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Relative assessment of mackerel stock in the ICNAF Area
and forecast of the possible catch in 1977

by

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Introduction

Aim of the present paper is to make a relative assessment of changes which occur in mackerel stocks in the ICNAF Area and to give a forecast of the possible catch from this Area in 1977, on basis of Bulgarian data solely on age and size composition, and also on catch per hour fished for the January-March quarter, as processed by V.P.A. The results we obtained, were then compared with those of STACRES (ICNAF Redbook 1976, p.110, table 22).

Materials and Methods

The Bulgarian distant-water fishing fleet entered into the mackerel fishery in the ICNAF Area in April 1969. In the subsequent 1970-1976 period this fishery was carried out mainly during the January-March quarter. In this season, the records of the catch per hour fished and of age- and size composition are comparatively the most indicative of the changes that occur in ICNAF's mackerel stocks and we used them in making the present relative assessment of these stocks by virtual population analysis (V.P.A).

The age-structure, the weights and sizes of the mackerel caught during the January-March fishing season (for 1969 of April's fishing operations only) are shown in Tables 1 and 2. As can be seen, the average body weights and sizes by ages for the 1969-1976 period are estimated in two ways, viz, as averages by ages and as averages by year-classes. The average weights as ob-

tained by both ways, we used in cases where records are not available, e.g. for 1965-68 and 1976 respectively. To make a comparison, in Table 2 are given the theoretic body sizes and weights as estimated by using the Von Bertalanffy's formula and the following parameters we established, i.e.

$$\begin{aligned} W_{\infty} &= 789.1 & n &= 3.42 \\ L_{\infty} &= 41.86 & k &= 0.252 & t_0 &= -1.81 \end{aligned}$$

The catches per hour fished (in numbers) by ages of the Bulgarian distant-water fishing vessels during the January-March quarter are shown in Table 3, except for the 1969's because the mackerel fishery began in April and also because it was not strictly directed. The records were then processed by V.P.A., taking $M = 0.3$, $F_{2+} = 0.60$ and $F_1 = 0.05$ for the 1976. For the 1965-69 period, $F_{2+} = 0.1$, and $F = 0.001$ respectively. The year classes' strenght was successively restored to age 1 of its initial numbers in 1970 and $B = 0.67$. The estimated strenght of the 1961 year-class was successively multiplied by 0.67 and found the numbers of the 1954-1960 year-classes. The extreme age was assumed to be 11 years. The estimated and admitted values of F are given in Table 4.

Results and Discussion.

The assessments we obtained of the relative abundance of mackerel expressed in numbers for the 1965-1976 (N) and in biomass (B) are plotted in Figs. 1 a, b.

Against each year are fitted in the stock numbers of N_{3+} (age 3 and older), N_{2+} (25% of age 2 fish, plus 100% of all older age-groups), N_{2+} (50% of age 2 fish, plus 100% of all older age-groups), N_{2+} (age 2 and older) and N_{1+} (age 1 and older). In the same way is fitted in the stock biomass (Fig. 1, b). The recruitment at age 1, in numbers, is fitted in against the respective birth year. From these data it is quite clear that the stock, as appraised by V.P.A. on basis of Bulgarian catch per hour fished records during the January-March quarter, shows an increase both in numbers and in biomass in 1976, this increase depending on the better strenght of the 1973 and 1974 year-classes.

In Figs.2 and 3 against each year are fitted in the spawning stocks in numerical expression (N) and in terms of biomass(B) and also the numerical strenght of the recruitment at age 1, as obtained by our own assessments and those of STACRES (ICNAF Red-book 1976, p.110. Table 22). As a matter of fact, the figures express the relationship between stock and recruitment in a developed form (by years), and also reveal the existing trends in mackerel reproduction. Between our own relative stock assessments and those of STACRES substantial differences are observed as to the 1976 due to different appraisals of the 1973 and 1974 year-classes. The assessments in view of forecasting the possible total allowable catch also differ, and to a major extent, as to the 1975 year-class strenght and as to the 1975 spawning stock. Our optimistic expectation of an acceptable strenght of the 1975 year-class is based on our own notes of Bulgarian distant-water fishing fleet catches during the 1975's January-March season (when the vessels operating in the ICNAF Area hardly found grounds without presence of this generation), and also relies upon the generally admitted "stock-recruitment" relationship which supposes apperance of strong year-classes in 1976 and 1977 too. If we assume that our expectations are real, then the fishing mortality in 1977 can and must be retained at its 1976 level, i.e, $F_{2+} = 0.6$.

The possible total allowable catch (TAC) in 1977 (or C_{77}) can be calculated by using the formula:

$$C_{77} = \frac{B_{77} \cdot C_{76} \cdot E(1-S)_{77}}{B_{76} \cdot E(1-S)_{76}}$$

where C_{76} - the expected 1976 catch of all member countries - 252224 tons

B_{76} - assessed relative 1976 stock biomass at age 2 and older = 16652 kgs (Fig.2b, B_{2+})

B_{77} - assessed relative 1977 stock biomass at age 2 and older = 17152 kgs (Fig.2b, B_{2+})

Results at different F_{77} - values ($F_{76} = 0,6$; $E(1-B) = 0,395$):
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F_{77}	$E(1-B)_{77}$	C_{77} (expected 1977 TAC)
0.6	0.395	259797 tons
0.5	0.344	226254 "
0.4	0.287	188764 "
0.35	0.257	169033 "

Keeping in mind that the assessments we made of the fishing mortality (F) for the 1965-1969 period, and also the stock values for the same years can differ from the actual ones, and with the purpose of creating major exploitable and spawning stocks in the ICNAF Area, one can admit a F -value equal to 0.45. In this case, by $E(1-B) = 0.317$, the 1977 TAC ($=C_{77}$) will be of the order of 208496 tons, 210000 tons.

Table 1 - Age structure by numbers of mackerel caught by Bulgarian distant-water fishing fleet in the ICNAF Area (weighted average for the January-March quarter) in ‰

Age Year	1	2	3	4	5	6	7	8	9	10	11
1969 +	2	688	70	8	4	2	4	8	10	4	-
1970	1	16	792	177	5	4	2	-	2	1	-
1971	26	359	57	447	66	4	6	6	3	2	-
1972	1	82	256	111	456	88	2	1	3	2	1
1973	103	506	39	150	55	130	12	2	1	-	-
1974	9	361	269	70	134	51	71	12	3	-	-
1975	336	483	74	41	20	29	10	13	2	1	-
1976	97	510	235	59	41	18	20	10	7	2	1

+/ For April only

Tabl.2 - Average weight and length of NW-Atlantic mackerel (ICNAF, s' Subarea 5 and Statistical Area 6) in January-March quarter (in gms. and cms).

Year (Jan-Mar)	Age											Average weight (gms)
	1	2	3	4	5	6	7	8	9	10	11	
	Weight (gms)											
1969	106	142	256	401	461	580	594	619	637	639	-	167
1970	64	196	208	321	415	564	593	-	641	704	-	229
1971	62	136	253	262	376	469	545	581	684	634	-	237
1972	97	190	233	309	324	416	557	564	575	630	736	300
1973	80	150	260	314	354	362	466	558	657	-	-	219
1974	60	169	261	344	384	416	445	509	626	-	-	273
1975	60	144	250	331	425	470	505	524	570	636	-	152
1976	79	163	268	373	445	501	532	576	603	645	666	224
Average	80	162	250	334	308	477	532	563	612	646	712	-
Average by Year- classes	80	164	252	329	389	460	516	550	602	641	417	-
Average by Both ways	80	163	251	332	394	466	525	556	607	644	714	-
Theoretic average	77,5	151,5	235,5	321,0	400,5	471,4	532,6	583,6	625,5	660,0	666,1	-

Year Jan.-Mar.	Length (cms)											Average (cms)
	Age											
	1	2	3	4	5	6	7	8	9	10	11	
1969	22,5	24,9	29,7	33,6	36,0	37,5	36,0	36,5	39,0	39,5	-	25,8
1970	19,8	26,3	26,5	32,4	35,2	37,5	36,5	-	39,5	40,5	-	29,3
1971	21,6	25,5	30,4	31,4	34,2	37,2	38,3	38,8	39,4	40,0	-	29,4
1972	22,5	26,2	29,8	32,3	32,7	35,3	36,5	36,8	39,0	39,8	41,5	31,8
1973	21,2	26,0	31,0	32,2	33,3	34,1	36,5	36,2	39,4	-	-	28,2
1974	20,8	26,6	30,5	32,8	33,8	34,8	35,5	37,0	39,0	-	-	30,3
1975	19,8	25,7	30,3	32,8	34,8	35,8	36,5	36,8	37,9	39,3	-	25,0
1976	20,4	26,1	30,3	33,1	34,8	36,1	36,7	37,5	38,0	38,6	39,5	27,9
Average	21,1	26,4	30,1	32,6	34,4	36,6	37,3	37,9	38,9	39,6	40,5	-
Average by Year- classes	21,2	26,7	30,4	32,8	34,4	35,9	37,1	37,7	38,5	39,2	40,0	-
Average by both ways	21,2	26,6	30,2	32,7	34,4	36,0	37,2	37,8	38,7	39,4	40,2	-
Theoretic average	21,2	25,8	29,4	32,2	34,3	36,0	37,3	38,3	39,1	39,7	40,2	-

Table 3 Bulgarian mackerel catches in numbers and total in numbers and kgs per hour fished during the January-March fishing season

Age Yer	1	2	3	4	5	6	7	8	9	10	11	Total intervals of	
												Numbers	Kgs
1970	24	387	19136	4276	121	97	48	48	24	-	-	24161	5538
1971	747	9578	1521	11926	2295	107	160	213	80	53	-	26660	6260
1972	14	1147	3580	1552	6405	1161	28	14	42	28	14	13935	4195
1973	2660	13217	1015	3902	1431	3352	312	52	26	-	-	26017	5698
1974	179	7189	5756	1394	2669	1016	1414	239	60	-	-	19916	5437
1975	10818	15459	2368	1312	640	672	320	320	64	32	-	32005	4665
1976	3072	15510	7116	1764	1217	547	808	398	182	61	30	30411	6812

Table 4 - Fishing mortality (F) in ICNAF Area (Subarea 5 and Statistical Area 6) mackerel as assessed after Bulgarian catch per hour fished records, assuming M= 0.3

Year-class	Fishing season (January-March)											
	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
1954	(0.1)											
1955	(0.1)	(0.1)										
1956	(0.1)	(0.1)	(0.1)									
1957	(0.1)	(0.1)	(0.1)	(0.1)								
1958	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)							
1959	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.300)						
1960	(0.1) ↑	(0.1) ↑	(0.1) ↑	(0.1) ↑	(0.1) ↑	(0.300)	(0.700)					
1961	(0.1) ↓	(0.1) ↓	(0.1) ↓	(0.1) ↓	(0.1) ↓	(0.320)	0.820	0.600				
1962	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.110)	0.670	0.600	(0.600)			
1963	(0.1)	(0.1)	(0.1)	(0.1)	(0.1) ←	(0.100)	0.990	0.600	(0.600)	(0.600)		
1964	(0.001)	(0.1)	(0.1)	(0.1)	(0.1) ←	(0.110)	0.290	0.165	0.600	0.600	(0.600)	
1965		(0.001)	(0.1)	(0.1)	(0.1) ←	(0.090)	0.145	0.06	0.160	0.310	0.300	(0.6)
1966			(0.001)	(0.1)	(0.1) ←	(0.430)	0.500	0.590	0.340	0.540	0.300	(0.6)
1967				(0.001)	(0.1) ←	0.360	0.450	0.530	0.680	0.790	0.460	(0.6)
1968					(0.001)	0.020	0.090	0.145	0.730	0.480	0.300	(0.6)
1969						(0.001)	0.310	0.200	0.390	0.585	0.315	(0.6)
1970							0.050	0.115	0.155	0.360	0.330	(0.6)
1971								(0.001)	0.580	0.620	0.310	(0.6)
1972									0.110	0.530	0.370	(0.6)
1973										0.004	0.545	(0.6)
1974											0.210	(0.61)
1975												(0.050)
Weighted F ₂₊ against F ₂₊	0.1	0.1	0.1	0.1	0.1	0.262	0.333	0.275	0.520	0.557	0.472	0.6

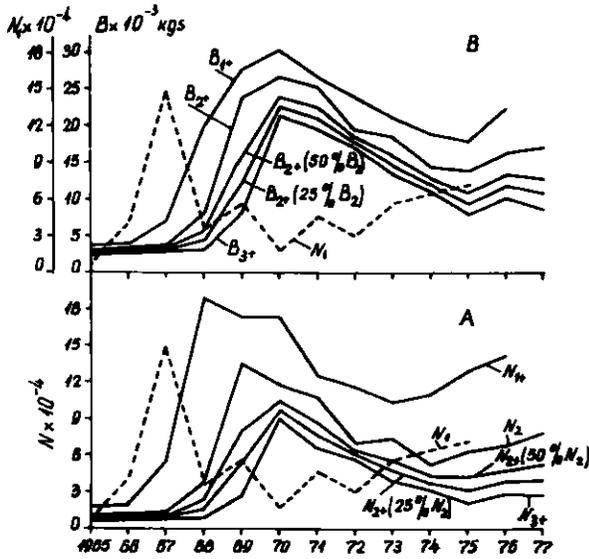


Fig. 1. Relative assessment of mackerel stocks in the ICNAF Area expressed as biomass (B), numbers (N) and as year-class strength in numbers at age 1 by using the VPA method, calculated on the basis of records of the Bulgarian catch per hour fished.

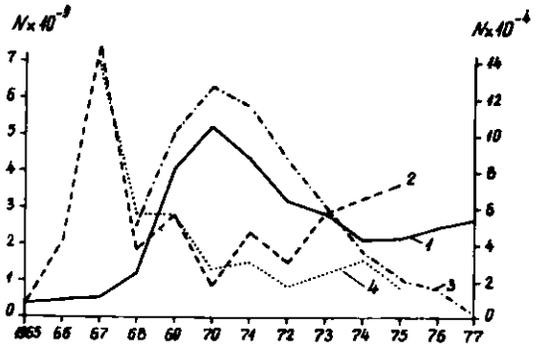


Fig. 2. Numerical abundance of the spawning stock, including 50% of age 2 fish and 100% of all older age-groups and recruitment at age 1. (1) Relative spawning stock (Bulgarian data). (2) Relative recruitment as year-class fish at age 1. (3) Spawning stock after STACRES (ICNAF Redbook 1976, p. 110, Table 22). (4) Recruitment as year-class at age 1 (Ibid., p. 110, Table 22).

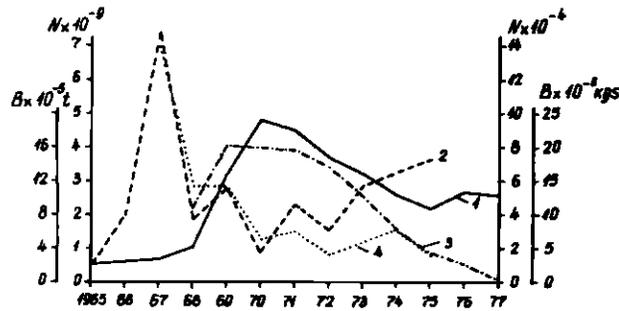


Fig. 3. Biomass of the mackerel spawning stock (B) including 50% of fish at age 2, and 100% of all older age-groups, and recruitment at age 1 in numbers (N). (1) Relative spawning stock (Bulgarian data). (2) Relative recruitment as fish at age 1 (Bulgarian data). (3) Spawning stock after STACRES (ICNAF Redbook 1976, p. 110, Table 22). (4) Recruitment at age 1 after STACRES (Ibid., p. 110, Table 22).

