Northwest Atlantic Fisheries Organization

Serial No. N1151

NAFO SCR Doc. 86/37

SCIENTIFIC COUNCIL MEETING - JUNE 1986

The Status of Redfish in NAFO Division 3LN

by

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Introduction

The present TAC of 25,000 t was first set for 1980 based on the results of general production analyses carried out in 1979. The long term average catch is slightly below this at about 22,000 t. In 1985, about 17,000 t were taken (Table 1, Fig. 1), up about 3000 t over the catch in 1984. The reported catch from Div. 3L in 1984 was down from that in 1983 (Table 1). This was the result of reduced landings by both Canada and the USSR (Table 2a). In Div. 3N, the USSR continued to dominate in 1984 (Table 2b). No breakdown of landings by Division is yet available for 1985. In both Divisions, the fishery is prosecuted throughout the year (Tables 3a and 3b). There are insufficient data available to carry out an analytical assessment of this stock.

Methods and Results

Catch and effort data extracted from ICNAF/NAFO statistics for the period 1959-1984 were combined with preliminary Canadian data for 1985 and analysed using a multiplicative model (Gavaris 1980) to derive a standardized catch rate series. Only those catches in which redfish comprised >50% of the total were used. Catches and/or effort of <10 units were not included as rounding of these low values could introduce biases. The data were weighted step wise by $\log_{10}$ effort as this resulted in a better fit based on plots of the residuals. The combinations of the various parameters used are shown in Table 4.

The regression results (Table 5) indicate significance. The difference in years (type 3) is significant but at a much lower f than the other categories. Effort has declined from the levels of the early 1970's but has remained fairly stable in recent years (Table 6, Fig. 2). The catch rates (Table 6, Fig. 3) show a great deal of fluctuation from year to year but overall, suggest reasonable stability.

Regressions of standardized catch rates on unlagged effort data and effort data lagged 6, 8 and 10 years (Gulland 1961) were run. None of these were significant (eg. Fig. 4 and 5). This same result has been obtained previously (Atkinson MS 1985). It was considered that a possible explanation for these results and the generally variable catch rates might be that the fish migrate (annual and/or seasonal) between Divisions, and the Div. 3N 'stock' may actually represent a mixture of stocks (NAFO Redbook 1985, p62).

In order to investigate this further, the catch and effort data were broken out by Division and analysed separately as above. Because landings by Division were not available for 1985, the total reported catch was split evenly between Div. 3L and 3N for this analysis. Parameter information from the multiplicative model is contained in Tables 7 and 8.

The regression results (Tables 9a and 9b) indicate that there are not significant differences in the catch rates between years (type 3) in Div. 3L but the differences are significant in Div. 3N. It can be seen that the greatest year to year variability occurs in Div. 3N while catch rates in Div. 3L are

stable or at most show a very gradual increase with time (Tables 10a and 10b, Fig. 6 and 7). It can be seen that in many years, a shift in catch rate in one Division is accompanied by a shift in the opposite direction in the other (Fig. 8). The trend in catch rates in the two Divisions follow fairly closely from about 1977 onwards.

These two series were examined further by regressing catch rates on effort (unlagged and lagged 6, 8 and 10 years). In Div. 3L, the regression of CPUE on unlagged effort is significant (Fig. 9) but because of the 1959 and 1974 points. The regressions using lagged effort data were not significant (eg. Fig. 10).

Similar results were obtained with the data from Div. 3N (Fig. 11 and 12). The regression using unlagged effort data is significant because two distinct clusters of points exist. Examination of the results using lagged effort data indicated that the 1974 point is an obvious outlier (Fig. 12). This year also showed up as being anomalous in the catch rate series for both Divisions (Fig. 6 and 7). The regressions using lagged effort data (6, 8 and 10 years) from Div. 3N were therefore rerun after excluding the 1974 point and recalculating the lagged effort values. All regressions were then significant and there was no serial correlation as indicated by the Durbin-Watson statistic. The regression using a lag of 8 years gave the best relationship (Fig. 13). The results from this regression were therefore input into an equilibrium general production model (Fig. 14). The results indicate a yield at 2/3 MSY effort of 15,500 t for Div. 3N.

Commercial frequencies from the 1985 fishery (Fig. 15 and 16) indicate that larger fish were taken in Div. 3L than in Div. 3N. This is consistent with the trend noted in previous years. The frequencies from the USSR fishery in Div. 3N also indicate the presence of a relatively strong year class(es), probably from the early 1980's. Results from previous surveys in Div. 3N by the USSR have also shown this year class(es) to be strong (NAFO Redbook 1985, p62).

There is only limited Canadian research vessel data available for this stock. Recent surveys to Div. 3N have not covered off all redfish depths and therefore do not give indications of stock status. Four surveys were conducted in Div. 3L in 1985. Results from these indicate a wide range of ages in the area (Fig. 17). During the spring survey, somewhat larger fish were caught than during the other periods. Biomass estimates from these surveys are as follows:

Season	Biomass (t)
Winter	65,311
Spring	90,442
Summer	112,119
Fall	74,831

These are all fairly close given the inherent problems with trawl surveys for redfish and indicate a trawlable biomass in the area of approximately 85,000 t.

Discussion

As stated previously, the variability in catch rate observed when examining data from Div. 3LN combined has been attributed to possible fish migrations. An examination of catch rates broken out by Division supports the hypothesis that the greatest variability occurs in Div. 3N. Whether this may be due to migration into and out of the Division or to movement to and from areas of trawlable bottom within Div. 3N is unclear at this time. The reversal in catch rate trends between Div. 3N and 3L in some years tends to support the idea of some movement between these two Divisions but an examination of fishing patterns by the various fleets is necessary to clarify this. A comparison of catch rates between Div. 3N and 3O is discussed elsewhere (Atkinson and Power MS 1986).

The results from the multiplicative model indicate that catch rates in Div. 3L are not significantly different over time so it is not unexpected that regressions of CPUE on effort are not significant. Although significant, the regressions of Div. 3N catch rates on lagged effort (excluding 1974) do not explain a great deal of the observed variability (only about 40-60%). When the data from the two Divisions are combined, it is not surprising that the regressions of CPUE on effort are not significant.

Because the catch rates in Div. 3N (and their year to year variability) are possibly due to fish movements and therefore not reflecting stock status, it is questionable whether an equilibrium general production model is appropriate. It is interesting to note however, that given a suggested yield in Div. 3N at 2/3 MSY effort of 15,500 t and the fact that on average (1959-1984), catches in Div. 3N have accounted for about 63% of the total for the stock, an adjusted yield at 2/3 MSY effort for Div. 3LN combined is about 25,000 t, the present TAC level.

The data available do not suggest any that any change in the TAC for 1987 from the present level of 25,000 t is warranted.

References

Atkinson, D.B. MS 1985.The Redfish of NAFO Div. 3LN. NAFO SCR DOC. 85/49.

Atkinson, D.B. and D. Power MS 1986. The stock complex of redfish in NAFO Divisions 3KLNOPs. NAFO SCR DOC. 86/?.

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.

Gulland, J.A. 1961. Fishing and stocks of fish at Iceland. U.K. Min. Agric. Fish. Food, Fish. Invest. (Ser. 2) 23(4): 52 p.

Table 1: Summary of nominal catches of redfish in Divisions 3LN.

Year	3L	3N	Total	TAC
1959	34,107	10,478	44,585	
1960	11,463	16,547	28,010	
1961	8,349	14,826	23,175	
1962	3,425	18,009	21,434	
1963	8,191	12,906	21,097	
1964	3,898	4,206	8,104	
1965	9,451	4,042	13,493	
1966	6,927	10,047	16,974	
1967	7,684	19,504	27,188	
1968	2,348	15,265	17,613	
1969	927	22,142	23,069	
1970	1,029	13,359	14,388	
1971	10,043	24,310	34,353	
1972	3,095	25,838	28,933	
1973	4,709	28,588	33,297	
1974	11,419	10,867	22,286	28,000
1975	3,838	14,033	17,871	20,000
1976	15,971	4,541	20,512	20,000
1977	13,452	3,064	16,516	16,000
1978	6,318	5,725	12,043	16,000
1979	5,584	8,483	14,067	18,000
1980	4,367	11,663	16,030	25,000
1981	9,407	14,873	24,280	25,000
1982	7,870	13,677	21,547	25,000
1983	8,657	11,090	19,747	25,000
1984*	2,680	12,064	14,744	25,000
1985*			17,031	25,000
1986				25,000

* Provisional.

Table 2a: Nominal catches of redfish in Division 3L by country and year.

Country	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984*
Canada (M)	1	-	1,671	1,671	18	934	554	1,696	1,003	2,663	52
Canada (N)	165	1,827	4,195	7,686	3,143	4,086	2,412	5,925	5,910	3,800	1,228
France (M)	2	6	13	6	45	4	3	-	-	-	-
France (SP)	3	-	4	-	8	-	11	-	-	-	-
FRG	50	-	29	-	-	7	-	-	-	-	89
GDR	-	-	744	144	918	168	375	509	12	586	849
Japan	-	-	-	87	522	-	26	128	159	-	105
Poland	397	-	81	-	-	4	2	-	-	2	1
Portugal	590	1,245	1,534	299	261	265	639	275	125	91	33
Spain	-	-	-	141	8	-	-	137	25	347	91
UK	171	120	9	4	-	2	-	-	-	-	-
USSR	10,040	640	7,691	3,231	1,395	114	345	737	607	1,168	232
Ireland	-	-	-	160	-	-	-	-	-	-	-
Cuba	-	-	-	23	-	-	-	-	-	-	-
Kor-S	-	-	-	-	-	-	-	-	29	-	-
TOTAL	11,419	3,838	15,971	13,452	6,318	5,584	4,367	9,407	7,870	8,657	2,680

* Provisional.
\+ Maritimes and Quebec were combined prior to 1979.

Table 2b: Nominal catches of redfish in Division 3N by country and year.

Country	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984*
Canada (M)	-	5	307	43	1	198	683	442	-	-	13
Canada (N)	34	48	320	137	18	1,285	367	63	337	1	1
France (M)	-	-	-	-	-	25	-	-	-	-	-
FRG	-	-	-	-	12	-	-	-	-	-	-
GDR	-	-	-	-	11	-	-	58	-	-	-
Poland	-	19	-	-	-	-	-	-	-	-	-
Portugal	20	104	-	-	-	-	-	-	1	-	365
Japan	24	-	-	-	-	-	-	-	-	-	81
Romania	-	-	-	-	-	9	-	-	-	-	-
Spain	-	-	-	59	1	-	14	239	278	875	239
UK	454	-	-	-	-	-	-	-	-	-	-
USSR	10,335	13,857	3,914	2,645	4,532	5,904	8,944	12,762	10,414	7,844	9,045
Cuba	-	-	-	180	1,150	1,052	1,644	1,309	2,621	2,370	2,320
USA	-	-	-	-	-	-	11	-	-	-	-
Kor-S	-	-	-	-	-	-	-	-	26	-	-
TOTAL	10,867	14,033	4,541	3,064	5,725	8,483	11,663	14,873	13,677	11,090	12,064

* Provisional.
\+ Maritimes and Quebec were combined prior to 1979.

Table 3a: Nominal catches of redfish in Division 3L by month and year.

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total	
1974	251	846	557	1,094	2,040	2,528	1,458	343	443	472	675	712	11,419	
1975	112	87	226	169	126	358	309	160	353	1,095	738	105	3,838	
1976	33	833	3,916	2,324	578	1,290	2,205	537	815	2,122	954	364	15,971	
1977	170	275	1,764	1,034	498	920	2,016	1,339	820	2,069	1,406	981	13,452	a
1978	41	535	301	356	466	669	272	48	19	224	933	2,454	6,318	
1979	76	1	1,084	1,391	116	132	492	466	5	22	1,290	509	5,584	
1980	271	112	396	119	373	261	80	10	718	311	22	1,694	4,367	
1981	280	61	137	1,120	2,286	532	73	90	404	161	1,980	2,283	9,407	
1982	1,126	672	1,232	1,225	295	289	459	37	643	1,367	173	352	7,870	
1983	1,304	496	672	1,080	934	708	274	642	562	1,070	799	116	8,657	
1984*	243	135	167	360	76	161	49	57	1,002	318	46	66	2,680	

* Provisional.
a includes a catch of 160t in month 'unknown'.

Table 3b: Nominal catches of redfish in Division 3N by month and year.

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1974	167	471	512	982	1,947	2,417	1,481	321	615	646	629	679	10,867
1975	-	700	3,002	640	970	1,023	1,284	947	3,716	1,453	136	162	14,033
1976	645	721	475	828	755	301	298	27	146	284	61	-	4,541
1977	454	91	1,383	305	47	135	390	217	22	1	19	-	3,064
1978	1	1,230	1,806	875	390	794	32	343	-	12	23	219	5,725
1979	3,693	1,177	562	1	1,091	21	563	804	248	98	155	70	8,483
1980	3,561	2,798	2,269	121	368	833	81	422	1,085	122	2	1	11,663
1981	6,293	3,657	877	78	77	145	1,035	1,577	413	273	208	240	14,873
1982	3,042	1,970	2,919	1,141	243	100	581	3,156	485	21	12	7	13,677
1983	869	609	2,029	2,186	1,226	675	1,121	1,266	303	376	208	222	11,090
1984*	4,562	1,763	1,821	676	67	74	1,693	1,014	156	93	131	14	12,064

* Provisional.

Table 4: Parameter estimates from the analysis of catch/effort for redfish in Divisions 3LN using a multiplicative model.

Country-Gear-TC	Estimate	Month	Estimate
USSR OTB 4	-0.942	Aug.	-0.116
		Oct.	
POR OTB 6	-0.628		
		Jan.	
CAN(MQ) OTB 4	-0.327	Feb.	
		Mar.	
CAN(N) OTB 4		May	
CAN(N) OTM 4	0.000	Jun.	0.000
CAN(M) OTB 4		Jul.	
POL OTB 7		Sep.	
		Nov.	
CAN(MQ) OTB 5	0.096	Dec.	
CAN(N) OTB 5			
		Apr.	0.226
CAN(M) OTB 5			
CAN(MQ) OTM 5	0.279		
GDR OTB 6			

CAN(N) OTM 5		Div.	
GDR OTB 5		---	
GDR OTB 7	0.396		
USSR OTB 7			combined
CUBA OTB 7		3L	since no
		3N	significant
CUBA OTM 7	0.747		difference
USSR OTM 7			
JPN OTB 7	1.222		

Table 5: Regression of multiplicative model for redfish in Divisions 3LN.

multiple r.....0.696
multiple r squared.....0.485

analysis of variance

source of variation	df	sums of squares	mean squares	f-value
intercept	1	3.582e1	3.582e1	
regression	36	1.022e2	2.840e0	16.301
type 1	8	5.949e1	7.436e0	42.683
type 2	2	3.950e0	1.975e0	11.336
type 3	26	1.756e1	6.753e-1	3.876
residuals	623	1.085e2	1.742e-1	
total	660	2.466e2		

Table 6: The predicted catch rate for redfish in Divisions 3LN.

year	total catch	catch rate mean	s.e.	effort
1959	44585	1.149	0.101	38808
1960	28010	0.986	0.106	28420
1961	23175	1.259	0.125	18402
1962	21434	1.307	0.097	16398
1963	21097	1.200	0.103	17577
1964	8104	1.032	0.141	7850
1965	13493	0.992	0.121	13596
1966	16974	1.388	0.156	12225
1967	27188	1.071	0.104	25389
1968	17613	0.721	0.100	24435
1969	23069	0.910	0.094	25363
1970	14388	1.076	0.134	13375
1971	34353	0.915	0.105	37549
1972	28933	1.012	0.108	28598
1973	33297	1.159	0.198	28725
1974	22286	1.176	0.218	18944
1975	17871	1.065	0.125	16786
1976	20512	0.988	0.087	20757
1977	16516	0.956	0.087	17285
1978	12043	0.814	0.078	14791
1979	14067	1.058	0.090	13297
1980	16030	1.424	0.135	11257
1981	24280	1.256	0.119	19327
1982	21547	1.404	0.133	15344
1983	19747	1.342	0.123	14719
1984	14744	0.918	0.101	16067
1985	17031	1.410	0.203	12079

average c.v. for the mean:0.110

Table 7: Parameter estimates from the analysis of catch/effort for redfish in Division 3L using a multiplicative model.

Country-Gear-TC	Estimate	Month	Estimate
USSR OTB 4	-0.802	Aug.	-0.314
		Oct.	
POR OTB 6	-0.634		
		May	
CAN(MQ) OTB 4	-0.238	Jun.	-0.158
		Sep.	
CAN(N) OTM 4	-0.133	Nov.	
CAN(N) OTB 4	0.000	Jan.	
		Feb.	
CAN(MQ) OTB 5		Mar.	0.000
CAN(N) OTB 5		Jul.	
POL OTB 7	0.206	Dec.	
GDR OTB 6			
POL OTB 7		Apr.	0.218
CAN(MQ) OTM 5			
CAN(M) OTB 5			
GDR OTB 5	0.311		
GDR OTB 7			
CAN(N) OTM 5	0.467		
USSR OTB 7			
USSR OTM 7	0.811		
JPN OTB 7	1.158		

Table 8: Parameter estimates from the analysis of catch/effort for redfish in Division 3N using a multiplicative model.

Country-Gear-TC	Estimate	Month	Estimate
USSR OTB 4	-1.204	Jan.	
		Feb.	
CAN(MQ) OTB 4	-0.217	Mar.	
POL OTB 7		Jul.	
		Aug.	0.000
CAN(M) OTB 5		Sep.	
CAN(N) OTB 4	0.000	Oct.	
CAN(N) OTB 5		Nov.	
		Dec.	
USSR OTB 7	0.343		
		Jun.	0.159
CUBA OTB 7	0.495		
USSR OTM 7		Apr.	0.297
		May	
CUBA OTM 7	0.931		

Table 9a: Regression of multiplicative model for redfish in Division 3L.

multiple r.....0.713
multiple r squared.....0.508

analysis of variance

source of variation	df	sums of squares	mean squares	f-value
intercept	1	1.258e1	1.258e1	
regression	38	6.602e1	1.737e0	8.766
type 1	9	3.163e1	3.514e0	17.733
type 2	3	7.481e0	2.494e0	12.583
type 3	26	1.056e1	4.061e-1	2.049
residuals	323	6.401e1	1.982e-1	
total	362	1.426e2		

Table 9b: Regression of multiplicative model for redfish in Division 3N.

multiple r.....0.826
multiple r squared.....0.683

analysis of variance

source of variation	df	sums of squares	mean squares	f-value
intercept	1	2.648e1	2.648e1	
regression	33	4.473e1	1.356e0	15.257
type 1	5	1.559e1	3.119e0	35.099
type 2	2	1.455e0	7.273e-1	8.185
type 3	26	1.339e1	5.151e-1	5.797
residuals	234	2.079e1	8.885e-2	
total	268	9.200e1		

Table 10a: Predicted catch rate for redfish in Division 3L.

year	total catch	catch rate mean	s.e.	effort
1959	34107	1.087	0.181	31384
1960	11463	0.925	0.153	12394
1961	8349	1.181	0.203	7071
1962	3425	0.970	0.165	3533
1963	8191	1.108	0.209	7392
1964	3898	1.246	0.347	3127
1965	9451	0.710	0.181	13309
1966	6927	0.693	0.170	9993
1967	7684	1.253	0.205	6132
1968	2348	0.949	0.186	2473
1969	927	0.981	0.205	945
1970	1029	1.182	0.287	871
1971	10043	1.173	0.226	8562
1972	3095	1.052	0.240	2942
1973	4709	1.356	0.585	3473
1974	11419	0.486	0.142	23490
1975	3838	1.187	0.260	3234
1976	15971	1.070	0.157	14932
1977	13452	0.989	0.144	13606
1978	6318	0.846	0.125	7466
1979	5584	1.146	0.180	4872
1980	4367	1.258	0.196	3472
1981	9407	1.238	0.198	7599
1982	7870	1.395	0.213	5642
1983	8657	1.509	0.237	5736
1984	2680	1.045	0.192	2564
1985	8515	1.534	0.271	5552

average c.v. for the mean: 0.198

Table 10b: Predicted catch rate for redfish in Division 3N.

year	total catch	catch rate mean	s.e.	effort
1959	10478	1.315	0.128	7969
1960	16547	1.283	0.185	12895
1961	14826	1.056	0.106	14038
1962	18009	1.335	0.097	13493
1963	12906	1.035	0.082	12464
1964	4206	0.895	0.114	4698
1965	4042	1.101	0.121	3672
1966	10047	1.673	0.177	6005
1967	19504	1.263	0.247	15441
1968	15265	0.546	0.095	27979
1969	22142	0.905	0.088	24477
1970	13359	1.076	0.134	12418
1971	24310	0.806	0.097	30145
1972	25838	0.998	0.096	25895
1973	28588	0.990	0.190	28887
1974	10867	2.066	0.368	5260
1975	14033	1.070	0.121	13116
1976	4541	0.704	0.099	6452
1977	3064	1.013	0.156	3025
1978	5725	0.764	0.103	7490
1979	8483	0.975	0.084	8701
1980	11663	1.576	0.147	7400
1981	14873	1.375	0.136	10818
1982	13677	1.475	0.147	9275
1983	11090	1.248	0.130	8887
1984	12064	0.992	0.114	12167
1985	8515	1.589	0.273	5358

average c.v. for the mean: 0.123

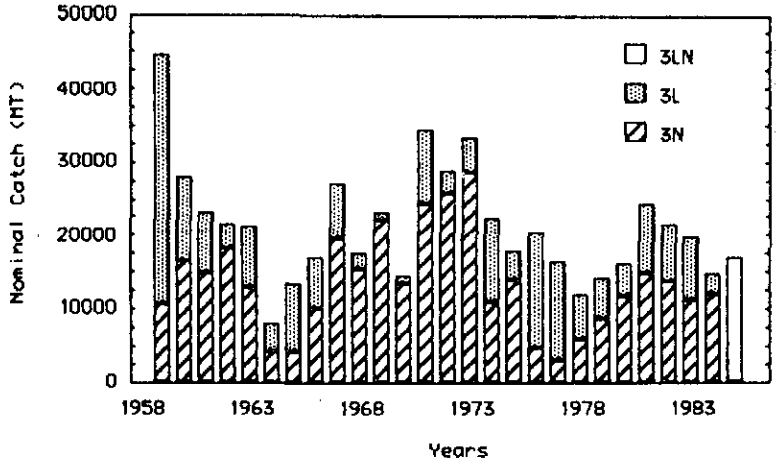

Fig. 1: Nominal catches of redfish from Divisions 3LN, 1959-1985. (1984 and 1985 are provisional)

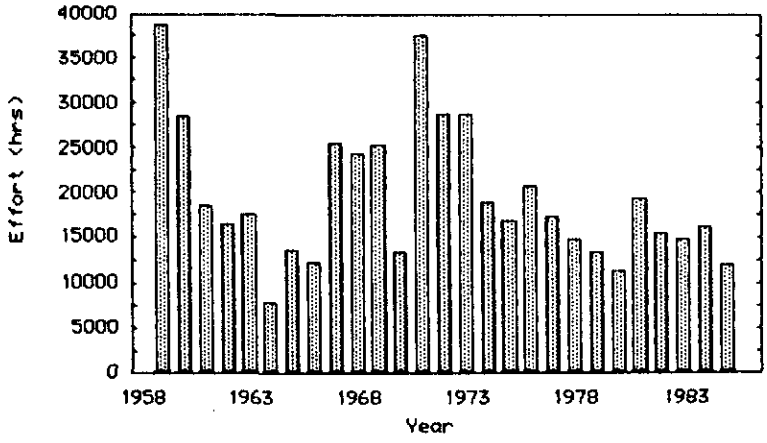

Fig. 2: Standardized effort for redfish in Divisions 3LN, 1959-1985. (1984 and 1985 are provisional)

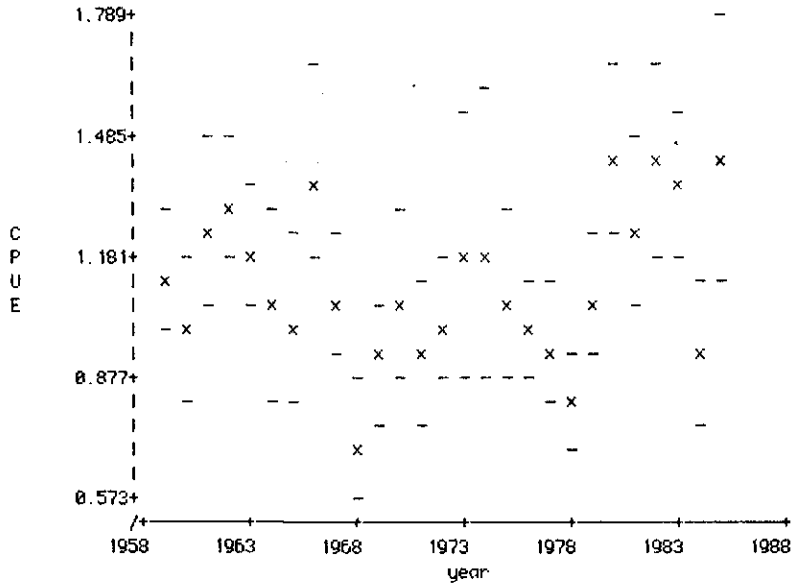

Fig. 3: Standardized CPUE (t/hr) for redfish in Divisions 3LN, 1959-1985. (1984 and 1985 Provisional)

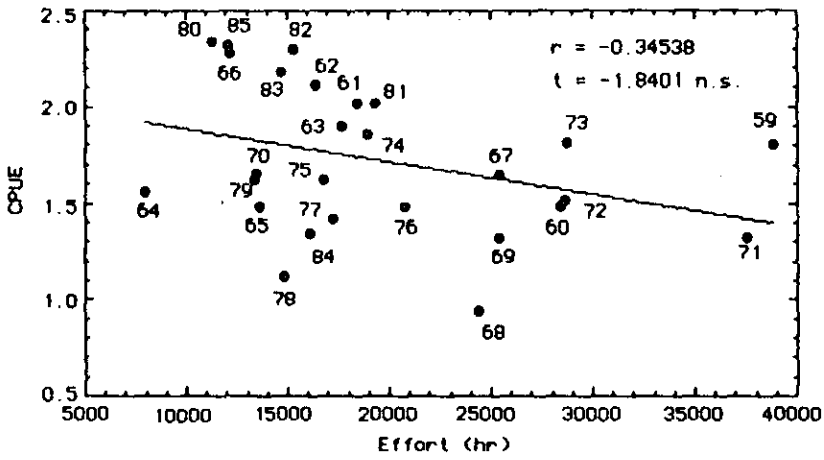

Fig. 4: Regression of standardized CPUE on unlagged effort for redfish in Divisions 3LN (1959-1985).

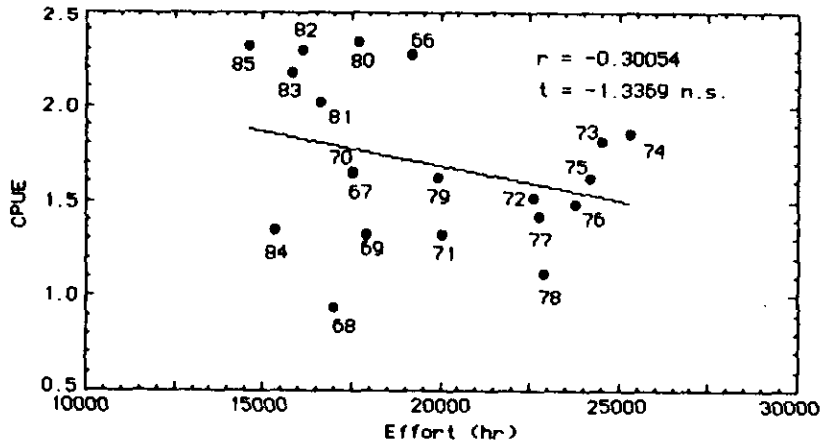

Fig. 5: Regression of standardized CPUE on effort lagged 8 years for redfish in Divisions 3LN (1959-1985).

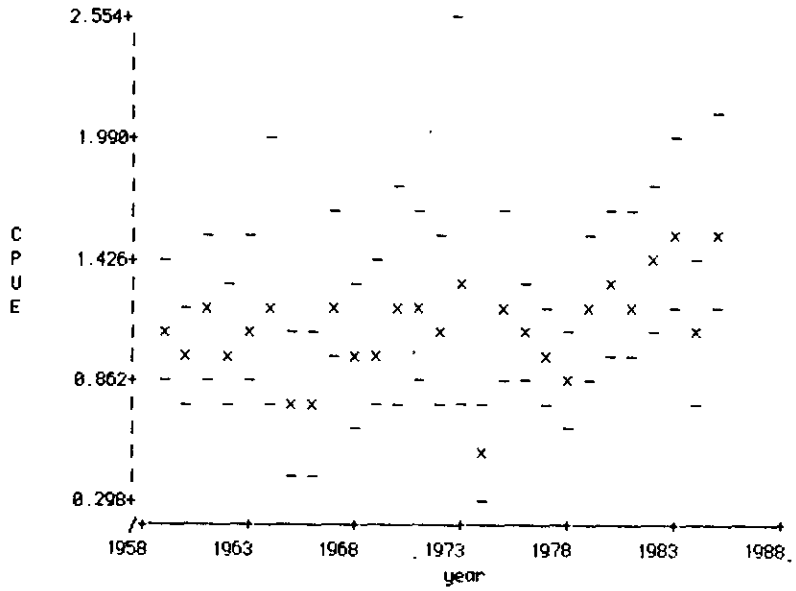

Fig. 6: Standardized CPUE (t/hr) for redfish in Division 3L, 1959-1985.
(1984 and 1985 Provisional)

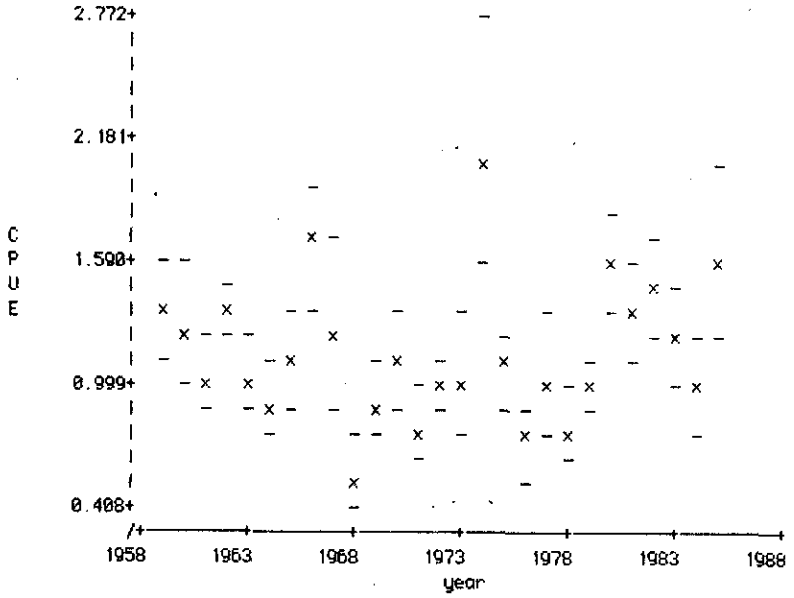

Fig. 7: Standardized CPUE (t/hr) for redfish in Division 3N, 1959-1985. (1984 and 1985 Provisional)

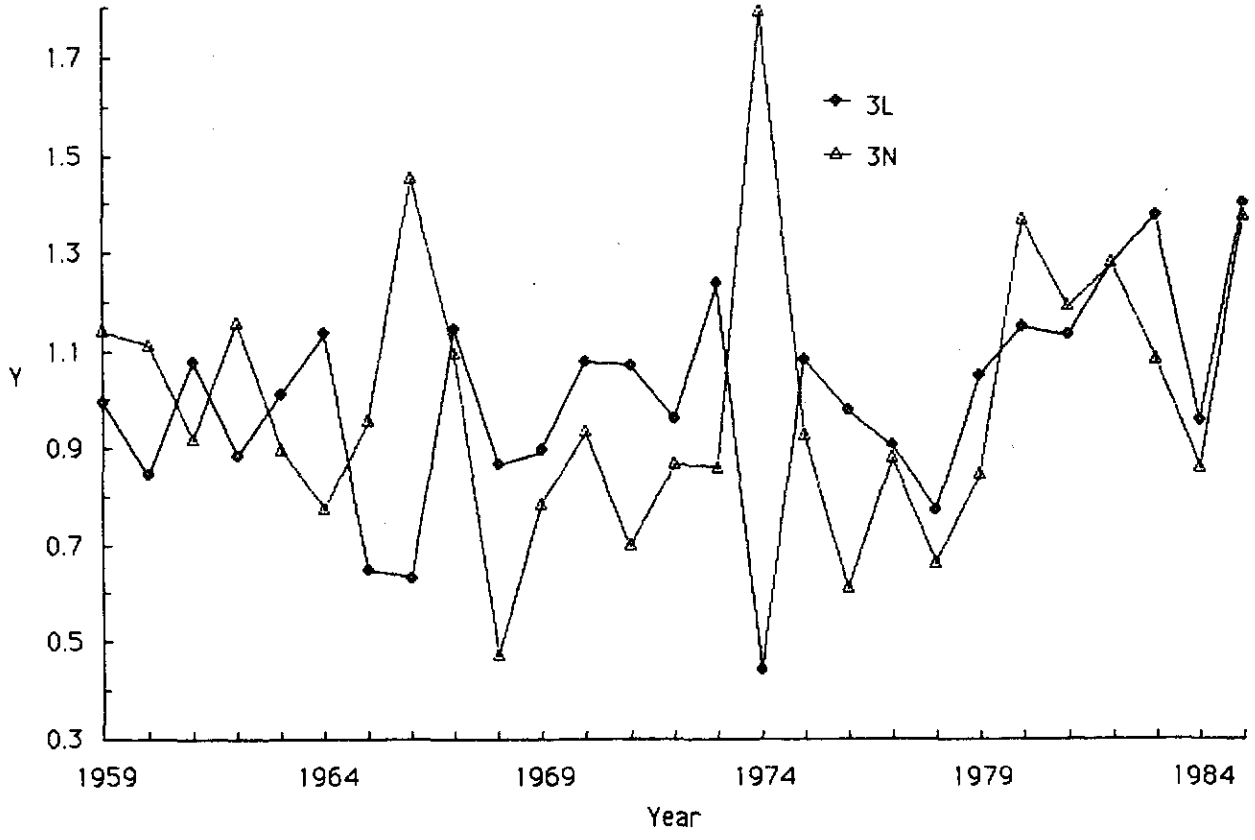

Fig. 8: Catch rates for redfish in Div. 3L and 3N (standardized to their means).

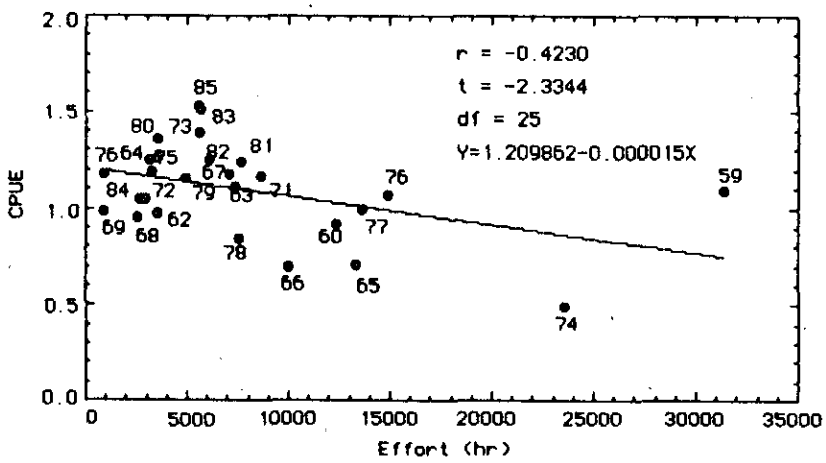

Fig. 9: Regression of standardized CPUE on unlagged effort for redfish in Division 3L (1959-1985).

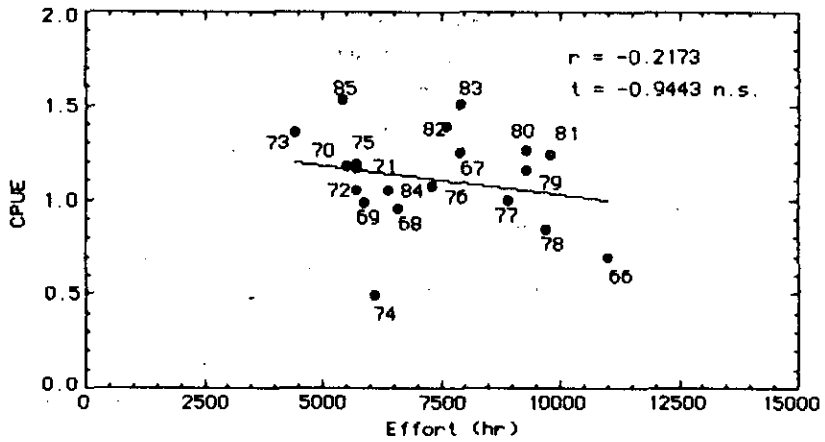

Fig. 10: Regression of standardized CPUE on effort lagged 8 years for redfish in Division 3L (1959-1985).

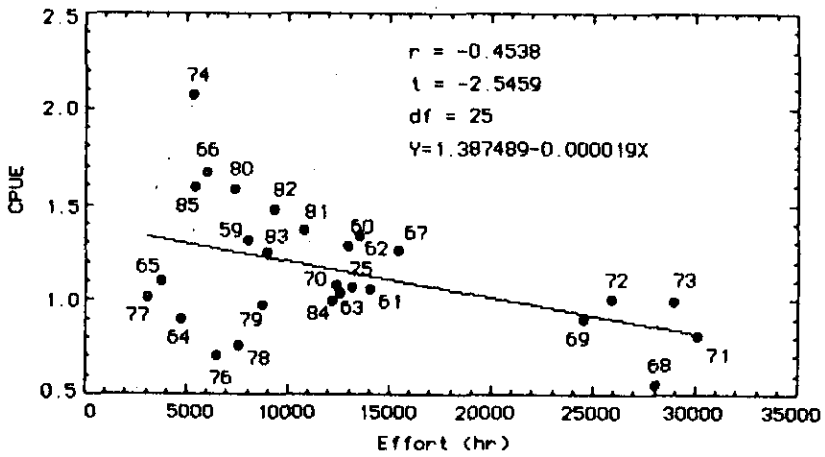

Fig. 11: Regression of standardized CPUE on unlagged effort for redfish in Division 3N (1959-1985).

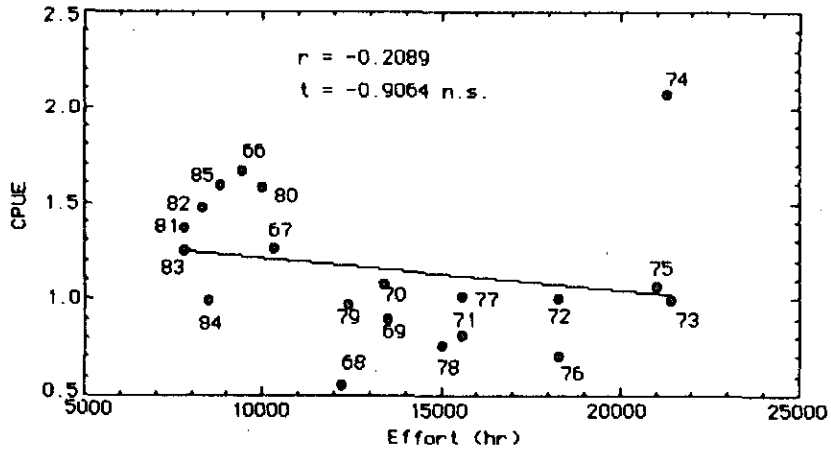

Fig. 12: Regression of standardized CPUE on effort lagged 8 years for redfish in Division 3N (1959-1985).

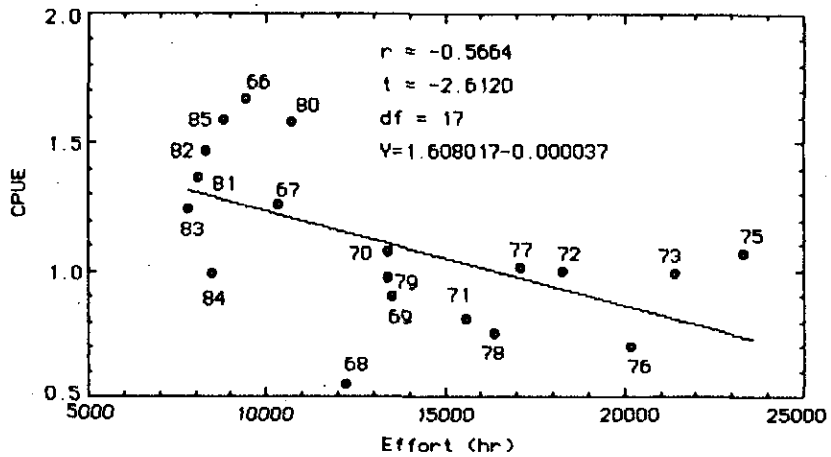

Fig. 13: Regression of standardized CPUE on effort data lagged 8 years for redfish in Division 3N (1959-1985, 1974 point excluded).

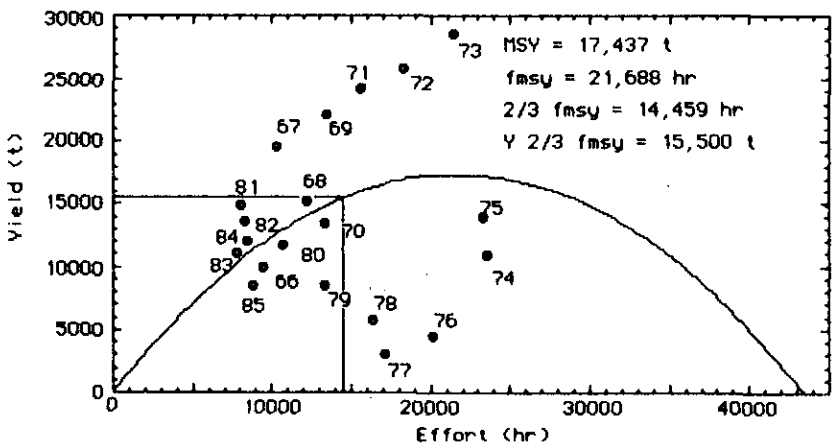

Fig. 14: Equilibrium general production curve for redfish in Division 3N derived from the relationship in Figure N above.

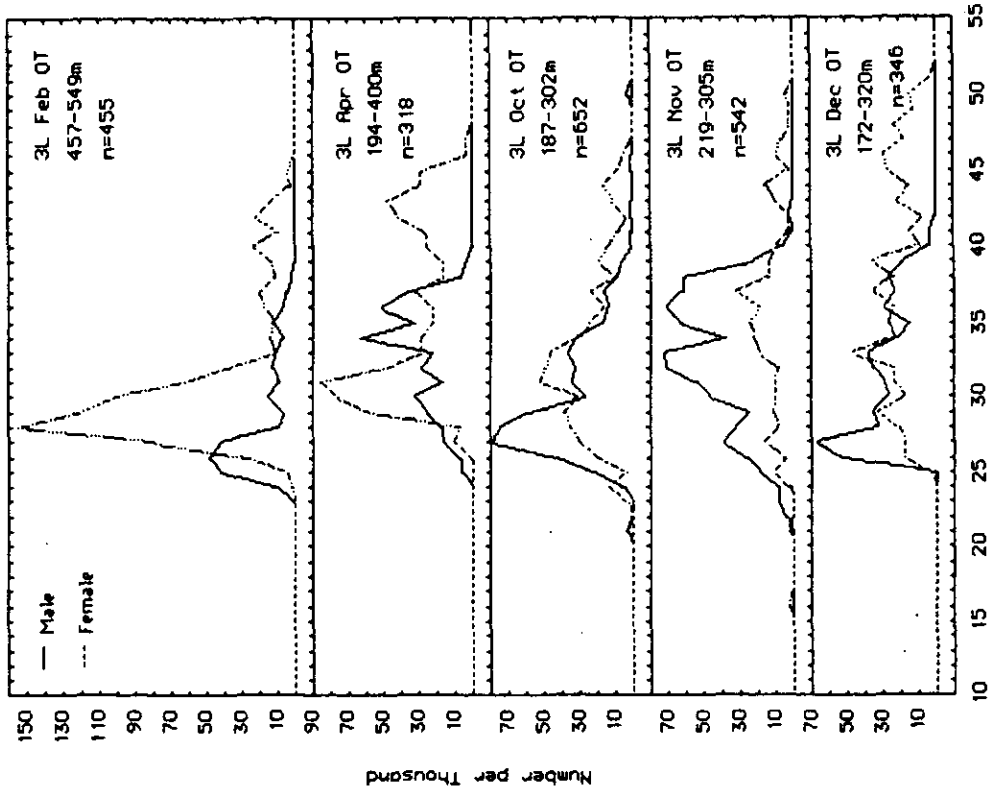

Fig. 16: Commercial frequencies from the Canadian (Nfld.) otter trawl fishery for redfish in Divisions 3LN; 1985 (port sampling).

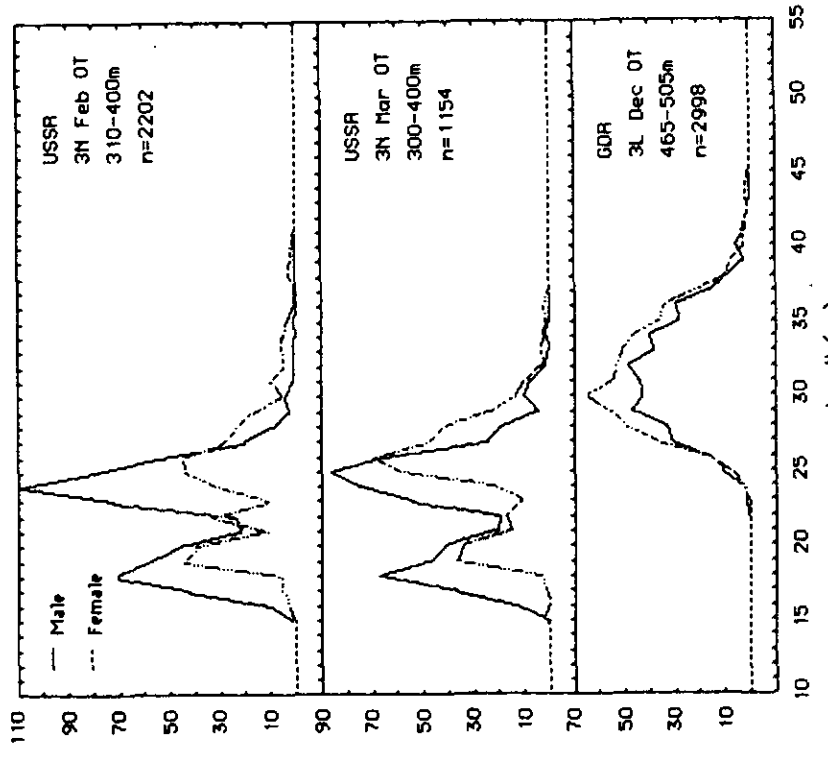

Fig. 15: Commercial frequencies from the foreign otter trawl fisheries for redfish in Divisions 3LN, 1985 (sea sampling).

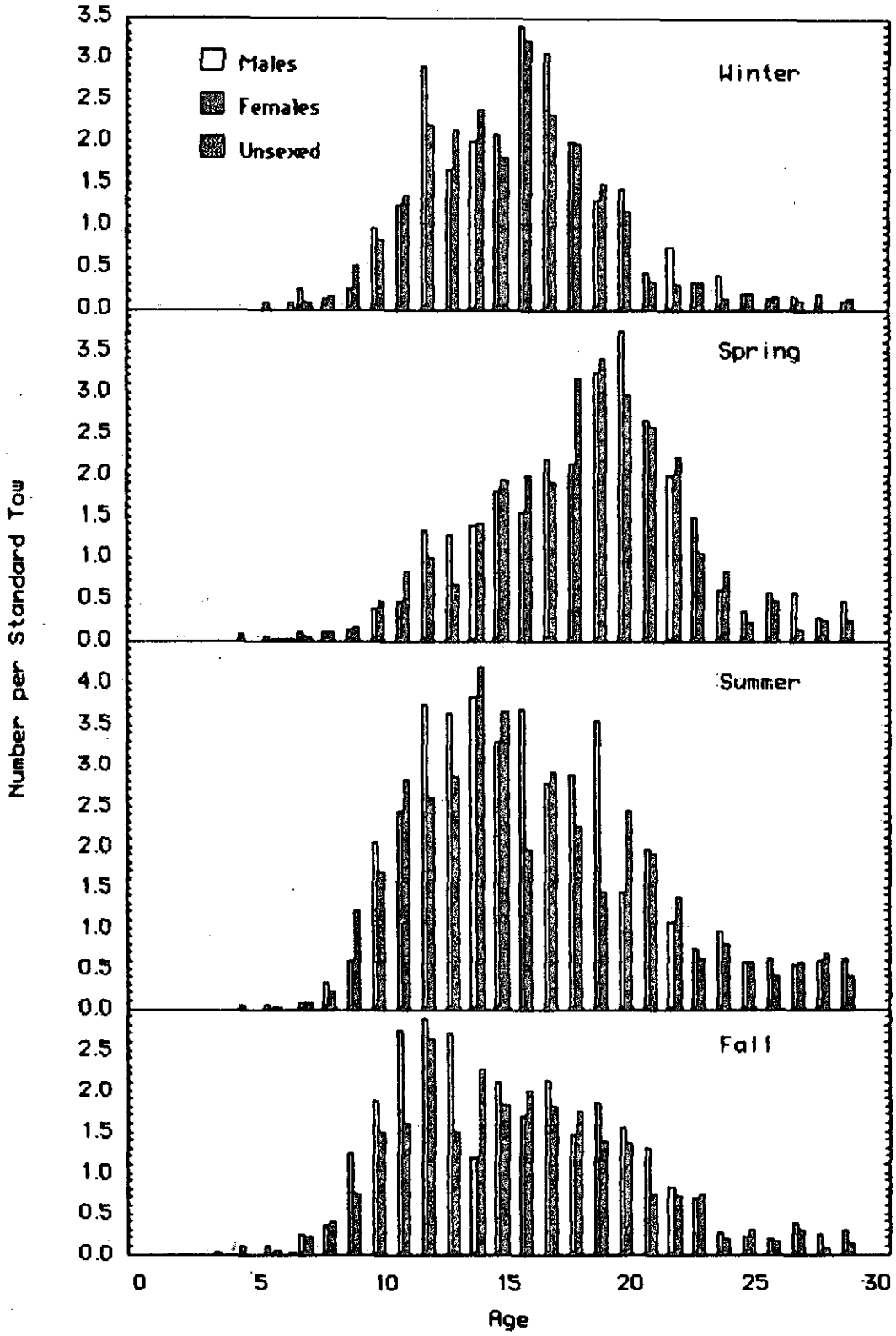

Fig. 17: Numbers of redfish caught at age per standard tow during Canadian research surveys in Division 3L in 1985.