GOLDEN MULLET, *LISA AURATA* RISSO

The golden mullet is the most abundant mullet species, which catches highly predominate over that of the other two species. According to YugNIRO data, the golden mullet catches represent around 98% of the total mullets catches of the former USSR. According to Alexandrova (1973) the percentage proportion among the three species in the Bulgarian catches from the near shore lakes and the Black Sea are as follows (**Tables 89** and **90**). This author also states that the differences (in percentage) in the ratio between these three species are due to the different salinity levels in the basin. The grey mullet sustains better a lower salinity in the near shore lakes, while the golden mullet prefers higher saline waters, so it rarely enters the lakes except for young individuals.

The golden mullet spawns in the Black Sea in June-August. Its fecundity varies from 800 000 to 3 million eggs. The males mature at 2-3 years of age and at lengths of 28-30 cm. The eggs and larvae develop in the surface waters until the young of the year golden mullet reach 5-6 cm by the end of October. The latter migrate towards the shore where they winter in suitable bays.

TABLE 89. Percentage composition of the three species in the Bulgarian catches from the near shore lakes (Alexandrova, 1973)

Year	*M.cephalus*	*L. saliens*	*L. aurata*
1956/1957	67.57	32.43	0.0
1957/1958	100.00	0.0	0.0
1958/1959	100.00	0.0	0.0
1959/1960	97.32	2.68	0.0
1960/1961	100.00	0.0	0.0
1961/1962	100.00	0.0	0.0
1962/1963	83.33	16.67	0.0
1963/1964	45.11	54.89	0.0
1964/1965	100.00	0.0	0.0
1965/1966	96.15	3.85	0.0
1966/1967	97.94	2.06	0.0
1967/1968	79.20	20.80	0.0
1968/1969	100.00	0.0	0.0
1969/1970	100.00	0.0	0.0
Average	90.47	9.53	0.0

TABLE 90. Percentage composition between the three species in the catches from the sea along the Bulgarian coast (Alexandrova, 1973)

Year	M. cephalus	L. saliens	L. aurata
1966	8.76	9.37	81.87
1967	3.93	34.40	61.67
1968	4.49	10.15	85.36
1969	6.09	9.07	84.84
1970	7.63	44.03	48.34
Average	6.18	21.40	72.42

Mullets are extremely sensitive to temperature changes of the sea, especially in the north-western part of the basin where their mortality can reach 90%. After the wintering period, they enter the near shore firths where they feed till the end of October. When the temperature suddenly drops in the month mentioned they usually cannot leave these areas and mass mortality occurs.

The young individuals forage on zooplankton, and adults on detritus and larvae of mussels. The maximum age of the golden mullet is 10-11 years. The growth rates in length and weight were established using von Bertalanffy's equations. For this purpose YugNIRO and Alexandrova's data (1964) for the mean length and weight by age were used. The parameters in the mentioned equations are as follows:

YugNIRO data	YugNIRO data	Alexandrova (1964)
$L_{oo} = 70.2$	$W_{oo} = 2235.4$	$L_{oo} = 54.98$
$k = 0.0801$	$k = 0.1004$	$k = 0.3005$
$t_o = -1.0199$	$t_o = -0.8627$	$t_o = -0.0316$
	$n = 2.9069$	
	$a = 0.0144$	

On the basis of the values obtained for k, n and t_o, having in mind the age at sexual maturity, the mean value of the natural mortality coefficient (M) was determined by means of Kutty and Quasim's (1973) and Rikhter and Efanov's (1976) equations (**Figure 29**). It can be seen from this figure that according to Kutty and Quasim's method the mean M is 0.45 ($t_c = 4.11$ years; $t_r = 4$ years). This equation offered by Kutty and Quasim (1965) includes the growth parameters of von Bertalanffy equations (n, k, t_o)

$$t_c = \frac{\ln (n.k + M) - \ln M}{k} + t_0$$

Hence, if the value of t_c (from Beverton, Holt equation, 1957) we can calculate the mean value of M. Theoretically, t_c must be bigger than t_r. So, if we know the value of t_r we can assume that the value of t_c is somewhat higher than t_r. Following Rikhter and Efanov's method, M is 0.40-0.41. On this account the value M = 0.425 is used later on.

In **Table 91** the catch age composition of the golden mullet during the period 1967-1990 is presented. The age composition was estimated on the basis of the YugNIRO data for the Crimean-Caucasian stock.
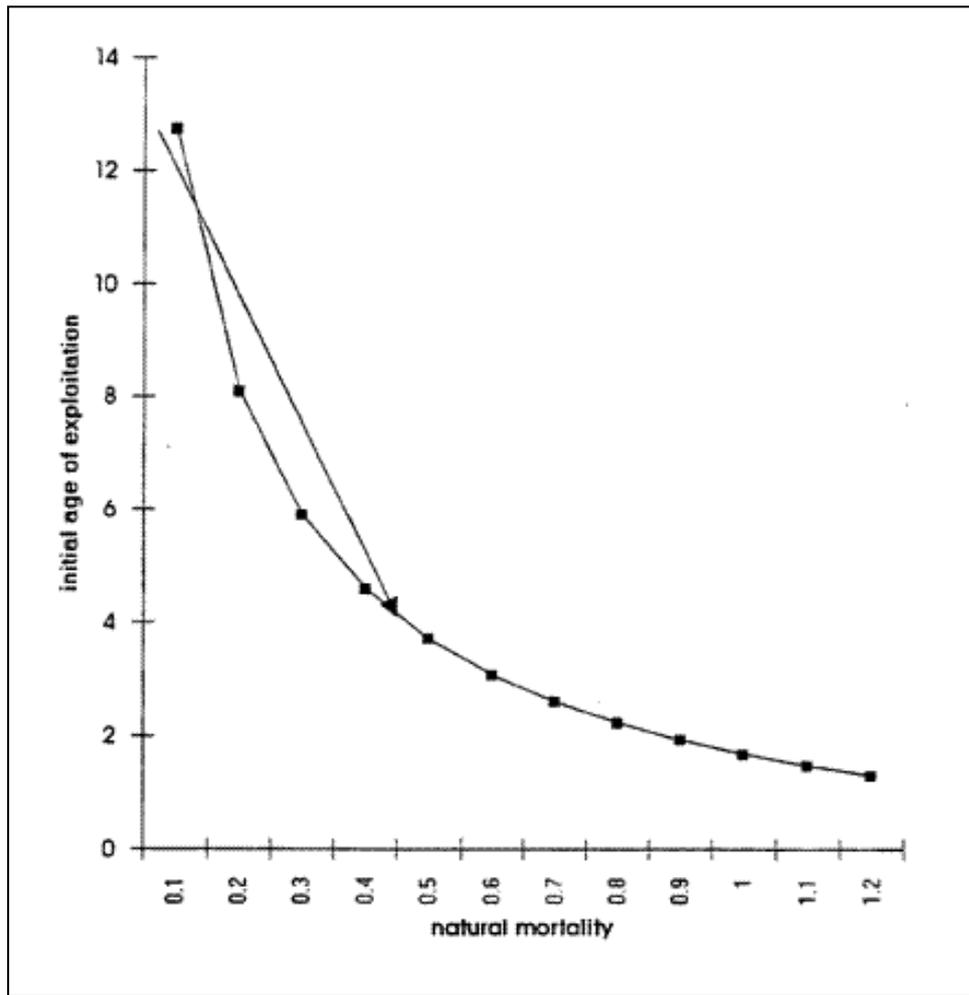
FIGURE 29. Estimating the value of the golden mullet's natural mortality coefficient according to Kutty and Quasim's method

TABLE 91. Age composition in numbers (x 10^{-3}) of golden mullet in the former USSR catches during 1967-1992

Years	1	2	3	4	5	6
1967	0.0	109.3	3115.8	419.1	0.0	0.0
1968	0.0	197.6	905.2	1112.5	139.1	75.6
1969	0.0	41.5	448.3	434.8	144.6	41.5
1970	0.1	130.1	116.2	232.0	152.2	219.1
1971	0.0	115.9	151.3	62.9	53.8	56.5
1972	51.6	254.8	500.1	216.9	58.7	40.9
1973	239.9	2253.2	466.9	132.9	51.9	42.2
1974	5.2	461.7	767.8	277.0	187.8	134.9
1975	423.7	1242.6	1160.5	782.6	118.3	40.1
1976	5.8	764.4	1515.9	337.5	188.9	50.5
1977	1.0	376.9	832.6	517.4	146.5	122.3
1978	0.0	236.5	585.8	202.4	52.3	14.9
1979	146.7	2925.2	584.6	365.6	70.2	22.7
1980	26.7	692.1	849.1	319.0	75.1	8.5
1981	43.9	1141.2	1400.1	526.0	123.7	14.0
1982	40.1	1041.1	1277.3	479.9	112.9	12.8
1983	49.5	1285.1	1576.6	592.3	139.4	15.8
1984	49.0	2102.9	2881.5	1030.0	55.2	6.1
1985	63.6	357.6	1168.2	699.4	349.7	10.6
1986	17.3	2241.0	924.0	949.9	138.2	34.5
1987	18.6	158.0	890.7	331.5	133.2	12.4
1988	32.4	773.3	746.6	240.0	66.7	21.0
1989	120.8	309.8	170.3	54.7	8.7	1.3
1990	11.4	25.2	217.5	45.4	15.8	0.0
1991	34.1	86.5	100.2	25.9	6.3	0.7
1992	33.9	84.6	86.8	37.9	5.3	0.8

Table 91 - continued

Years	7	8	9	10	11	CN
1967	0.0	0.0	0.0	0.0	0.0	3644.2
1968	9.8	0.0	0.0	0.0	0.0	2439.8
1969	9.6	1.1	0.0	0.0	0.0	1120.7
1970	55.8	12.5	2.3	1.4	0.0	922.6
1971	60.2	17.1	4.8	6.4	4.0	532.9
1972	35.0	21.3	7.5	0.6	1.2	1185.2
1973	25.9	19.5	4.9	3.2	2.0	3242.5
1974	64.3	120.4	40.5	13.5	2.0	2075.1
1975	42.0	3.8	1.9	1.9	0.0	3817.5
1976	11.5	4.3	1.4	1.1	2.5	2884.7
1977	17.2	3.0	1.0	1.0	2.0	2020.9
1978	7.7	0.6	0.0	0.0	0.0	1100.0
1979	8.3	4.1	2.1	2.1	0.0	4131.6
1980	2.8	1.0	0.8	0.4	0.0	1975.2
1981	4.5	1.6	1.3	0.6	0.0	3256.7
1982	4.2	1.4	1.2	0.6	0.0	2971.2
1983	5.1	1.8	1.5	0.7	0.0	3667.5
1984	6.1	0.0	0.0	0.0	0.0	6130.8
1985	2.6	2.6	2.6	2.6	0.0	2649.1
1986	4.3	4.3	4.3	0.0	0.0	4317.9
1987	1.5	1.5	1.5	0.0	0.0	1549.0
1988	15.2	5.7	1.9	1.9	0.0	1904.6
1989	1.3	0.7	0.0	0.0	0.0	667.7
1990	0.0	0.0	0.0	0.0	0.0	315.3
1991	0.1	0.0	0.0	0.0	0.0	253.8
1992	0.1	0.0	0.0	0.0	0.0	249.4

The VPA results with ad hoc tuning of the FST values for the oldest age groups are presented in Figure 30. It is seen that the total golden mullet biomass (B1+) from the Crimean-Caucasian stock during the period 1967-1992 has varied between 54.5 (1991) and 1354.5 tonnes (1967) and the spawning biomass - between 9.2 (1991) and 356.5 tonnes (1967). The variations in these biomasses are determined by the year class strength, that varied from 0.658 x 106 (1990) to 14.193 x 106 (1982) specimens. The year classes of 1981 (13.517 x 106), 1972 (12.496 x 106) and 1978 (10.076 x 106) were also strong, and these of 1991 (0.717 x 106), 1989 (0.741 x 106), 1988 (1.368 x 106) and 1992 (1.902 x 106) were weak. The fluctuations in the total and spawning biomass are determined not only by the strength of the different year classes, but also by the fishing mortality rate that is highest during 1988, 1989 and 1974. As a result, the golden mullet biomass has sharply declined. At present, the recommendation of YugNIRO colleagues is that this species not to be fished for a few years. According to their estimates by cohort analysis (1993 annual report of YugNIRO) the golden mullet abundance during the period 1989-1993 has been the following:

Abundance (x 10-6)	1989	1990	1991	1992	1993	Average
N1+	2.3682	1.4618	0.8924	0.6437	0.4736	1.1679
N4+	0.0063	0.0880	0.3148	0.4933	0.3401	0.2485
*	2.0265	1.4395	1.4299	2.6371	2.4379	1.9942
**	0.1092	0.0892	0.0698	0.0868	0.0895	0.0889

* and ** - our estimates for N1+ and N4+

It can be seen from the last table that according to our estimates the total stock abundance (N1+) is higher by 70% on average than that estimated by YugNIRO colleagues, while that of the spawning stock is lower, by an average of 2.8 fold (0.2485 x 106 and 0.0889 x 106). These differences are due to the different estimates of fishing mortality of 1-3 year old fish. The golden mullet catch of the former USSR in the near shore lakes is based on the biological peculiarities of age 0+ (1) year old fish that enter the lakes in the next spring and leave them by the end of October, i.e. at age 1+, then being subjected to commercial fishery. Based on this assumption F values varied between 0.0215 and 0.2213, averaging 0.0650.

For ages 2 and 3, the mean F values are 0.2393 and 0.8028 respectively. The latter figure is rather high, but one must bear in mind that until sexual maturity is reached, a large proportion of these age groups enter the Sea of Azov for feeding (May-September) and leave it usually early in October. In the course of these migrations through the Kerch Strait the species is fished very successfully, even at low biomass levels. That is why the temporary suspension of the fishery would promote the more rapid recovery of its stock. Taking into consideration the catches of Turkey and the remaining Black Sea countries, one may suppose that, at present, the total species biomass in the Black Sea does not exceed 10 000 tonnes.

One of the major reasons for the stock decline of all mullets including the golden mullet, are the deteriorated conditions of life both in the near shore lakes and in the Black Sea.

According to Alexandrova (1973), the mullets inhabiting the Bulgarian coast are related to the western stock that feeds in the bays, river mouths and lakes on the whole western Black Sea coast. After analysing environmental conditions in the Bulgarian lakes, this author pointed out that 1/3 of their total area was already unusable. Subsequently these unsuitable areas increased, resulting in a sharp decline of Bulgarian catches. Following Alexandrova's data (1973) the average mullet catch of Bulgaria during the period 1950-1970 was 192 tonnes: 146 tonnes caught in the lakes (76%) and 46 tonnes (24%) in the Black Sea.

The situation of the near shore lakes in the remaining Black Sea countries is rather similar. This and the deteriorating life conditions in the Black Sea are the major reasons for the present state of mullet stocks.
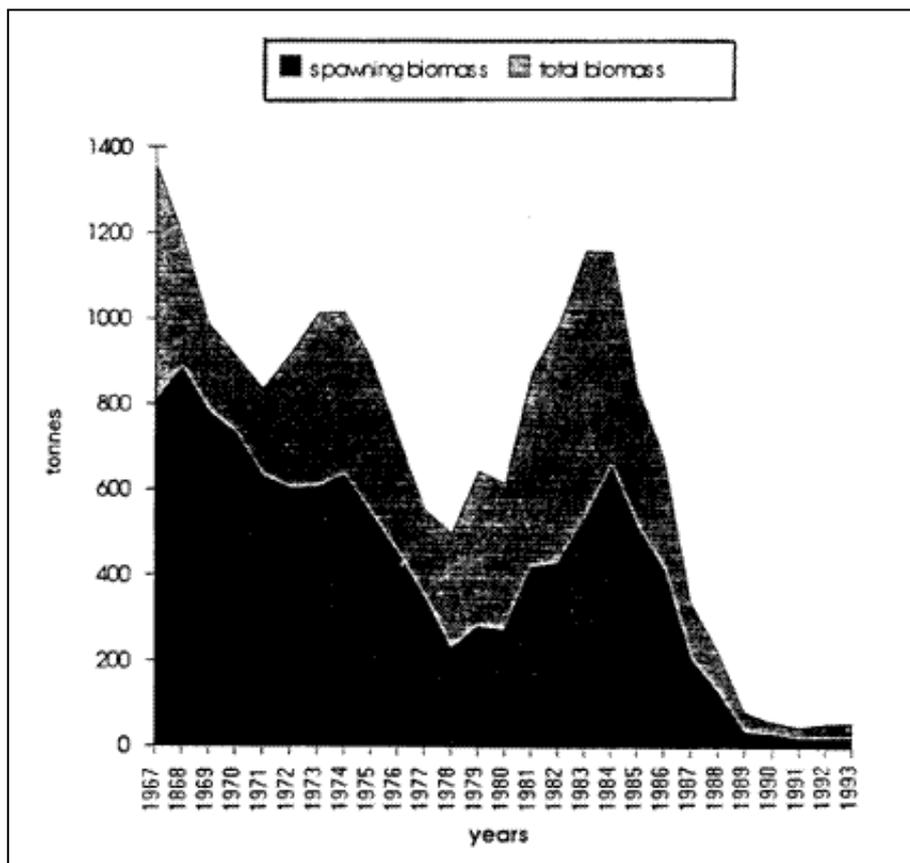
FIGURE 30.Exploited and spawning biomasses (in tonnes) of golden mullet from the Crimean-Caucasian stock during the period 1967-1993