks shows sharp variations as the level of fishing mortality is very high even exceeding in certain years the optimum allowable value. Besides the Mnemiopsis leidyi impact on fish populations also reduced after the invasion since 1997 of one more ctenophore Beroe ovata which is predator on the former species. This confirms for the present the conclusions made by C h r i s t e n s e n, C a d d y (1993) who on the base of ECOPATH model insisted for the artificial introduction of B. ovata in order to restrain the M. leidyi impact.

The improved state of whiting stocks is of great significance for the turbot and spiny dogfish stocks as the species takes up prevailing share in their ration.

Conclusions

During the period in research the whiting biomass varies from 43.1 (1990) to 186.3 (1978) thousand tons. In 1997 it reaches 120.8 tons. The gradual recovering of the whiting biomass will have a favourable effect on the turbot and spiny dogfish stocks, too as the two species feed mainly on whiting and sprat.

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Оценка на запасите на меджида (Merlangius merlangus) в западната част на Черно море през 1971 - 1997 г.

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(Резюме)

Запасите на меджида имат важно значение за рибната част на черноморската екосистема. Поради това изчисляването на тяхната численост и биомаса е крайно необходимо. В статията са дискутирани размерите на запасите на меджида в западната част на Черно море през периода 1971 - 1997 г. Установено е, че тяхната биомаса е варирала от 43.1 (1990) до 186.3 (1978) хиляди тона. През 1997 г. тя достига до 120.8 хиляди тона. Постепенното възстановяване на биомасата на меджида ще има благоприятен ефект върху запасите на калкана, черноморската акула, тъй като и двата вида се хранят главно с меджид и трицона.