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The Redfish of NAFO Subarea 2 and Division 3K

by

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Abstract

Catch rates have increased in recent years, and the 1984 level is the highest ever recorded for this stock. These high rates are attributed to recruitment to the fishery of the relatively strong year classes of the early to mid 1970's. Research survey data indicate that there has been poor subsequent recruitment so that catch rates are expected to decrease somewhat in the future. The TAC's have not been taken since 1979 due to decreased effort in the area. SPA was attempted but the short time series and low effort resulting in low F's made tuning impossible. The results from general production analyses were variable with the yield at 2/3 effort MSY ranging between 26,000 and 37,000 t.

Résumé

La quantité des prises pour ce stock a augmenté au cours des dernières années pour atteindre son maximum en 1984. Ces prises élevées sont attribuables au recrutement de pêcheurs parmi les classes relativement nombreuses de la première moitié des années 70. Les résultats des enquêtes indiquent un plus faible recrutement ultérieur qui laisse supposer une baisse des prises dans l'avenir. Vu que l'effort a diminué dans ce domaine, le total des prises admissibles n'a pas été relevé depuis 1979. On a essayé d'établir l'ASP, mais la courte série chronologique et le faible effort qui a donné lieu à de faibles F (taux instantané de mortalité par pêche) ont empêché l'ajustement. Les résultats des analyses générales de la production étaient variables avec un rendement à 2/3 de l'effort de RMS, variant entre 26 000 et 37 000 t.

Introduction

In 1959 and 1960, catches of redfish from 2+3K were over 100,000 t, but have fluctuated between 15,000 and 55,000 t since then (Fig. 1). The present TAC of 35,000 t was set based on an equilibrium general production model (Gavaris MS 1979) but has not been achieved in recent years because of low effort. Attempts at analytical assessments of this stock have not been successful to date due to the relatively short time series of data available coupled with the low effort and consequent low F's.

Methods and Results

Since 1977, Canadian landings have accounted for the major portion of the catch of the stock (Table 1). This corresponds to the period of Canada's extended jurisdiction. The USSR accounts for the next highest landings by country.

While catches in 2G and 2H are usually taken in the second half of the year (due to ice cover) (Table 2a), they are spread out more evenly throughout the year in both 2J and 3K (Tables 2b and 2c). Over the history of the fishery, catches have generally been greatest in 3K (Table 3). The catch in 1984 was up compared to those of 1980-1983.

As in past assessments, catch and effort data from catches where redfish comprised >50% of the total were used in the multiplicative model (Gavaris 1980). Some modifications were made to these data before and during analysis however. The country-gear-TC combinations incorporated in the model were modified so that it is no longer necessary to split the data into two separate analyses as in the past. The corrected Maritimes data were included in the analysis this year. All catch and effort levels <10 were deleted from the data set before analysis. The data were weighted step-wise by effort within the model.

The results (Table 4) indicate that the regression is significant. Type 1 represents country-gear-TC combinations while type 2 represents month groupings. Effort has been dropping since 1979 (Table 5, Fig. 2) while catch rates have shown an increase (Table 5, Fig. 3). The 1984 point is the highest on record although it must be remembered that the data are preliminary and only include records from Canada.

A general production model run in 1979 (Gavaris MS 1979) indicated a yield at 2/3 effort MSY of 35,000 t. Because 6 years have past since this analysis and because of the present modifications to the data used in the multiplicative model, another general production analysis was carried out for this assessment. Runs were made with the effort data unlagged and lagged 6, 8 and 10 years (Gulland 1961). The regressions of CPUE on effort were all significant. The results are:

LAG	MSY	$EFFORT_{msy}$	2/3 $EFFORT_{msy}$	YIELD 2/3 $EFFORT_{msy}$
nil	37,594	54,167	36,111	33,417
6	28,750	23,670	15,780	25,555
8	32,799	20,166	13,444	29,155
10	41,832	18,264	12,176	37,184

Figures 4 and 5 show the results with a lag of 10 years, while the regression using unlagged data is shown in Fig. 6.

The commercial length frequencies available from the 1984 fishery (Fig. 7-12) were combined (Fig. 13) to derive the estimated numbers caught at age (Gavaris and Gavaris 1983) (Table 6).

Weights at age were determined using the relationships:

$$WT(males)=0.01659FL^{2.9548}$$

$$WT(females)=0.01372FL^{3.0210}$$

The catch and weight at age matricies available for this stock are shown in Tables 7 and 8.

SPA was again attempted this year. Runs were done at F_t's from 0.025 to 0.100 at 0.025 intervals. No regression of exploitable biomass (fully recruited at ages 15+) on CPUE was significant (95%). Regressions of 6+, 10+ and 15+ mid-year biomass on CPUE resulted in only one that was significant with a positive slope (Fig. 14). The 1984 point makes this regression. Regressions of 6+, 10+ and 15+ weighted F on effort were significant for all values of F_t but the difficulty with these is that they are all essentially '2-point' regressions (Fig. 15). Based upon these, it was concluded that once again the SPA could not be tuned satisfactorily because of the short time series and low recent effort.

The survey results (Table 9) indicate a drop (about 50%) in the numbers and weight per tow from 1983 to 1984. With the known difficulties in using trawl survey results as indicators of redfish abundance, this drop is not a cause for alarm at this time. The numbers caught at age (Fig. 16) show that the year classes of the early to mid 1970's are still well represented but there has been only poor recruitment since that time.

Conclusions

The catch rate series shows an increase from 1979 to the present with the preliminary 1984 estimate being the highest on record. This increase is believed to be due to the growth and recruitment to the fishery of the relatively strong year classes of the early to mid 1970's and the 1984 survey results indicate that these year classes are still well represented in the population. The drop in the numbers and weights per tow between the 1983 and 1984 surveys is not a cause for concern at this time although the situation will be monitored closely in the future.

SPA again could not be tuned due to the short time series and low annual effort in recent times. The general production model results, although variable depending on the lag period used, do not differ greatly from the results obtained in previous assessments.

Based on these, there does not appear to be any evidence to indicate a change in the TAC in 1986 from the present level of 35,000 t. The apparent poor recruitment since the mid 1970's will result in a drop in the catch rates as the relatively strong year classes currently contributing to the fishery pass through it.

References

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Table 1. Nominal catches of Subarea 2 + Division 3K redfish, 1972-84.

Country	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983[a]	1984[a]
Bulgaria	20	0	0	0	0	0	0	0	0	0	0	0
Canada	374	153	445	3,894	3,498	22,052	26,587	7,785	13,416	11,134	9,297	17,368
Cuba	0	0	0	0	0	0	43	0	0	0	0	0
Faroes	9	0	0	0	0	0	0	0	0	0	0	0
GDR	2,484	2,465	2,447	1,729	1,305	2,909	543	1,102	720	425	626	485
Iceland	0	0	0	2	0	0	0	0	0	0	0	0
Japan	0	0	0	0	4	255	0	9	4	2,662	0	1,214
Norway	30	13	0	9	0	0	0	1	0	0	0	0
Poland	4,489	3,646	4,219	3,950	2,269	625	302	870	635	24	1,406	367
Portugal	2,784	4,820	2,971	823	845	378	544	266	393	456	183	0
Romania	305	0	0	0	312	0	0	0	0	0	0	0
Spain	0	0	26	0	134	37	0	44	0	0	0	0
USSR	24,230	11,898	13,575	14,881	8,014	2,685	2,578	4,208	2,474	3,073	3,722	3,684
Denmark	51	9	0	0	0	0	0	0	0	0		0
France	4	48	4	11	110	22	3	7	0	9	0	0
FRG	3,349	6,593	1,837	647	803	157	68	148	0	180	77	0
UK	836	500	35	19	245	26	62	79	0	20	0	0
Others	0	0	0	0	0	0	0	0	0	0	0	114
Total	38,965	30,145	25,559	25,965	17,539	29,146	30,730	14,519	17,642	17,983	15,311	23,232

[a]Provisional.

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

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
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
1983[a]							37		22	7	87	5	158

[a]Provisional.

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

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	NK	Total
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	27	294	191	63	197	410	1,134	2,395	2,188	123	14	12	-	7,048
1983	37	225	96	93	-	34	403	269	41	18	250	700		2,166

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

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	NK	Total
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	73	136	112	576	1,187	370	1,010	2,031	424	634	2,214	1,585		10,352
1983	447	1,073	2,558	1,354	972	751	627	3,772	532	548	40	313		12,987

[a]Provisional.

Table 3. Historical catches (t) of redfish in Divisions 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	7,048	10,352	17,983
1983[b]	-	158	2,166	12,987	15,311
1984[b]	-	-	-	-	23,232

[a]Totals include unallocated catch in Subarea 2.

[b]Provisional.

Table 4: Regression of multiplicative model for redfish in 2+3K.

multiple r.....0.560
multiple r squared.....0.314

analysis of variance

source of variation	df	sums of squares	mean squares	f_value
intercept	1	1.711e1	1.711e1	
regression	27	5.460e1	2.022e0	8.320
type 1	1	2.161e1	2.161e1	88.910
type 2	1	6.550e0	6.550e0	26.952
type 3	25	3.163e1	1.265e0	5.206
residuals	491	1.193e2	2.430e-1	
total	519	1.910e2		

Table 5: Predicted catch rate for redfish in 2+3K, 1959-1984

year	total catch	catch rate mean	s.e.	effort
1959	186837	1.027	0.107	181957
1960	129773	0.658	0.085	197346
1961	55455	0.960	0.191	57770
1962	19657	0.775	0.153	25369
1963	23644	1.349	0.156	17530
1964	50154	1.417	0.152	35390
1965	40425	1.274	0.143	31742
1966	32730	1.081	0.159	30285
1967	26162	1.034	0.091	25310
1968	18881	0.841	0.115	22449
1969	19883	0.587	0.101	33870
1970	16970	0.723	0.164	23469
1971	19306	0.921	0.145	20961
1972	20033	0.990	0.154	20231
1973	38965	0.671	0.105	58071
1974	30145	1.371	0.237	21993
1975	25559	0.582	0.132	43948
1976	25965	0.877	0.097	29602
1977	17539	0.976	0.092	17978
1978	29146	1.010	0.076	28851
1979	30730	0.988	0.075	31106
1980	14519	0.840	0.080	17292
1981	17642	0.938	0.084	18814
1982	17983	1.210	0.105	14859
1983	15311	1.529	0.164	10011
1984	23232	2.067	0.235	11239

Table 6: Estimated numbers of redfish caught at age during the fishery in 2+3K, 1984.

	average		catch		
age	weight	length	mean	std. err.	c. v.
* 5	0.032	13.000	1		
6	0.100	18.960	2	1.63	0.80
* 7	0.118	20.022	14	5.44	0.38
8	0.170	22.636	59	22.47	0.38
* 9	0.201	23.964	1038	138.25	0.13
10	0.228	25.005	3064	271.70	0.09
11	0.246	25.668	3641	327.24	0.09
12	0.273	26.526	3905	366.85	0.09
13	0.305	27.507	4918	417.85	0.08
14	0.353	28.834	4502	408.48	0.09
15	0.373	29.403	4386	397.04	0.09
16	0.403	30.149	3925	367.66	0.09
17	0.443	31.184	2615	279.84	0.11
18	0.477	31.924	2648	269.58	0.10
19	0.508	32.655	1660	198.48	0.12
20	0.568	33.840	1815	191.26	0.11
21	0.633	34.995	1639	176.71	0.11
22	0.678	35.756	1339	156.92	0.12
23	0.699	36.190	1024	134.00	0.13
24	0.741	36.837	1160	140.62	0.12
25	0.765	37.244	938	122.12	0.13
26	0.830	38.296	936	117.40	0.13
27	0.827	38.268	743	102.66	0.14
28	0.860	38.786	790	97.94	0.12
*29	0.873	39.080	639	80.89	0.13
*30	1.132	42.247	2715	105.53	0.04

* For the ages flagged by * there was an age length key with only one age determination for some length. Since the variance formula has n-1 in the denominator, it cannot be evaluated for this length. Consequently this variance component is not included in the variance for the flagged ages. This is generally not a serious problem since it occurs when few fish are caught at that length.

Table 7: Catch-at-age matrix for redfish from 2+3K, 1976-1984.

catch at age

age	1976	1977	1978	1979	1980	1981	1982	1983	1984
6	7	22	4	240	28	44	1	1	2
7	30	102	400	2159	301	199	224	13	14
8	136	219	1241	5678	1669	607	998	351	59
9	1265	612	3297	8798	996	1398	2252	955	1038
10	2067	843	4071	9251	869	1819	3678	1155	3064
11	3866	1569	4495	6700	839	1536	3920	1271	3641
12	5580	1930	5806	4011	1031	1047	3967	2051	3905
13	7818	2241	6207	7374	1549	1348	4122	2090	4918
14	8652	3315	6267	6646	1889	1409	3479	2352	4502
15	8615	3162	5265	6571	2050	2138	3765	1855	4386
16	2700	2776	5331	6075	1727	1887	3135	1624	3925
17	1826	2504	3969	5544	1753	2302	3052	1641	2615
18	946	1812	2250	1796	1032	1920	2049	1398	2648
19	757	1778	1488	1241	793	1470	1537	1206	1660
20	1128	1638	1495	1391	1058	1308	1044	912	1815
21	968	895	1084	1412	669	1019	1060	956	1639
22	885	940	950	789	532	1001	627	710	1339
23	1100	555	591	573	503	1093	498	613	1024
24	1005	618	883	599	748	1004	517	823	1160
25	684	598	828	930	521	828	324	771	938
26	678	514	746	569	524	903	369	560	936
27	512	435	509	590	505	540	341	597	743
28	632	418	535	589	389	749	256	565	790
29	284	200	139	283	415	580	226	492	639

Table 8: Average weight at age of redfish caught in 2+3K, 1976-1984.

average weight at age

age	1976	1977	1978	1979	1980	1981	1982	1983	1984
6	0.10	0.10	0.10	0.10	0.11	0.09	0.10	0.10	0.10
7	0.14	0.14	0.14	0.14	0.17	0.11	0.14	0.14	0.12
8	0.17	0.17	0.17	0.17	0.18	0.16	0.17	0.16	0.17
9	0.20	0.20	0.20	0.20	0.22	0.20	0.21	0.19	0.20
10	0.24	0.24	0.24	0.24	0.24	0.22	0.25	0.22	0.23
11	0.28	0.28	0.28	0.28	0.28	0.24	0.27	0.25	0.25
12	0.32	0.32	0.32	0.32	0.29	0.28	0.30	0.28	0.27
13	0.36	0.36	0.36	0.36	0.31	0.32	0.33	0.30	0.31
14	0.40	0.40	0.40	0.40	0.36	0.35	0.36	0.33	0.35
15	0.44	0.44	0.44	0.44	0.42	0.40	0.41	0.37	0.37
16	0.48	0.48	0.48	0.48	0.46	0.44	0.45	0.41	0.40
17	0.52	0.52	0.52	0.52	0.53	0.49	0.49	0.48	0.44
18	0.56	0.56	0.56	0.56	0.57	0.54	0.56	0.52	0.48
19	0.60	0.60	0.60	0.60	0.60	0.59	0.60	0.57	0.51
20	0.63	0.63	0.63	0.63	0.67	0.63	0.65	0.60	0.57
21	0.67	0.67	0.67	0.67	0.65	0.70	0.69	0.64	0.63
22	0.70	0.70	0.70	0.70	0.75	0.73	0.71	0.67	0.68
23	0.73	0.73	0.73	0.73	0.79	0.76	0.80	0.72	0.70
24	0.76	0.76	0.76	0.76	0.75	0.81	0.79	0.74	0.74
25	0.79	0.79	0.79	0.79	0.77	0.82	0.85	0.80	0.77
26	0.81	0.81	0.81	0.81	0.95	0.84	0.86	0.80	0.83
27	0.84	0.84	0.84	0.84	0.93	0.93	0.87	0.83	0.83
28	0.87	0.87	0.87	0.87	0.92	0.92	0.88	0.82	0.86
29	0.89	0.89	0.89	0.89	1.00	0.89	0.90	0.90	0.87

Table 9. Numbers and weights of redfish caught, per standard tow and total estimated biomass, from Canadian research cruises in Division 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)
1984	201	113.7 (.20)	47.0 (.21)	139,381 (.21)

[a]Excluding two large catches.

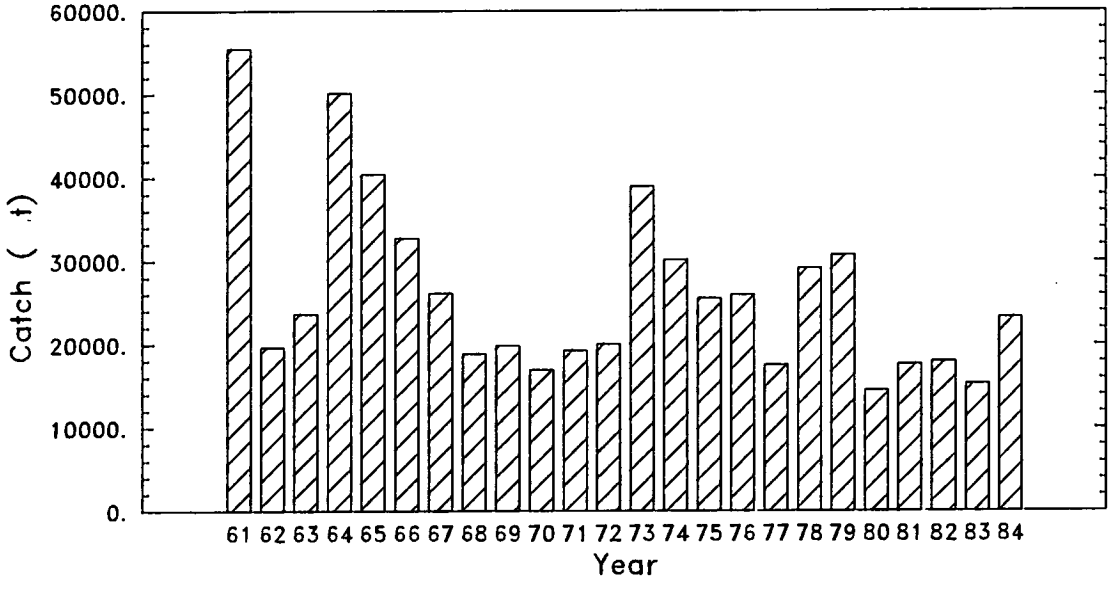

Fig.1: Nominal catches of redfish from 2+3K, 1961–1984.
(1983 and 1984 Provisional)

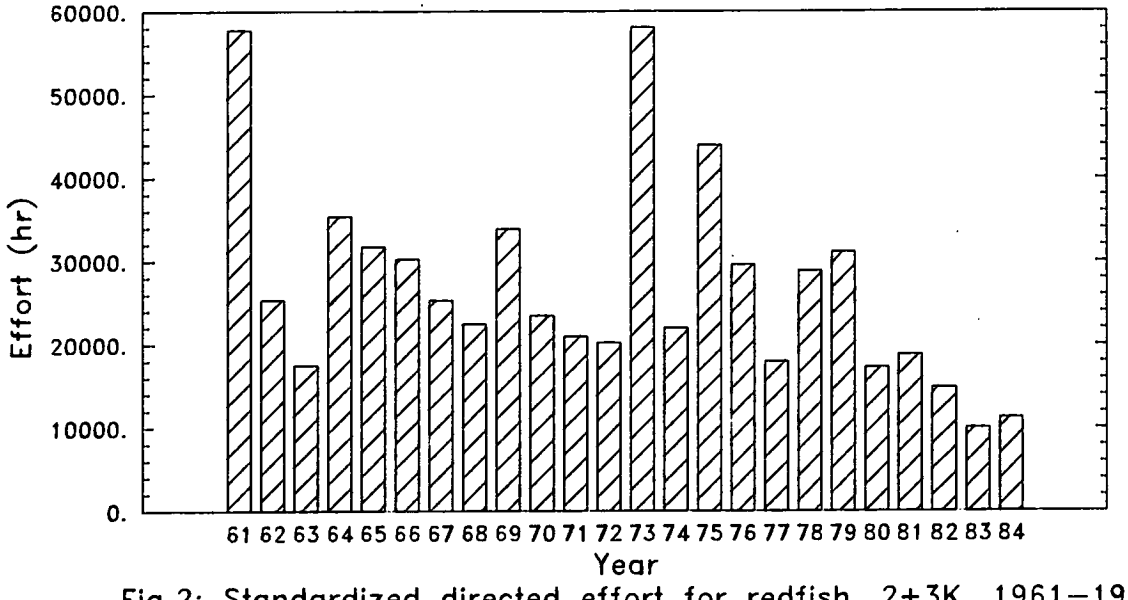

Fig.2: Standardized directed effort for redfish, 2+3K, 1961–1984.
(1983 and 1984 Provisional)

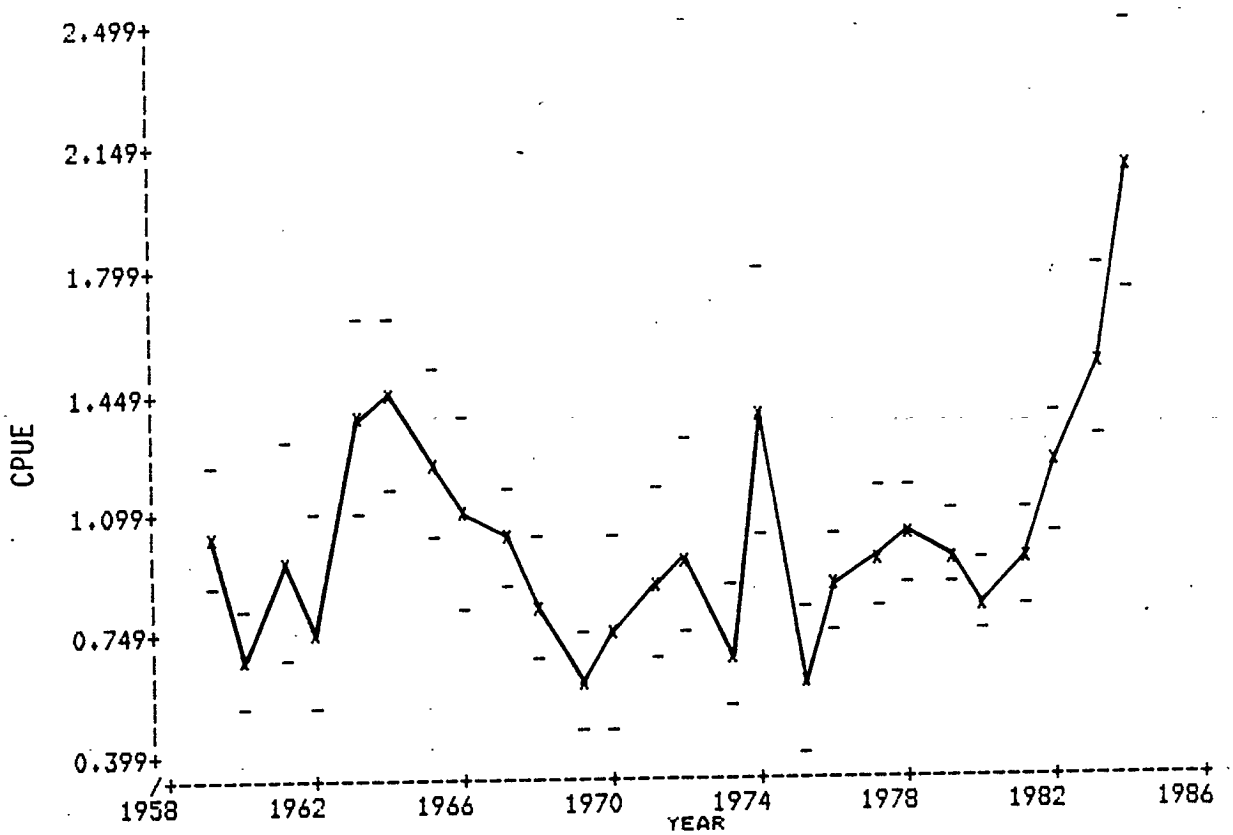

Fig. 3: Standardized CPUE (t/hr) for redfish in 2+3K, 1959-1984.
(1983 and 1984 Provisional)

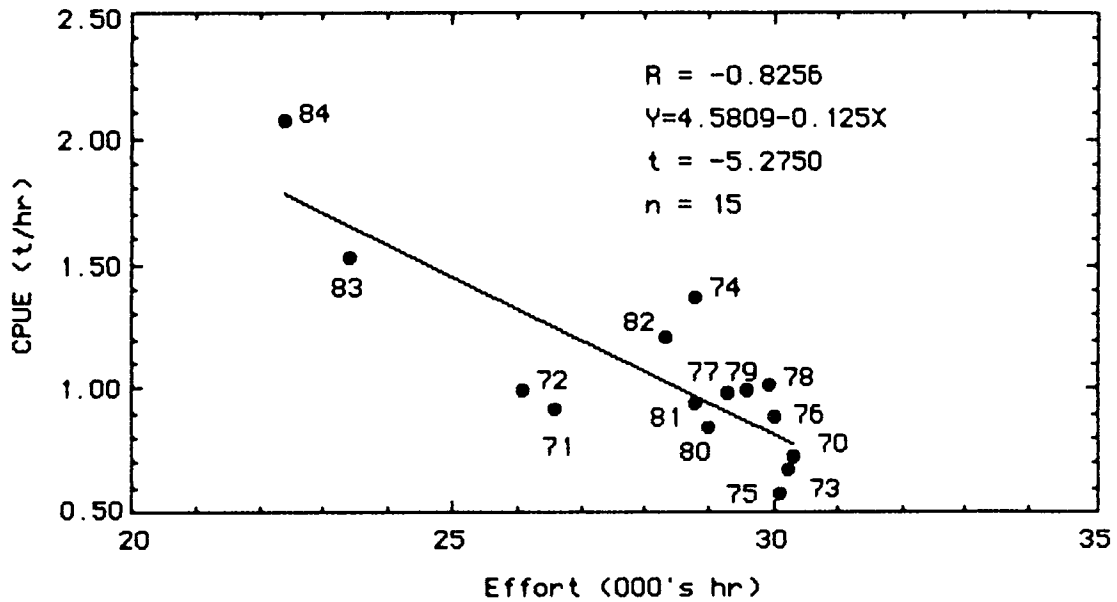

Fig.4: Regression of standardized CPUE on standardized effort for redfish in 2+3K using data lagged 10 years.

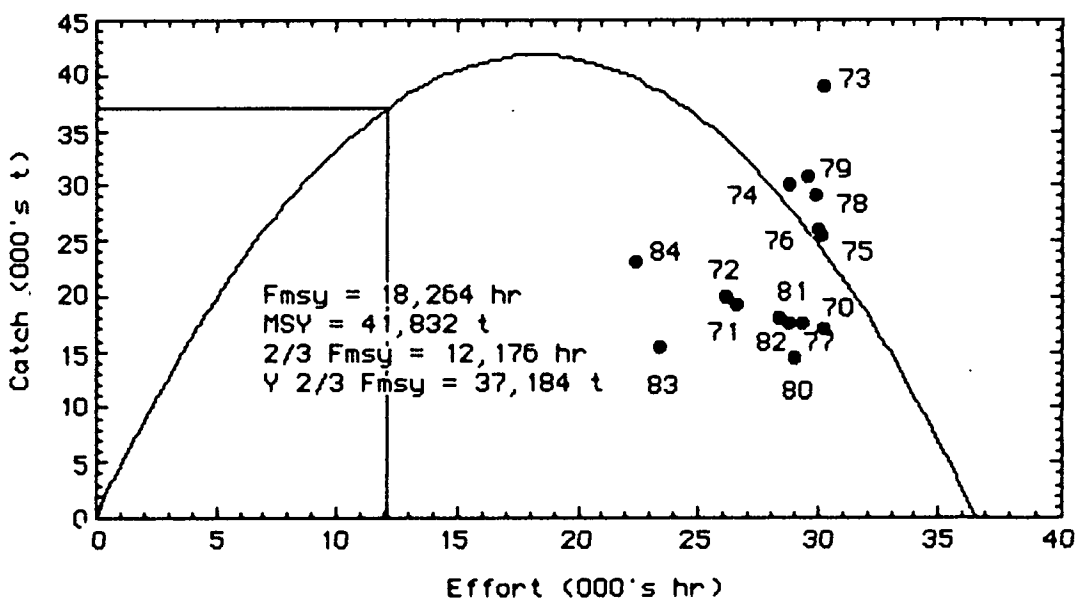

Fig.5: General production curve derived from regression of Fig.4.

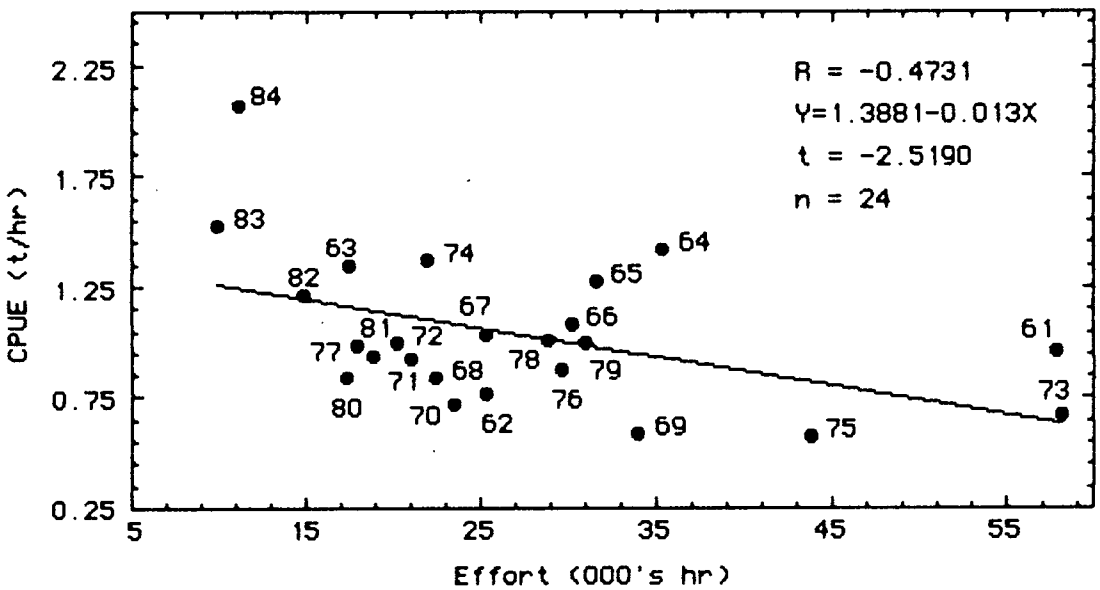

Fig.6: Regression of standardized CPUE on standardized effort for redfish in 2+3K using unlagged data.

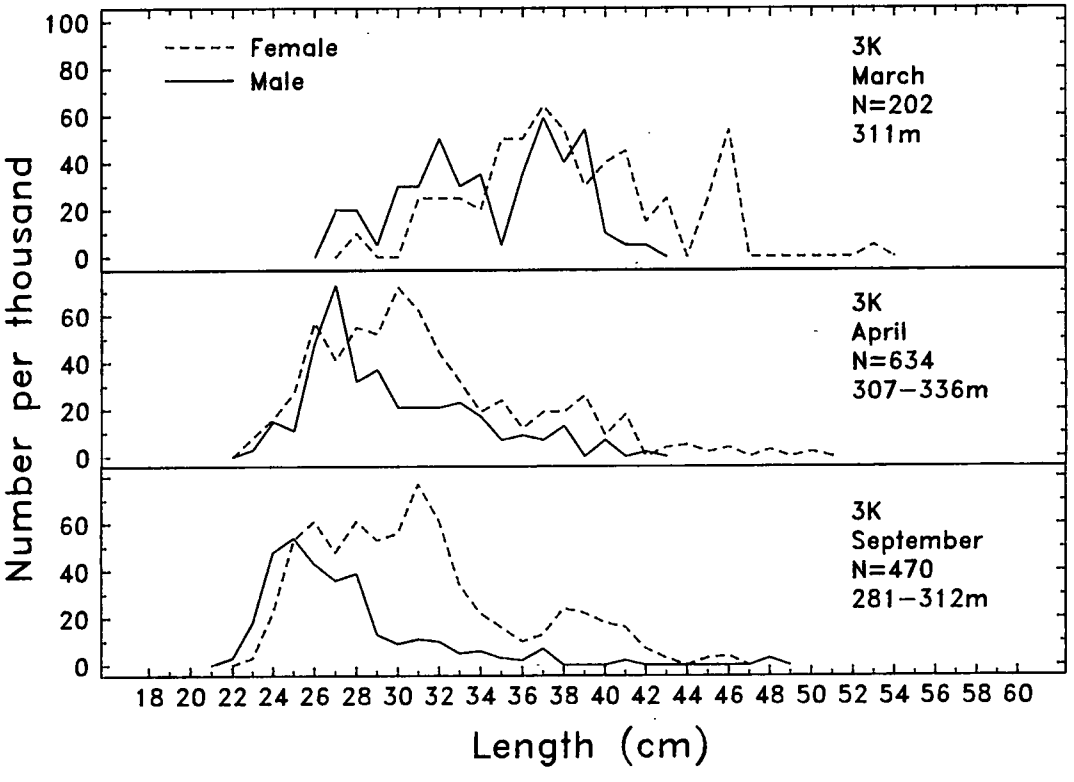

Fig.7: Commercial frequencies from Can (SF) otter trawl redfish fishery in 2+3K in 1984 (port sampling).

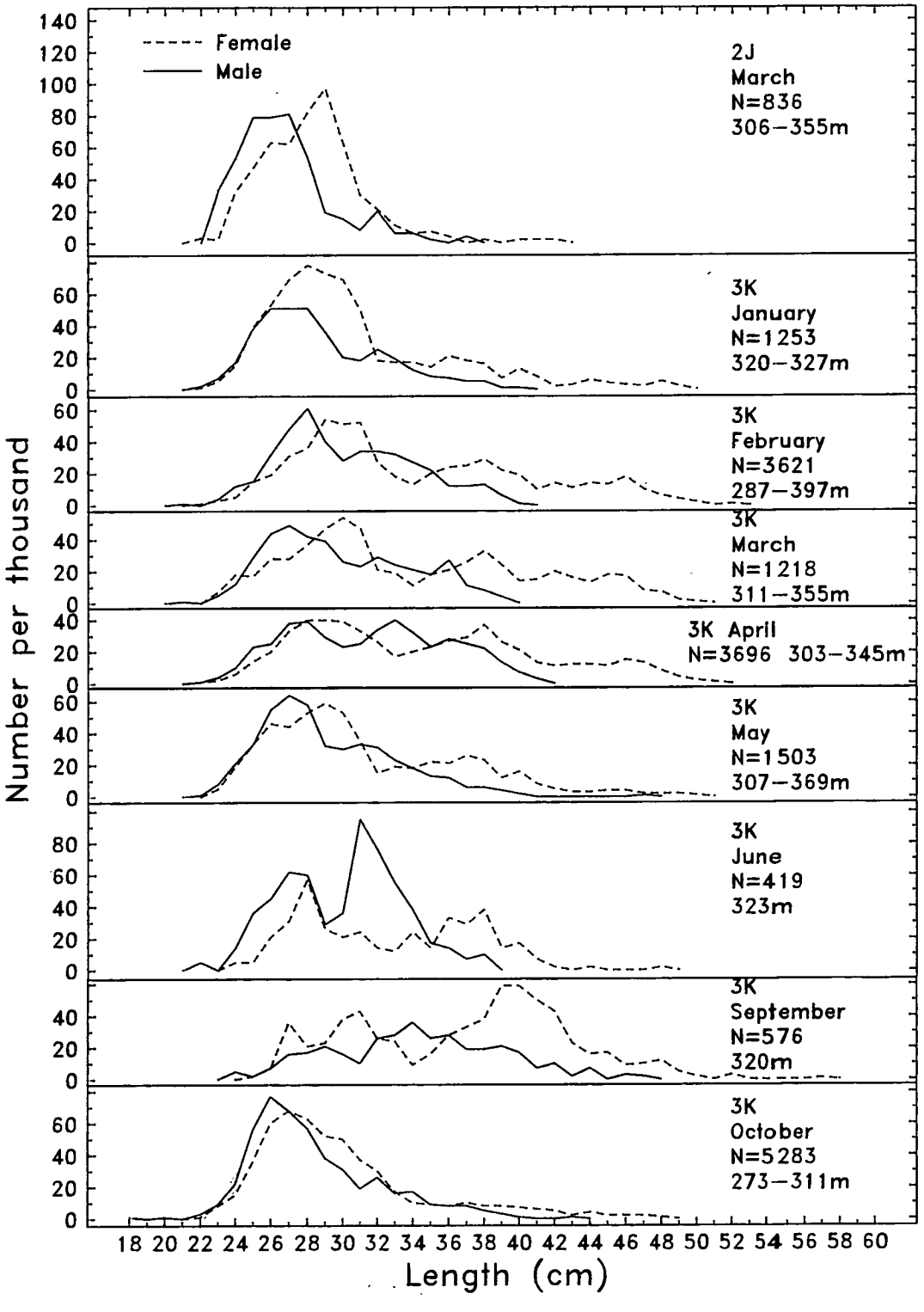

Fig.8: Commercial frequencies from Can (Nfld) otter trawl redfish fishery in 2+3K in 1984 (port sampling).

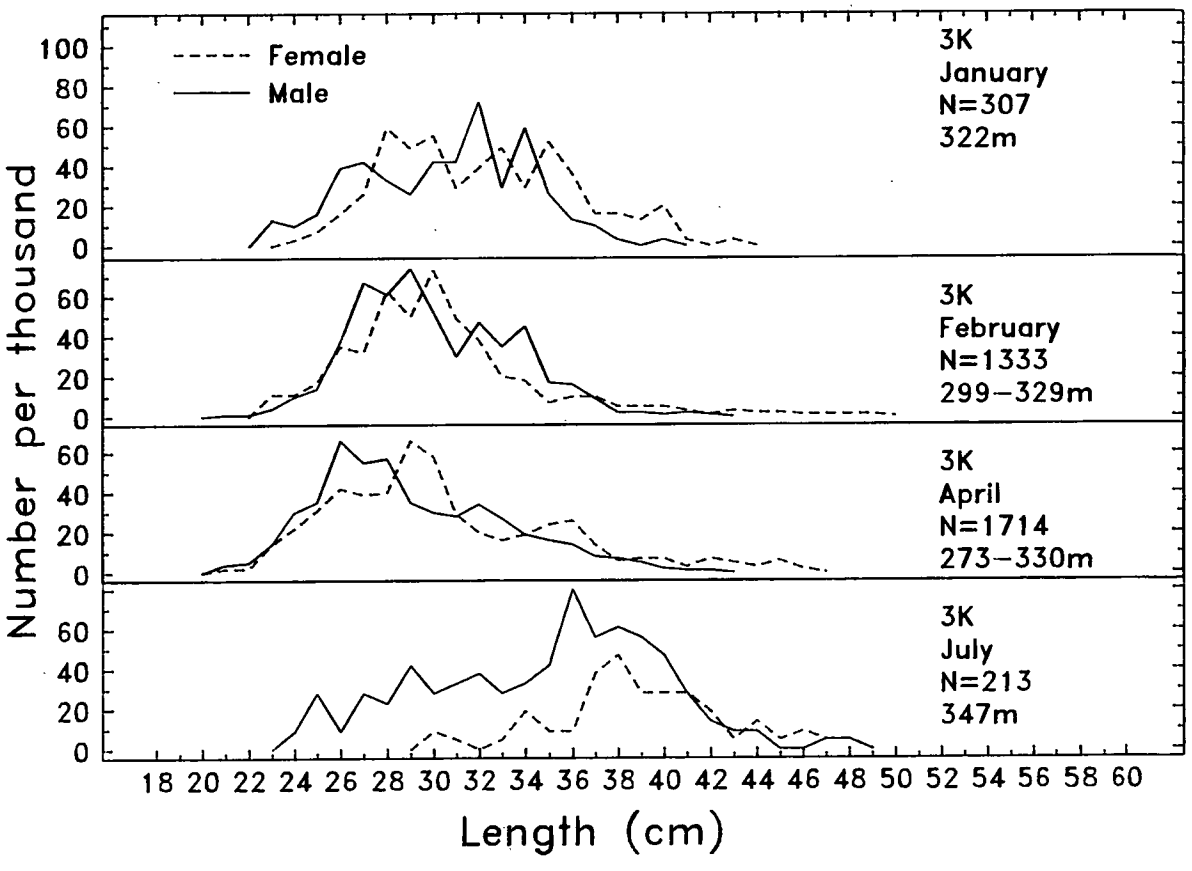

Fig.9: Commercial frequencies from Can (Nfld) otter trawl redfish fishery in 2+3K in 1984 (sea sampling).

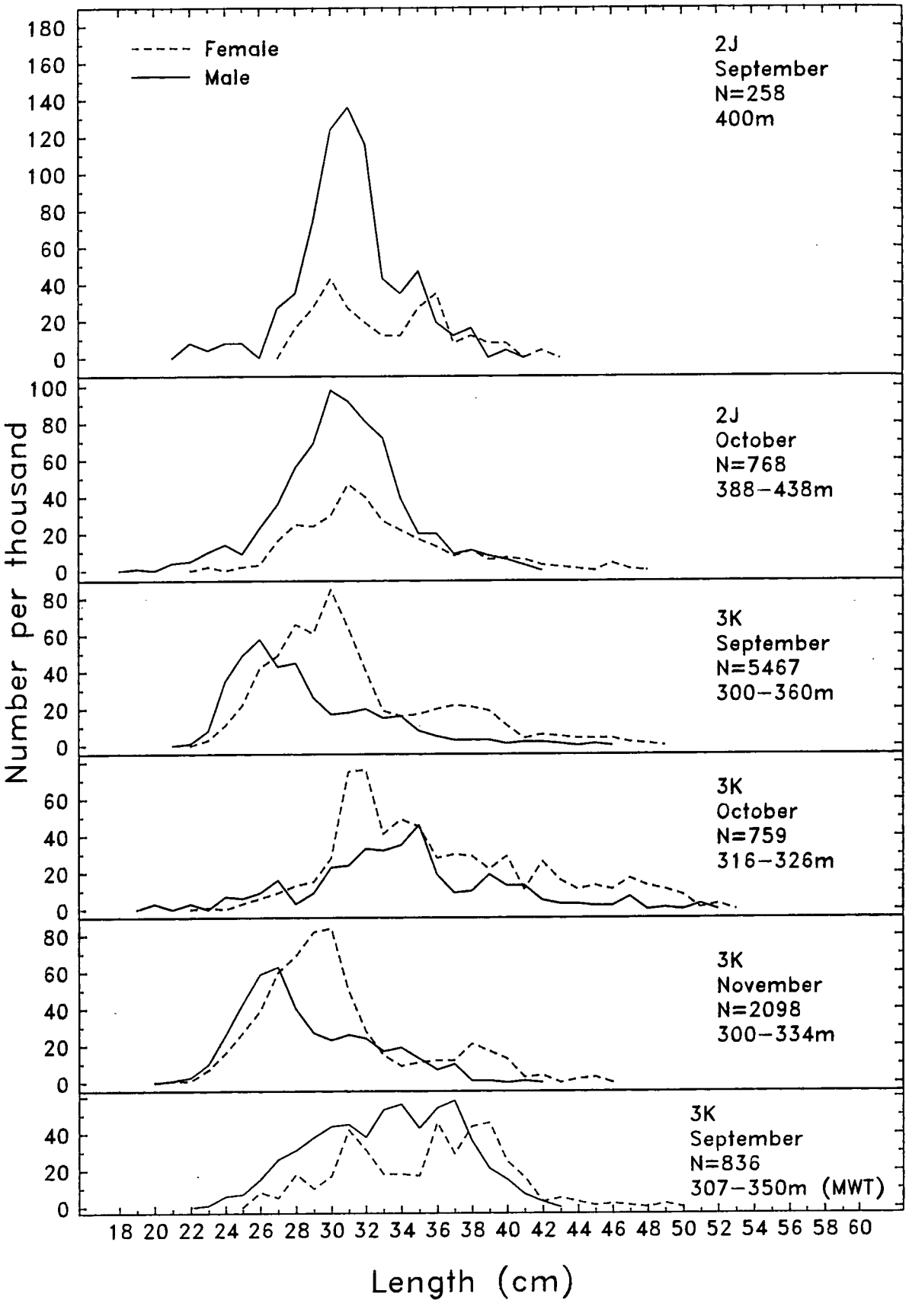

Fig.10: Commercial frequencies from Japanese otter and midwater trawl redfish fishery in 2+3K in 1984 (sea sampling).

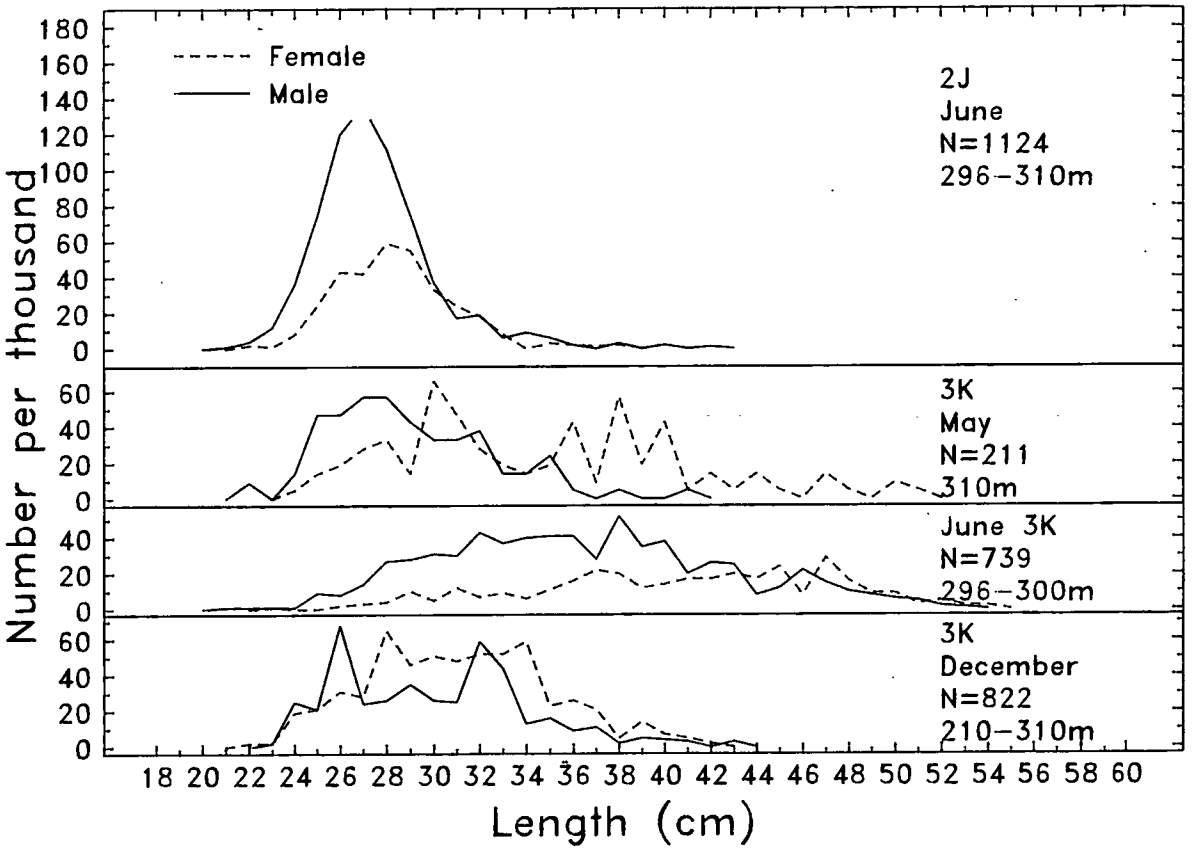

Fig.11: Commercial frequencies from Poland otter trawl redfish fishery in 2+3K in 1984 (sea sampling).

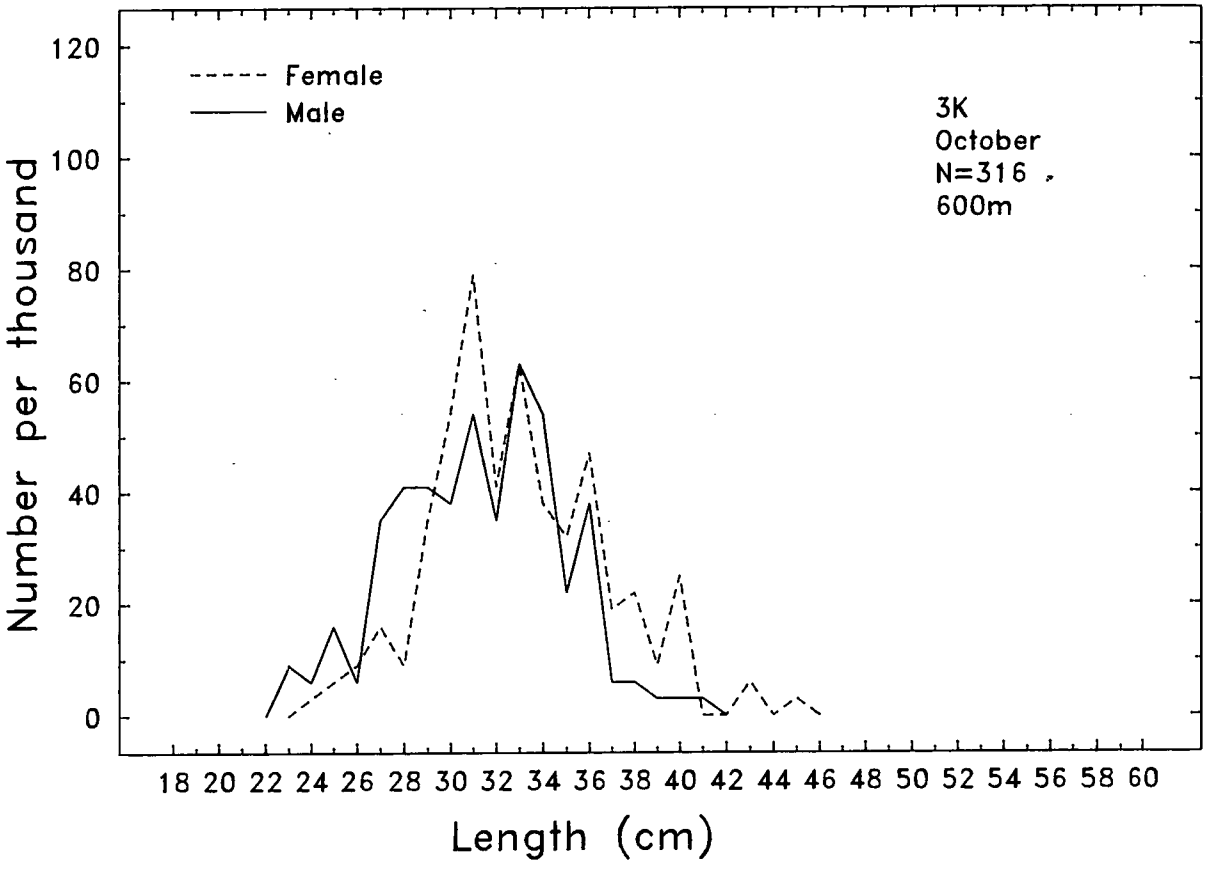

Fig.12: Commercial frequencies from G.D.R otter trawl redfish fishery in 2+3K in 1984 (sea sampling).

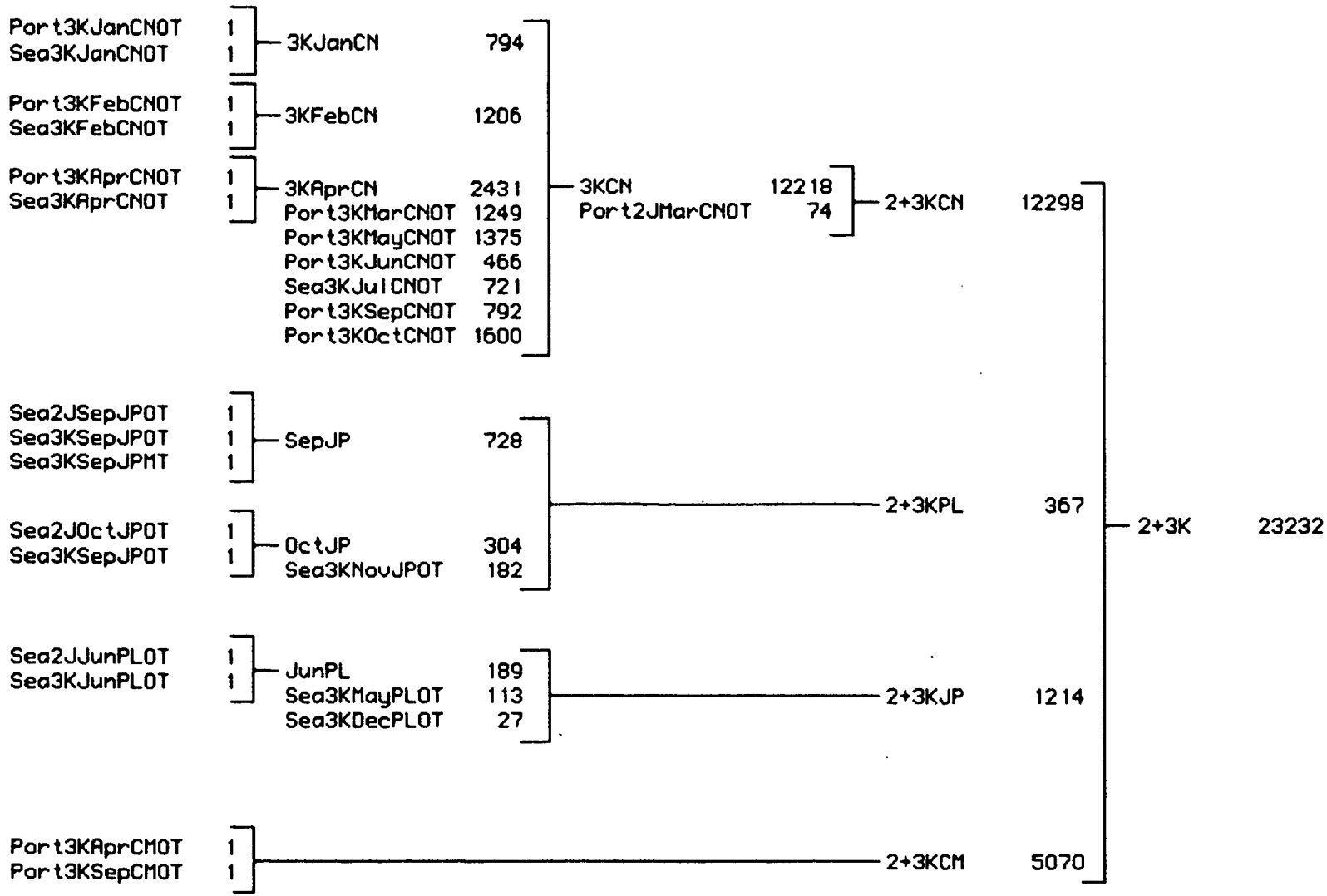

Fig.13: Commercial frequencies used and the process of combining them to derive the number of redfish caught at age in 2+3K, 1984.

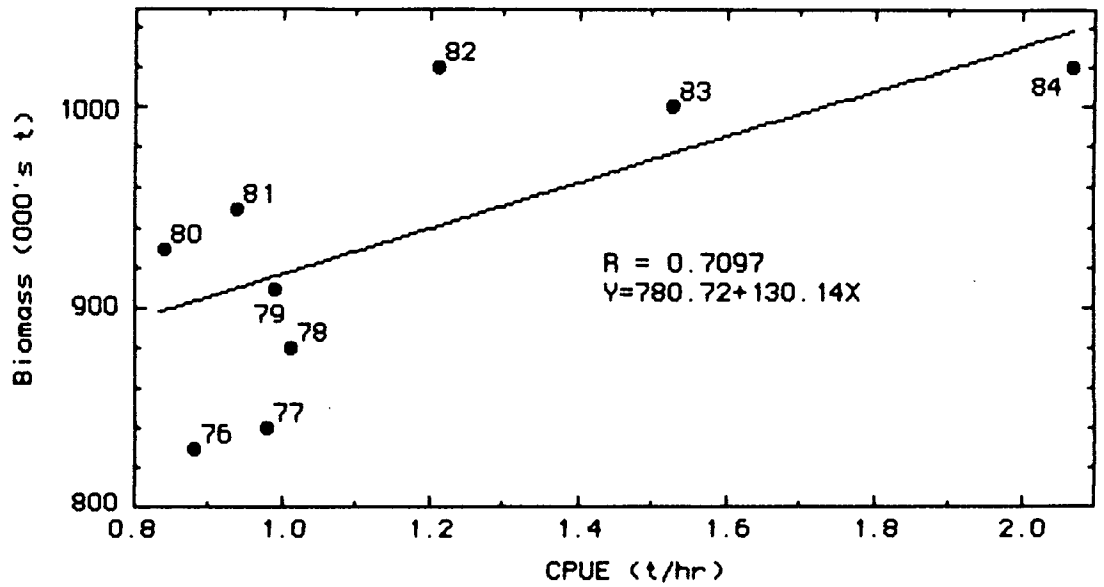

Fig. 14: Regression of biomass (ages 10-29) on CPUE at Ft=0.025 for redfish in 2+3K (including 1984 point).

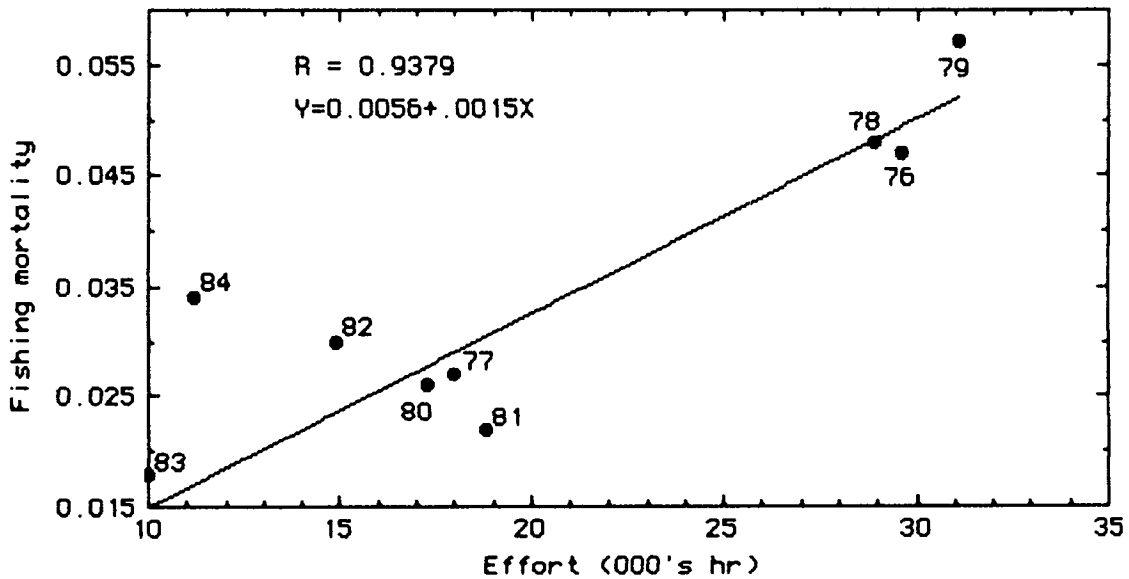

Fig. 15: Regression of F (10+) on effort for redfish in 2+3K at Ft=0.05 (1984 point excluded).

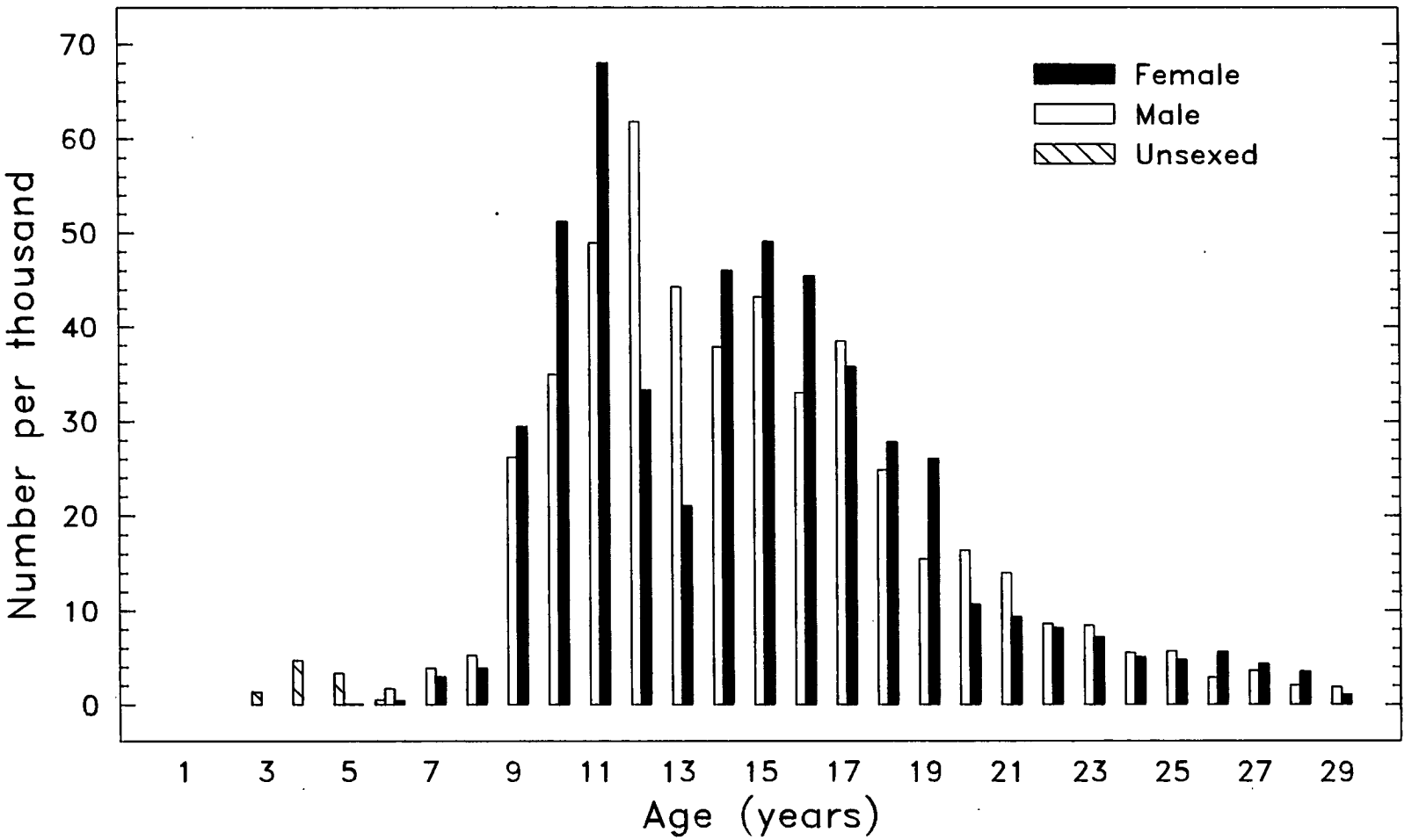

Fig.16: Number of redfish at age per standard tow adjusted to number per thousand caught during research cruise to 2J3K, fall, 1984.