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Redfish in NAFO Divisions 3LN

by

D. Power and D. B. Atkinson

Department of Fisheries and Oceans, Science Branch  
P. O. Box 5667, St. John's, Newfoundland, Canada A1C 5X1

Introduction

Historical nominal catches from this stock have ranged from a low of 8104 t to a high of 44,585 t (Table 1, Fig. 1). The average catch over the 1959-1986 period is just over 21,000 t. Since 1980, when the present TAC level of 25,000 t was set, the proportion taken from Div. 3N has been about 60% of the total. Provisional statistics for 1986 indicate an increase of about 19,000 t over the 1985 level due, mainly, to increased catches by the EEC (primarily Portugal).

A breakdown of the landings by division and country (Tables 2a and 2b) for the 1975-1986 period indicates that the USSR is the dominant participant in the Div. 3N fishery while Canada dominates in Div. 3L. No breakdown of the 1986 landings was available at the time of document preparation. The fishery is prosecuted throughout the year (Tables 3a and 3b) in both divisions, but catches are taken in Div. 3N mainly during the January to July period.

Analytical analyses are not possible at present due to a lack of commercial catch-at-age data. Only catch and effort data have been employed to monitor the status of this stock.

Methods and Results

Catch and effort data obtained from ICNAF/NAFO Statistical Bulletins for the period 1959-1984 were combined with preliminary NAFO data for 1985 and preliminary Canadian data for 1986. There were no Canadian data for Div. 3N in 1986. Only those data where redfish comprised >50% of the total catch were used. These data were analysed using a multiplicative model (Gavaris 1980) to derive a standardized catch rate series. To reduce potential bias due to rounding errors associated with low values, catch and/or effort data comprising <10 units were deleted prior to analysis as were country-gear-tonnage class or month category types with <5 data points. In past assessments (eg. Atkinson and Power MS 1986) grouping of similar category types within a category was done *a posteriori*. This practice has been questioned for statistical reasons, so for this assessment, the same groupings as were employed previously (Atkinson and Power MS 1986) were maintained. The data from Div. 3LN combined were analysed as were the data from Div. 3L and 3N separately. The parameter estimates and regression results are shown in Tables 4 to 10 inclusive.

Effort for Div. 3LN combined is shown in Figure 2 and Table 6 while the combined catch rates are illustrated in Table 6 and Figure 3. There is a great deal of fluctuation in the catch rates between years. There appears to be a considerable increase in catch rates between 1985 and 1986 but it must be remembered that this year contains Canadian data only. The catch rates for each division (Table 10, Figures 4 and 5) also show a considerable amount of inter-annual fluctuations. The rates in Div. 3L appear to be increasing slightly in recent years while those in Div. 3N appear to be declining. In some years (particularly 1974) the catch rates in the two divisions appear to be anomalous and move in opposite directions.

A non-equilibrium analysis (Rivard and Bledsoe 1978) (Schaefer type) of the three data series was carried out. Although the model converged for all three series at various fixed input values of  $q$  (catchability coefficient), it would not converge when allowed to estimate  $q$ . Because no independent measure of  $q$  was available, the use of the model was discarded.

Previously (Atkinson and Power MS 1986), regressions of standardized CPUE on

standardized effort (lagged and unlagged) for the Div. 3LN combined series were not significant. The same was true for this assessment so the data for Div. 3L and 3N were analysed separately. It was also noted by Atkinson and Power (MS 1986) that the 1974 point appeared to be anomolous an it was removed in their analysis of the Div. 3N data. Since this year (1974) appears anomolous in both divisions, it was removed from both the Div. 3L and Div. 3N data prior to analysis (ie all lagging was done with the 1974 point removed and it was not included in the regressions of CPUE on effort).

Regressions of standardized CPUE on standardized effort (unlagged and lagged 6, 8 and 10 years (Gulland 1961)) were carried out. With Div. 3L data, only the regression using an 8 year lag was significant (Fig. 6a). The general production analysis (Fig. 6b) indicates an equilibrium yield at 2/3 effort MSY of only 8572 t. The position of the 1986 point suggests that the stock is slightly below equilibrium. Regressions of CPUE on unlagged effort and effort lagged 6 and 8 years were significant using the Div. 3N data. Because serial correlation existed in the regression using the unlagged data, this was rejected. A lag of eight years was accepted as being most appropriate, based on the p-value (Fig. 7a). General production analysis indicates an equilibrium yield at 2/3 effort MSY of 15,735 t and the position of the 1985 point would suggest that the stock is above equilibrium. Combined, the analyses indicate an equilibrium yield of 24,307 t for Div. 3LN.

A few commercial frequencies are available from the fishery in Div. 3L in 1986 (Fig. 8-10). None were available from the Div. 3N fishery. These indicate that fish 30 cm or more predominated in the catches from depths >300 m but that smaller fish were taken in shallower water.

#### Discussion

An examination of the trends in catch rates in Div. 3L and 3N separately indicates differing trends with time. In this situation it is inappropriate to combine these data sets in the multiplicative model as the assumption of a constant relationship is violated. The rates in Div. 3L appear to be increasing in recent years, while those in Div. 3N are decreasing. The general production analyses indicate an equilibrium yield at 2/3 effort MSY of about 25,000 t, the current TAC level, partitioned at about 35:65 between Div. 3L and 3N. This proportion is very close to the historical ratio of catches in the two divisions (36:64). Some caution should be exercised in use of the production results, however, particularly those for Div. 3L, since the relationship between CPUE and effort in this division is dependent on one point, 1966.

#### References

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Table 1: Summary of nominal catches (t) 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	2,696	12,065	14,761	25,000
1985*	3,674	16,795	20,469	25,000
1986*			39,745	25,000
1987				25,000

\* Provisional.

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

Country	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985*
Canada (M)	-	1,671	1,671	18	934	554	1,696	1,003	2,663	52	342
Canada (N)	1,827	4,195	7,686	3,143	4,086	2,412	5,925	5,910	3,800	1,229	1,713
France (M)	6	13	6	45	4	3	-	-	-	-	-
France (SP)	-	4	-	8	-	11	-	-	-	-	-
FRG	-	29	-	-	7	-	-	-	-	89	309
GDR	-	744	144	918	168	375	509	12	586	849	672
Japan	-	-	87	522	-	26	128	159	-	105	129
Poland	-	81	-	-	4	2	-	-	2	1	4
Portugal	1,245	1,534	299	261	265	639	275	125	91	48	4
Spain	-	-	141	8	-	-	137	25	347	91	192
UK	120	9	4	-	2	-	-	-	-	-	-
USSR	640	7,691	3,231	1,395	114	345	737	607	1,168	232	309
Ireland	-	-	160	-	-	-	-	-	-	-	-
Cuba	-	-	23	-	-	-	-	-	-	-	-
Kor-S	-	-	-	-	-	-	-	29	-	-	-
TOTAL	3,898	15,971	13,452	6,318	5,584	4,367	9,407	7,870	8,657	2,696	3,674

\* Provisional.

+ Maritimes and Quebec were combined prior to 1979.

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

Country	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985*
Canada (M)	5	307	43	1	198	683	442	-	-	13	311
Canada (N)	48	320	137	18	1,285	367	63	337	1	2	82
France (M)	-	-	-	-	25	-	-	-	-	-	-
FRG	-	-	-	12	-	-	-	-	-	-	-
GDR	-	-	-	11	-	-	58	-	-	-	-
Poland	19	-	-	-	-	-	-	-	-	-	-
Portugal	104	-	-	-	-	-	-	1	-	365	890
Japan	-	-	-	-	-	-	-	-	-	81	-
Romania	-	-	-	-	9	-	-	-	-	-	-
Spain	-	-	59	1	-	14	239	278	875	239	2,881
UK	-	-	-	-	-	-	-	-	-	-	-
USSR	13,857	3,914	2,645	4,532	5,904	8,944	12,762	10,414	7,844	9,045	10,576
Cuba	-	-	180	1,150	1,062	1,644	1,309	2,621	2,370	2,320	2,055
USA	-	-	-	-	-	11	-	-	-	-	-
Kor-S	-	-	-	-	-	-	-	26	-	-	-
TOTAL	14,033	4,541	3,064	5,725	8,483	11,663	14,873	13,677	11,090	12,055	16,795

\* Provisional.

+ Maritimes and Quebec were combined prior to 1979.

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

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1975	112	87	226	159	126	358	309	160	353	1,095	738	105	3,838
1976	39	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 <sup>a</sup>
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	168	360	76	161	49	57	1,002	318	46	81	2,696
1985*	481	120	177	331	215	164	40	77	575	645	441	408	3,674

\* Provisional.

<sup>a</sup> includes a catch of 160t in month 'unknown'.

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

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
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	1,694	1,014	156	93	131	14	12,065
1985*	1,110	2,169	2,181	4,212	1,645	354	1,660	676	784	541	230	1,223	16,795

\* 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	-0.914	Aug.	-0.153
		Oct.	
POR OTB 6	-0.622		
		Jan.	
CAN(MQ) OTB 4	-0.317	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		Dec.	
CAN(N) OTB 5	0.122		
POR OTB 7		Apr.	0.142
CAN(M) OTB 5			
CAN(MQ) OTM 5	0.286		
GDR OTB 6		_____	
		Div.	
CAN(N) OTM 5		_____	
GDR OTB 5			
GDR OTB 7	0.442		combined since no significant difference
USSR OTB 7		3L	
CUBA OTB 7		3N	
CUBA OTM 7	0.702		
USSR OTM 7			
JPN OTB 7	1.180		

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

multiple r..... 0.644  
 multiple r squared..... 0.415

analysis of variance

source of variation	df	sums of squares	mean squares	f-value
intercept	1	4.004e1	4.004e1	
regression	37	1.076e2	2.908e0	12.542
type 1	8	6.462e1	8.077e0	34.841
type 2	2	3.781e0	1.891e0	8.155
type 3	27	1.953e1	7.233e-1	3.120
residuals	654	1.516e2	2.318e-1	
total	692	2.992e2		

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

year	In transform		retransformed		catch	effort
	mean	s.e.	mean	s.e.		
1959	0.0474	0.0111	1.171	0.123	44585	38072
1960	0.0881	0.0145	1.021	0.122	28010	27436
1961	0.1182	0.0138	1.255	0.147	23175	18461
1962	0.2062	0.0078	1.375	0.121	21434	15590
1963	0.0799	0.0109	1.210	0.126	21097	17437
1964	0.0349	0.0235	1.149	0.175	8104	7051
1965	0.0247	0.0217	1.084	0.159	13493	12449
1966	0.2461	0.0132	1.427	0.163	16974	11895
1967	0.0311	0.0117	1.082	0.117	27188	25119
1968	0.4649	0.0227	0.698	0.105	17613	25250
1969	0.2317	0.0176	0.883	0.117	23069	26126
1970	0.0054	0.0215	1.117	0.163	14388	12879
1971	0.1020	0.0229	1.003	0.151	34353	34264
1972	0.1027	0.0184	1.004	0.136	28933	28812
1973	0.0507	0.0271	1.166	0.191	33297	28567
1974	0.1361	0.0285	1.269	0.213	22286	17567
1975	0.0039	0.0240	1.114	0.172	17871	16042
1976	0.0863	0.0089	1.026	0.096	20512	19999
1977	0.1555	0.0096	0.957	0.094	16516	17263
1978	0.3180	0.0104	0.813	0.083	12043	14815
1979	0.0452	0.0076	1.171	0.102	14067	12017
1980	0.2213	0.0104	1.394	0.142	16030	11499
1981	0.0949	0.0109	1.228	0.128	24280	19769
1982	0.2338	0.0102	1.412	0.142	21547	15263
1983	0.1853	0.0098	1.345	0.133	19747	14680
1984	0.1295	0.0140	0.980	0.116	14761	15066
1985	0.0086	0.0120	1.107	0.121	20469	18494
1986	0.4094	0.0180	1.676	0.224	38478	22957

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	-0.947	Aug. Oct.	-0.324
POR OTB 6	-0.727	May Jun.	-0.154
CAN(MQ) OTB 4	-0.334	Sep. Nov.	
CAN(N) OTM 4	-0.207	Jan. Feb.	
CAN(N) OTB 4	0.000	Mar. Jul.	0.000
CAN(MQ) OTB 5		Dec.	
CAN(N) OTB 5			
POL OTB 7	0.102		
GDR OTB 6		Apr.	0.184
POR OTB 7			
CAN(MQ) OTM 5			
CAN(M) OTB 5			
GDR OTB 5	0.237		
GDR OTB 7			
CAN(N) OTM 5	0.430		
USSR OTB 7			
USSR OTM 7	0.731		
JPN OTB 7	1.081		

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	-0.996	Jan. Feb. Mar.	
CAN(MQ) OTB 4	-0.237	Jul. Aug.	0.000
POL OTB 7		Sep. Oct.	
CAN(M) OTB 5		Nov. Dec.	
CAN(N) OTB 4	0.000		
CAN(N) OTB 5			
USSR OTB 7	0.326	Jun.	0.144
CUBA OTB 7	0.504	Apr. May	0.232
USSR OTM 7			
CUBA OTM 7	0.681		



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

multiple r..... 0.717  
multiple r squared..... 0.515

analysis of variance

<u>source of variation</u>	<u>df</u>	<u>sums of squares</u>	<u>mean squares</u>	<u>f-value</u>
intercept	1	1.552e1	1.552e1	
regression	39	7.889e1	2.023e0	9.271
type 1	9	3.783e1	4.203e0	19.265
type 2	3	7.154e0	2.385e0	10.930
type 3	27	1.540e1	5.704e <sup>-1</sup>	2.615
residuals	341	7.440e1	2.182e <sup>-1</sup>	
total	381	1.688e2		

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

multiple r..... 0.789  
multiple r squared..... 0.623

analysis of variance

<u>source of variation</u>	<u>df</u>	<u>sums of squares</u>	<u>mean squares</u>	<u>f-value</u>
intercept	1	2.612e1	2.612e1	
regression	33	5.277e1	1.599e0	12.104
type 1	5	1.419e1	2.838e0	21.483
type 2	2	1.166e0	5.831e <sup>-1</sup>	4.414
type 3	26	1.751e1	6.736e <sup>-1</sup>	5.099
residuals	242	3.197e1	1.321e <sup>-1</sup>	
total	276	1.109e2		

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

year	In transform		retransformed		catch	effort
	mean	s.e.	mean	s.e.		
1959	0.0373	0.0337	1.139	0.207	34107	29956
1960	0.0891	0.0271	1.007	0.165	11463	11387
1961	0.2147	0.0403	1.355	0.270	8349	6161
1962	0.0067	0.0316	1.091	0.193	3425	3140
1963	0.1033	0.0336	1.216	0.221	8191	6734
1964	0.4422	0.0896	1.660	0.487	3898	2349
1965	0.2595	0.0740	0.829	0.222	9451	11397
1966	0.3381	0.0541	0.774	0.178	6927	8947
1967	0.2196	0.0260	1.372	0.220	7684	5602
1968	0.1452	0.0409	0.945	0.189	2348	2484
1969	0.0202	0.0473	1.112	0.239	927	834
1970	0.2085	0.0563	1.325	0.310	1029	776
1971	0.1533	0.0428	1.275	0.261	10043	7874
1972	0.0388	0.0467	1.133	0.242	3095	2732
1973	0.3194	0.1303	1.438	0.503	4709	3274
1974	0.7508	0.0763	0.507	0.138	11419	22531
1975	0.3025	0.0542	1.469	0.338	3838	2612
1976	0.1031	0.0214	1.224	0.178	15971	13053
1977	0.0434	0.0215	1.057	0.154	13452	12729
1978	0.2329	0.0208	0.875	0.126	6318	7223
1979	0.1632	0.0239	1.298	0.200	5584	4303
1980	0.1843	0.0244	1.325	0.206	4367	3296
1981	0.1321	0.0265	1.256	0.204	9407	7487
1982	0.3695	0.0230	1.596	0.241	7870	4932
1983	0.3669	0.0244	1.591	0.247	8657	5443
1984	0.0689	0.0315	1.176	0.208	2696	2292
1985	0.3966	0.0265	1.620	0.262	3674	2267
1986	0.5237	0.0253	1.860	0.295	4500	2420

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

year	In transform		retransformed		catch	effort
	mean	s.e.	mean	s.e.		
1959	0.2082	0.0112	1.309	0.138	10478	8008
1960	0.1470	0.0271	1.221	0.200	16547	13551
1961	0.0026	0.0130	1.064	0.121	14826	13928
1962	0.2534	0.0066	1.372	0.112	18009	13125
1963	0.0138	0.0102	1.049	0.106	12906	12308
1964	0.1915	0.0189	0.874	0.120	4206	4812
1965	0.1127	0.0189	1.185	0.162	4042	3412
1966	0.4595	0.0100	1.683	0.168	10047	5968
1967	0.0428	0.0449	1.090	0.229	19504	17887
1968	0.7059	0.0351	0.518	0.096	15265	20451
1969	0.2187	0.0218	0.849	0.125	22142	26070
1970	0.0340	0.0224	1.021	0.152	13359	13080
1971	0.2004	0.0468	0.854	0.183	24310	28459
1972	0.0185	0.0188	1.039	0.142	25838	24866
1973	0.0261	0.0286	1.026	0.173	26588	27859
1974	0.6885	0.0261	2.099	0.338	10067	5176
1975	0.0021	0.0258	1.057	0.169	14833	13276
1976	0.4333	0.0183	0.687	0.093	4541	6614
1977	0.0673	0.0235	0.987	0.151	3064	3104
1978	0.2254	0.0243	0.843	0.131	5725	6794
1979	0.0326	0.0085	1.030	0.095	8483	8236
1980	0.4676	0.0111	1.696	0.179	11663	6876
1981	0.2716	0.0118	1.394	0.152	14873	10672
1982	0.4051	0.0120	1.593	0.174	13677	8588
1983	0.2194	0.0149	1.321	0.161	11090	8397
1984	0.1165	0.0182	1.190	0.160	12065	10141
1985	0.1396	0.0152	0.922	0.114	16795	18211

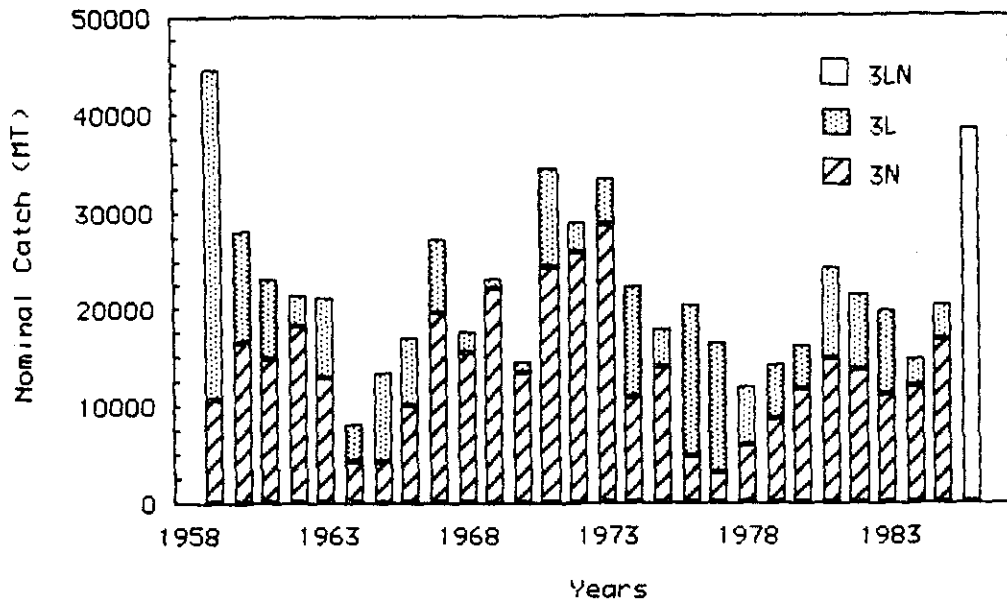


Fig. 1: Nominal catches of redfish from Divisions 3LN, 1959-1986. (1985 and 1986 are provisional)

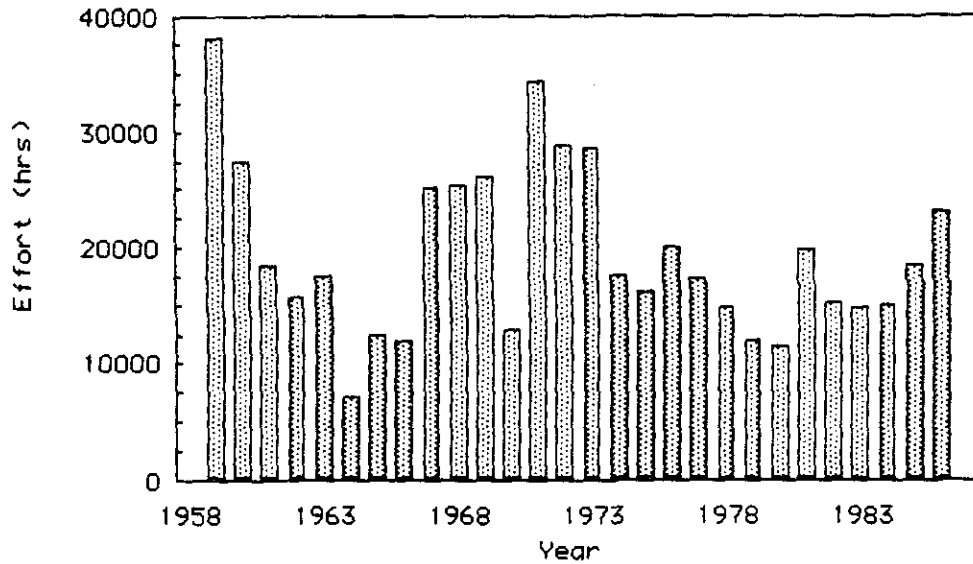


Fig. 2: Standardized effort for redfish in Divisions 3LN, 1959-1986. (1985 and 1986 are provisional)

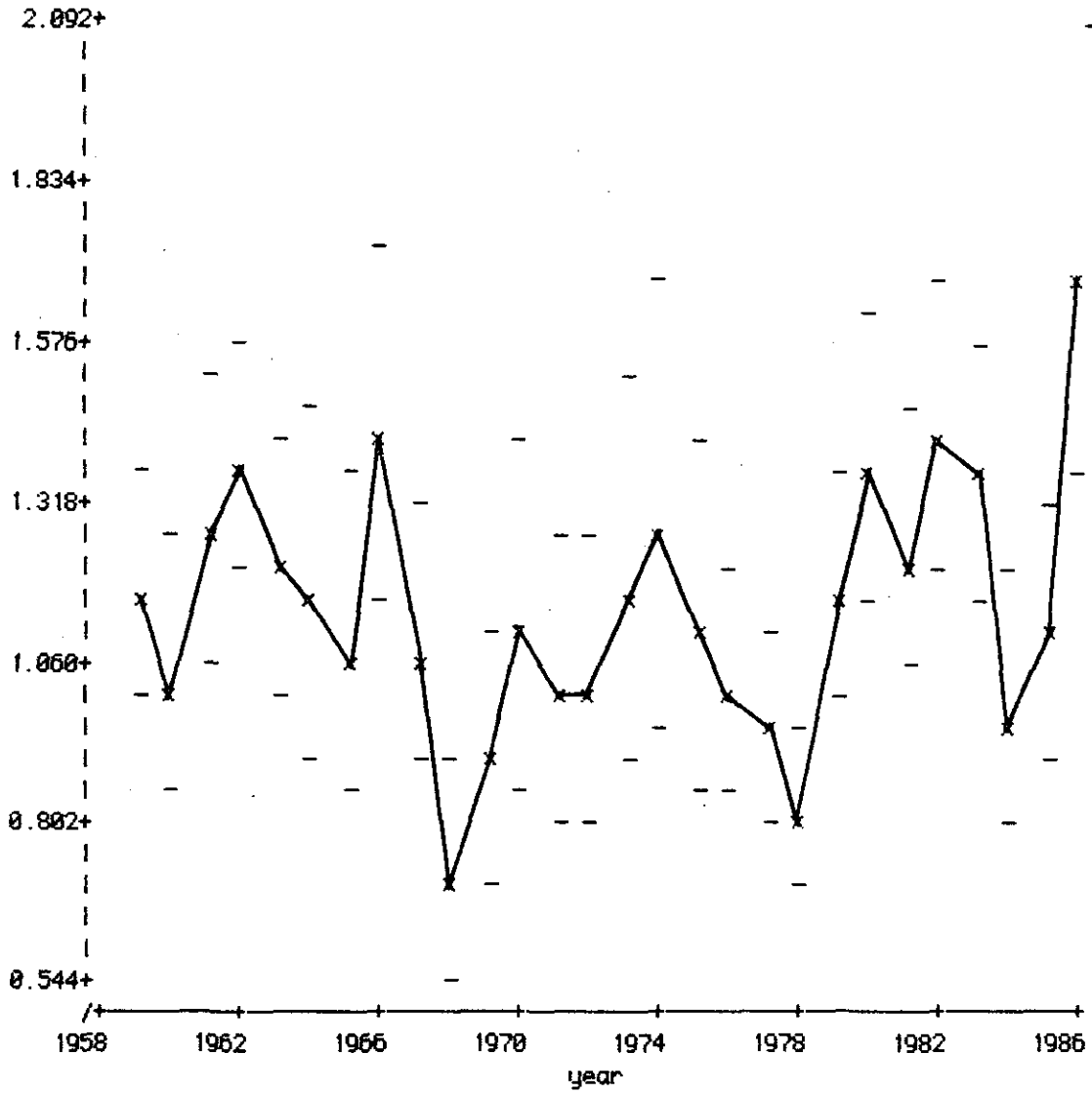


Figure 3: Plot of catch rates for redfish in NAFO Divisions 3LN in the period 1959-1986 as derived using a multiplicative model (1985 and 1986 are preliminary).

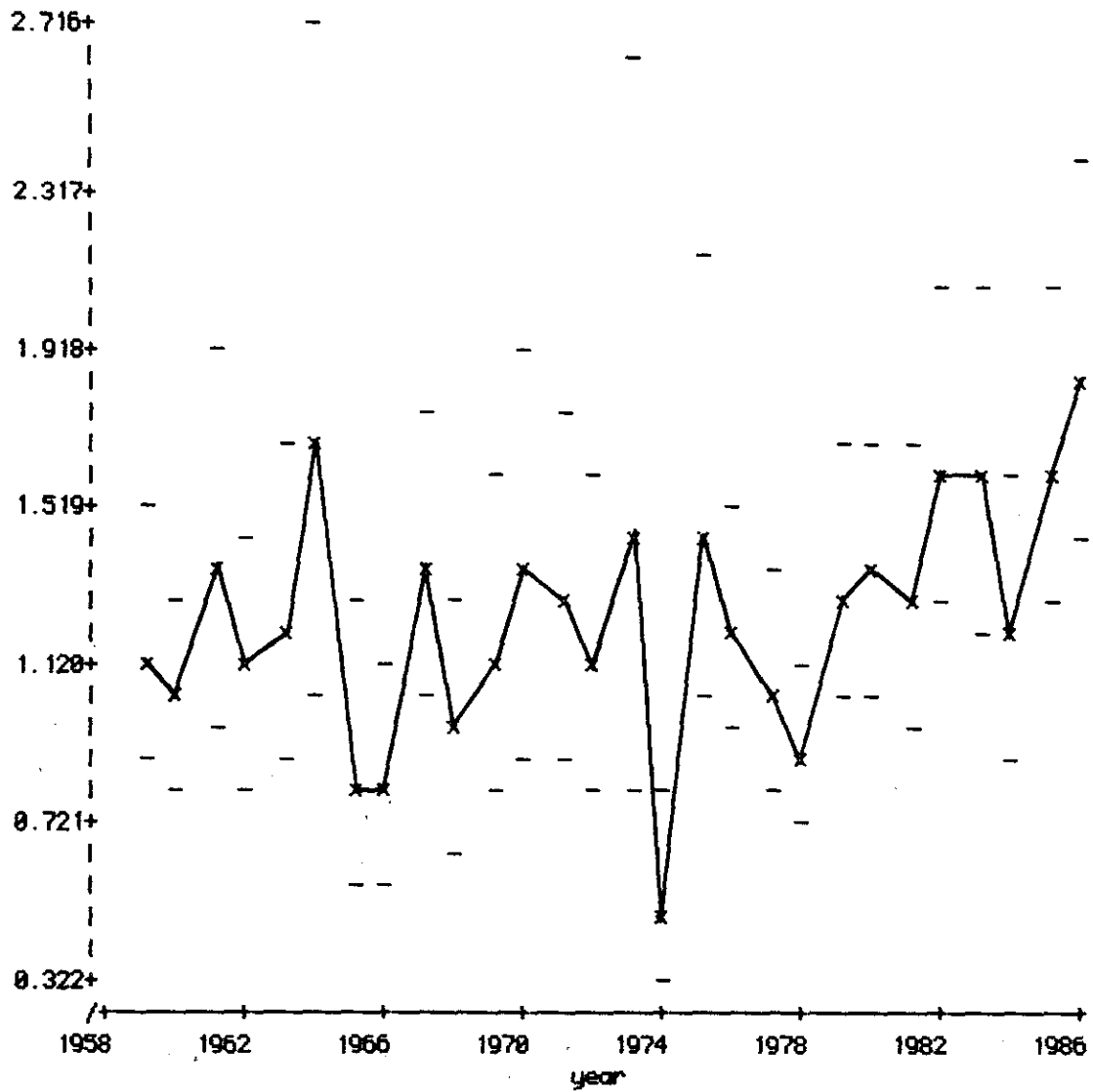


Figure 4: Plot of catch rates for redfish in NAFO Division 3L in the period 1959-1986 as derived using a multiplicative model (1985 and 1986 are preliminary).

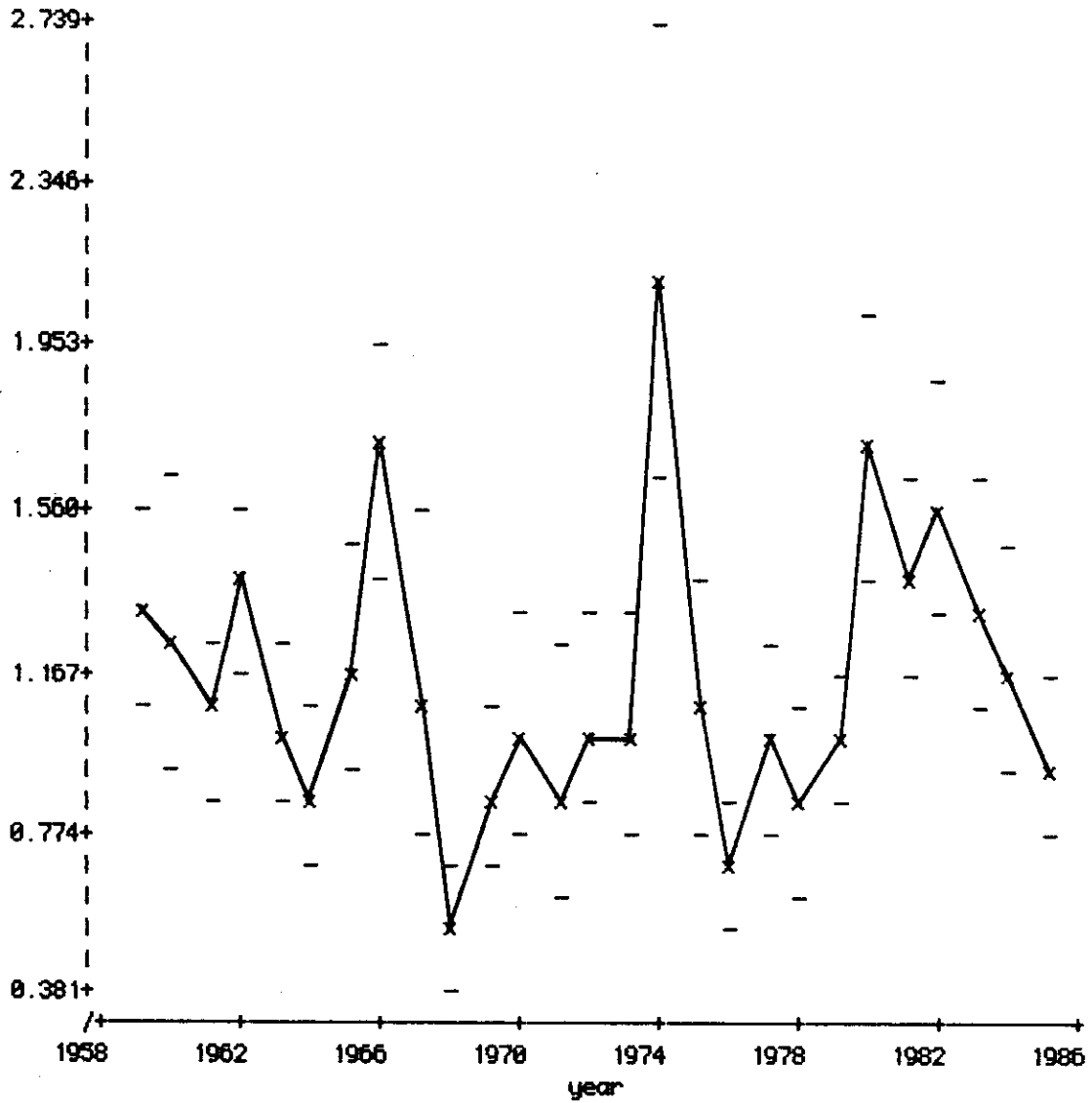


Figure 5: Plot of catch rates for redfish in NREFO Division 3N in the period 1959-1985 as derived using a multiplicative model (1985 is preliminary).

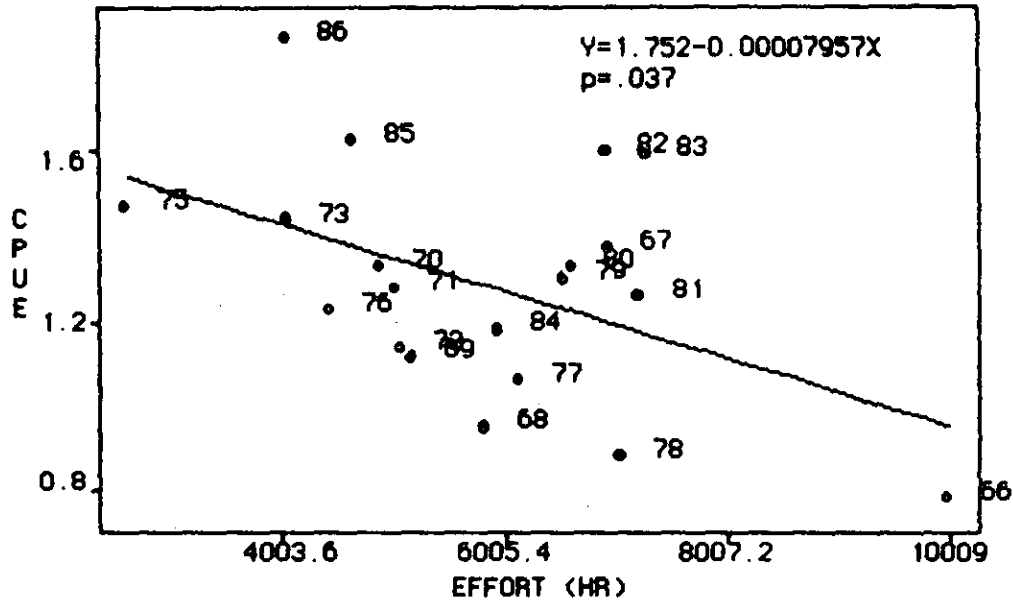


Figure 6a: Regression of standardized CPUE on standardized effort lagged 8 years for redfish in NAFO Division 3L.

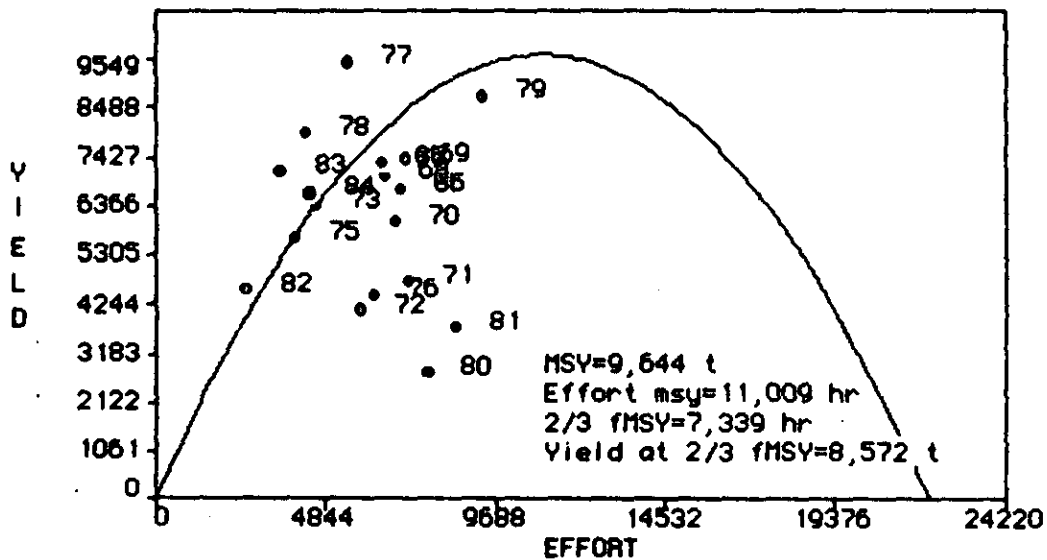


Figure 6b: Equilibrium curve derived from regression above showing unlagged yield and effort values.

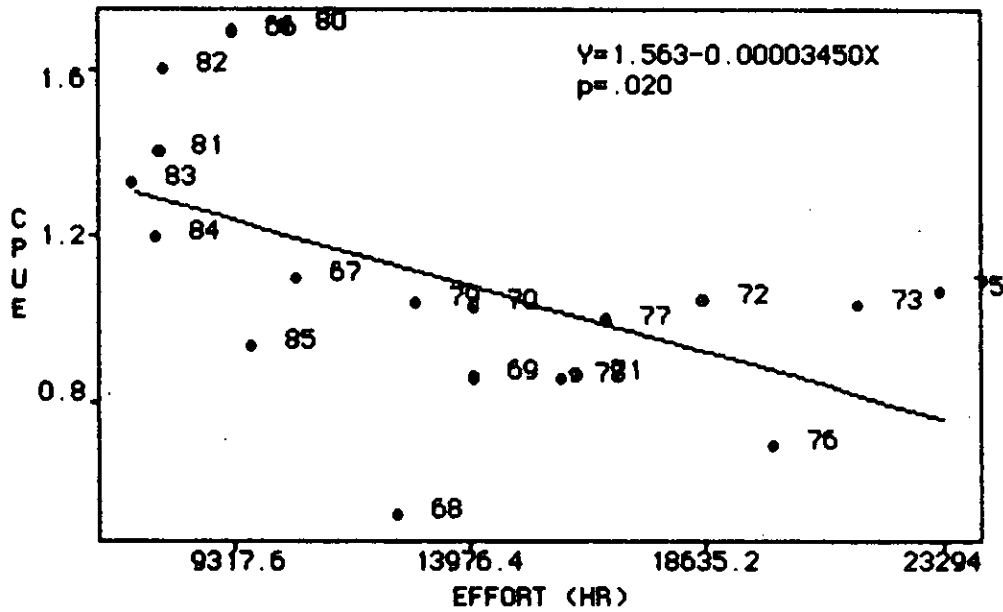


Figure 7a: Regression of standardized CPUE on standardized effort lagged 8 years for redfish in NAFO Division 3N.

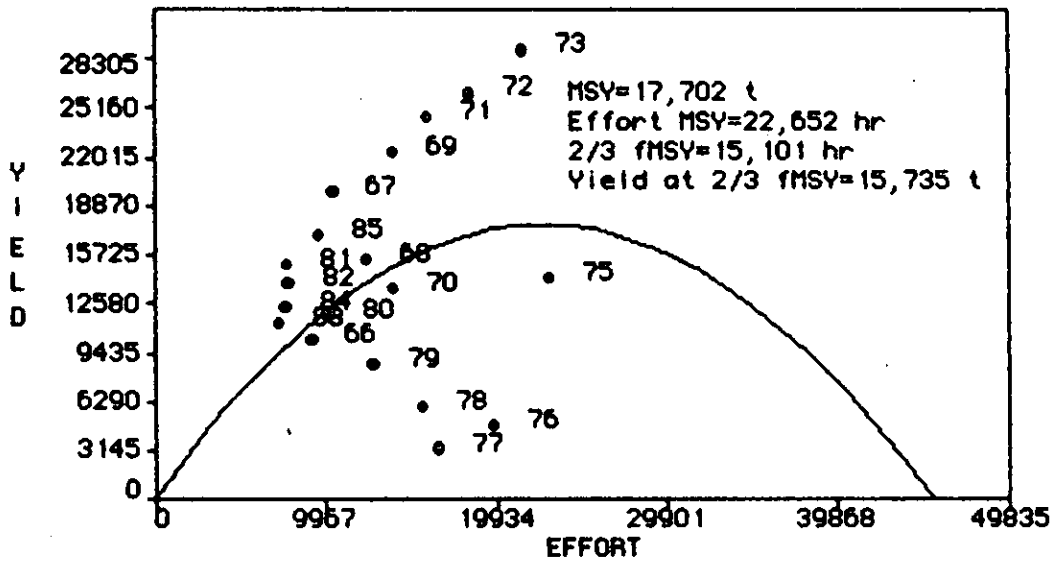


Figure 7b: Equilibrium curve derived from regression above showing unlagged yield and effort values.



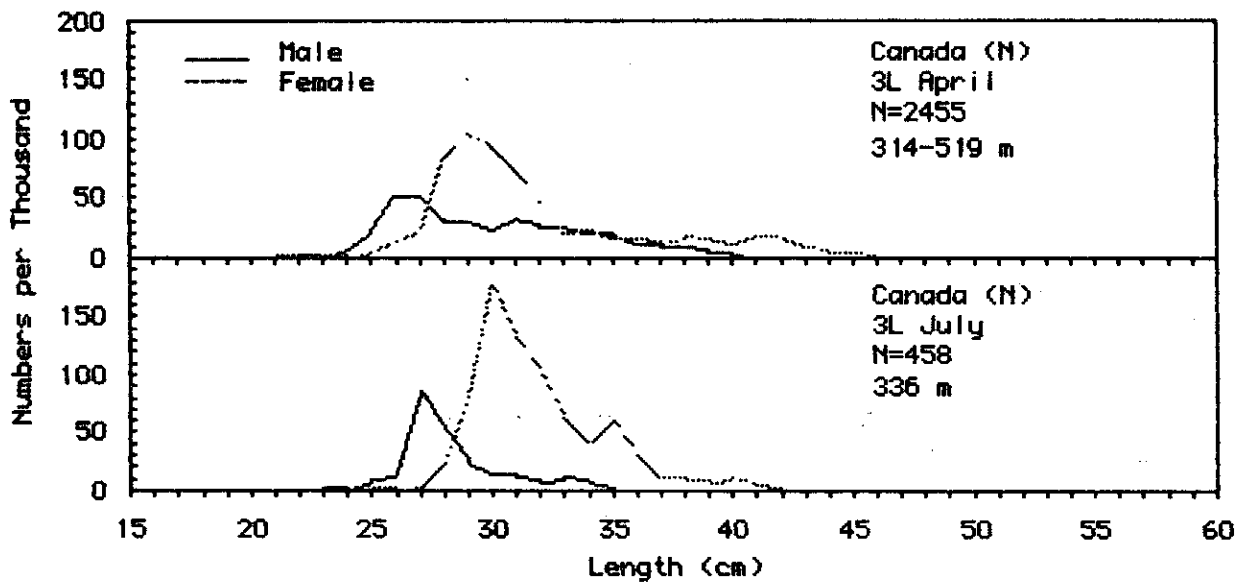


Fig. 8: Commercial length frequencies of redfish caught by Canada in NAFO Divisions 3LN in 1986 (port sampling).

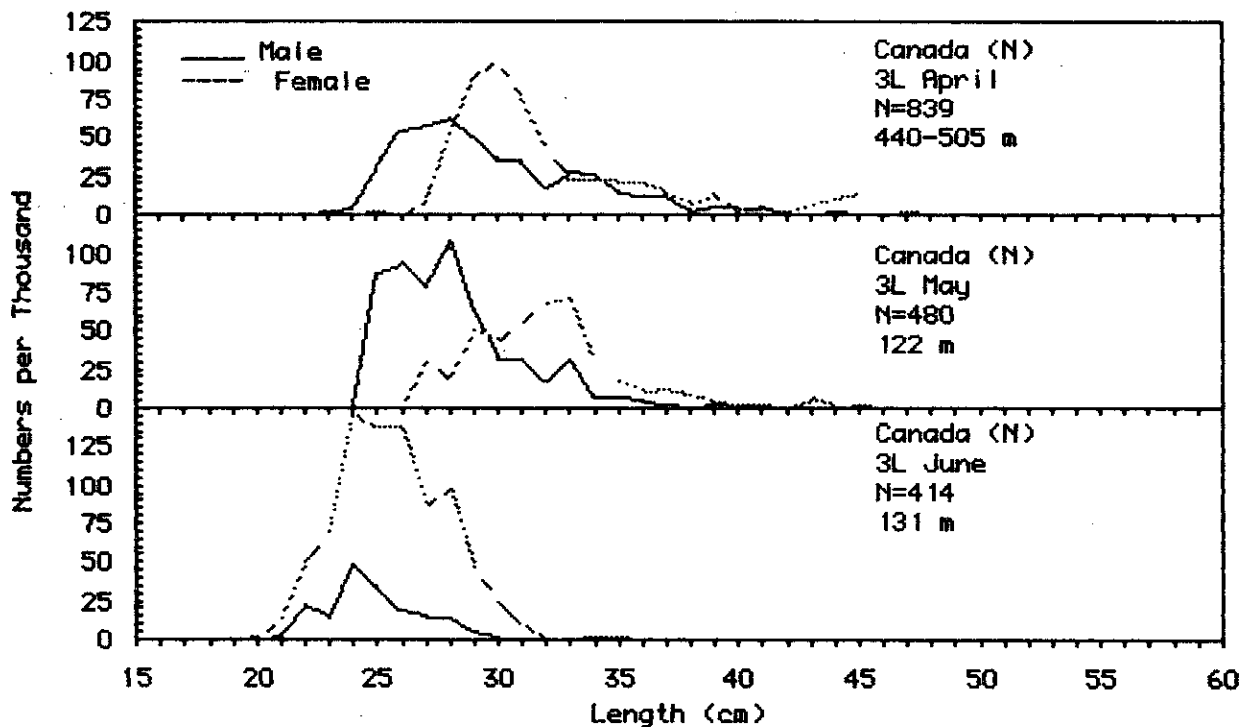


Fig. 9: Commercial length frequencies of redfish caught by Canada in NAFO Divisions 3LN in 1986 (sea sampling).

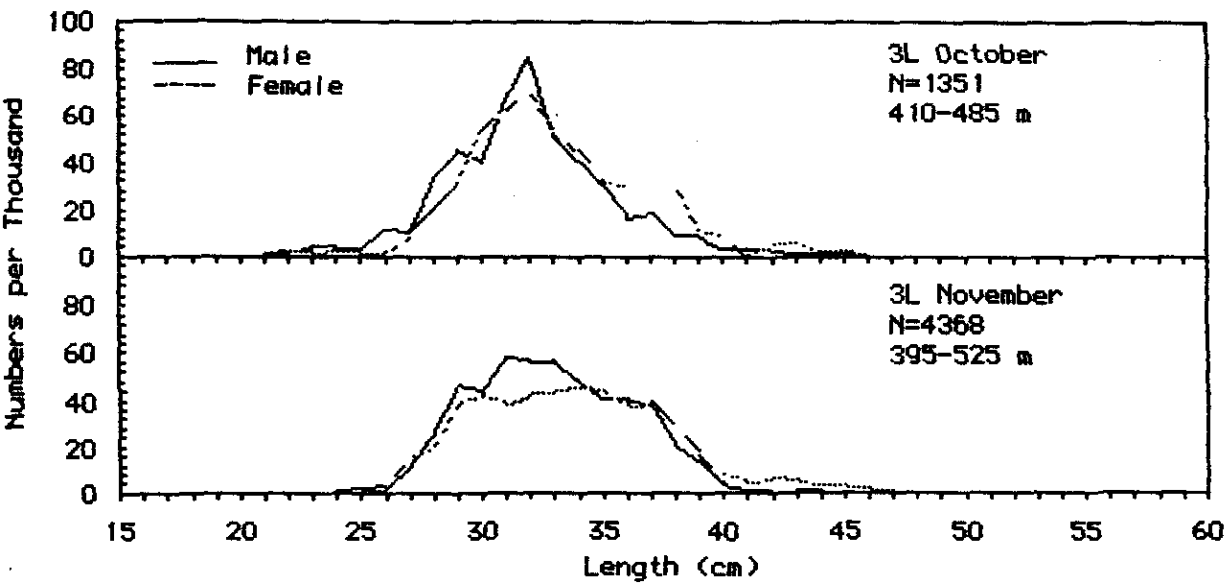


Fig. 10: Commercial length frequencies of redfish caught by the German Democratic Republic in Divisions 3LN in 1985 (sea sampling).