



Serial No. 4042
(D.c.2)

ICNAF Res.Doc. 76/XII/146

NINTH SPECIAL COMMISSION MEETING-DECEMBER 1976

Variability in Mackerel Age Data Reported to ICNAF

by

E. D. Anderson, C. F. Cole, and P. W. Wood

National Marine Fisheries Service
Northeast Fisheries Center
Woods Hole Laboratory
Woods Hole, Massachusetts 02543, USA

Abstract

Mackerel age-length keys reported to ICNAF were found to exhibit considerable variability between countries and years. USSR and Polish keys for first quarter, 1976 varied substantially in the assignment of ages 2 and 3 at the 25-27 cm (FL) interval. Polish and USSR ages agreed with length-frequency modes in 1975, but USSR ages did not agree in 1976 while Polish data did agree. USSR age-length keys produced a greater number of age 3 fish than age 2 in the catch than did Polish keys applied to the same length-frequencies.

Introduction

During the recent recalculation of the numbers at age of the 1968-75 SA 3-6 mackerel catch (Anderson *et al.*, 1976) using all of the sampling data reported to ICNAF, examination of the various country age-length keys indicated definite differences between countries within some years and between years for some countries. In addition and of particular concern, were the differences between the 1976 USSR and Polish age-length keys recently submitted to ICNAF. The differences constituted different interpretations of age at particular lengths and different sample sizes. The implication arising from the observed differences is that the numbers at age determined by the use of those age-length keys are subject to considerable variation. Since these numbers constitute the major data base of the mackerel assessment, it was felt that further examination of the age data was necessary.

The purpose of this paper is to compare age-length keys reported to ICNAF by various countries during recent years, suggest possible reasons for difference, and examine some of the consequences of calculating numbers at age from selected keys.

Results and Discussion

The USSR and Polish age-length data for 1976, recently reported to ICNAF, were compared for consistency. The USSR data for the first quarter included one age-length key for SA 5 and one for SA 6 and were based on eight samples totalling 352 fish. The Polish data for the first quarter consisted of 27 individual age-length samples by month and area (five in January and two in February from Div. 6A, nine in January and two in February from Div. 6B, two in January from Div. 6C, three in February and three in March from Subdiv. 5Ze, and one in March from Subdiv. 5Zw) totalling 2,692 fish. Comparison of these data indicated some major differences in the assignment of ages for fish in the 25-27 cm (FL) interval (Table 1). Length-frequency samples submitted by the USSR and Poland both showed a large mode at 25-27 cm (FL) and a smaller mode at 30-31 cm (FL). These two modes were represented as age 2 and age 3, respectively, in length-frequency material submitted at the April 1976 Assessments Subcommittee meeting (Figure 1). The USSR age-length keys collectively had about 43% (29 of 68) of the fish in the 25-27 cm interval assigned to age 3, whereas the Polish keys had only 2.5% (17 of 674) assigned to age 3. The effect of this difference

is that the USSR age-length keys, when applied to length data from the catches, indicate a much greater catch at age 3 than at age 2, in contrast to what the Polish keys indicate. This was confirmed by applying both the USSR and Polish age-length keys to the first quarter USSR length-frequency data and catch (Table 2). The results show 34% of age 2 and 47% of age 3 fish using the USSR data and 52% of age 2 and 26% of age 3 fish using the Polish data. These differences contrast with 1975 in which length-frequency modes agreed well with age 2 and age 3 determinations (Table 9, Figure 2).

The differences between the USSR and Polish age-length keys at the 25-27 cm (FL) interval in 1976 (first quarter) are either the result of insufficient numbers of fish in the USSR keys or incorrect age determination by one or the other. Sample sizes differed considerably; the USSR data included 152 fish at age 3, of which 29 or 19% were from the 25-27 cm interval, whereas the Polish samples included 721 fish at age 3, of which only 17 or 2.4% were from the 25-27 cm interval. It is possible that, with additional samples, the higher percentage of fish which were called age 3 in the USSR keys would diminish.

The possibility of incorrect age determinations in the USSR age-length keys at the 25-27 cm (FL) interval was examined. On the basis of the pronounced modes in the length-frequency data available for the first quarter of 1976, it appears that the 25-27 cm (FL) fish should be largely, if not entirely, age 2. The next mode at 30-31 cm (FL) represents age 3 fish which is confirmed by both USSR and Polish age-length keys. Age-length keys from 1976 spring bottom trawl survey samples (Penttila and Anderson, 1976) are in full agreement with the Polish age-length keys. In addition, Bulgarian age composition data for January-March 1976 (Ivanov, 1976) indicate 51% at age 2 and 23.5% at age 3 which tends to agree with the Polish age interpretation. Although the relatively small USSR sample size may have caused some of the apparent conflict, it is possible that errors were made in ageing.

Representative age-length keys from 1970-75 (first quarter) from various countries were examined to see if the differences observed in 1976 between USSR and Polish age-length keys were evident in other years and between other countries. Tables 3-9 contain the portions of age-length keys showing the length-frequency of age 2 and age 3 fish as well as a commercial length-frequency from an appropriate month and area.

In 1970 (Table 3) both the USSR and Bulgarian keys indicated that age 3 fish (1967 year-class) were dominant over age 2 fish beginning at 26 cm (TL). There was a definite mode in the length-frequencies at 27-28 cm (TL) which is equivalent to 24.5-25.5 cm (FL). The 1976 data had a mode at 25-27 cm (FL) which was considered to represent age 2 fish. It is possible that the difference in length between 1970 and 1976 at age 3 reflected slower growth of the strong 1967 year-class.

The 1971 USSR and Bulgarian age-length keys (Table 4) showed a considerable difference in that the USSR results had a much greater proportion of age 3 fish at the 24-27 cm (TL) interval. However, the Bulgarian ageing was consistent with both the USSR and Bulgarian length-frequencies which contained a mode at 24-25 cm (age 2) and another mode at 29-31 cm (age 3).

Age-length keys from USSR, Poland, and Bulgaria in 1972 (Table 5) were inconsistent. The USSR and Polish sample sizes were small, and the modes in the age-length keys for age 3 were 29 cm (TL) for the USSR and 33 cm for Poland. The Bulgarian sample size was large and the ageing agreed with that of the USSR.

The 1973 data (Tables 6-7) showed that Poland, Bulgaria, and GDR were fairly consistent in ageing. They assigned fish at a large length-frequency mode of 27-29 cm (TL) to age 2, whereas the USSR key assigned fish at that length interval to age 3.

In 1974 (Table 8) there was reasonable agreement in ageing from the USSR, GDR, and Poland except that the USSR assigned a greater proportion of fish at the 25-28 cm (TL) interval to age 3 than did GDR and Poland. Length-frequency modes tend to support the GDR and Polish interpretations of age.

There was virtually total agreement in 1975 (Table 9) between the USSR, GDR, Polish, and Bulgarian age-length keys and length-frequency modes. A strong mode was present at 24-26 cm (FL) which all keys interpreted as being age 2. Comparison of the 1975 (Table 9) and 1976 (Table 1) age-length keys indicates consistency of the Polish age-length keys with length-frequency interpretations, but definite inconsistency at the critical 25-27 cm (FL) interval of the USSR age-length keys between 1975 and 1976.

Standard deviations about the mean length for age 2 and age 3 numbers at length in the various age-length keys that were examined indicate, to some extent, the degree of consistency in the data (Table 10). The Polish and Bulgarian data appeared to remain fairly consistent over years based on maintaining a relatively stable standard deviation. The USSR data, however, did not show a constant level of standard deviation, and high values were especially evident in 1970-71, 1974, and 1976. Low standard deviation can be interpreted to represent consistent ageing.

An additional analysis was made to examine the effect of applying different age-length keys to a given length-frequency. Various monthly length-frequencies were selected to which at least two different country's age-length keys could be applied. The results expressed in per mille at age (Table 11) showed marked differences using age-length keys submitted by different countries. USSR age-length keys generally assigned a greater proportion to age 3 than to age 2 than did other keys. It thus appears that the USSR ageing differs from that of other countries and is less consistent with length-frequency observations.

In conclusion, it is evident from the examination of mackerel age-length keys that there have been definite differences in age interpretation by the various countries. It is also clear that small age-length samples can produce inconsistent and likely unreliable estimates of numbers at age. The differences between the USSR and Polish age-length keys in 1976 may be related to differences in sample size as well as differences in ageing. However, the use of the USSR data assigns a higher proportion of its 1976 catch to age 3 instead of age 2 which is in conflict with USA, Polish and Bulgarian ageing.

The results of applying Polish age-length keys for the first quarter to the USSR length-frequency data for determining numbers at age in the 1976 catch are given in Table 12.

Literature Cited

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Table 2. Numbers at age in USSR mackerel catch during January-March 1976 in SA 5-6 as determined by applying USSR and Polish age-length keys to USSR length frequencies.

Age-length key	Number by age and year-class										Total	Tons
	1 1975	2 1974	3 1973	4 1972	5 1971	6 1970	7 1969	8 1968	9 1967	10+ 1966+		
USSR												
No. x10 ⁶	2.8	142.5	198.6	29.0	20.0	6.8	10.8	6.8	1.1	0.3	418.7	86,902
Per mille	7	340	474	69	48	16	26	16	3	1	1000	
Poland												
No. x10 ⁶	2.5	219.5	107.5	27.0	19.3	6.7	12.6	10.6	8.3	4.7	418.7	86,902
Per mille	6	524	257	65	46	16	30	25	20	11	1000	

Table 3. USSR and Bulgarian mackerel age-length keys at ages 2 and 3 and commercial length frequencies in the first quarter of 1970.

Total length (cm)	USSR-Qtr I- SA 6			Bulgaria-Qtr I-Div. 6B		
	Age 2	Age 3	January length frequency	Age 2	Age 3	February length frequency
16	-	-	1	-	-	-
17	-	-	3	-	-	-
18	1	-	11	-	-	-
19	-	-	15	-	-	-
20	2	-	9	-	-	-
21	-	-	8	-	-	-
22	2	-	4	-	-	-
23	-	-	4	-	-	-
24	-	2	3	-	-	-
25	3	-	16	2	5	7
26	4	13	78	2	110	112
27	1	25	144	3	224	229
28	3	43	128	-	205	207
29	-	55	100	9	105	123
30	-	38	96	-	91	106
31	-	43	93	-	38	61
32	-	21	105	-	11	82
33	-	13	74	-	2	36
34	-	6	36	-	-	25
35	-	3	13	-	-	-
36	-	-	11	-	-	2
37	-	-	14	-	-	4
38	-	-	18	-	-	2
39	-	-	10	-	-	2
40	-	-	5	-	-	2
41	-	-	1	-	-	-
N	16	262		16	791	
\bar{X}	24.5	29.6		27.8	28.0	
SD	3.14	2.05		1.57	1.49	

Table 4. USSR and Bulgarian mackerel age-length keys at ages 2 and 3 and commercial length frequencies in the first quarter of 1971.

Total length (cm)	USSR-Qtr I-Div 6A			Bulgaria-Qtr I-SA 5-6		
	Age 2	Age 3	January length frequency	Age 2	Age 3	January-March length frequency
19	-	-	2	-	-	2
20	-	-	6	-	-	6
21	-	-	6	1	-	13
22	4	-	8	3	-	8
23	13	-	28	22	-	24
24	21	1	68	98	-	99
25	41	10	70	123	-	123
26	27	6	40	64	1	65
27	8	3	30	38	1	40
28	-	3	65	10	7	33
29	-	3	120	-	15	92
30	-	5	169	-	12	130
31	-	1	120	-	12	100
32	-	-	97	-	7	84
33	-	2	74	-	2	67
34	-	-	39	-	-	61
35	-	-	22	-	-	23
36	-	-	10	-	-	8
37	-	-	9	-	-	4
38	-	-	9	-	-	11
39	-	-	6	-	-	5
40	-	-	1	-	-	2
41	-	-	1	-	-	-
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N	114	34		359	57	
\bar{X}	24.9	27.3		25.0	29.9	
SD	1.21	2.46		1.22	1.50	

Table 5. USSR, Polish, and Bulgarian mackerel age-length keys at ages 2 and 3 and commercial length frequencies in the first quarter of 1972.

Total length (cm)	USSR-Qtr I-Div 5Z			Poland-Qtr I-SA 6			Bulgaria-Qtr I-Div 6A		
	Age 2	Age 3	January length frequency	Age 2	Age 3	March length frequency	Age 2	Age 3	January length frequency
22	-	-	-	-	-	-	-	-	1
23	-	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	1	-	1
25	-	-	4	-	-	-	11	-	12
26	2	-	23	-	-	-	41	1	47
27	6	-	70	-	-	-	34	8	47
28	3	7	96	-	-	1	27	68	100
29	-	14	85	-	-	3	6	70	92
30	-	10	105	1	-	15	2	40	88
31	1	7	165	-	1	50	-	11	146
32	-	1	177	1	7	59	-	3	183
33	-	-	135	1	10	81	-	1	103
34	-	1	66	-	8	112	-	-	93
35	-	-	30	-	2	144	-	-	48
36	-	-	13	-	-	146	-	-	27
37	-	-	11	-	-	107	-	-	4
38	-	-	6	-	-	98	-	-	7
39	-	-	8	-	-	56	-	-	1
40	-	-	6	-	-	41	-	-	-
41	-	-	-	-	-	19	-	-	-
42	-	-	-	-	-	18	-	-	-
43	-	-	-	-	-	28	-	-	-
44	-	-	-	-	-	11	-	-	-
45	-	-	-	-	-	7	-	-	-
46	-	-	-	-	-	2	-	-	-
47	-	-	-	-	-	1	-	-	-
48	-	-	-	-	-	1	-	-	-
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N	12	40		3	28		122	202	
\bar{X}	27.4	29.6		31.7	33.1		26.8	28.9	
SD	1.31	1.27		1.53	.99		1.15	1.08	

Table 6. USSR, GDR, and Polish mackerel age-length keys at ages 2 and 3 and commercial length frequencies in the first quarter of 1973.

Total length (cm)	USSR-Qtr I-SA 5-6			GDR-Qtr I-SA 5			Poland-Qtr I-SA 5		
	Age 2	Age 3	January length frequency	Age 2	Age 3	January length frequency	Age 2	Age 3	February length frequency
14	-	-	-	-	-	1	-	-	-
15	-	-	4	-	-	1	-	-	1
16	-	-	19	-	-	3	-	-	8
17	-	-	9	-	-	8	-	-	15
18	-	-	8	-	-	11	-	-	35
19	-	-	4	-	-	13	-	-	56
20	-	-	3	-	-	4	-	-	29
21	-	-	3	-	-	8	-	-	35
22	2	-	5	-	-	11	-	-	73
23	2	-	7	-	-	8	-	-	60
24	9	-	23	-	-	3	-	-	26
25	13	2	42	-	-	2	-	-	17
26	5	7	48	1	-	9	1	-	47
27	3	13	42	-	-	27	17	-	272
28	2	12	26	-	-	48	72	-	429
29	-	3	33	2	1	38	66	-	339
30	-	4	53	1	-	16	21	-	121
31	-	-	113	2	-	7	6	2	38
32	-	-	177	-	2	6	-	2	12
33	-	-	140	-	3	40	1	3	21
34	-	-	105	-	4	103	-	1	70
35	-	-	53	-	2	154	-	1	77
36	-	-	35	-	1	166	-	-	53
37	-	-	25	-	-	129	-	-	53
38	-	-	11	-	-	85	-	-	20
39	-	-	7	-	-	47	-	-	24
40	-	-	4	-	-	20	-	-	10
41	-	-	1	-	-	13	-	-	4
42	-	-	-	-	-	8	-	-	1
43	-	-	-	-	-	6	-	-	-
44	-	-	-	-	-	2	-	-	3
45	-	-	-	-	-	1	-	-	-
46	-	-	-	-	-	1	-	-	-
47	-	-	-	-	-	1	-	-	-
N	36	41		6	13		184	9	
\bar{X}	24.9	27.5		29.3	33.4		28.6	32.7	
SD	1.41	1.29		1.86	1.76		1.00	1.32	

Table 7. Bulgarian mackerel age-length keys at ages 2 and 3 and a commercial length frequency in the first quarter of 1973.

Fork length (cm)	Bulgaria - Qtr I -Subdiv 52w		
	Age 2	Age 3	January length frequency
14	-	-	1
15	-	-	1
16	-	-	10
17	-	-	4
18	-	-	6
19	-	-	9
20	-	-	38
21	-	-	43
22	-	-	30
23	13	-	15
24	308	-	108
25	794	-	249
26	436	-	139
27	139	-	32
28	27	9	7
29	6	18	5
30	6	45	24
31	-	65	71
32	-	39	89
33	-	3	53
34	-	-	32
35	-	-	17
36	-	-	11
37	-	-	4
38	-	-	1
39	-	-	1
40	-	-	-
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N	1,729	179	
X	25.3	30.7	
SD	.99	1.13	

Table 8. USSR, GDR, and Polish mackerel age-length keys at ages 2 and 3 and commercial length frequencies in the first quarter of 1974.

Total length (cm)	USSR-Qtr I-SA 6			GDR-Qtr I-SA 5-6			Poland-Qtr I-Div 6A		
	Age 2	Age 3	January length frequency	Age 2	Age 3	January length frequency	Age 2	Age 3	February length frequency
22	-	-	+	-	-	-	2	-	5
23	1	-	1	-	-	-	1	-	5
24	7	-	11	-	-	-	5	-	24
25	8	2	78	-	-	2	14	1	72
26	9	3	105	1	-	18	38	7	169
27	14	7	79	9	1	42	33	2	164
28	6	10	54	13	1	49	20	4	92
29	7	14	55	9	-	32	7	14	84
30	-	26	103	1	1	8	4	26	82
31	-	16	51	-	5	21	2	43	82
32	-	16	49	-	9	39	-	19	53
33	-	3	77	1	6	34	-	5	29
34	-	2	131	-	-	19	-	2	44
35	-	-	92	-	-	82	-	-	26
36	-	-	62	-	-	130	-	-	36
37	-	-	27	-	-	181	-	-	21
38	-	-	16	-	-	154	-	-	10
39	-	-	6	-	-	111	-	-	2
40	-	-	2	-	-	57	-	-	-
41	-	-	1	-	-	15	-	-	-
42	-	-	+	-	-	3	-	-	-
43	-	-	-	-	-	2	-	-	-
44	-	-	-	-	-	1	-	-	-
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N	52	99		35	26		126	123	
X	26.4	29.9		28.2	31.6		26.7	30.4	
SD	1.64	1.90		1.23	1.53		1.57	1.73	

Table 9. USSR, GDR, Polish, and Bulgarian mackerel age-length keys at ages 2 and 3 and commercial length frequencies in the first quarter of 1975.

Fork length (cm)	USSR-Qtr I-Div 5Z			GDR-Qtr I-SA 6			Poland-Qtr I-Div 6B			Bulgaria-Qtr I-Subdiv 5Ze		
	Age 2	Age 3	March length frequency	Age 2	Age 3	February length frequency	Age 2	Age 3	January length frequency	Age 2	Age 3	January length frequency
14	-	-	-	-	-	-	-	-	-	-	-	-
15	-	-	+	-	-	13	-	-	-	-	-	1
16	-	-	21	-	-	10	-	-	-	-	-	2
17	-	-	68	-	-	25	-	-	-	-	-	3
18	-	-	67	-	-	18	-	-	-	-	-	2
19	-	-	33	-	-	14	-	-	-	-	-	10
20	-	-	27	-	-	16	-	-	1	-	-	10
21	-	-	21	-	-	17	-	-	3	-	-	37
22	-	-	24	-	-	34	-	-	19	-	-	33
23	-	-	24	2	-	34	2	-	36	4	-	52
24	5	-	46	12	-	101	5	-	192	36	-	265
25	10	-	116	20	-	185	21	3	114	114	-	282
26	10	1	118	20	-	129	16	4	64	150	-	130
27	13	2	80	11	-	50	7	3	19	86	-	56
28	7	8	56	5	1	31	1	7	19	70	8	27
29	-	16	38	8	8	30	8	18	55	15	27	19
30	-	14	35	7	16	37	-	21	92	10	50	19
31	-	15	31	2	28	29	-	9	71	-	63	26
32	-	2	26	2	43	43	-	2	55	-	46	16
33	-	2	26	1	5	48	-	-	32	-	22	7
34	-	1	27	-	1	22	-	-	73	-	3	6
35	-	-	30	-	-	61	-	-	68	-	2	3
36	-	-	28	-	-	20	-	-	24	-	-	6
37	-	-	25	-	-	12	-	-	17	-	-	4
38	-	-	17	-	-	8	-	-	9	-	-	3
39	-	-	9	-	-	4	-	-	3	-	-	-
40	-	-	4	-	-	5	-	-	2	-	-	-
41	-	-	2	-	-	3	-	-	1	-	-	-
42	-	-	1	-	-	1	-	-	-	-	-	-
43	-	-	+	-	-	-	-	-	-	-	-	-
44	-	-	+	-	-	-	-	-	2	-	-	-
45	-	-	+	-	-	-	-	-	-	-	-	-
N	55	61		90	77		73	67		485	221	
X	25.7	29.8		26.4	30.7		25.0	29.1		25.2	29.9	
SD	1.55	1.51		2.17	1.37		1.25	1.64		1.38	1.38	

Table 10. Standard deviation about the mean for numbers at length at age 2 and 3 in various first quarter age-length keys for mackerel in SA 5-6.

	Age 2				Age 3			
	Poland	Bulgaria	GDR	USSR	Poland	Bulgaria	GDR	USSR
1970	-	1.57	-	3.14	-	1.49	-	2.05
1971	-	1.22	-	1.21	-	1.50	-	2.46
1972	1.53	1.15	-	1.31	.99	1.08	-	1.27
	-	1.37	-	-	-	1.01	-	-
	-	1.20	-	-	-	0.97	-	-
1973	1.00	0.99	1.86	1.41	1.32	1.13	1.76	1.29
	1.76	-	-	-	0.73	-	-	-
	1.51	-	-	-	0.41	-	-	-
1974	1.36	1.40	1.23	1.64	1.61	1.35	1.53	1.90
	1.57	-	-	-	1.73	-	-	-
	0.83	-	-	-	0.91	-	-	-
1975	1.35	1.38	2.17	1.55	1.25	1.38	1.37	1.51
	1.24	-	-	-	1.85	-	-	-
	1.25	-	-	-	1.64	-	-	-
	1.30	-	-	-	1.48	-	-	-
1976	1.38	-	-	1.71	1.45	-	-	2.21
	1.35	-	-	1.52	1.23	-	-	2.00
	1.37	-	-	-	1.30	-	-	-

Table 11. Comparison of mackerel age compositions (per mille) in various months and areas obtained by applying different country age-length keys to the same length frequency.

Age-length key	Per Mille Values at Age										Country	Length freq. Month	Area	
	1	2	3	4	5	6	7	8	9	10				11+
1971-QTR I														
USSR	28	198	78	500	149	23	4	1	1	14	4	USSR	Jan.	6
BULGARIA	22	254	75	541	81	6	8	6	4	2	1	"	"	"
QTR II														
USSR	8	106	111	528	148	42	16	4	4	13	20	USSR	May	5Z
POLAND	76	494	42	325	46	14	2	1	-	-	-	"	"	"
1972-QTR II														
USSR	-	10	124	272	519	43	8	6	14	4	-	USSR	May	5Z
POLAND	-	-	484	146	339	25	5	1	-	-	-	"	"	"
1973-QTR I														
USSR	60	94	144	261	178	219	26	11	4	1	2	USSR	Jan.	5Zw
BULGARIA	61	185	84	254	100	257	41	6	10	1	1	"	"	"
POLAND	153	295	327	119	37	57	8	1	1	1	1	"	"	"
QTR II														
USSR	38	67	348	118	214	188	13	5	1	6	2	USSR	May	5Z
BULGARIA	34	389	46	97	81	272	58	8	6	8	1	"	"	"
1974-QTR I														
USSR	117	133	280	91	99	112	136	23	6	1	2	USSR	Feb.	5Z
BULGARIA	112	169	214	51	121	84	172	53	21	1	2	"	"	"
GDR	117	275	163	137	158	75	62	10	2	-	1	"	"	"
QTR II														
USSR	92	170	332	84	80	138	72	25	5	1	1	USSR	Apr.	5Z
BULGARIA	92	240	259	49	114	70	118	32	24	1	1	"	"	"
GDR	92	450	204	95	81	46	23	6	2	1	-	"	"	"
QTR III														
USSR	215	207	104	76	192	97	75	33	1	-	-	POLAND	Aug.	5Z
POLAND	363	117	75	124	122	107	73	16	3	-	-	"	"	"
1976-QTR I														
USSR	1	381	509	50	28	8	15	6	1	1	-	USSR	Feb.	6
POLAND	1	606	277	37	26	9	12	17	11	4	-	"	"	"

Table 12. Estimated numbers at age of mackerel caught in 1976 by country, area, and months in SA 3-6 using available catch and sampling data reported to ICNAF.

Country	Number (10 ⁶) by age and year-class											Total		
	0 1976	1 1975	2 1974	3 1973	4 1972	5 1971	6 1970	7 1969	8 1968	9 1967	10 1966	11+ 1965+	Number	Tons
USSR ¹														
SA 5-6														
Jan-Mar	-	2.5	219.5	107.5	27.0	19.3	6.7	12.6	10.6	8.3	4.7	-	418.7	86,902
Poland														
SA 3-6														
Jan-Mar	-	1.0	33.9	27.6	6.7	6.1	2.6	5.1	4.1	2.9	1.7	-	91.7	26,579
Poland														
SA 3-6														
Apr-May	-	0.6	23.3	12.6	2.0	1.5	1.2	0.5	0.7	0.4	+	-	42.8	8,147
USSR ²														
SA 4														
Apr-Jan	-	+	2.4	3.4	1.6	2.3	0.4	0.1	0.9	0.3	+	0.1	11.5	4,935
Total	-	4.1	279.1	151.1	37.3	29.2	10.9	18.3	16.3	11.9	6.4	0.1	564.7	126,563

¹Polish age-length keys were used.

²USSR age-length keys were used.

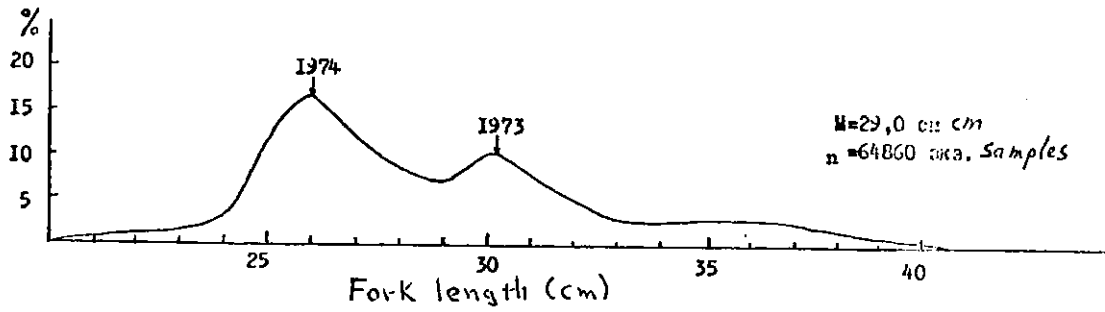


Figure 1. Length-frequency of the USSR January-March 1976 commercial mackerel catches in SA 5-6 as reported in ICNAF Working Paper 76/IV/64.

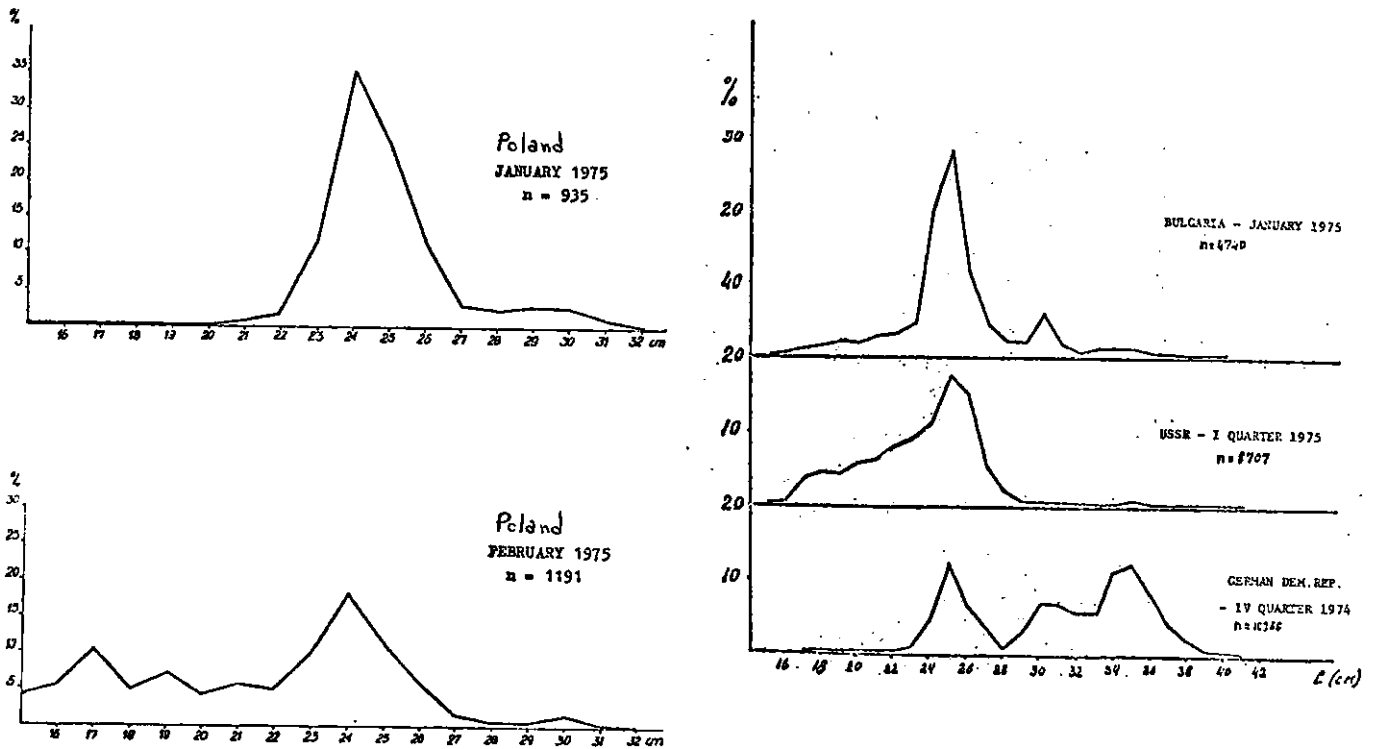


Figure 2. Length-frequency of Polish, Bulgarian, and USSR first quarter commercial catches in 1975 and GDR fourth quarter 1974 commercial catches (Falk et al., 1975).

