Canadian Atlantic Fisheries
Scientific Advisory Committee

CAFSAC
Research Document # 82/31

An Assessment of Redfish in Subarea 2 + Division 3K

by

C. A. Gavaris and D. B. Atkinson
Fisheries Research Branch
Department of Fisheries and Oceans
P. O. Box 5667
St. John's, Newfoundland
A1C 5X1

Abstract

The status of the redfish stock in Subarea 2 and Div. 3K was evaluated using standardized catch rate data, commercial length and age frequencies and research vessel surveys. The catch rate series showed a moderate increase from 1979 to 1981, the data for both 1980 and 1981 being preliminary. The 1981 research vessel survey showed an abundance of 25-29 cm fish which would correspond to the early 1970's year-classes. These year-classes have been in evidence in previous surveys but not as strongly as in 1981. Commercial length frequencies also showed an abundance of 25-29 cm fish. The stock may be increasing, however the data available at present do not permit a firm quantative assessment of the increase. Catches from 1970-81 averaged 24,250 t well below the present TAC of 35,000 t.

Résumé

On a évalué l'état du stock de sébaste de la sous-zone 2 et de la division 3K en utilisant des taux de capture standardisés, des statistiques relatives à la longueur et à l'âge des prises commerciales ainsi que les résultats de recensements effectués à bord de navires de recherche. La série des taux de capture indique qu'il y a eu une augmentation modérée de 1979 à 1981; les données pour les années 1980 et 1981 sont toutefois provisoires. Les recensements effectués à bord des navires de recherche en 1981 révèlent une abondance de poissons de 25 à 29 cm appartenant sans doute aux classes d'âge du début des années 1970. D'autres recensements avaient déjà fait ressortir l'abondance des individus appartenant à ces classes d'âge, mais non de façon aussi marquée qu'en 1981. Les statistiques relatives à la longueur des prises commerciales révèlent également une abondance de poissons de 25 à 29 cm. Il se peut que le stock augmente, mais les données recueillies ne permettent pas encore d'évaluer de façon précise l'importance de cet accroissement. De 1970 à 1981, les prises se sont élevées, en moyenne, à 24 250 t, ce qui est bien inférieur aux PTA actuelles de 35 000 t.

Introduction

Catches of redfish in Subarea 2 + Div. 3K have fluctuated greatly from a high of 187,000 t in 1959 to a low of 14,000 t in 1980. The TAC of 35,000 t was not caught in 1980 or 1981 due to decreased effort.

An increase in the redfish catch taken by Canadian vessels began in 1976 and has continued to 1981. The Canadian catch is largely a redfish directed fishery, defined as fishing trips where 50% or more of the catch is redfish. Prior to 1976 when the fishery was mainly prosecuted by USSR vessels, redfish catches were often reported as by-catch.

Estimation of Parameters

Standardization of catch and effort data

Catch and effort data were available from NAFO for 1959-79, while preliminary data for 1980 and 1981 were obtained for Canadian vessels from the Economics Branch, Fisheries and Oceans. A major difference was found between the final effort statistics reported for 1979 for Canadian Maritime vessels and the preliminary statistics which were available for the 1981 assessment. This resulted in an overall increase in the average yearly catch rate of Maritime otter trawl TC 5 vessels, as shown below:

	1981 Assessment	1982 Assessment
Yearly average Catch rate	0.75 t/hr	1.60 t/hr

As the catch by this vessel type comprised 60% of the directed redfish catch, a substantial revision occurred in the catch rate for 1979.

Catch and effort data were standardized using the multiplicative model developed by Gavaris (1980). As a change in the fleet composition of the fishery occurred in the period 1976-81, as shown in Table 1, the data were analysed in two parts: 1959-76 and 1976-81. The results of the regressions of ln (catch rate), weighted by effort, against categories of vessel type, month, and year are shown in Tables 2a and 3a for the two periods respectively. The abundance indices calculated from the regressions were the relative power of years which appear in Tables 2b and 3b. The combined series is shown in Table 4 and Fig. 1.

Catch at age and weight at age

The catches of redfish in Subarea 2 + Div. 3K in 1981 by Canadian otter trawl vessels by Division and month are given in Table 5. The commercial length frequencies sampled from these landings are listed in Table 6, along with the total number of otoliths read. From these data, the catch at age and weight at age for 1981 were calculated according to the procedure outlined by Gavaris and Gavaris (unpublished)[1] and appear in Table 7. The catch at age for 1976-81 is shown in Table 8. The weight at age for 1976-81 is given in Table 9, the weights in 1980 being calculated as for 1981 while

[1]Paper entitled "Estimation of catch at age and its variance for groundfish stocks in the Newfoundland Region" was presented to the DFO seminar on "Sampling of commercial marine fish and invertebrate catches", Ottawa, February, 1982.

the weights for 1976-79 represent a standard age/weight relationship for redfish.

Research survey indices

Research vessel surveys have been conducted in Div. 2J, 3K in the fall from 1978-81 by the GADUS ATLANTICA. The number of sets in the 200-1000 m depth zone for strata covered in all 4 years, were 108, 89, 84, and 165 respectively. The trends in total numbers and weight and catch per tow in numbers and weights for strata surveyed in all 4 years are shown in Table 10. The age composition of the population as shown by the surveys, including all sets, is given in Table 11. The catch per tow at length for each of Div. 2J, 3K are illustrated in Fig. 5 for comparison with commercial length frequencies.

Results and Discussion

The commercial abundance index (the relative power of years) showed a moderate increase from 1979 to 1981 (Table 4 and Fig. 1). This was in contrast to the series presented in the 1981 assessment (Gavaris 1981) which showed a decline based on erroneous preliminary catch and effort data for 1979. Catches were relatively high in 1979 but low in 1980 and 1981.

Commercial length frequencies sampled from Canadian OT vessels fishing in Div. 2J and 3K in 1981 (Fig. 2-4) showed a broad distribution of lengths. Generally, frequencies from catches at depths less than 300 m showed an abundance of fish in the 25-30 cm range while at greater depths fish to 45 cm were common.

The catch at age for 1981 (Table 7) showed a wide, rather uniform, distribution of ages. Fish aged 9-11 yr accounted for 15% of the total, by number, while fish older than 29 yr (30+), comprised 9%. The catch at age for 1976-81 (Table 8) showed considerable variation in the age composition of the catch from year to year. More young fish were caught in 1979 than in 1980 or 1981.

The research vessel survey results presented in Table 10 were derived from strata in depths of 200-1000 m which were surveyed in all 4 years. The large coefficients of variation illustrate the high variability of the estimates. The abundance indices for 1980 and 1981 were at similar levels, however, the average size of fish was smaller in 1981 than in 1980. An examination of the distribution of the catches in 1981 showed that 42% of the estimated population numbers (35% of the weight) could be attributed to a single set in Div. 2J in which 25-29 cm fish were predominant. A similar situation existed in the 1980 survey where a single set in Div. 3K accounted for 37% of the estimated numbers and 51% of the weight. The extreme skewness of the catches may, therefore, affect both the abundance index and the estimated size structure of the population. The observations based on the surveys which follow should therefore be interpreted with caution.

The length frequency from the research vessel survey in 1981 was dominated by 25-29 cm fish (Fig. 5). Relatively fewer large fish were sampled compared to the commercial fishery. The 25-29 cm length group would represent the early 1970's year-classes. The age distribution from the research vessel

surveys (Table 11) showed 9-11-yr-old fish represented 37% of the population numbers while fish older than 29 yr comprised 2% in 1981. Assuming the research vessel survey results are representative of the population, the fishery in 1981 would appear to have selected the larger and older fish.

Prior to the 1981 survey, the estimates of the population age distribution (Table 11) have shown some evidence of a few relatively strong early 1970's year-classes recruiting to the fishery, more on the basis of the gradual progression of subsequent poor year-classes than on a distinct modality of good ones. This may have two causes: problems with ageing which tend to spread successful year-classes over several neighbouring ones and the high variability of the surveys which may result in a misrepresentation of the population age structure.

Cohort analysis was not pursued due to the few years of data available and the consequent difficulty in determining F_T. This method of analysis may become useful as more years of data are accumulated.

On the basis of moderately increasing catch rates and relatively good recruitment of ages 9-11, the stock may be increasing in abundance. The presence of older fish in the catch suggests the stock has not been over-exploited in the past. Catches from 1970-81 averaged 24,250 t, well below the present TAC of 35,000 t.

References

Gavaris, C. A. 1981. An assessment of redfish in Subarea 2+ Division 3K. CAFSAC Res. Doc. 81/50.

Gavaris, S. 1980. Use of a multiplicative model to estimate catch rate and effort from commercial data. Can. J. Fish. Aquat. Sci. 37: 2272-2275.

Table 1. Nominal catches of Subarea 2 + Division 3K redfish, 1970-81.

Country	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Bulgaria	0	0	0	20	0	0	0	0	0	0	0	0
Canada	63	153	49	374	153	445	3,894	3,498	22,052	26,587	7,752	13,392
Cuba	0	0	0	0	0	0	0	0	0	43	0	0
Faroes	0	0	0	9	0	0	0	0	0	0	0	0
GDR	4,827	2,662	2,400	2,484	2,465	2,447	1,729	1,305	2,909	543	1,014	719
Iceland	0	209	296	0	0	0	2	0	0	0	0	0
Japan	10	48	0	0	0	0	0	4	255	0	0	0
Norway	175	53	4	30	13	0	9	0	0	0	0	0
Poland	5,229	6,184	2,136	4,489	3,646	4,219	3,950	2,269	625	302	874	529
Portugal	0	0	620	2,784	4,820	2,971	823	845	378	544	272	200
Romania	845	168	329	305	0	0	0	312	0	0	0	0
Spain	0	0	3	0	0	26	0	134	37	0	45	0
USSR	10,379	9,785	13,481	24,230	11,898	13,575	14,881	8,014	2,685	2,578	4,029	2,474
Denmark	0	0	0	51	9	0	0	0	0	0	0	0
France	0	0	19	4	48	4	11	110	22	3	0	0
FRG	439	94	470	3,349	6,593	1,837	647	803	157	68	121	0
UK	11	0	226	836	500	35	19	245	26	62	45	0
Others	0	0	0	0	0	0	0	0	0	0	172	0
Total	21,970	19,356	20,033	38,966	30,145	25,559	25,965	17,539	29,146	30,730	14,324	17,314

Table 2a. Results of the regression, weighted by effort, of ln (catch rate) versus vessel type, month, and year categories (Type 1, 2, and 3 respectively) for SA 2 + Div. 3K redfish, 1959-76.

MULTIPLE R,.....0.829
MULTIPLE R SQUARED,....0.687

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	1.911E1	1.911E1	
REGRESSION	24	1.672E1	6.967E-1	9.126
TYPE 1	3	1.032E1	3.438E0	45.035
TYPE 2	9	1.094E1	1.215E0	15.917
TYPE 3	12	4.877E0	4.064E-1	5.323
RESIDUALS	100	7.635E0	7.635E-2	
TOTAL	125	4.347E1		

Table 2b. The nominal catch, catch rate trends, and standardized effort for SA 2 + Div. 3K redfish, 1959-76. Several years are missing due to low levels of directed effort.

YEAR	TOTAL CATCH	PROP.	RELATIVE POWER MEAN	S.E.	EFFORT
1959	186837	0.358	1.000	0.000	186837
1960	129773	0.223	0.590	0.051	219977
1962	19657	0.048	1.168	0.486	16828
1963	23671	0.437	2.108	0.712	11228
1964	56178	0.312	1.957	0.651	28700
1965	42653	0.452	1.984	0.659	21498
1966	32730	0.288	1.418	0.475	23077
1967	26162	0.079	1.341	0.503	19509
1970	21970	0.012	0.919	0.479	23907
1971	19356	0.145	0.842	0.274	22979
1973	38965	0.151	0.948	0.140	41116
1975	25559	0.013	0.864	0.388	29598
1976	25965	0.325	1.225	0.182	21188

AVERAGE C.V. FOR THE MEAN:0.293

Table 3a. Results of the regression, weighted by effort, of ln (catch rate) versus vessel type, month, and year categories (Type 1, 2, and 3 respectively) for SA 2 + Div. 3K redfish, 1976-81. Data for 1980 and 1981 were preliminary.

MULTIPLE R.....0.707
MULTIPLE R SQUARED.....0.500

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	8.525E0	8.525E0	
REGRESSION	17	2.147E1	1.263E0	9.357
TYPE 1	4	4.874E0	1.218E0	9.026
TYPE 2	8	7.378E0	9.223E-1	6.832
TYPE 3	5	5.177E-1	1.035E-1	0.767
RESIDUALS	159	2.146E1	1.350E-1	
TOTAL	177	5.146E1		

Table 3b. The nominal catch, catch rate trends, and standardized effort for SA 2 + Div. 3K redfish, 1976-81. Estimates for 1980 and 1981 are preliminary.

YEAR	TOTAL CATCH	PROP.	RELATIVE POWER MEAN	S.E.	EFFORT
1976	25965	0.393	1.000	0.000	25965
1977	17539	0.425	1.046	0.144	16769
1978	28896	0.698	1.062	0.143	27208
1979	30730	0.764	1.134	0.146	27087
1980	14483	0.280	1.341	0.248	10797
1981	17333	0.677	1.426	0.211	12155

AVERAGE C.V. FOR THE MEAN:0.122

Table 4. Historical catches of redfish in Subarea 2+Div. 3K. The relative powers of the years are listed with associated standard error and effort index.

Year	Total catch	Prop.	Relative power		Effort (hrs)
			Mean	S.E.	
1959	186,837	.358	1.00		186,837
1960	129,773	.223	0.590	0.051	219,977
1961	55,455				
1962	19,657	.048	1.168	0.486	16,828
1963	23,671	.437	2.108	0.712	11,228
1964	56,178	.312	1.957	0.651	28,700
1965	42,653	.452	1.984	0.659	21,498
1966	32,730	.288	1.418	0.475	23,077
1967	26,162	.079	1.341	0.503	19,509
1968	18,913				
1969	24,786				
1970	21,970	.012	0.919	0.479	23,907
1971	19,356	.145	0.842	0.274	22,979
1972	20,033				
1973	38,965	.151	0.948	0.140	41,116
1974	30,145				
1975	25,559	.013	0.864	0.388	29,598
1976	25,965	.393	1.225	0.182	21,188
1977	17,539	.425	1.281	0.176	13,692
1978	28,896	.698	1.301	0.175	22,211
1979	30,730	.764	1.389	0.179	22,124
1980	14,483	.280	1.643	0.304	8,815
1981	17,333	.677	1.747	0.257	9,922

Table 5. Catches of redfish in Subarea 2 + Div. 3K in 1981 by Canadian OT vessels by division and month.

Month	Divisions 2G CanM	2H CanM	2J CanM	2J CanN	3K CanM	3K CanN
January			11	52		108
February			18	47	24	313
March						499
April					14	1,068
May					7	520
June		2	18	11	343	2,573
July	10	18	1,003	374	253	2,686
August		12	1,321	562	62	867
September						91
October						6
November						23
December						56
Div. Totals (all gears)	10	32		3422		9947

Table 6. Number of commercial length frequency samples for Subarea 2 + Div. 3K redfish in 1981 by month and Division from Canadian (Maritimes and Newfoundland) OT vessels. The number of otoliths read is also listed.

Month	Division	
	2J	3K
January	4	1
February	1	
March		5
April		3
May		2
June		5
July	2	5
August	2	
September		
October		
November		1
December		

Otoliths read: Female - 789
Male - 590

Table 7. The average weight at age (kg) and catch at age (no. X 10^{-3}) and its variance for SA 2 + Div. 3K redfish, 1981.

AGE	WEIGHT	CATCH	VAR(CATCH)	STD.ERROR	COEF.VAR
5	0.050	8	0.007	0.08	0.01
6	0.088	43	169.449	13.02	0.30
7	0.115	195	1065.250	32.64	0.17
8	0.158	596	6551.254	80.94	0.14
9	0.198	1372	24545.535	156.67	0.11
10	0.220	1785	33148.622	182.07	0.10
11	0.241	1507	31182.655	176.59	0.12
12	0.277	1028	22275.665	149.25	0.15
13	0.317	1323	27294.071	165.21	0.12
14	0.352	1383	34446.251	185.60	0.13
15	0.397	2098	50717.554	225.21	0.11
16	0.445	1852	49196.859	221.80	0.12
17	0.493	2259	58858.632	242.61	0.11
18	0.544	1884	53677.552	231.68	0.12
19	0.593	1443	39704.219	199.26	0.14
20	0.629	1284	38284.395	195.66	0.15
21	0.703	1000	30182.578	173.73	0.17
22	0.733	982	28915.970	170.05	0.17
23	0.757	1073	30213.801	173.82	0.16
24	0.808	985	27250.159	165.08	0.17
25	0.822	813	23625.089	153.70	0.19
26	0.843	886	24029.807	155.02	0.17
27	0.933	530	12905.039	113.60	0.21
28	0.918	735	15828.736	125.81	0.17
29	0.891	569	15014.374	122.53	0.22
30	1.320	2873	34430.977	185.56	0.06

Table 8. The catch at age (no. X 10^{-3}) for SA 2 + Div. 3K redfish, 1976-81.

AGE	1976	1977	1978	1979	1980	1981
6	7	22	4	240	28	43
7	30	102	400	2159	297	195
8	136	219	1241	5678	1647	596
9	1265	612	3297	8798	983	1372
10	2067	843	4071	9251	857	1785
11	3866	1569	4495	6700	828	1507
12	5580	1930	5806	4011	1017	1028
13	7818	2241	6207	7374	1528	1323
14	8652	3315	6267	6646	1864	1383
15	5615	3162	5265	6571	2022	2098
16	2700	2776	5331	6075	1704	1852
17	1826	2504	3969	5544	1729	2259
18	946	1812	2250	1796	1018	1884
19	757	1778	1488	1241	782	1443
20	1128	1638	1495	1391	1044	1284
21	968	895	1084	1412	660	1000
22	885	940	950	789	525	982
23	1100	555	591	573	496	1073
24	1005	618	883	599	738	985
25	684	598	828	930	514	813
26	678	514	746	569	517	886
27	512	435	509	590	498	530
28	632	418	535	589	384	735
29	284	200	139	283	409	569

Table 9. The weight at age (kg) for SA 2 + Div. 3K redfish was derived from the "standard" redfish age/ weight relationship for 1976-79 while those for 1980-81 were calculated using commercial sampling data.

AGE	1976	1977	1978	1979	1980	1981
6	0.103	0.103	0.103	0.103	0.110	0.088
7	0.135	0.135	0.135	0.135	0.170	0.115
8	0.169	0.169	0.169	0.169	0.184	0.158
9	0.205	0.205	0.205	0.205	0.217	0.198
10	0.243	0.243	0.243	0.243	0.240	0.220
11	0.282	0.282	0.282	0.282	0.279	0.241
12	0.322	0.322	0.322	0.322	0.287	0.277
13	0.362	0.362	0.362	0.362	0.314	0.317
14	0.403	0.403	0.403	0.403	0.361	0.352
15	0.443	0.443	0.443	0.443	0.418	0.397
16	0.482	0.482	0.482	0.482	0.463	0.445
17	0.521	0.521	0.521	0.521	0.534	0.493
18	0.559	0.559	0.559	0.559	0.566	0.544
19	0.596	0.596	0.596	0.596	0.596	0.593
20	0.631	0.631	0.631	0.631	0.674	0.629
21	0.665	0.665	0.665	0.665	0.651	0.703
22	0.698	0.698	0.698	0.698	0.747	0.733
23	0.730	0.730	0.730	0.730	0.788	0.757
24	0.759	0.759	0.759	0.759	0.754	0.808
25	0.788	0.788	0.788	0.788	0.769	0.822
26	0.815	0.815	0.815	0.815	0.946	0.843
27	0.841	0.841	0.841	0.841	0.931	0.933
28	0.866	0.866	0.866	0.866	0.922	0.918
29	0.889	0.889	0.889	0.889	0.999	0.891

Table 10. Estimates of total abundance and mean catch per tow, in numbers and weights, from research surveys in Divisions 2J-3K, 1978-81. The coefficients of variation of the estimates appear in brackets.

Year	Total abundance: Numbers X 10^{-3}	Total abundance: Weight (kg) X 10^{-3}	Mean weight (kg)
1978	2,148,272 (62)	648,792 (43)	0.30
1979	638,600 (222)	284,884 (228)	0.45
1980	988,860 (250)	509,912 (327)	0.52
1981	1,184,426 (56)	477,711 (49)	0.40

	Mean catch per tow: Number	Mean catch per tow: Weights (kg)
1978	735.73	222.20
1979	219.72	98.02
1980	332.25	171.33
1981	397.95	160.51

Table 11. Abundance at age (nos X 10^{-3}) of redfish in Div. 2J, 3K from research vessel surveys, 1978-81. The 30+ age category included fish older than 29 yr.

AGE	1978	1979	1980	1981
1	1844	28	0	0
2	6962	231	108	22
3	22230	1380	1003	40
4	40073	9235	679	507
5	103961	17299	7149	299
6	88083	28339	19475	5322
7	81465	37140	46813	27505
8	181965	48701	66260	43556
9	289594	73479	87098	160142
10	224923	50775	50564	173119
11	232678	43011	67318	109467
12	110416	41985	68180	117306
13	138400	62204	74392	101752
14	99762	47006	49179	54756
15	104211	29645	61714	61877
16	78728	20047	87243	93834
17	39526	25754	46176	63701
18	22295	15743	58174	46282
19	26230	15001	29501	42004
20	38878	5373	39792	17005
21	37440	7294	13405	14821
22	19517	6133	14590	10833
23	18292	3551	14297	8702
24	14806	4361	12659	5787
25	30708	5348	3286	4662
26	21951	5456	7281	6218
27	11399	5681	8163	6414
28	13770	3944	8720	6106
29	5752	3432	1800	4168
30+	41757	21156	43908	21011

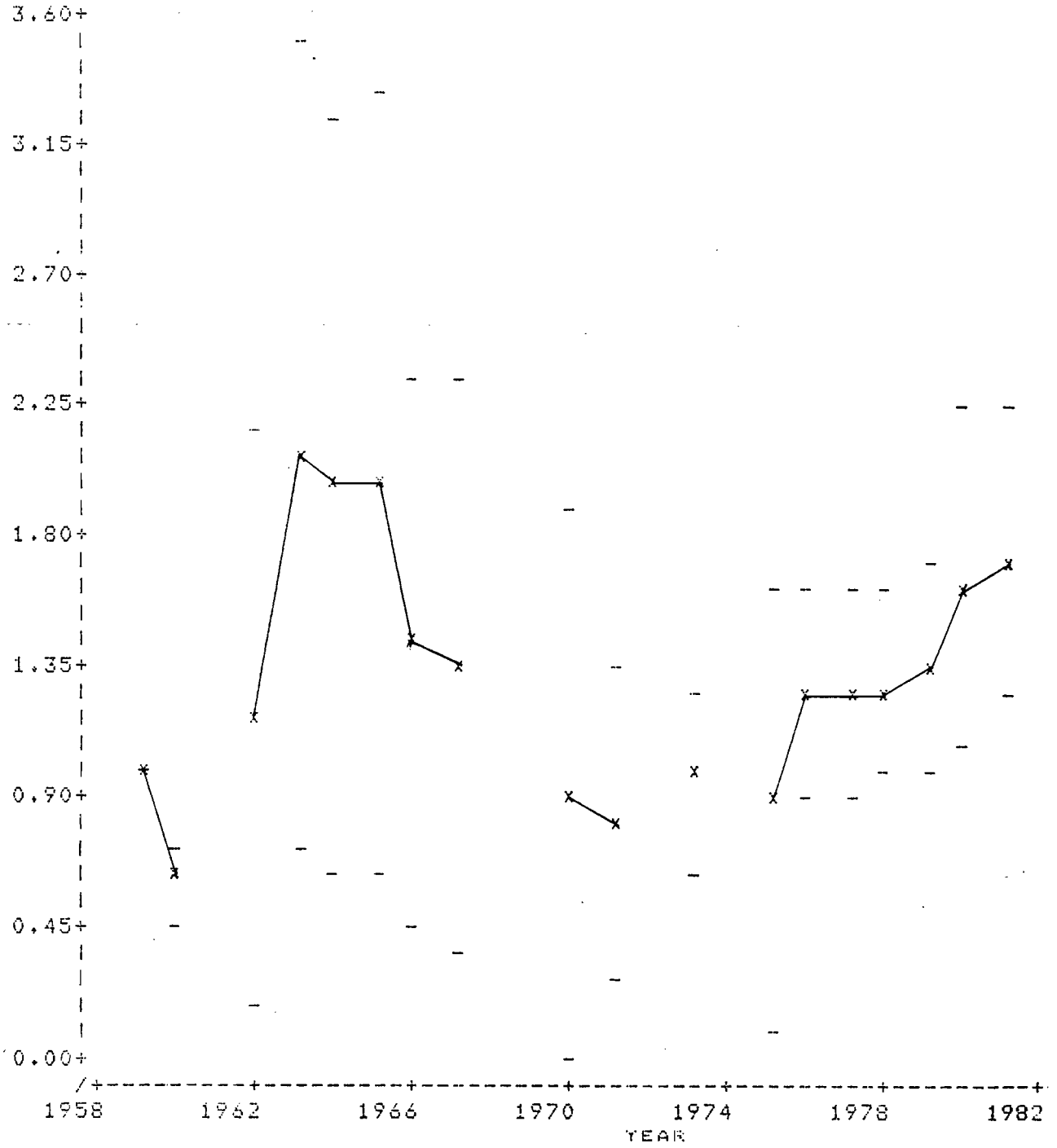

Fig. 1. The trend in relative power of years from 1959 to 1981 (with 95% C.I.) for SA 2 + Div. 3K redfish. Estimates for 1980-81 were preliminary based on Canadian (M and N) vessels only. Estimates for several years were missing due to low levels of directed effort.

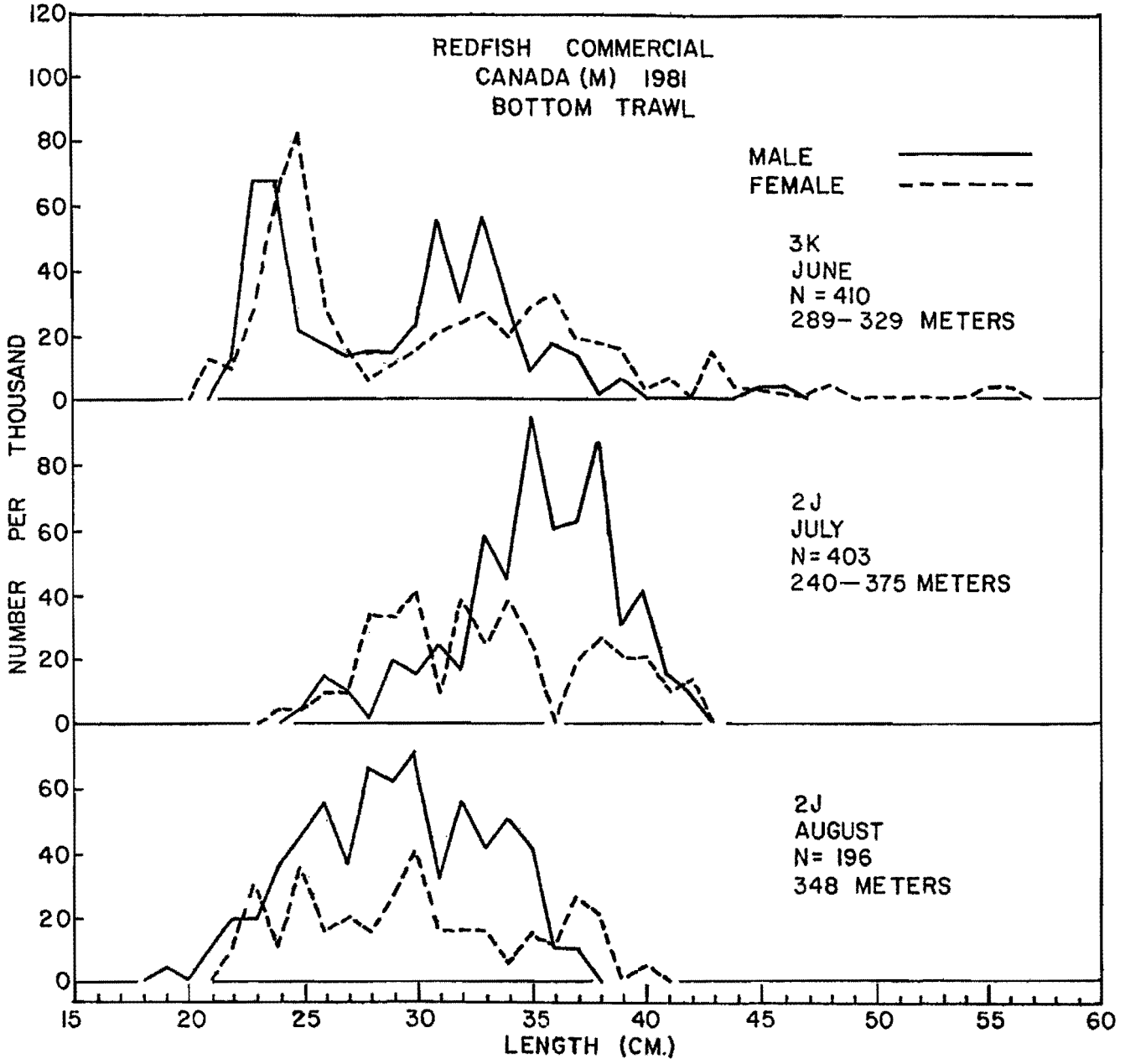

Fig. 2. Commercial length frequencies (no. per mille) for Div. 2J and 3K redfish from Canada (N) bottom trawl vessels in 1981.

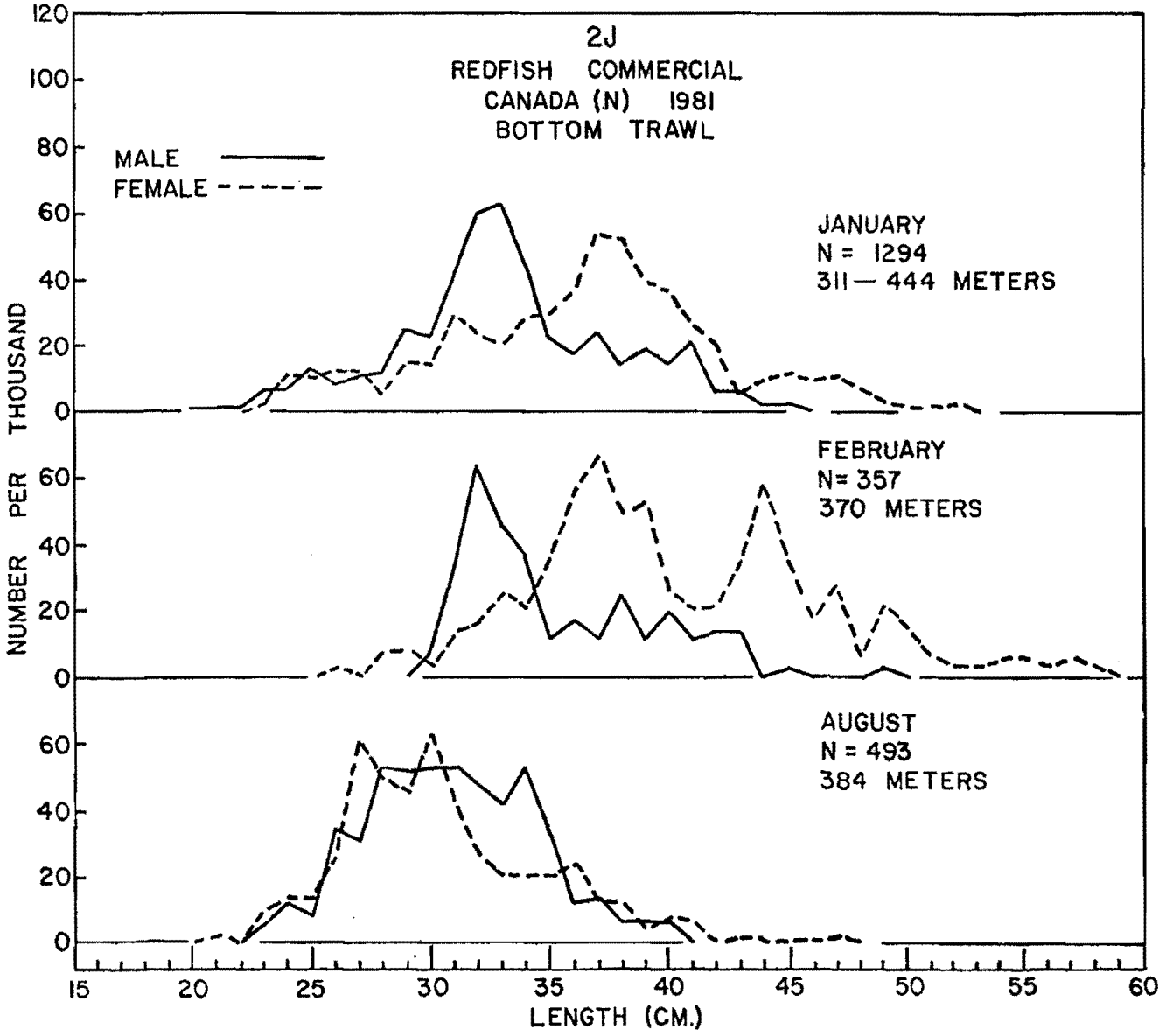

Fig. 3. Commercial length frequencies (no. per mille) for Div. 2J redfish from Canada (N) bottom trawl vessels in 1981.

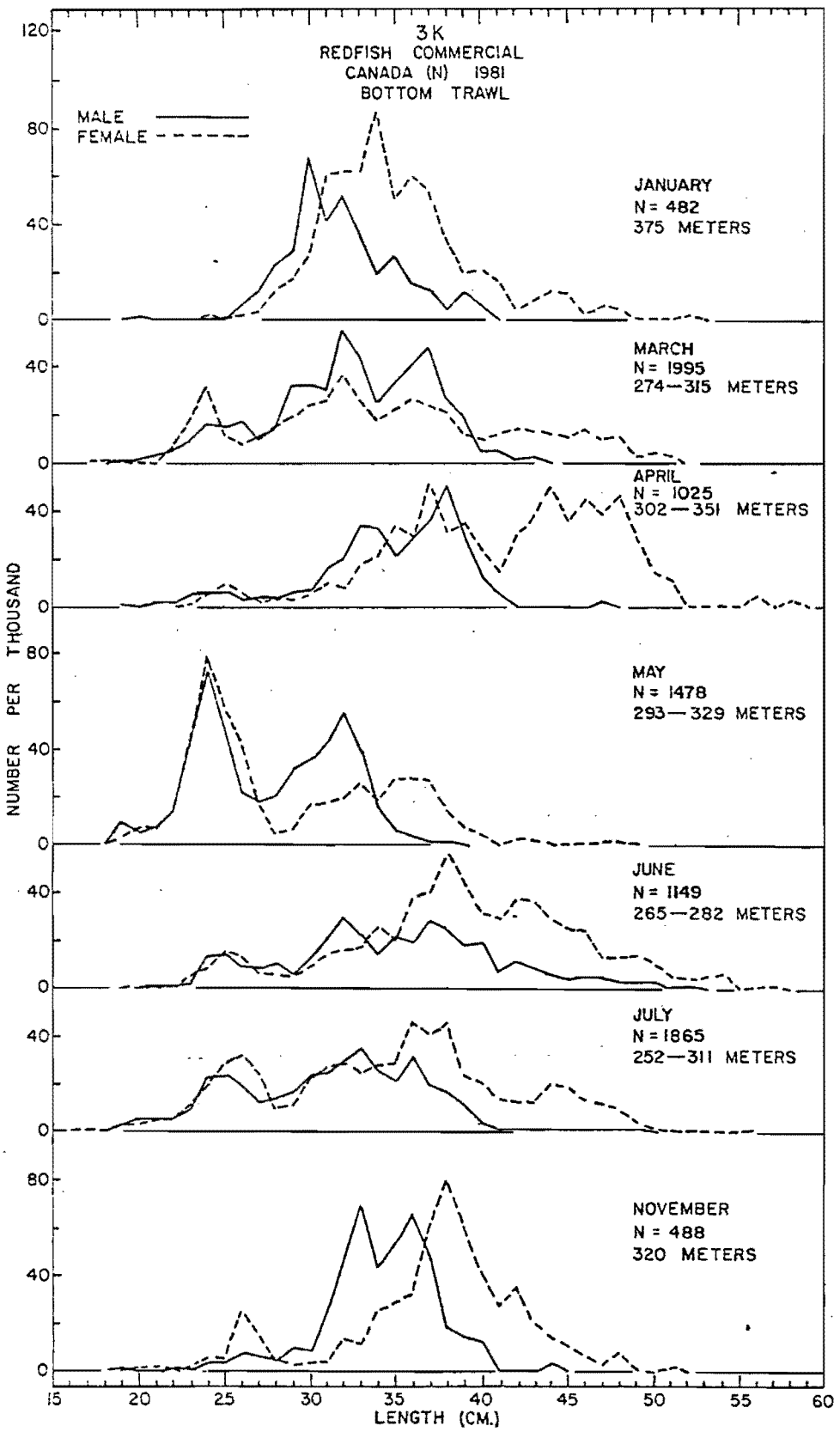

Fig. 4. Commercial length frequencies (no. per mille) for Div. 3K redfish from Canada (N) bottom trawl vessels in 1981.

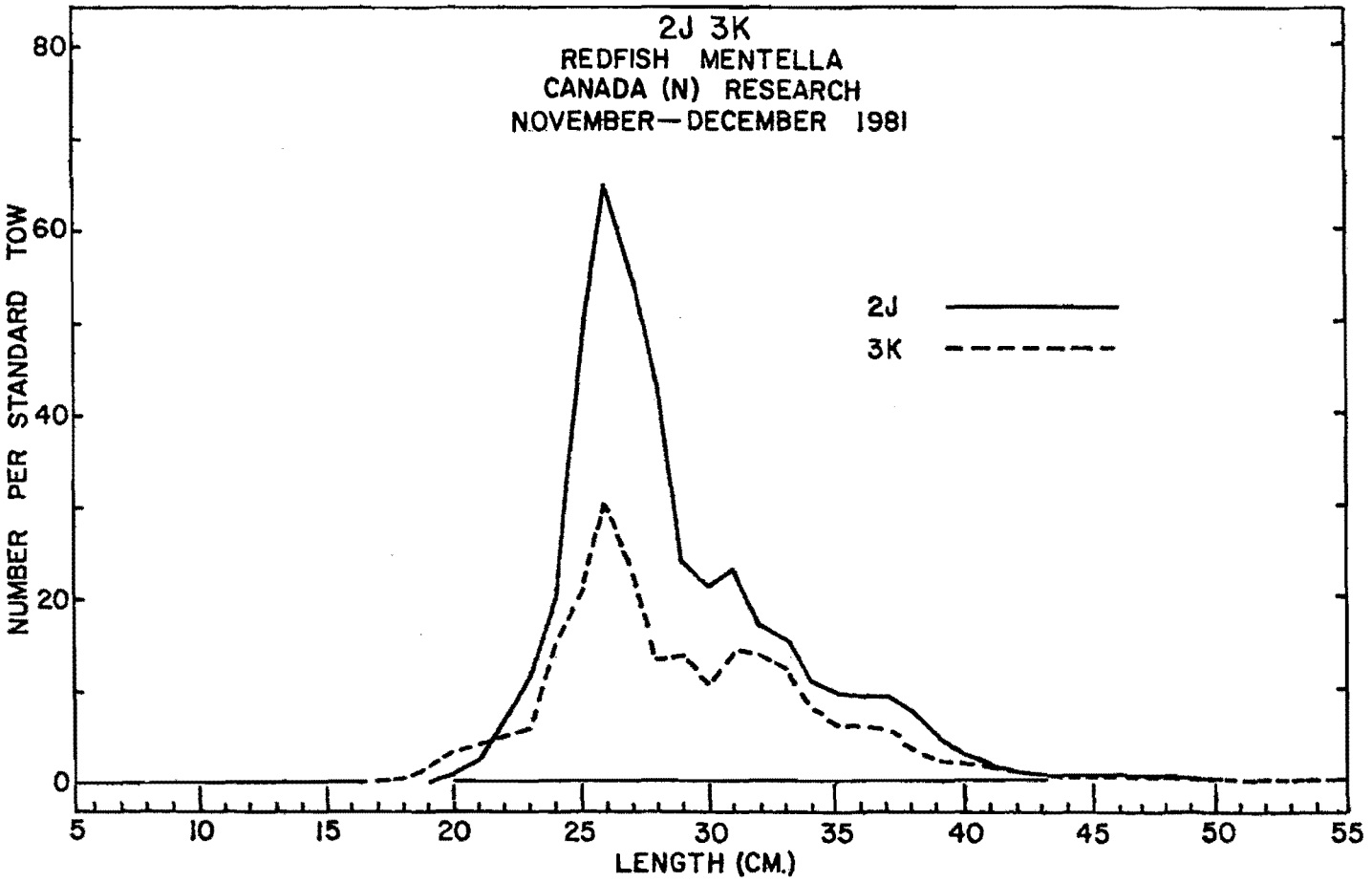

Fig. 5. Abundance at length (nos. per standard tow) of male and female redfish from Div. 2J and 3K from the 1981 research vessel survey to the area.