Assessment of the Redfish Stock in Subarea 2 and Div. 3K

by

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Abstract

Commercial catch rates have increased since 1976 and in 1983 reached a level comparable to the highest rate on record (1962-1964). Research survey data indicate a wide range of ages in the stock. The lack of any significant recruitment since the early 1970's as determined from research vessel surveys suggests that commercial catch rates will level off or begin to decline in a few years. Since 1980, only about half of the TAC's have been taken due to a reduction of effort in the area. Cohort analysis was attempted but the short time series available, coupled with the low recent effort and hence F, made tuning impossible.

Résumé

Les taux de capture commerciaux ont augmenté depuis 1976 et atteint en 1983 un sommet comparable au plus haut niveau jamais enregistré (1962-1964). Les données recueillies par navires de recherche indiquent la présence, dans le stock, d'une gamme d'âges étendue. Le manque de recrutement significatif depuis le début des années 1970, comme le démontrent les relevés par navires de recherche, donnent à penser que d'ici quelques années, les taux de capture commerciaux atteindront un plateau ou commenceront à décliner. Depuis 1980, environ la moitié seulement des TPA a été capturée, à cause d'une diminution de l'effort de pêche dans cette région. Nous avons tenté une analyse par cohortes, mais la brièveté de la série chronologieque à notre disposition, jointe au faible effort de pêche et, partant, un F moindre, ont rendu tout ajustage impossible.

Introduction

Catches of redfish in Subarea 2 and Div. 3K have fluctuated greatly from a high of about 187,000 t in 1959 to a low of about 15,000 t in 1980 and 1983. Since the mid-1960's catches have fluctuated between 20,000-30,000 t. The TAC's have not been achieved in recent years due to decreased effort. The present TAC of 35,000 t is based on a general production model done a number of years ago (Gavaris MS 1979). Since then the data base has increased to the point where analytical assessments have been attempted but due to low effort and the resultant low fishing mortalities, it has not been possible to tune these.

Materials and Results

Landings

With the extension of jurisdiction in 1977, Canada has dominated this fishery (Table 1). In earlier years, the USSR took the major portion of the catch. In Div. 2G and 2H catches are taken in the second half of the year (Table 2a) due to ice cover during the earlier period. In Div. 2J and 3K (Tables 2b and 2c), fishing has been conducted throughout the year, although in more recent years the trend has been toward greater effort in the second half. A summary of the landings (Table 3) indicates that the largest amounts have generally been from Div. 3K. Total landings have decreased since 1979 (Fig. 1).

Catch and Effort

ICNAF/NAFO data (redfish catches comprising >50% total catch) were utilized for 1959-82, while preliminary data for 1983 were obtained from Economics Branch, Newfoundland Region. Since insufficient time was available for inclusion of corrected Maritimes data, these were not used.

Catch/effort data were standardized using the multiplicative model (Gavaris 1980). As a change in the fleet composition occurred around 1976, the data were analysed in two parts: 1959-76 and 1976-83 with 1976 as the standard. For the 1959-76 data, ln catch rate was regressed (unweighted) against categories of vessel-gear type, month, and year, while the 1976-83 data were weighted stepwise by $\log_{10}$ effort and included Divisions as a category. The results (Tables 4a and 4b) indicate significance.

The resultant standardized effort and catch rates are shown in Tables 5a and 5b and Fig. 2, 3a, and 3b. After bottoming out in the late 1960's to the mid-1970's, the catch rates have shown an increasing trend since 1976 and in 1983 reached a level comparable to the highest rate on record (1962-64). It should be remembered, however, that the Maritimes data are not included and their influence on this trend is unknown at present.

Catch and Weight at Age

The commercial length frequencies available for 1983 (Fig. 4-9) were combined (Fig. 10), then converted to numbers at age by the method of Gavaris

and Gavaris (1983) using the age-length key constructed from otolith collections from the 1983 Canadian commercial fishery. Weights at age were determined from the relationships:

$$Wt_{males}\ (gm) = 0.01659FL^{2.9548}$$

$$Wt_{females}\ (gm) = 0.01372FL^{3.0210}$$

The results (Table 6) indicate that fish aged 10-19 dominated in the catches. The estimated numbers caught at age in the commercial fishery from 1976 to 1983 and their corresponding weights are shown in Tables 7 and 8.

Research Survey Indices

Research vessel surveys have been conducted in Div. 2J and 3K in the fall from 1978 to 1983 by the GADUS ATLANTICA. The numbers and weights caught per standard tow, as well as the total estimated biomass, is shown in Table 9. The numbers and weights caught per standard tow are similar in 1979, 1980, and 1982. The higher figures for 1981 and 1983 were attributed to two extremely large catches in each year. With these large catches eliminated, the new values for numbers and weight per tow and biomass were similar to those of 1979, 1980, and 1982. The 1978 estimates cannot be attributed to one or a few large catches as large numbers were caught in a great number of sets. With the large sets omitted, the 1979-83 data suggest a fairly constant stock biomass with an increasing trend since 1979. This gradual increase can be attributed to growth of the early 1970's year-classes (Fig. 11). It can be seen that from the mid-1970's on, recruitment to the stock has been poor.

Discussion

Both the commercial abundance index (catch rate) and research survey index show a moderate increase from 1979 to 1983, although the confidence limits and coefficients of variation are quite large. The increases noted are reflective of growth and recruitment to the fishery of the early 1970's year-classes.

Cohort analysis was attempted but the short time series available, coupled with the low recent effort and hence F, made tuning impossible except to say that F_t is below 0.1. This can also be deduced by comparing the 1983 catch and TAC, assuming that the TAC is reasonable and $F_{0.1} \simeq 0.15$.

The moderately increasing catch rates and the presence of a wide range of ages in the research survey both results suggest that this stock is healthy. However, the lack of significant recruitment since that of the early 1970's suggests that catch rates will begin to drop off as the early 1970's year-classes pass through the fishery. This should be monitored closely. The data available are insufficient to suggest any change from the present TAC of 35,000 t.

References

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Table 1. Nominal catches (t) of Subarea 2+ Division 3K redfish, 1972-83.

Country	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983[a]
Bulgaria	0	20	0	0	0	0	0	0	0	0	0	0
Canada	49	374	153	445	3,894	3,498	22,052	26,587	7,785	13,416	11,134	9,294
Cuba	0	0	0	0	0	0	0	43	0	0	0	0
Faroes	0	9	0	0	0	0	0	0	0	0	0	0
GDR	2,400	2,484	2,465	2,447	1,729	1,305	2,909	543	1,102	720	425	622
Iceland	296	0	0	0	2	0	0	0	0	0	0	0
Japan	0	0	0	0	0	4	255	0	9	4	2,673	0
Norway	4	30	13	0	9	0	0	0	1	0	0	0
Poland	2,136	4,489	3,646	4,219	3,950	2,269	625	302	870	635	24	1,419
Portugal	620	2,784	4,820	2,971	823	845	378	544	266	393	456	194
Romania	329	305	0	0	0	312	0	0	0	0	0	0
Spain	3	0	0	26	0	134	37	0	44	0	0	0
USSR	13,481	24,230	11,898	13,575	14,881	8,014	2,685	2,578	4,208	2,474	3,073	3,722
Denmark	0	51	9	0	0	0	0	0	0	0	0	
France	19	4	48	4	11	110	22	3	7	0	8	0
FRG	470	3,349	6,593	1,837	647	803	157	68	148	0	180	0
UK	226	836	500	35	19	245	26	62	79	0	20	0
Others	0	0	0	0	0	0	0	0	0	0	0	76
Total	20,033	38,965	30,145	25,559	25,965	17,539	29,146	30,730	14,519	17,642	17,993	15,327

[a]provisional

Table 2a. Redfish catches (t) by month and year in Divisions 2G and 2H.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1972	320						1	233	16	63		26	659
1973	3					8	93	303	500	9	5	13	934
1974	40		12			2	112	91	22	111	24	100	514
1975	33	42	145	24	11	7	126	36	4	17	1	4	450
1976	232	35	94	4		30	85	159	175	416	426	39	1,695
1977	48	3	12	8		54	38	140	306	194	49	17	869
1978	224	1					5	55	33	9	98	158	583
1979	93				11			35	22	81	23	5	270
1980	9		10		1		1		14	12		2	49
1981	22					2	28	97	19	32	15	12	227
1982	33					29		1	300	5	106	109	583

Table 2b. Redfish catches (t) by month and year in Division 2J.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	NK	Total
1972	1,808	770	186	2,769	512	85	-	104	142	249	1,365	456	433	8,879
1973	3,963	42	295	207	157	227	455	572	2,020	1,559	648	400		10,545
1974	1,237	1,545	294	318	208	444	786	667	25	9	32	378		5,943
1975	3,736	1,586	2,155	1,636	810	651	1,345	1,538	210	109	158	162		14,096
1976	2,206	485	-	2	55	73	1,495	7,208	1,827	392	63	606		14,412
1977	217	512	588	54	25	135	914	1,469	1,467	336	619	173		6,509
1978	669	217	418	177	6	1	353	3,994	3,614	1,577	527	251		11,804
1979	137	277	36	-	20	68	2,026	4,452	6,071	3,336	204	32		16,659
1980	43	357	91	59	246	6	13	464	2,784	38	106	216		4,423
1981	206	65	75	12	-	29	1,398	1,886	11	55	114	390		4,241
1982	7	133	214	168	141	359	1,222	2,389	2,177	123	14	12	89	7,048

Table 2c. Redfish catches (t) by month and year in Division 3K.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	NK	Total
1972	172	4,480	502	730	1,374	265	72	639	96	402	1,554	22	187	10,495
1973	3,236	5,189	1,059	4,681	1,294	1,421	414	5,803	2,445	610	719	606	9	27,486
1974	261	1,633	7,983	1,388	2,222	831	1,260	2,028	1,354	400	1,961	2,367		23,688
1975	1,142	2,570	2,588	1,633	212	259	617	932	433	151	341	135		11,013
1976	2,260	1,920	929	561	187	307	1,019	604	357	88	304	1,322		9,858
1977	214	1,624	754	382	245	347	3,699	1,103	1,180	377	163	73		10,161
1978	295	589	4,294	2,565	1,757	412	377	597	1,847	469	1,652	1,905		16,759
1979	134	954	1,874	1,800	1,747	951	450	2,107	1,431	2,073	115	165		13,801
1980	112	209	1,154	1,671	1,087	140	196	1,400	693	509	1,845	1,031		10,047
1981	139	342	501	1,085	630	3,405	3,212	1,998	713	120	416	613		13,174
1982	35	133	117	574	1,187	365	1,004	2,030	414	627	2,209	1,301	367	10,363

Table 3. Historical catches (t) of redfish in Div. 2G, 2H, 2J, and 3K.

Year	2G	2H	2J	3K	Total
1959	-	23	52,519	134,065	186,837[a]
1960	-	56	82,800	46,861	129,773[a]
1961	-	542	25,052	29,861	55,455
1962	-	155	7,576	11,925	19,657[a]
1963	245	16	5,873	17,510	23,644
1964	120	938	16,001	23,044	50,154[a]
1965	851	1,735	15,367	16,748	40,245[a]
1966	197	4,678	9,135	18,720	32,730
1967	24	3,327	13,699	9,112	26,162[a]
1968	670	3,156	4,937	10,103	18,881[a]
1969	55	180	5,838	13,785	19,883[a]
1970	85	393	6,482	10,010	16,970
1971	471	1,079	5,084	12,672	19,306
1972	22	637	8,879	10,495	20,033
1973	192	742	10,545	27,486	38,965
1974	85	429	5,943	23,688	30,145
1975	67	383	14,096	11,013	25,559
1976	89	1,606	14,412	9,858	25,965
1977	99	770	6,509	10,161	17,539
1978	29	554	11,804	16,759	29,146
1979	14	256	16,659	13,801	30,730
1980	2	47	4,423	10,047	14,519
1981	24	203	4,241	13,174	17,642
1982	-	583	7,047	10,363	17,993
1983[b]					15,327

[a]Totals include unallocated catch in Subarea 2.

[b]Provisional.

Table 4a. Regression of multiplicative model for SA2 + Div. 3K redfish, 1959-76.

MULTIPLE R.....0.782
MULTIPLE R SQUARED.....0.611

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	2.287E-2	2.287E-2	
REGRESSION	24	5.183E1	2.160E0	6.554
TYPE 1	3	1.703E1	5.676E0	17.226
TYPE 2	9	1.863E1	2.069E0	6.281
TYPE 3	12	1.010E1	8.415E-1	2.554
RESIDUALS	100	3.295E1	3.295E-1	
TOTAL	125	8.480E1		

Table 4b. Regression of multiplicative model for SA2 + Div. 3K redfish, 1976-83.

MULTIPLE R.....0.621
MULTIPLE R SQUARED.....0.386

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	2.611E0	2.611E0	
REGRESSION	19	3.241E1	1.706E0	5.824
TYPE 1	4	5.169E0	1.292E0	4.413
TYPE 2	7	8.450E0	1.207E0	4.122
TYPE 3	1	6.519E0	6.519E0	22.260
TYPE 4	7	3.785E0	5.407E-1	1.846
RESIDUALS	176	5.154E1	2.929E-1	
TOTAL	196	8.656E1		

Table 5a. Predicted relative power for SA2 + Div. 3K redfish, 1959,76.

YEAR	TOTAL CATCH	PROP.	RELATIVE POWER MEAN	S.E.	EFFORT
1959	186837	0.358	0.921	0.235	202904
1960	129773	0.223	0.634	0.203	204717
1962	19657	0.048	2.484	1.020	7913
1963	23644	0.437	2.489	0.834	9498
1964	50154	0.349	2.389	0.902	20998
1965	40245	0.479	2.096	0.704	19204
1966	32730	0.288	1.693	0.622	19331
1967	26162	0.079	1.251	0.433	20910
1970	21970	0.012	1.198	0.461	18337
1971	19306	0.145	0.921	0.308	20955
1973	38965	0.151	0.734	0.170	53075
1975	25559	0.013	1.288	0.444	19846
1976	25965	0.325	1.000	0.000	25965

AVERAGE C.V. FOR THE MEAN:0.308

Table 5b. Predicted relative power for SA2 + Div. 3K redfish, 1976-83.

YEAR	TOTAL CATCH	PROP.	RELATIVE POWER MEAN	S.E.	EFFORT
1976	25965	0.325	1.000	0.000	25965
1977	17539	0.392	1.334	0.274	13151
1978	29146	0.332	1.224	0.219	23820
1979	30730	0.300	1.234	0.224	24901
1980	14519	0.385	1.548	0.304	9379
1981	17642	0.612	1.446	0.269	12199
1982	17993	0.403	1.744	0.325	10315
1983	15327	0.202	2.397	0.510	6394

AVERAGE C.V. FOR THE MEAN:0.168

Table 6. Catch at age (x 10^{-3}) and weight at age (kg) for redfish from SA2 + Div. 3K, 1983.

	AVERAGE		CATCH		
AGE	WEIGHT	LENGTH	MEAN	STD. ERR.	C. V.
7	0.140	21.164	13	9.73	0.73
8	0.163	22.316	351	55.02	0.16
9	0.189	23.409	956	90.53	0.09
10	0.224	24.835	1156	127.65	0.11
11	0.249	25.704	1272	149.34	0.12
12	0.279	26.689	2053	199.43	0.10
13	0.303	27.451	2092	211.94	0.10
14	0.329	28.214	2354	223.37	0.09
15	0.369	29.305	1857	199.90	0.11
16	0.414	30.474	1626	177.51	0.11
17	0.475	31.952	1643	164.90	0.10
18	0.517	32.861	1399	147.59	0.11
19	0.573	33.890	1207	144.09	0.12
20	0.596	34.283	913	124.89	0.14
21	0.640	35.125	957	128.13	0.13
22	0.670	35.647	711	113.75	0.16
23	0.724	36.555	614	103.56	0.17
24	0.740	36.838	824	117.85	0.14
25	0.800	37.820	772	111.44	0.14
26	0.802	37.931	561	93.80	0.17
27	0.825	38.239	598	95.12	0.16
28	0.824	38.283	566	91.31	0.16
29	0.897	39.267	493	80.66	0.16
30	1.159	42.511	2586	119.44	0.05

Table 7. Catch at age (x 10^{-3}) for SA2 + Div. 3K redfish, 1976-83.

CATCH AT AGE

AGE	1976	1977	1978	1979	1980	1981	1982	1983
6	7	22	4	240	28	44	1	1
7	30	102	400	2159	301	199	224	13
8	136	219	1241	5678	1669	607	999	351
9	1265	612	3297	8798	996	1398	2253	956
10	2067	843	4071	9251	869	1819	3680	1156
11	3866	1569	4495	6700	839	1536	3922	1272
12	5580	1930	5806	4011	1031	1047	3969	2053
13	7818	2241	6207	7374	1549	1348	4124	2092
14	8652	3315	6267	6646	1889	1409	3481	2354
15	8615	3162	5265	6571	2050	2138	3767	1857
16	2700	2776	5331	6075	1727	1887	3137	1626
17	1826	2504	3969	5544	1753	2302	3054	1643
18	946	1812	2250	1796	1032	1920	2050	1399
19	757	1778	1488	1241	793	1470	1538	1207
20	1128	1638	1495	1391	10058	1308	1045	913
21	968	895	1084	1412	669	1019	1061	957
22	885	940	950	789	532	1001	627	711
23	1100	555	591	573	503	1093	498	614
24	1005	618	883	599	748	1004	517	824
25	684	598	828	930	521	828	324	772
26	678	514	746	569	524	903	369	561
27	512	435	509	590	505	540	341	598
28	632	418	535	589	389	749	256	566
29	284	200	139	283	415	580	226	493

Table 8. Weight at age (kg) for SA2 + Div. 3K redfish, 1976-83.

AVERAGE WEIGHT AT AGE

AGE	1976	1977	1978	1979	1980	1981	1982	1983
6	0.10	0.10	0.10	0.10	0.11	0.09	0.10	0.10
7	0.14	0.14	0.14	0.14	0.17	0.11	0.14	0.14
8	0.17	0.17	0.17	0.17	0.18	0.16	0.17	0.16
9	0.20	0.20	0.20	0.20	0.22	0.20	0.21	0.19
10	0.24	0.24	0.24	0.24	0.24	0.22	0.25	0.22
11	0.28	0.28	0.28	0.28	0.28	0.24	0.27	0.25
12	0.32	0.32	0.32	0.32	0.29	0.28	0.30	0.28
13	0.36	0.36	0.36	0.36	0.31	0.32	0.33	0.30
14	0.40	0.40	0.40	0.40	0.36	0.35	0.36	0.33
15	0.44	0.44	0.44	0.44	0.42	0.40	0.41	0.37
16	0.48	0.48	0.48	0.48	0.46	0.44	0.45	0.41
17	0.52	0.52	0.52	0.52	0.53	0.49	0.49	0.48
18	0.56	0.56	0.56	0.56	0.57	0.54	0.56	0.52
19	0.60	0.60	0.60	0.60	0.60	0.59	0.60	0.57
20	0.63	0.63	0.63	0.63	0.67	0.63	0.65	0.60
21	0.67	0.67	0.67	0.67	0.65	0.70	0.69	0.64
22	0.70	0.70	0.70	0.70	0.75	0.73	0.71	0.67
23	0.73	0.73	0.73	0.73	0.79	0.76	0.80	0.72
24	0.76	0.76	0.76	0.76	0.75	0.81	0.79	0.74
25	0.79	0.79	0.79	0.79	0.77	0.82	0.85	0.80
26	0.81	0.81	0.81	0.81	0.95	0.84	0.86	0.80
27	0.84	0.84	0.84	0.84	0.93	0.93	0.87	0.83
28	0.87	0.87	0.87	0.87	0.92	0.92	0.88	0.82
29	0.89	0.89	0.89	0.89	1.00	0.89	0.90	0.90

Table 9. Numbers and weights of redfish caught, per standard tow and total estimated biomass, from Canadian research cruises in 2J and 3K. Coefficient of variation shown in brackets.

Year	No. sets	No. per tow	Weight per tow (kg)	Total biomass (t)
1978	118	707.5 (.39)	215.4 (.27)	657,320 (.27)
1979	197	163.5 (.24)	69.0 (.26)	210,513 (.26)
1980	203	163.4 (.24)	77.2 (.33)	235,532 (.33)
1981	171	388.7 (.48)	156.9 (.43)	478,660 (.43)
1981[a]	169	136.3 (.20)	65.4 (.22)	199,364 (.22)
1982	230	182.8 (.33)	68.6 (.33)	209,166 (.33)
1983	199	615.7 (.45)	199.0 (.38)	601,135 (.38)
1983[a]	197	232.2 (.18)	94.6 (.16)	285,618 (.16)

[a]Excluding two large catches.

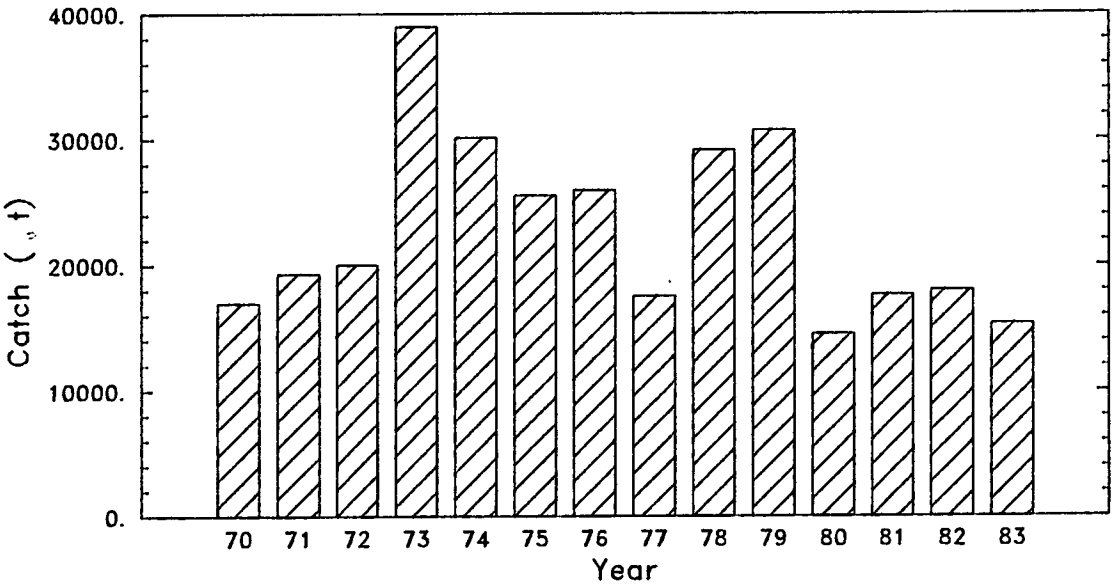

Fig.1: Nominal catches of redfish from 2+3K, 1970–1983. (1983 Provisional)

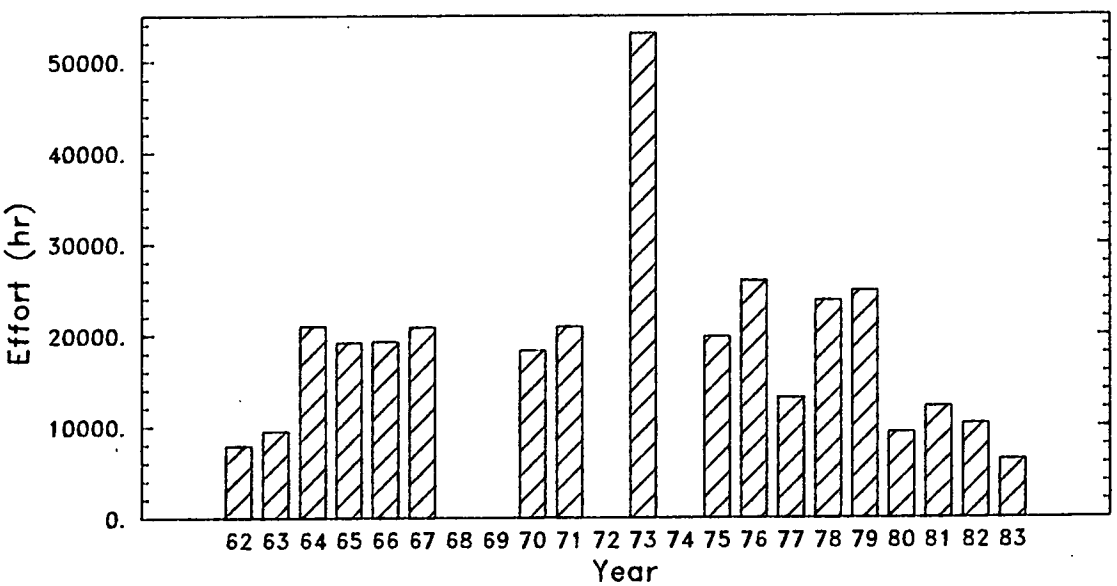

Fig.2: Standardized directed effort for redfish, 2+3K, 1962–1983. (1983 Provisional)

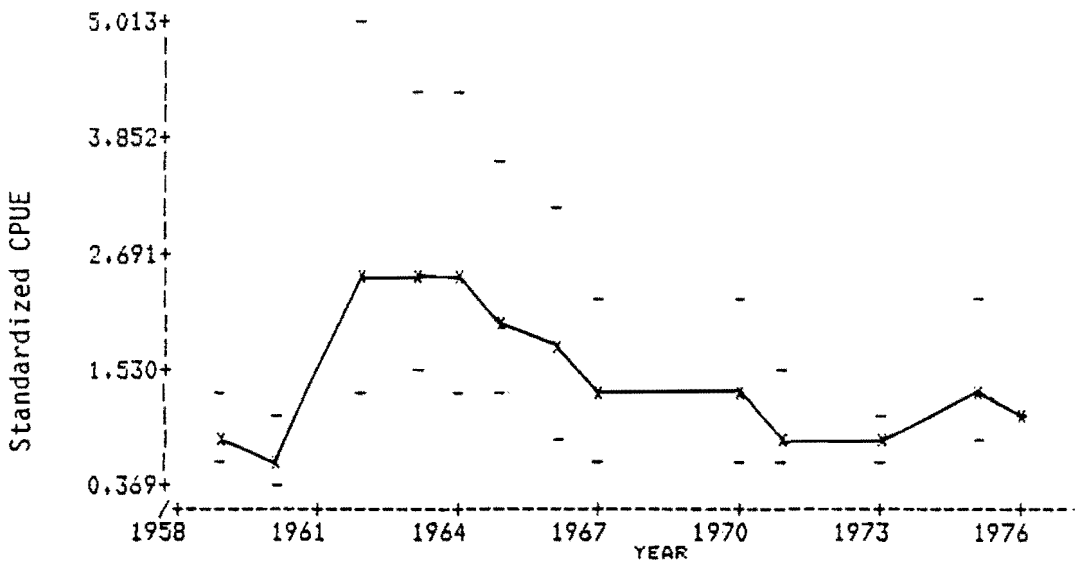

Fig. 3a. Standardized CPUE 1959-76 for redfish in SA2 + Div. 3K.

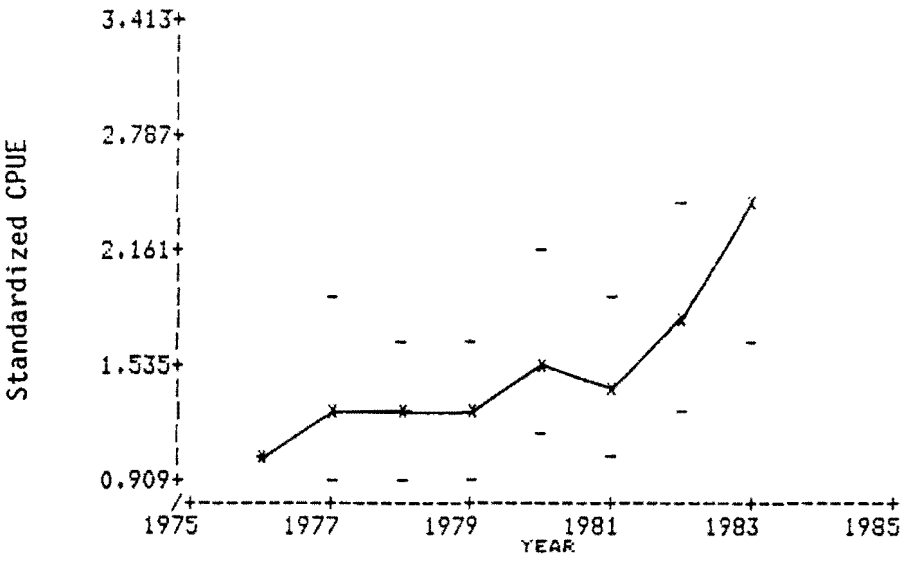

Fig. 3b. Standardized CPUE 1976-83 for redfish in SA2 + Div. 3K.

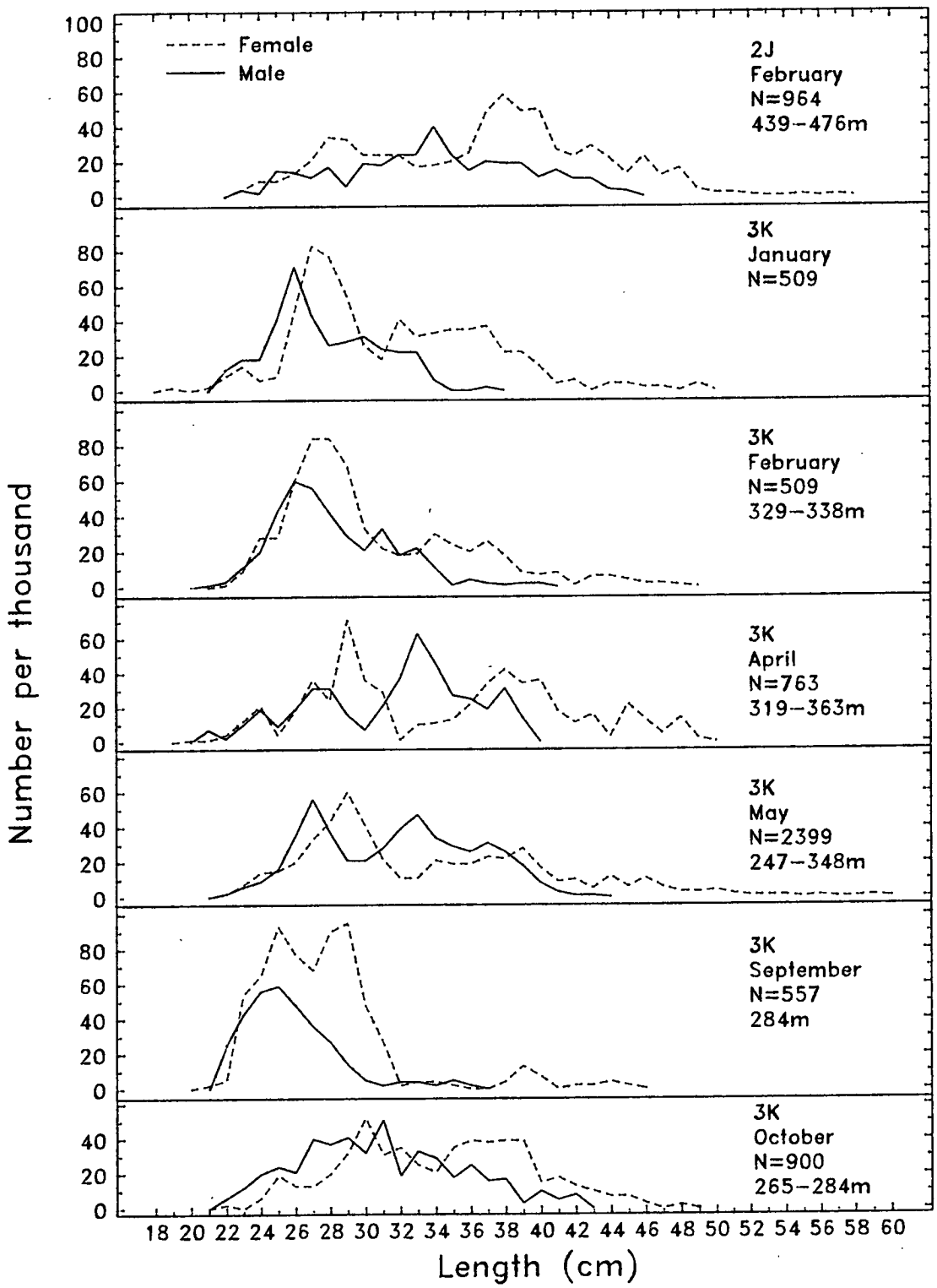

Fig.4: Commercial frequencies from Canadian (Nfld.) otter trawl redfish fishery in 2J+3K in 1983 (port sampling).

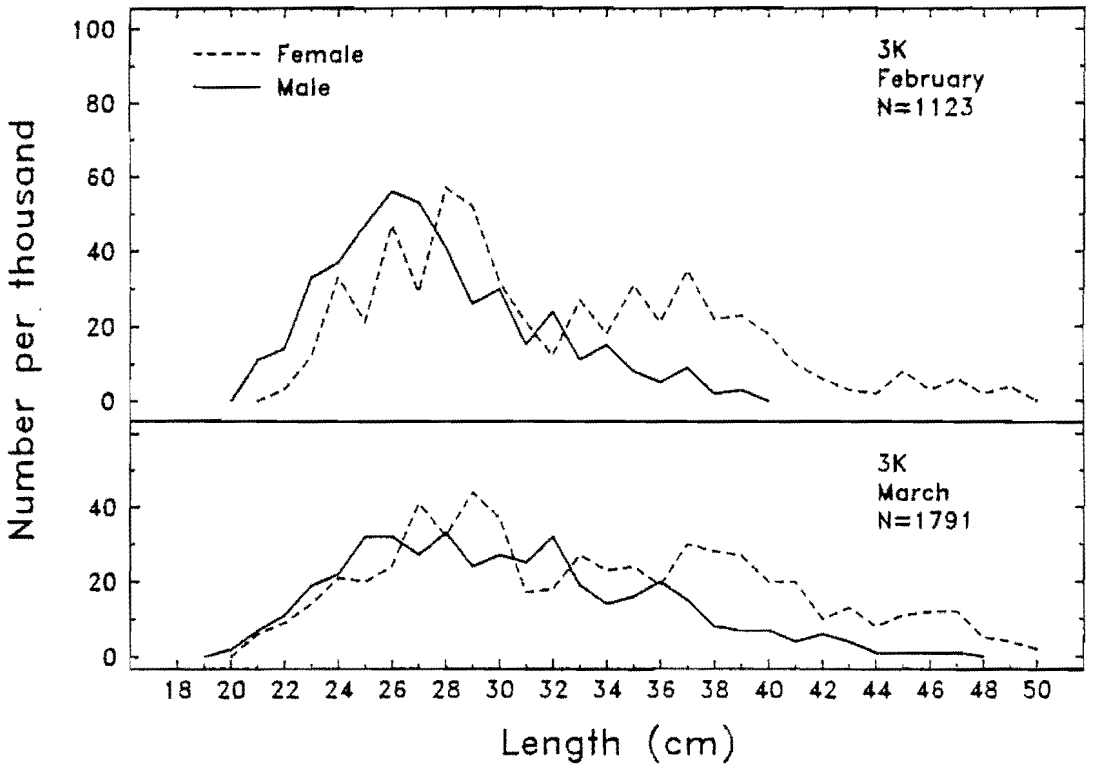

Fig. 5: Commercial frequencies from Canadian (Nfld.) otter trawl redfish fishery in 2J + 3K in 1983 - Foreign Cooperative Research (FRC) samping.

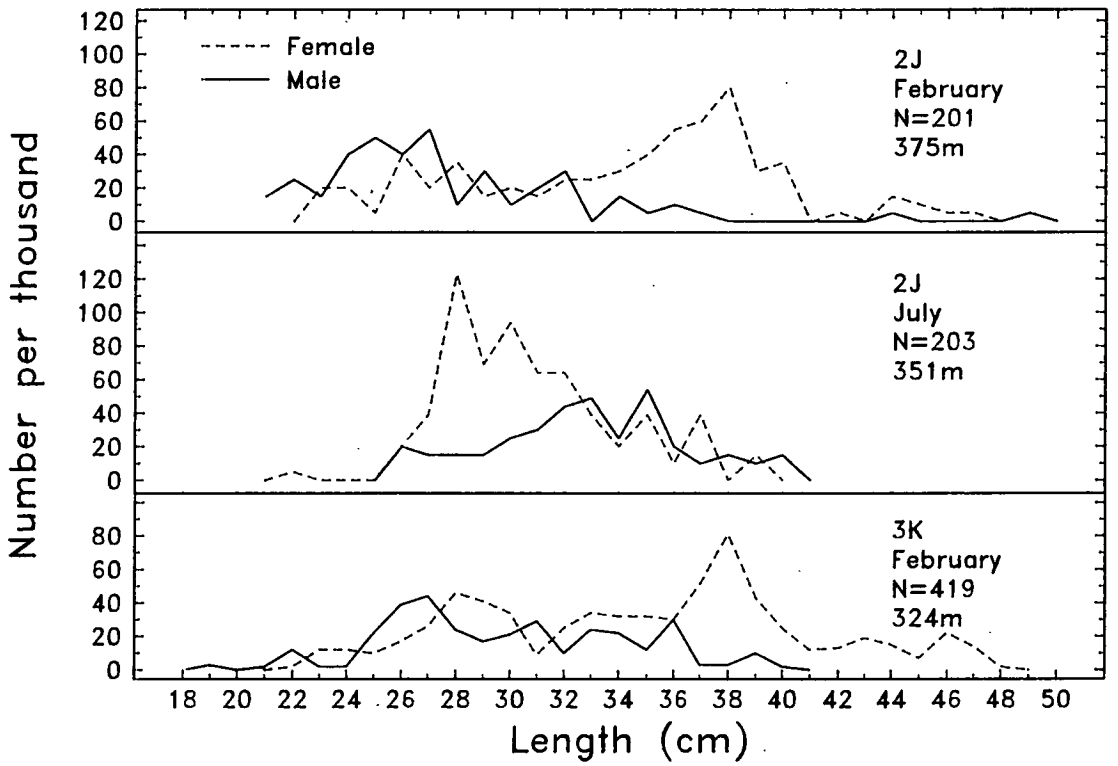

Fig.6: Commercial frequencies of Canadian (Maritimes) otter trawl redfish fishery in 2J+3K in 1983 (port sampling).

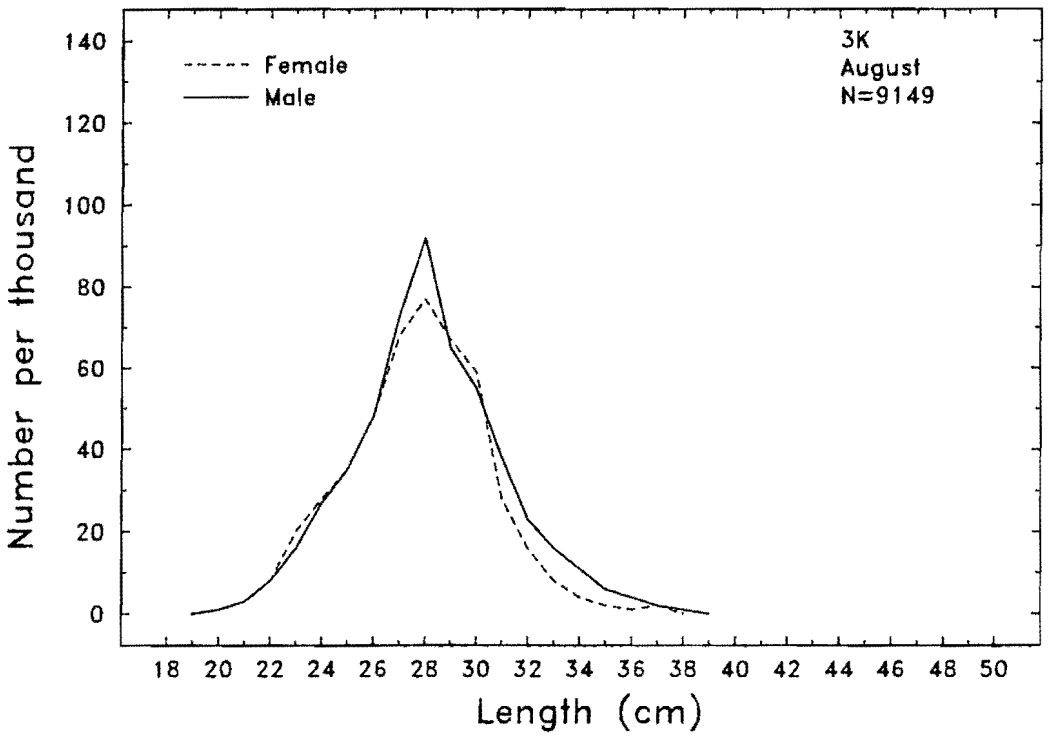

Fig. 7: Commercial frequencies from USSR otter trawl redfish fishery in 3K in 1983 (FRC sampling).

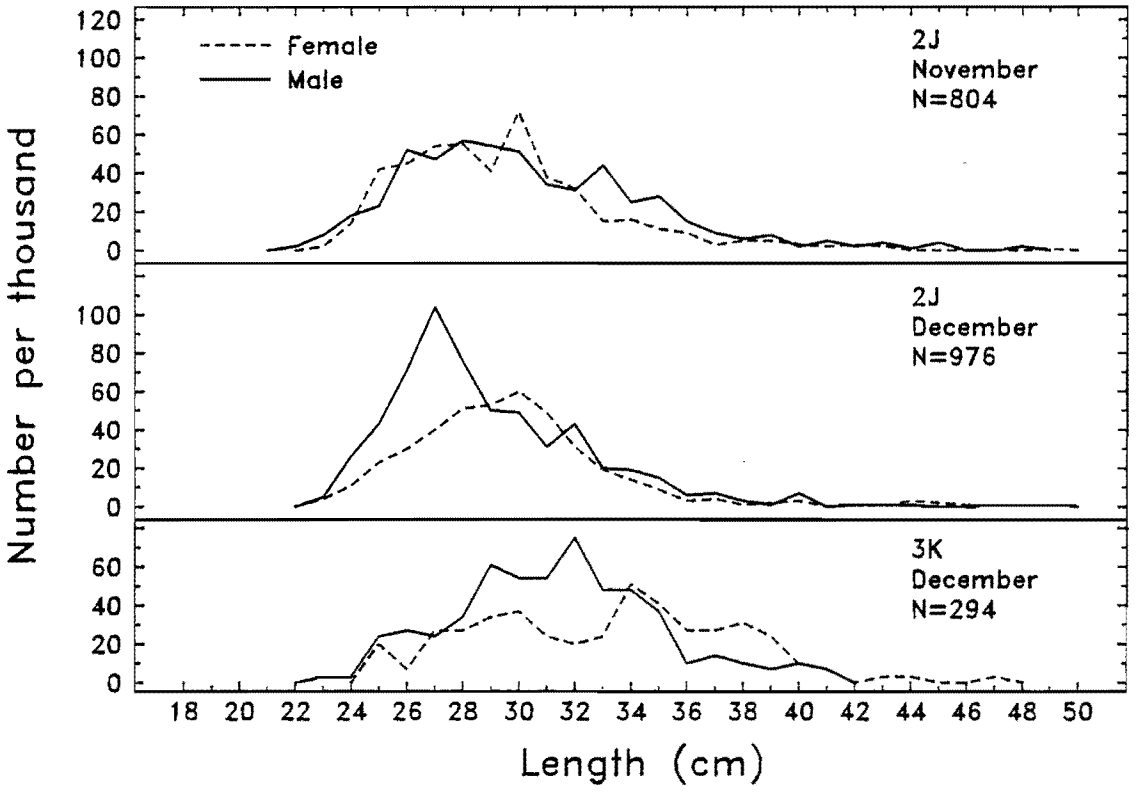

Fig.8: Commercial frequencies from Poland otter trawl redfish fishery in 2J+3K in 1983 (FCR sampling).

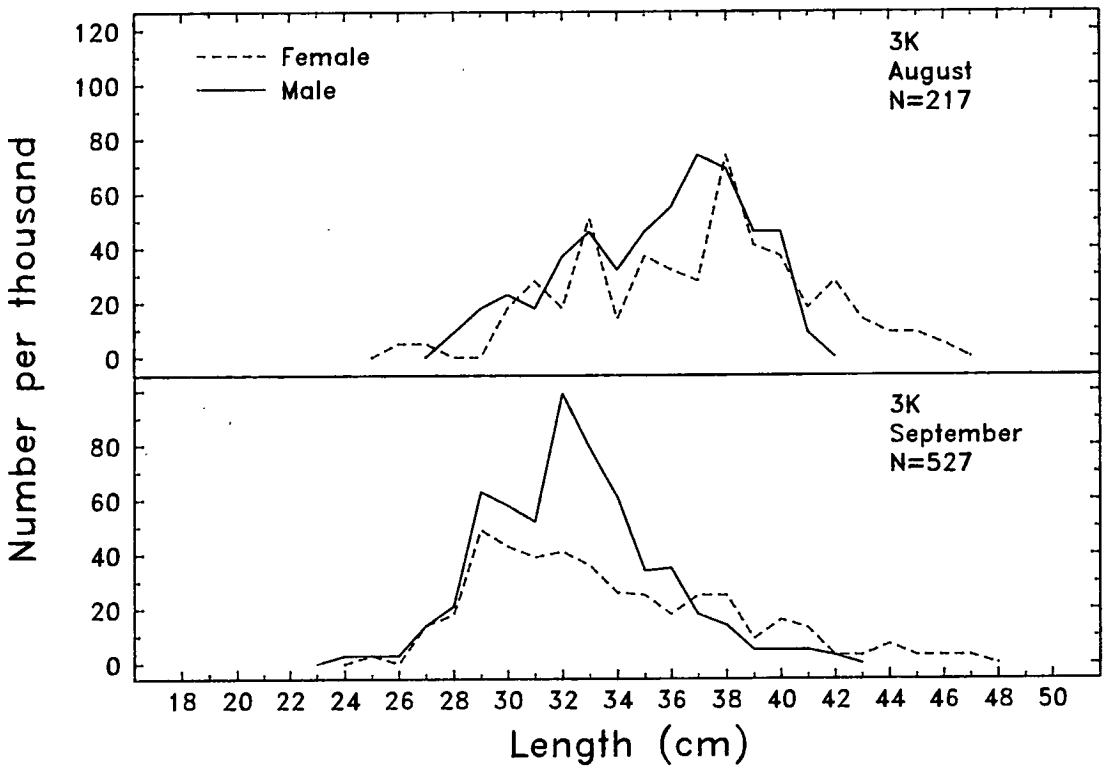

Fig.9: Commercial frequencies from G.D.R. otter trawl redfish fishery in 3K in 1983 (FCR sampling).

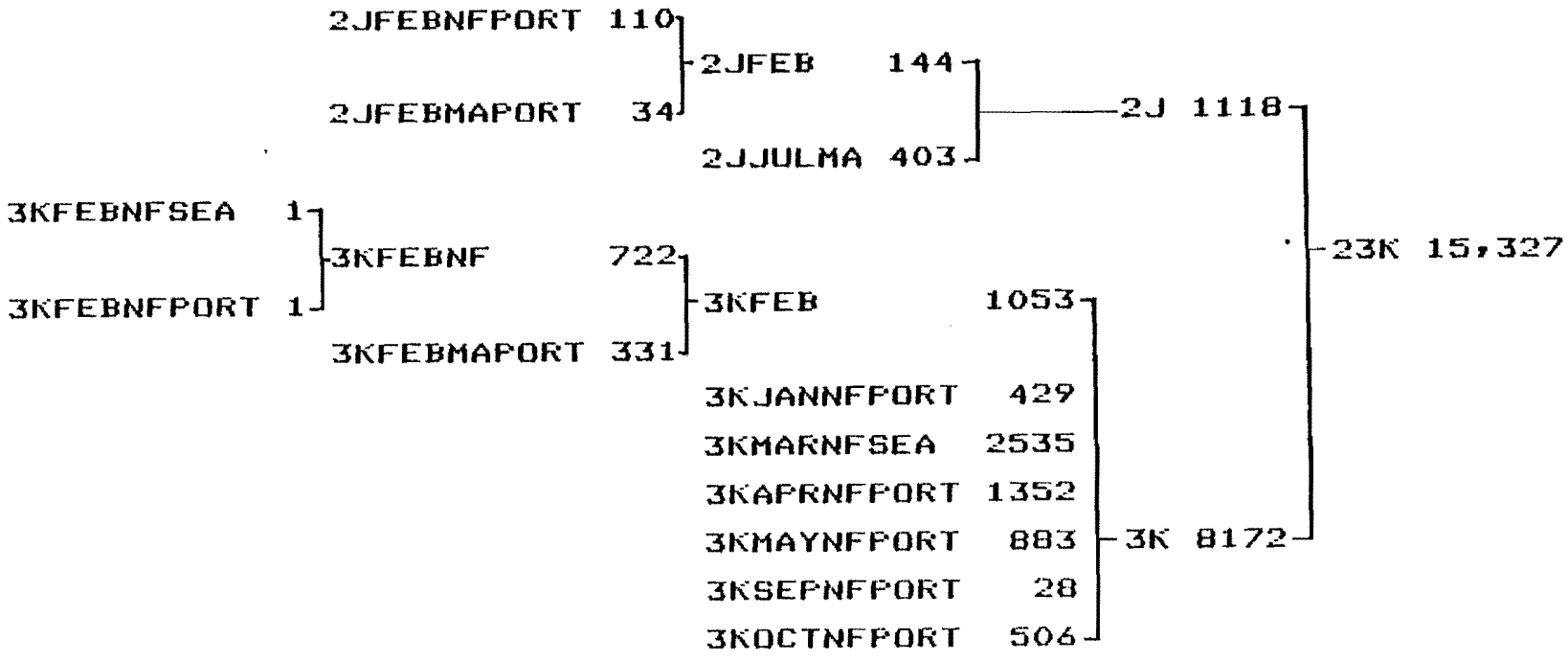

Fig. 10. Commercial frequencies used and the combination process used to derive the final commercial redfish frequency for 2+3K, 1983 (USSR, Poland, and GDR commercial frequencies were not used).

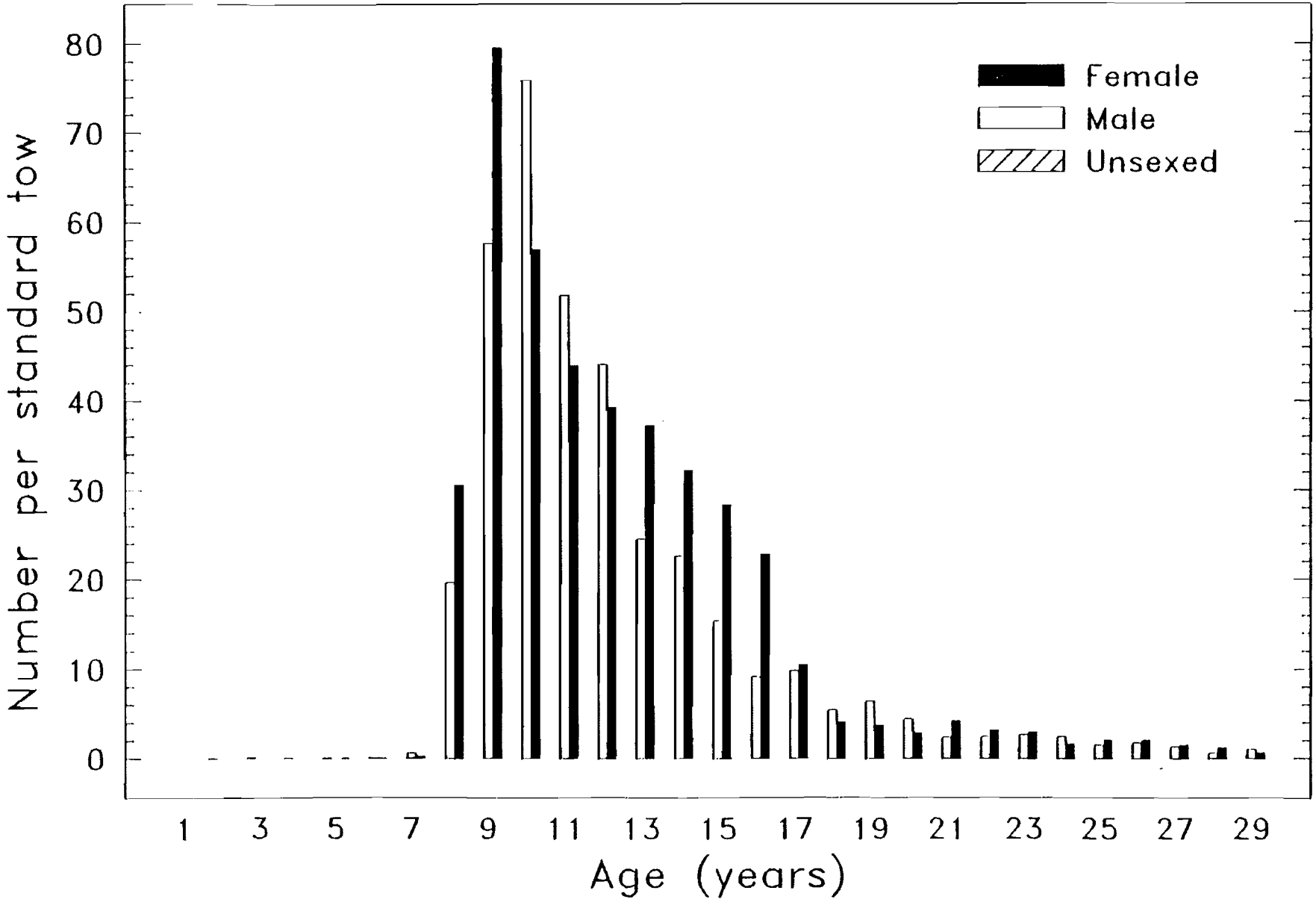

Fig.11: Number of redfish caught at age per standard tow during research cruise to 2J3K, fall, 1983.