BLACK SEA SHAD, *ALOSA KESSLERI PONTICA* EICHWALD

In the Black Sea only representatives of the genus *Alosa* exist; the commercially most important being the shad (also called the Danube scomber) - *Alosa kessleri pontica* = *Alosa pontica*, according to FAO Fishery Statistics. The taxonomic position of the shads is quite complicated but relying on the FAO Yearbook of Fishery statistics we assign the catches of the remaining species or subspecies to *Alosa* spp.

The Black Sea shad is an anodromous fish undertaking spawning migrations in rivers, mainly in the Danube. The main part of the stock winters off the Turkish coast, and in the early spring migrates along the Bulgarian and Romanian coasts towards Danube river. The fish enters the river delta during the second half of March when the water temperature is 4-6°C (Serdjuk, 1979; Kolarov, 1986).

The fishery for shad is carried out in the sea (with trap-nets), as well as in the river, and this is why its catches are assigned to two areas - area 05 (Bulgaria, Romania and former USSR) and area 37 (Bulgaria, Romania, Turkey and former USSR). Ukrainian catches have always been realised mainly in the Danube, and to a considerably lesser degree in the river Dnestra (area 07). During the period 1987-1992, Turkish catches exceeded 1 000 tonnes, and in the FAO Fishery Statistics, these catches are related to *Alosa* spp. The greater amount of Turkish catches are made on the eastern Anatolian coast, and for this reason it is unlikely that these catches are from the Danube population of the Black Sea shad. This is the reason also why the part of Romanian catches related to *Alosa* spp. according to FAO, are not included. The Romanian statistic show that during the period 1970-1992, the following amounts of clupeoid fish are caught: (**Table 29**)

TABLE 29. Romanian shad (genus *Alosa*) catches during 1970 - 1992

Year	Alosa pont.	Alosa caspia	Year	Alosa pont.	Alosa caspia	Year	Alosa pont.	Alosa caspia
1970	211	77	1978	247	137	1986	-	1137
1971	375	136	1979	471	-	1987	-	1357
1972	311	95	1980	392	-	1988	-	388
1973	726	188	1981	251	332	1989	8	229
1974	878	219	1982	232	494	1990	-	150
1975	2158	540	1983	230	669	1991	-	255
1976	534	451	1984	236	501	1992	13	85
1977	640	161	1985	140	348			

In **Table 30** the total Black Sea shad catches (*A.pontica*) in area 05 and 37 are presented.

TABLE 30. Total Black Sea shad catches (tonnes) during 1970-1992

Year	A.pontica	Year	A.pontica	Year	A.pontica
1970	1473	1978	1698	1986	985
1971	1526	1979	2920	1987	709
1972	1291	1980	1475	1988	1695
1973	2269	1981	1284	1989	699
1974	4491	1982	2520	1990	947
1975	6043	1983	2127	1991	414
1976	3845	1984	2030	1992	1007
1977	3018	1985	1791		

Stock assessments of Black Sea shad by VPA are available from the monograph of Ivanov and Beverton (1985) and also from Kolarov's doctorate thesis (1986).

Our own assessment concerns the period 1970-1992 and is based on the following data:

-the age composition for the period 1970 - 1982 follows Kolarov's doctorate thesis, and for the period 1983-1992 from summarised data of Shlyakhov and Maxim

-the natural mortality coefficients by age group is after Ivanov and Beverton (1985)

-the values of total mortality coefficient are computed on the base of age composition using regressions

-the mean value of M was subtracted from the obtained values of Z in order to get the initial values of F_{st}

-the weight by age classes are summarised using Bulgarian, Romanian and Ukrainian data

The assessments are carried out by means of the software package ANACO with tuning of F values. The results from the analysis are presented in **Tables 31** and **32**, **Figures 5** and **Figure 6**.

TABLE 31. Stock assessment (x 10^{-6} specimens) of *A. pontica* in the Black Sea during 1970-1992

Year	1	2	3	4	5	6	7
1970	40.297	11.477	13.028	5.244	4.717	0.389	0.000
1971	56.520	28.397	8.084	6.806	2.027	1.775	0.023
1972	67.136	39.829	20.003	4.634	1.836	0.427	0.138
1973	46.647	47.309	27.991	10.715	2.189	0.667	0.015
1974	35.557	32.852	33.113	16.051	4.376	0.508	0.035
1975	24.593	25.057	22.924	14.309	6.410	1.570	0.000
1976	28.985	17.329	17.464	8.697	2.390	1.437	0.053
1977	31.099	20.423	11.951	6.834	1.173	0.347	0.053
1978	21.652	21.911	13.827	3.154	1.172	0.296	0.027
1979	38.127	15.245	14.808	5.583	1.106	0.458	0.013
1980	39.764	26.866	10.293	3.452	0.742	0.316	0.022
1981	26.788	28.021	18.691	4.533	1.930	0.043	0.000
1982	19.848	18.873	19.522	9.618	1.738	0.420	0.000
1983	22.775	13.946	12.972	7.893	3.685	0.519	0.000
1984	13.416	16.018	9.658	5.339	2.473	1.490	0.000
1985	17.693	9.426	11.118	4.689	0.841	0.431	0.000
1986	13.325	12.442	6.154	5.004	0.577	0.140	0.030
1987	12.101	9.375	8.709	3.021	1.810	0.084	0.000
1988	8.650	8.517	6.537	5.282	0.777	0.772	0.000
1989	12.748	6.072	5.903	3.075	0.326	0.056	0.046
1990	4.355	8.975	4.242	3.669	0.723	0.061	0.000
1991	18.523	3.056	6.225	2.704	0.500	0.050	0.000
1992	7.738	13.047	2.110	4.261	0.970	0.105	0.000
1993		5.440	9.088	1.184	0.769	0.140	0.003

TABLE 32. Fishing mortality rate of *A. pontica* during 1970-1992

Year	F_{st}	F_{3-6}	Year	F_{st}	F_{3-6}	Year	F_{st}	F_{3-6}
1970	0.537	0.363	1978	0.380	0.561	1986	1.055	0.539
1971	1.075	0.585	1979	1.076	1.209	1987	0.530	0.343
1972	0.494	0.307	1980	2.001	0.653	1988	1.664	1.291
1973	0.884	0.327	1981	0.530	0.367	1989	0.667	0.480
1974	0.423	0.499	1982	0.352	0.570	1990	1.303	0.919
1975	1.145	0.913	1983	0.401	0.574	1991	0.359	0.261
1976	1.508	0.959	1984	1.225	0.847	1992	0.294	0.426

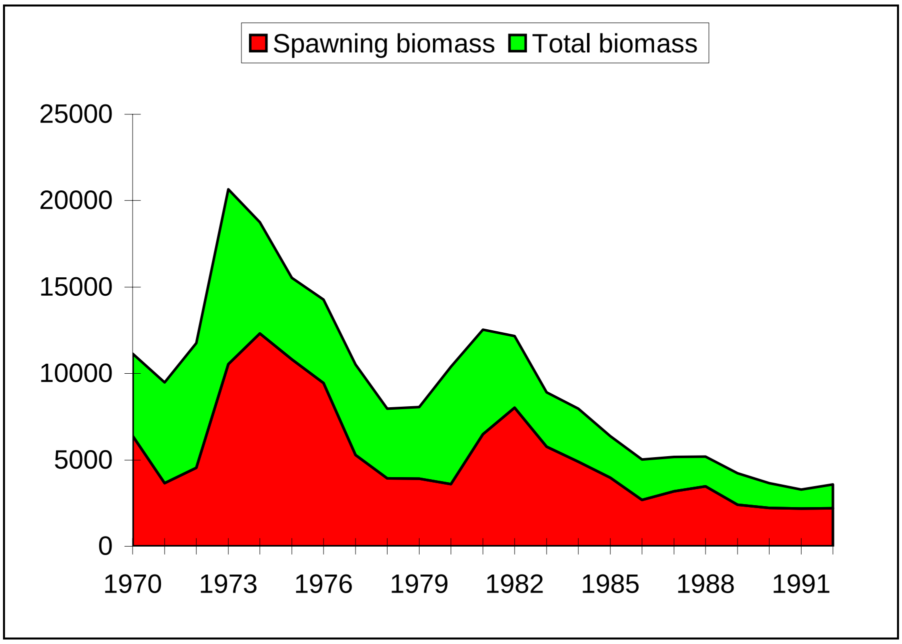

FIGURE 5. Total and spawning biomass of *A. pontica* (tonnes)

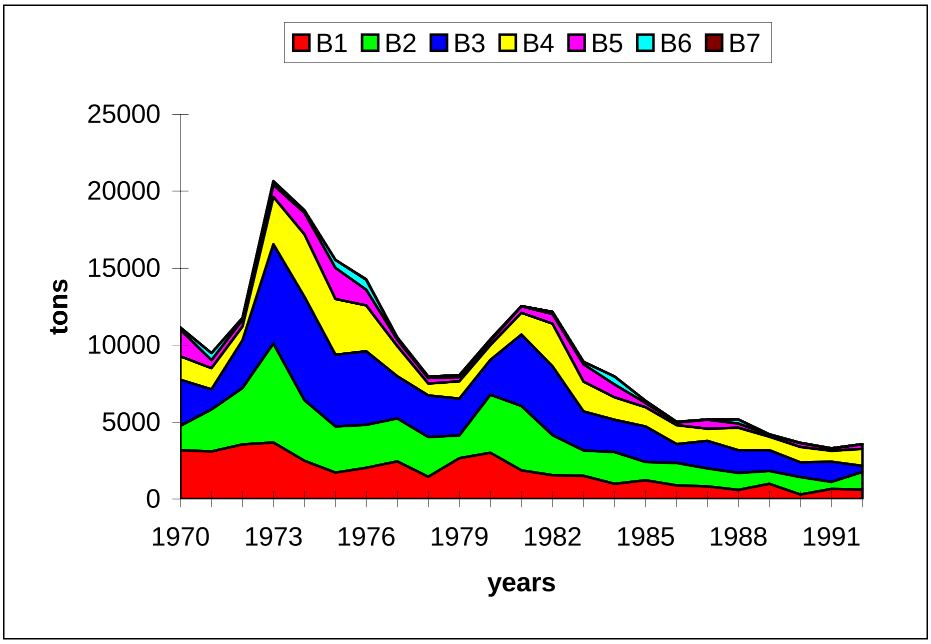

FIGURE 6. Exploited biomass (by age groups) of Black Sea shad (*A. pontica*)

Table 32 shows the estimates of F_{st} and also the mean weight values of $F_{3\text{-}6}$ following iteration procedures. In **Figure 5** are shown the fluctuations in the total (B1+) and in the spawning (B3+) biomasses of the Black Sea shad during the period 1970-1992. **Figure 6** presents the results from VPA for the biomass, by age groups. The assessments shown have a similar trend to Kolarov's estimations (Kolarov, 1986), but they differ in absolute values our assessments being considerably higher. The principal reason for these differences is that Kolarov uses the mean value of the coefficient M and does not make tune the VPA by the corresponding iterations for F_{st} values. Our estimate is very close to that obtained by Ivanov and Beverton (1985) who use considerably higher values for M for the oldest age groups in order to explain the sharp decrease of abundance in the catches. According to the authors mentioned, the total shad biomass in 1968 and 1974 was 2 957 and 20 007 tonnes, respectively. Our estimates show that the total biomass in 1973 and 1974 was, respectively, 20 664.9 and 18 759.3 tonnes, i.e. very close to the corresponding value for 1974 stated by Ivanov and Beverton (1985).

The stock-recruitment relationship of Black Sea shad was derived on the basis of VPAs results for recruitment (R-1 year old fish) and spawning biomass (Br) during the previous year. The data used are presented in table 32b.

TABLE 32b. Data points used in Figure 7

Years	R	Br	Years	R	Br
1971	56.520	7968.5	1982	19.848	10666.3
1972	67.136	6387.6	1983	22.775	10601.5
1973	46.647	8207.5	1984	13.416	7393.8
1974	35.557	16973.4	1985	17.693	6964.0
1975	24.593	16264.0	1986	13.325	5142.7
1976	28.995	13816.5	1987	12.101	4131.5
1977	31.099	12253.3	1988	8.650	4336.4
1978	21.652	8065.4	1989	12.748	4583.7
1979	38.127	6519.7	1990	4.355	3238.6
1980	39.764	5389.1	1991	18.523	3360.6
1981	26.788	7365.5	1992	7.738	2640.6

Figure 7 shows the relationship between the biomass of fish older than 2 years (according to Kolarov, 1986 over 95% of 2 year old fish have reached sexual maturity), and the abundance of 1 year old fish during the following year. It is seen from the figure that the goodness of fit (r) for Ricker's equation ($R = a.E.e^{-bE}$) is 0.3355, i.e. the impact of the environment is much more significant than the size of the parent stock. The parameters of Ricker's equation found are as follows: a = 6.1841; b = -0.00005697; R_{max} = 39933.4 x 10^{-6} specimens of 1 year old fish; B_{opt} = 17553.1 tonnes spawning biomass.

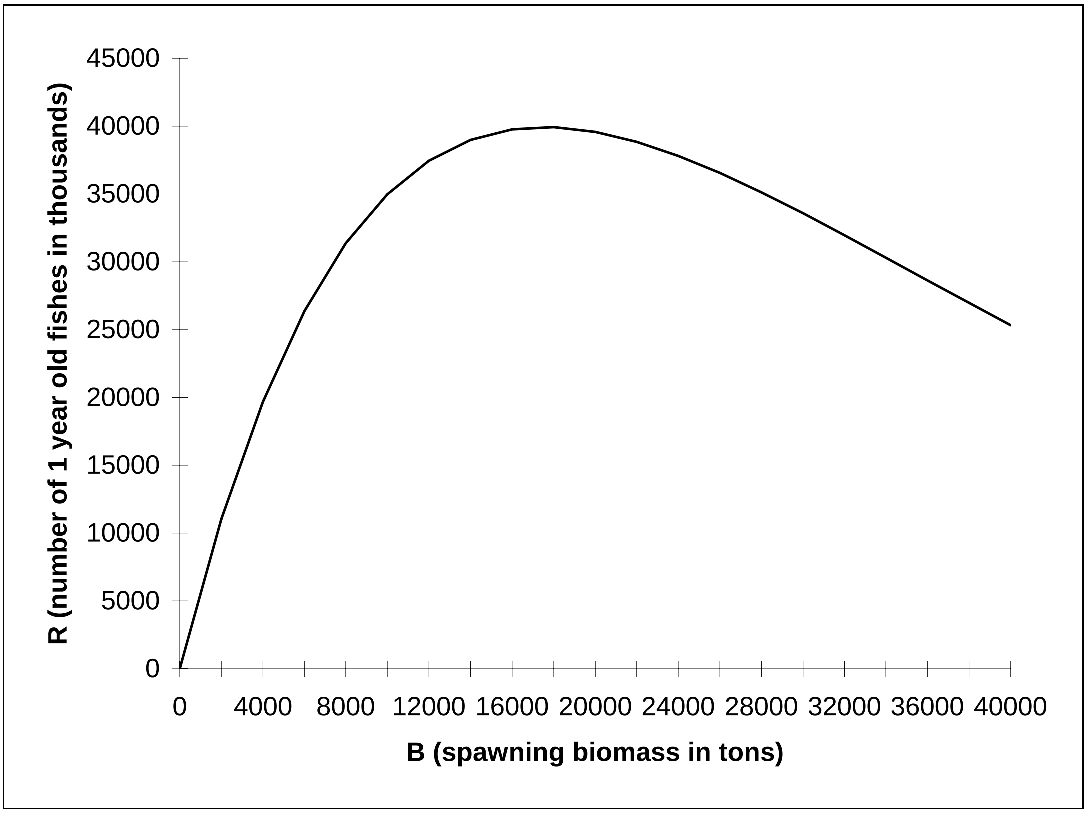

FIGURE 7. Stock-recruitment relationships of *Alosa pontica*

Ivanov and Kolarov (1979) established the existence of inverse interrelationships between catch size and solar activity (measured from the number of sun spots - the Wolf's number). In order to explain this phenomenon, these authors suppose that in years of transition from maximum to minimum solar activity, more favourable conditions for shad are created. The same authors, as well as Ivanov and Beverton (1985), point out that the historical data for Wolf's number not only confirms this cyclic recurrence, but may even precede an increase of catches for the next cycle. This conclusion was arrived at on the basis of existing data for the period 1927-1979. Other authors (Vladimirov, 1953; Moroz and Krotov, 1969) draw attention to the fact that when the water level of the Danube river is high during spring and summer, it coincides with appearance of a strong year class and after some years leads to increased shad catches.