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An assessment of Redfish in NAFO Divisions 3LN

by

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Introduction

The average reported nominal catch for this fishery for the period 1959-1985 was about 21,000 t. During this period catches have been as high as 45,000 t (1959) but have never been lower than the 8,000 t taken in 1964 (Table 1, Fig. 1). From 1980 to 1985 between 60%-80% of the total was taken in Div. 3N. Over this period catches averaged 19,000 t. In 1986, reported landings doubled to 43,000 t with 65% taken in Div. 3L. This increase was due to the greater participation of EEC-Portugal in both Div. 3L (13,000 t) and Div. 3N (8,000 t)(Table 2). The USSR, which had taken the majority of its catch from Div. 3N since 1978, also diverted the major portion of its fishery to Div. 3L in 1986. Catches increased again in 1987 to the highest reported historically at 71,000 t. This is attributed to further increases by EEC-Portugal in Div. 3L (6,000 t more than 1986), increases by USSR (8,000 t) and substantial catches by South Korea (16,000 t). In 1988, landings declined to about 45,000 t and were split evenly between both divisions. Preliminary reported statistics indicate that 32,000 t were taken in 1989 (60% from Div. 3L) and 25,000 t in 1990 (60% in Div. 3L).

Canadian surveillance estimates for countries fishing in the Regulatory area who are not members of NAFO and have not reported statistics indicate that total catches may have been as much as 78,000 t in 1987, 53,000 t in 1988, 34,000 t in 1989 and 29,000 t in 1990 (Table 3). From 1980 to 1990 the TAC for this stock has been 25,000 t. The TAC for 1991 is 14,000 t. The TAC has been exceeded in every year from 1986 to 1990.

From the monthly pattern of reported catches (Table 4) the fishery is prosecuted throughout the year in Div. 3L and Div. 3N. A tabulation of the of the catches for each division by gear type since 1976 (Table 5) shows the bottom trawl is the predominant method of capture. From 1986 to 1988, midwater trawling has accounted for about one third of the catch in each division. In 1989, the majority of the catch was accounted for in Div. 3L (62%) and in Div. 3N (80%) by midwater trawling.

Commercial Fishery Data

Catch and Effort

Catch and effort data were obtained from 1959 to 1988 from ICNAF/NAFO Statistical Bulletins and were combined with provisional 1989 NAFO data and preliminary Canadian data for 1990. In addition to this, data available in Portuguese research reports for 1989 (Avila de Melo at al, MS 1990) and 1990 (Godinho et al, MS 1991) from the annual Portuguese sampling program were also incorporated into this database. Only those data where redfish comprised more than 50% of the total catch were selected for further analysis.

The catch/effort data were analysed with a multiplicative model (Gavaris 1980) to derive a standardized catch rate series in tons per hour. Effects included in the model were a combination country-gear-tonnage class category type (CGT), NAFO division, month, and a category type representing the amount of bycatch associated with each observation, consistent with last years assessment (Power and Atkinson, MS 1990). In the usual practise, catch or effort data of less than 10 units were eliminated prior to analysis as were data where there was less than five samples from any one category type except year. An unweighted regression was run because of unknown percentages of prorating prior to 1984.
The data were analysed for each division separately because of different trends in the catch rate series in recent years, which violates a basic assumption of the model if the data are combined.

A preliminary analysis of Div. 3L data revealed four outliers that were eliminated. Residual plots (Fig. 2) for the final run of the regression did not show any pattern to suggest the model was inappropriate. The regression was significant ($p < .05$), explaining 64% of the variation in catch rates (Table 6). All category types were significant ($p < .05$). For the year category type, the estimated coefficients for 1964 and 1986 are the only two that are different from 1959 (within 2 s.e.). The standardized catch rate series (Table 8, Fig. 4) while showing much within year variability indicates a gradual increase from 1959 to 1964. There is a trend of decline to 1978 except for the large increase in 1973 and equally large decrease in 1974. The rate increased in 1979 and have remained relatively stable to 1990.

A preliminary analysis of Div. 3N catch rate data revealed three outliers that were not used. Residual plots for the final regression (Fig. 3) did not reveal any disturbing patterns. The regression was significant ($p < .05$), explaining 67% of the variability in the CPUE data (Table 7). All category types were significant except for month ($.10 < p < .20$) For the year category type only 1965, 1966, 1974, 1980, 1982 and 1987 are significantly different from 1959 (within 2 s.e.).

The standardized catch rate series (Table 9, Fig. 4) shows much within year variability over time. There is a general trend of increase to 1967. In 1968 the catch rate dropped substantially. This was followed by a period of increase to the same level as the 1967 to 1969 rates. Catch rate dropped sucessively in 1975 and 1976 to a rate comparable to 1968. From 1976 to 1982 catch rate rose to a level similar to 1967-1969. Since 1982 the rates decreased yearly until 1987, a year comparable to 1968. There was a dramatic increase experienced in 1988 followed by three sucessive years of decline to 1990, the lowest rate historically. However, the 1990 estimate is based on one CPUE value with a low associated catch (41 t).

Effort calculated using the standardized catch rates show a decrease in both Div. 3L and Div. 3N in recent years, consistent with the decline in catches (Fig. 5).

Since the multiplicative analyses on Div. 3L and Div. 3N CPUE data indicated there was generally no contrast in the estimated catch rate series over time, general production analyses were not considered appropriate. The results of previous attempts for Div. 3L (NAFO Sci. Coun. Rep., 1987) and for Div. 3N (NAFO Sci. Coun. Rep., 1988) have been viewed with little confidence.

Catch at Age

Catch at age and mean weight at age estimated from USSR sampling (Vaskov and Oganin, MS 1991) indicate ages 7-8 dominated the catch in 1990. These 1982-83 year classes comprised 80% of the catch in numbers and 72% of the catch in weight.

Length compositions from the Portuguese fishery in Div. 3L (Godhino et al., MS 1991) indicate the dominant size in the catch was between 26-31 cm for both males and females. Limited sampling in Div. 3N suggest the dominant size range was 22-27 cm. Length

frequencies available from Canadian sampling from Div. 3L indicate the majority of the catch was composed of 27-32 cm for males and 29-37 cm for females (Fig. 6). Limited sampling of the Spanish fishery in Div. 3N (Vázquez et al., MS 1991) indicates sizes 22-26 cm were dominant.

Research Survey Data

A number of stratified-random surveys have been conducted by Canada in Div. 3L in various years and seasons from 1978 to 1990 in which strata up to a maximum of 732 m (400 fathoms) were sampled. Although these surveys were conducted at various times of the year throughout the period, they provide an indication of relative abundance and dynamics of the population. The design of the surveys was based on the stratification scheme for Div. 3LN in Fig 15.

Generally these surveys confirm that the most dense concentrations were in strata greater than 367 m (Table 10-11). Although these surveys do not provide a consistent time series, estimates of density in 1990 were the lowest observed over the time period in terms of mean number and weight (kg.) per tow (Fig. 7).

An interesting occurance comes from the estimates of density from seasonal surveys conducted in 1985 and 1990. The stratified mean density increases progressing from winter through summer and subsequently decreases in the fall to a level comparable to the winter density. It is unclear whether this may related to migration or avaliability to the trawl.

USSR bottom trawl surveys in Div. 3L (Power and Chumakov, MS 1991) indicate that from 1984 to 1990 there has been a steady decline in density in terms of mean number and mean weight per standard tow. In Div. 3N , although there are still some rather dynamic changes over this period, there is an indication of a general decline. This is evident in both the mean number and weight per standard tow. A comparison of Canadian and USSR bottom trawl surveys in Div. 3L indicate a decline in density estimates in terms of stratified mean number (Fig. 8) and weight (Fig. 9) from 1984 to 1990.

The USSR have also conducted an acoustic survey in Div. 3LN concurrent with the trawl survey since 1987. Estimates of total abundance and biomass from the trawl-acoustic surveys are as follows (from Vaskov and Oganin, MS 1991, Table 1):

Year	Abundance ($x10^{-6}$)	Biomass ('000 t)
1987[a]	510.8	135.0
1988	822.2	158.1
1989	145.2	29.2
1990	139.3	39.6

[a] based assuming that 50% of the resource is in Div. 3LN (see NAFO Sci. Counc. Rep., 1990, Pg. 66)

These indicate a substantial reduction in population size over a very short time period.

Stratified mean number per tow at length from the Canadian surveys in Div. 3L expressed as number per thousand indicate there has been relatively poor recruitment observed since 1978 (Figs. 10-12). The 1990 fall survey indicate a uniform distribution between 21-38 cm. Length compositions from the USSR bottom trawl surveys to Div. 3LN from 1986 to 1990 indicate quite different size distributions in both divisions (Vaskov and Oganin, MS 1991, Fig. 1). The data for Div. 3N suggests the size range sampled over the time period is generally between 18 and 29 cm while in Div. 3L there tends to be a considerable proportion greater than 29 cm. These surveys also indicate a relatively strong pulse of recruitment in Div. 3N in 1989. This was not observed in Div. 3L. In 1990 the size of this recruitment was proportionately smaller.

Illustrative sequential population analyses

Catch at age from 1968 to 1990 for ages 5 to 23 provided in Vaskov and Oganin (MS 1991) were utilized in sequential population analyses for illustrative purposes. Three terminal fishing mortalities (F_t=.25, .50 and .75) used to start the analysis in order to estimate historic population sizes and fishing mortalities for the converged years and to determine the extent of the convergence. Partial recruitment was adopted from the paper mentioned above. The fishing mortality on the oldest age was set to the average (weighted by population numbers) for ages 11-17. Natural mortality was assumed to be 0.1 over all age groups. Fishing mortality on the oldest age in each year was then calculated iteratively from the fishing mortality matrix until there was little difference from the previous iteration.

The results indicate there is less than a 2% difference in the population estimates up to 1984 (Table 12, Fig. 13). According to the SPA the population declined from 1968 (550 million) to 1976 (332 million). Since 1976 the population increased steadily to 1984 at about 590 million. Yields of between 14,000 t and 33,000 t have generated estimated fishing mortalities on ages 11-17 between 0.08 to 0.43 (Table 12, Fig. 14) over the assumed converged portion of the SPA (around 1984). It is interesting to note that regardless what we think the fishing mortality is in 1990 (assume for example it is between the illustrative values 0.25 and 0.75), a fishing mortality of greater than 1.0 is estimated for 1987 and 1988. This corresponds to a period when large amounts of catch were taken from this resource.

Prognosis

The catch rate indices derived for Div. 3L and Div. 3N show much between and within year variability. Some of the changes in mean catch rate between some years are too dramatic to be explained by the population dynamics of such a long-lived species as redfish. The indices indicate stability in Div. 3L and a steady decline in Div. 3N since 1982. USSR Bottom trawl surveys indicate a decline in density to historically low values in 1989 and 1990 for Div. 3L and Div. 3N. The situation in Div. 3L is comfirmed in the surveys conducted by Canada that cover the deep water sufficiently. However, it is tenuous to draw conclusions about stock status given the inherent variability in the bottom trawl surveys. The variability associated with density is mostly due to the patchy and sometimes highly concentrated distribution of redfish. USSR trawl-acoustic estimates of total abundance suggest a rather dynamic reduction in abundance from an average of 140,000 t in 1987-88 to about 34,000 in 1989-1990. Although this appears to be rather dynamic it is consistent with the large removals from this stock in recent years. Using the same approach that was used in the 1990 assessment of this stock, applying $F_{0.1}$ and F_{max} exploitation rates of 11% and 20% respectively to the average total biomass estimate from USSR trawl-acoustic surveys, gives yields of 10,000 t and 18,000 t.

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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	3,677	16,880	20,557	25,000
1986	27,833	14,972	42,805	25,000
1987	30,342	40,949	78,441[b]	25,000
1988	22,317	23,049	53,266[b]	25,000
1989[a]	18,946	12,902	33,648[b]	25,000
1990[a]	15,481	9,305	29,086[b]	25,000
1991				14,000

[a] Provisional.
[b] Includes estimates of catch for non-members who do not report to NAFO.

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

Country	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987[c]	1988[c]	1989[a,c]	1990[a,c]
Canada (M)[b]	18	934	554	1,696	1,003	2,663	52	342	2,597	2,352	5,042	1,095	32
Canada (N)	3,143	4,086	2,412	5,925	5,910	3,800	1,229	1,716	2,235	2,159	1,444	489	947
France (M)	45	4	3	-	-	-	-	-	-	5	-	-	-
France (SP)	8	-	11	-	-	-	-	-	-	-	-	-	-
FRG	-	7	-	-	-	-	89	309	54	-	33	3	-
GDR	918	168	375	509	12	586	849	672	486	696	661	739	643
Japan	522	-	26	128	159	-	105	129	135	114	152	114	151
Poland	-	4	2	-	-	2	1	4	-	-	-	-	-
Portugal	261	265	639	275	125	91	48	4	13,469	19,858	9,867	5,408	4821
Spain	8	-	-	137	25	347	91	192	199	335	94	109	823
UK	-	2	-	-	-	-	-	-	-	-	-	-	-
USSR	1,395	114	345	737	607	1,168	232	309	8,658	4,459	5,004	10,037	7003
Ireland	-	-	-	-	-	-	-	-	-	-	-	-	-
Cuba	-	-	-	-	-	-	-	-	-	-	-	-	-
Kor-S	-	-	-	-	29	-	-	-	-	364	20	952	1061
TOTAL	6,318	5,584	4,367	9,407	7,870	8,657	2,696	3,677	27,833	30,342	22,317	18946	15481

[a] Provisional.
[b] Maritimes and Quebec were combined prior to 1979.
[c] Does not include non-member catches for countries who do not report to NAFO.

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

Country	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987[c]	1988[c]	1989[a,c]	1990[a,c]
Canada (M)[b]	1	198	683	442	-	-	13	311	-	-	1	22	189
Canada (N)	18	1,285	367	63	337	1	2	82	17	21	4	4	11
France (M)	-	25	-	-	-	-	-	-	-	8	-	-	-
FRG	12	-	-	-	-	-	-	-	-	-	-	-	-
GDR	11	-	-	58	-	-	-	-	-	-	-	-	96
Portugal	-	-	-	-	1	-	365	890	8,273	7,854	2,147	600	1234
Japan	-	-	-	-	-	-	81	-	12	51	-	39	4
Romania	-	9	-	-	-	-	-	-	-	-	-	-	-
Spain	1	-	14	239	278	875	239	2,881	1,393	132	581	224	316
UK	-	-	-	-	-	-	-	-	-	-	-	-	-
USSR	4,532	5,904	8,944	12,762	10,414	7,844	9,045	10,576	2,227	14,397	6,735	941	359
Cuba	1,150	1,062	1,644	1,309	2,621	2,370	2,320	2,055	2,429	2,433	2,483	2,869	2456
USA	-	-	11	-	-	-	-	85	4	-	-	-	-
Kor-S	-	-	-	-	26	-	-	-	617	16,053	11,098	8203	4640
TOTAL	5,725	8,483	11,663	14,873	13,677	11,090	12,065	16,880	14,972	40,949	23,049	12902	9305

[a] Provisional.
[b] Maritimes and Quebec were combined prior to 1979.
[c] Does not include non-member catches for countries who do not report to NAFO.

Table 3. Canadian surveillance estimates of redfish catch in Div. 3LN from 1987-1990 for countries who are not members of NAFO and have not reported their catches.

	ESTIMATED CATCH			
COUNTRY	1987	1988	1989	1990
Caymen Islands	4500	3000	0	200
Malta	0	0	300	1000
Panama	2650	3900	1500	1500
St. Vincents	0	1000	0	1650
Total	7150	7900	1800	8000

Table 4a. Nominal catches (t) of redfish in Div. 3L by month and year.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
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	165	41	78	354	866	441	408	3,677
1986	423	845	3,470	7,266	3,662	503	975	2,196	544	3,964	2,166	1,819	27,833
1987	2,439	1,631	5,306	1,423	1,765	75	1,233	3,877	3,285	4,215	3,712	1,381	30,342
1988	2,856	1623	865	1466	471	1,213	2,776	4,800	1,628	1,869	682	2,068	22,317
1989[a]	786	4,381	4,259	891	1,203	469	1,647	1,311	832	1,151	1,002	62	17,994

[a]Provisional.(Does not include catch of South Korea)

Table 4b. Nominal catches (t) of redfish in Div. 3N by month and year.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
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	1,668	420	1,665	676	784	541	230	1,223	16,880[a]
1986	392	665	406	534	454	915	4,392	81	1,196	110	4,131	1,696	14,972
1987	3,787	3,118	1,885	2,203	2,698	2,383	4,339	6,280	7,287	2,431	1,004	3,534	40,949
1988	662	648	815	841	952	1,295	2,327	4,505	3,390	1,419	3,453	2,742	23,049
1989[b]	45	20	48	4	117	1060	889	1,817	220	188	227	64	4,699

[a]Includes a catch of 1 t in month 'unknown.'
[b]Provisional.(Does not include catch of South Korea)

Table 5. Breakdown of catches by gear type for redfish in Div. 3LN.

	3L				3N				
Year	Bottom trawl	MW trawl	Gillnets	Misc	Bottom trawl	MW trawl	Gillnets	Misc	Total
1976	9,450	6,224	297	-	1,715	2,826	-	-	20,512
1977	7,116	5,724	609	3	2,489	555	20	-	16,516
1978	3,283	2,884	151	-	4,858	867	-	-	12,043
1979	3,134	2,381	69	-	8,371	112	-	-	14,067
1980	3,920	314	133	-	9,197	2,463	3	-	16,030
1981	8,534	650	223	-	9,097	5,774	2	-	24,280
1982	7,259	466	145	-	7,675	6,001	1	-	21,547
1983	8,107	308	238	4	7,925	3,165	-	-	19,747
1984	2,241	237	218	-	3,298	8,767	-	-	14,761
1985	3,242	307	128	-	10,426	6,453	-	1	20,557
1986	18,964	8,624	122	123	10,423	3,405	-	1,144	42,805
1987	25,294	4,441	276	331	32,391	8,527	-	31	71,291
1988	15,435	6,722	105	55	16,740	6,269	17	23	45,366
1989	6,589	10,922	449	34	928	3,746	-	25	22,693[a]

[a]Provisional.(Does not include catch of South Korea)

Table 6. Anova results and regression coefficients from a multiplicative model to derive a standardized catch rate series for redfish in NAFO Div. 3L.

REGRESSION OF MULTIPLICATIVE MODEL

MULTIPLE R,..... 0.799
MULTIPLE R SQUARED,..... 0.638

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	2.478E1	2.478E1	
REGRESSION	73	1.382E2	1.893E0	10.514
CGT: TYPE 1	27	6.005E1	2.224E0	12.354
MONTH: TYPE 2	11	9.598E0	8.725E-1	4.847
PCT : TYPE 3	4	1.686E1	4.215E0	23.416
YEAR : TYPE 4	31	1.037E1	3.346E-1	1.859
RESIDUALS	436	7.849E1	1.800E-1	
TOTAL	510	2.414E2		

REGRESSION COEFFICIENTS

CATEGORY	CODE	VARIABLE	COEFFICIENT	STD. ERROR	NO. OBS.
1	3125	INTERCEPT	0.005	0.158	510
2	6				
4	95				
5	59				
1	2114	1	-0.591	0.181	9
	2125	2	-0.087	0.172	8
	2155	3	-0.031	0.194	6
	3114	4	-0.395	0.163	15
	3124	5	-0.042	0.154	9
	3154	6	-0.450	0.209	5
	3155	7	0.192	0.110	25
	10127	8	-0.647	0.209	5
	11115	9	-0.417	0.190	10
	11116	10	-0.273	0.197	8
	11125	11	0.053	0.105	22
	11126	12	0.062	0.188	11
	11127	13	0.004	0.122	20
	14126	14	-0.333	0.167	8
	14127	15	0.756	0.210	11
	16127	16	0.009	0.161	27
	17116	17	-0.718	0.161	10
	17126	18	-0.776	0.163	9
	17127	19	0.265	0.159	9
	20114	20	-1.165	0.178	11
	20116	21	-0.137	0.195	11
	20127	22	0.371	0.087	56
	20145	23	1.291	0.306	12
	20157	24	0.545	0.088	38
	27125	25	0.153	0.085	36
	27126	26	0.344	0.204	5
	27157	27	1.086	0.209	5
2	1	28	0.190	0.110	29
	2	29	0.249	0.104	33
	3	30	0.397	0.092	46
	4	31	0.452	0.091	49
	5	32	0.139	0.098	33
	7	33	0.139	0.086	55
	8	34	-0.021	0.089	51
	9	35	-0.181	0.093	43
	10	36	-0.014	0.089	48
	11	37	0.063	0.091	45
	12	38	0.186	0.112	24
4	55	39	-0.599	0.094	31
	65	40	-0.595	0.076	45
	75	41	-0.313	0.067	67
	85	42	-0.064	0.058	97
5	60	43	0.200	0.180	13
	61	44	0.461	0.231	7
	62	45	0.123	0.211	10
	63	46	0.337	0.219	9
	64	47	0.604	0.299	3
	65	48	0.494	0.254	5
	66	49	0.049	0.198	13
	67	50	0.347	0.195	19
	68	51	0.171	0.234	7
	69	52	0.194	0.212	7
	70	53	0.220	0.226	8
	71	54	0.177	0.221	12
	72	55	0.049	0.226	6
	73	56	0.503	0.284	3
	74	57	-0.354	0.298	15
	75	58	0.256	0.230	6
	76	59	0.035	0.152	32
	77	60	-0.046	0.158	33
	78	61	-0.231	0.161	27
	79	62	0.150	0.170	24
	80	63	0.122	0.176	18
	81	64	0.154	0.174	18
	82	65	0.254	0.169	23
	83	66	0.295	0.167	20
	84	67	0.116	0.181	15
	85	68	0.285	0.175	19
	86	69	0.352	0.164	30
	87	70	0.122	0.174	19
	88	71	0.050	0.161	34
	89	72	0.255	0.185	15
	90	73	0.287	0.192	16

Table 7. Anova results and regression coefficients from a multiplicative model to derive a standardized catch rate series for redfish in NAFO Div. 3N.

REGRESSION OF MULTIPLICATIVE MODEL

MULTIPLE R..... 0.821
MULTIPLE R SQUARED..... 0.674

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	4.869E1	4.869E1	
REGRESSION	61	8.996E1	1.475E0	10.324
CGT:TYPE 1	15	2.385E1	1.590E0	11.132
MONTH:TYPE 2	11	2.785E0	2.532E-1	1.772
PCT:TYPE 3	4	1.435E1	3.589E0	25.120
YEARS:TYPE 4	31	1.456E1	4.696E-1	3.287
RESIDUALS	305	4.357E1	1.429E-1	
TOTAL	367	1.822E2		

REGRESSION COEFFICIENTS

CATEGORY	CODE	VARIABLE	COEFFICIENT	STD. ERROR	NO. OBS.
1	3125	INTERCEPT	0.346	0.143	367
2	6				
4	95				
5	59				
1	2114	1	-0.313	0.140	17
	3114	2	-0.072	0.115	59
	3124	3	0.080	0.182	6
	4127	4	0.418	0.134	18
	4157	5	0.613	0.131	25
	11115	6	-0.513	0.224	5
	14127	7	0.535	0.216	5
	16127	8	-0.133	0.198	5
	20114	9	-0.853	0.183	8
	20116	10	-0.065	0.180	8
	20127	11	0.689	0.101	79
	20157	12	0.714	0.109	62
	25126	13	0.125	0.168	11
	25127	14	0.678	0.140	24
	27125	15	0.398	0.188	6
2	1	16	-0.294	0.111	27
	2	17	-0.305	0.116	23
	3	18	-0.329	0.110	29
	4	19	-0.224	0.119	22
	5	20	-0.191	0.115	21
	7	21	-0.186	0.095	48
	8	22	-0.151	0.096	48
	9	23	-0.241	0.097	50
	10	24	-0.328	0.108	29
	11	25	-0.232	0.114	23
	12	26	-0.433	0.122	19
4	55	27	-0.672	0.088	33
	65	28	-0.604	0.078	41
	75	29	-0.432	0.072	48
	85	30	-0.299	0.065	57
5	60	31	0.213	0.205	5
	61	32	0.159	0.162	11
	62	33	0.220	0.146	16
	63	34	0.184	0.179	8
	64	35	0.198	0.188	8
	65	36	0.437	0.194	7
	66	37	0.492	0.145	17
	67	38	0.448	0.223	6
	68	39	-0.341	0.232	4
	69	40	-0.019	0.177	8
	70	41	-0.010	0.174	8
	71	42	-0.064	0.247	3
	72	43	-0.004	0.162	10
	73	44	0.175	0.188	8
	74	45	0.521	0.191	7
	75	46	0.298	0.197	6
	76	47	-0.264	0.175	8
	77	48	-0.083	0.197	6
	78	49	-0.062	0.178	8
	79	50	0.079	0.142	17
	80	51	0.377	0.143	16
	81	52	0.242	0.150	17
	82	53	0.423	0.146	16
	83	54	0.124	0.148	15
	84	55	0.050	0.162	12
	85	56	-0.151	0.156	15
	86	57	-0.165	0.164	12
	87	58	0.325	0.133	38
	88	59	0.002	0.146	24
	89	60	-0.313	0.191	7
	90	61	-0.597	0.402	1

Table 8. Standardized catch rate series for Div. 3L as derived from a multiplicative model (1989-90 based on preliminary data).

STANDARDS USED VARIABLE NUMBERS: 3125 6 95

PREDICTED CATCH RATE

YEAR	LN TRANSFORM MEAN	LN TRANSFORM S.E.	RETRANSFORMED MEAN	RETRANSFORMED S.E.	CATCH	EFFORT
1959	0.0054	0.0250	1.087	0.171	34107	31387
1960	0.2051	0.0294	1.324	0.226	11463	8658
1961	0.4669	0.0514	1.701	0.381	8349	4908
1962	0.1284	0.0414	1.219	0.246	3425	2810
1963	0.3429	0.0453	1.507	0.317	8191	5434
1964	0.6096	0.0851	1.929	0.552	3898	2020
1965	0.4990	0.0612	1.748	0.426	9451	5406
1966	0.0540	0.0325	1.136	0.203	6927	6095
1967	0.3527	0.0290	1.535	0.260	7684	5007
1968	0.1766	0.0432	1.278	0.263	2348	1837
1969	0.1994	0.0359	1.312	0.247	927	707
1970	0.2251	0.0484	1.338	0.291	1029	769
1971	0.1827	0.0416	1.287	0.260	10043	7805
1972	0.0540	0.0458	1.129	0.239	3095	2742
1973	0.5085	0.0737	1.754	0.468	4709	2685
1974	-0.3485	0.0796	0.742	0.206	11419	15386
1975	0.2611	0.0366	1.395	0.265	3838	2751
1976	0.0400	0.0130	1.132	0.129	15971	14112
1977	-0.0408	0.0130	1.044	0.119	13452	12887
1978	-0.2252	0.0131	0.868	0.099	6318	7278
1979	0.1559	0.0158	1.269	0.159	5584	4400
1980	0.1269	0.0155	1.233	0.153	4367	3542
1981	0.1598	0.0155	1.274	0.158	9407	7383
1982	0.2595	0.0126	1.410	0.158	7870	5582
1983	0.3005	0.0142	1.468	0.175	8657	5899
1984	0.1218	0.0173	1.225	0.161	2696	2200
1985	0.2903	0.0151	1.452	0.178	3677	2532
1986	0.3579	0.0121	1.556	0.171	27833	17890
1987	0.1274	0.0159	1.233	0.155	30342	24603
1988	0.0550	0.0126	1.149	0.129	22317	19422
1989	0.2604	0.0190	1.407	0.193	17994	12793
1990	0.2928	0.0218	1.451	0.213	11200	7720

AVERAGE C.V. FOR THE RETRANSFORMED MEAN: 0.170

Table 9. Standardized catch rate series for Div. 3N as derived from a multiplicative model (1989-90 based on preliminary data).

PREDICTED CATCH RATE

YEAR	LN TRANSFORM MEAN	LN TRANSFORM S.E.	RETRANSFORMED MEAN	RETRANSFORMED S.E.	CATCH	EFFORT
1959	0.3456	0.0204	1.502	0.214	10478	6974
1960	0.5582	0.0467	1.834	0.393	16547	9023
1961	0.5043	0.0312	1.751	0.307	14826	8466
1962	0.5659	0.0252	1.868	0.295	18009	9641
1963	0.5295	0.0384	1.790	0.348	12906	7212
1964	0.5436	0.0417	1.812	0.367	4206	2321
1965	0.7830	0.0443	2.299	0.479	4042	1758
1966	0.8380	0.0183	2.461	0.332	10047	4083
1967	0.7939	0.0485	2.319	0.505	19504	8409
1968	0.0044	0.0496	1.053	0.232	15265	14503
1969	0.3262	0.0315	1.465	0.258	22142	15110
1970	0.3554	0.0328	1.508	0.271	13359	8861
1971	0.2814	0.0666	1.377	0.350	24310	17658
1972	0.3414	0.0277	1.491	0.247	25838	17335
1973	0.5207	0.0337	1.778	0.324	28588	16079
1974	0.8664	0.0378	2.507	0.484	10867	4335
1975	0.6440	0.0401	2.005	0.398	14033	6999
1976	0.0817	0.0335	1.146	0.208	4541	3961
1977	0.2628	0.0378	1.371	0.264	3064	2235
1978	0.2841	0.0312	1.405	0.247	5725	4074
1979	0.4249	0.0203	1.626	0.231	8483	5216
1980	0.7221	0.0208	2.189	0.315	11663	5328
1981	0.5877	0.0216	1.913	0.280	14873	7776
1982	0.7685	0.0206	2.293	0.328	13677	5965
1983	0.4697	0.0230	1.699	0.257	11090	6529
1984	0.3959	0.0279	1.574	0.261	12065	7665
1985	0.1949	0.0252	1.289	0.204	16880	13094
1986	0.1805	0.0277	1.269	0.210	14972	11797
1987	0.6710	0.0191	2.081	0.287	40949	19674
1988	0.3474	0.0235	1.503	0.229	23049	15339
1989	0.0323	0.0356	1.090	0.204	4699	4311
1990	-0.2512	0.1523	0.774	0.291	7835	10120

AVERAGE C.V. FOR THE RETRANSFORMED MEAN: 0.182

Table 10. Mean number per standard tow from various Canadian surveys in Div. 3L where strata greater than 366 m (200 fathoms) were sampled. Dashes (–) represent unsampled strata. Number of successful sets in brackets. G.A. = GADUS ATLANTICA, W.T. = WILFRED TEMPLEMAN, A.N. = ALFRED NEEDLER.

Stratum	Depth range (m)	Area (sq. n. mi)	Aug 16–Aug 29 1978 (G.A. 12)	Sep 4–Sep 10 1979 (G.A. 25)	May 8–May 13 1980 (G.A. 36)	Sep 18–Sep 26 1981 (G.A. 55)	Jul 26–Sep 3 1984 (W.T. 16–18)	Jan 10–Feb 11 1985–1 (W.T. 22–24)	Apr 17–May 26 1985–2 (W.T. 28–30)	Jul 27–Aug 25 1985–3 (W.T. 32–34)	Oct 9–Nov 18 1985–4 (W.T. 37–39)
345	275–366	1432	68.50(2)	96.75(4)	12.00(4)	46.60(5)	37.80(7)	3.33(3)	3.20(5)	62.29(7)	5.11(9)
346	275–366	865	206.00(2)	126.75(4)	27.00(2)	70.33(3)	263.33(6)	10.00(4)	20.00(2)	91.33(3)	84.40(5)
347	184–274	983	131.67(3)	0.00(2)	0.00(4)	3.96(4)	0.00(6)	0.00(5)	0.40(5)	0.00(3)	0.00(5)
366	184–274	1394	197.00(3)	13.50(2)	9.83(6)	47.67(6)	13.91(11)	0.00(5)	1.33(6)	17.40(5)	17.22(9)
368	275–366	334	2709.00(2)	140.00(3)	24.00(2)	526.50(2)	4379.50(2)	4.50(2)	14.50(2)	320.50(2)	351.50(2)
369	184–274	961	0.00(3)	1.00(2)	0.25(4)	13.75(4)	0.43(7)	0.00(5)	0.20(5)	0.17(6)	0.00(6)
386	184–274	983	115.67(3)	11.50(2)	2.00(4)	11.00(4)	23.13(8)	0.00(5)	0.40(5)	19.60(5)	0.60(5)
387	275–366	718	532.00(2)	595.40(5)	23.67(3)	1748.67(3)	4678.00(3)	102.00(4)	11.33(6)	1807.33(3)	628.00(4)
388	275–366	361	1240.50(2)	2326.33(3)	4.50(2)	464.50(2)	195.00(2)	16.00(3)	20.00(2)	397.00(2)	78.00(2)
389	184–274	821	0.33(3)	0.00(1)	29.50(2)	4.00(3)	21.67(6)	4.00(4)	0.20(5)	1.75(4)	7.40(5)
391	184–274	282	0.00(2)	19.00(2)	4.00(2)	1.50(2)	0.50(2)	0.00(2)	0.00(2)	0.00(2)	12.50(2)
392	275–366	145	–	818.00(3)	27.33(3)	536.50(2)	2811.00(2)	4.00(2)	10.00(2)	131.50(2)	1398.50(2)
729	367–549	186	–	488.00(3)	77.00(1)	1050.00(2)	448.00(2)	3406.00(2)	24.50(2)	1231.00(2)	2720.50(2)
730	550–731	170	1135.00(2)	399.33(3)	295.00(2)	496.50(2)	100.50(2)	816.00(2)	8926.00(2)	347.00(2)	37.50(2)
731	367–549	216	486.00(2)	457.00(3)	325.50(2)	176.00(2)	257.00(2)	80.67(3)	63.00(2)	257.00(2)	502.00(2)
732	550–731	231	85.50(2)	54.00(2)	104.00(2)	53.00(2)	90.00(2)	416.00(2)	141.50(2)	48.00(2)	39.00(2)
733	367–549	468	817.00(2)	1300.67(3)	43.67(3)	1420.50(2)	480.00(4)	1921.67(3)	1147.53(3)	1699.50(2)	727.00(3)
734	550–731	228	1435.50(2)	535.67(3)	1756.00(2)	760.50(2)	557.00(3)	195.50(2)	366.00(2)	912.00(2)	540.00(2)
735	367–549	272	810.50(2)	452.67(3)	39.00(2)	768.00(2)	723.33(3)	10.50(2)	52.50(2)	282.00(2)	232.00(2)
736	550–731	175	163.50(2)	270.33(3)	119.00(1)	84.00(2)	17.00(1)	–	532.50(2)	26.50(2)	222.00(2)
Weighted mean (by area) (incl. strata with 1 sample)			349.30	257.32	64.45	293.48	567.48	174.69	208.71	286.83	187.88
Abundance of surveyed area ($\times 10^{-6}$)			285.64	216.82	54.30	247.28	478.16	144.90	175.86	241.68	158.30

Table 10. (Cont'd.)

Stratum	Depth range (m)	Area (sq. n. mi)	Jan 22–Feb 27 1986–1 (W.T. 42–44)	Nov 13–Nov 30 1986–4 (A.N. 72)	Jan 17–Jan 25 1990–1 (W.T. 90)	Aug 7–Aug 19 1990–3 (W.T. 98)	Oct 18–Nov 18 1990–4 (W.T. 101)
345	275–366	1432	1.33(3)	6.68(4)	0.40(5)	16.33(6)	1.00(5)
346	275–366	865	4.25(4)	22.13(3)	14.67(3)	247.66(7)	67.00(3)
347	184–274	983	1.50(4)	0.00(4)	0.50(4)	1.93(4)	0.00(2)
366	184–274	1394	1.50(2)	5.50(4)	1.00(5)	9.00(4)	0.00(6)
368	275–366	334	7.00(1)	24.90(2)	21.00(2)	1728.57(7)	57.50(2)
369	184–274	961	0.00(3)	4.24(3)	0.00(4)	2.50(4)	0.00(4)
386	184–274	983	0.86(7)	4.10(4)	5.50(4)	1.29(7)	2.00(4)
387	275–366	718	12.00(4)	6.00(2)	135.00(3)	297.70(10)	89.67(3)
388	275–366	361	15.67(3)	–	13.00(2)	183.86(7)	16.00(2)
389	184–274	821	1.50(4)	2.25(4)	0.00(3)	5.33(3)	1.00(3)
391	184–274	282	0.00(3)	18.00(2)	0.50(2)	1.00(5)	0.00(2)
392	275–366	145	9.67(3)	359.50(2)	4.00(2)	146.56(9)	9.00(2)
729	367–549	186	2690.00(2)	1491.22(2)	206.50(2)	328.43(7)	206.50(2)
730	550–731	170	1822.50(1)	–	109.50(2)	183.52(4)	42.00(1)
731	367–549	216	153.00(1)	220.80(1)	68.00(2)	166.83(6)	275.50(2)
732	550–731	231	1694.00(1)	–	68.00(2)	59.44(9)	193.00(2)
733	367–549	468	452.07(2)	–	72.00(2)	490.87(9)	216.00(2)
734	550–731	228	451.00(2)	–	142.93(2)	271.60(5)	42.00(2)
735	367–549	272	–	153.50(2)	223.00(2)	603.51(6)	195.00(1)
736	550–731	175	–	24.74(2)	208.50(2)	93.50(6)	281.00(2)
Weighted mean (by area) (incl. strata with 1 sample)			146.43	49.90	33.92	156.20	45.91
Abundance of surveyed area ($\times 10^{-6}$)			118.46	36.58	28.58	131.6	38.68

Table 11. Mean weight (kg) per standard tow from various Canadian surveys in Div. 3L where strata greater than 366 m (200 fathoms) were sampled. Dashes (-) represent unsampled strata. Number of successful sets in brackets. G.A. = GADUS ATLANTICA, W.T. = WILFRED TEMPLEMAN, A.N. = ALFRED NEEDLER.

Stratum	Depth range (m)	Area (sq. n. mi)	Aug 16–Aug 29 1978 (G.A. 12)	Sep 4–Sep 10 1979 (G.A. 25)	May 8–May 13 1980 (G.A. 36)	Sep 18–Sep 26 1981 (G.A. 55)	Jul 26–Sep 3 1984 (W.T. 16–18)	Jan 10–Feb 11 1985–1 (W.T. 22–24)	Apr 17–May 26 1985–2 (W.T. 28–30)	Jul 27–Aug 25 1985–3 (W.T. 32–34)	Oct 9–Nov 18 1985–4 (W.T. 37–39)
345	275–366	1432	51.08(2)	78.92(4)	8.50(4)	35.80(5)	31.10(7)	0.83(3)	3.14(5)	44.41(7)	3.32(9)
346	275–366	865	151.18(2)	80.88(4)	14.75(2)	64.83(3)	163.33(6)	5.80(4)	18.25(2)	67.50(3)	61.50(5)
347	184–274	983	42.52(3)	0.00(2)	0.00(4)	1.32(4)	0.00(6)	0.00(5)	0.00(5)	0.00(3)	0.00(5)
366	184–274	1394	35.42(3)	1.82(2)	2.00(6)	25.01(6)	1.14(11)	0.00(5)	0.05(6)	4.00(5)	5.33(9)
368	275–366	334	1154.53(2)	61.72(3)	7.25(2)	176.75(2)	1915.75(2)	2.00(2)	5.35(2)	181.75(2)	151.50(2)
369	184–274	961	0.00(3)	0.80(2)	0.25(4)	2.40(4)	0.00(7)	0.00(5)	0.20(5)	0.17(6)	0.00(6)
386	184–274	983	62.99(3)	11.34(2)	1.25(4)	8.50(4)	14.18(8)	0.00(5)	0.21(5)	15.30(5)	0.44(5)
387	275–366	718	203.16(2)	286.77(5)	6.83(3)	572.00(3)	1972.33(3)	71.50(4)	4.68(6)	633.03(3)	279.17(4)
388	275–366	361	262.18(2)	562.10(3)	1.10(2)	145.50(2)	63.00(2)	14.17(3)	7.65(2)	130.50(2)	30.75(2)
389	184–274	821	0.03(3)	0.00(1)	9.25(2)	2.33(3)	8.83(6)	0.50(4)	0.01(5)	0.63(4)	1.46(5)
391	184–274	282	0.00(2)	6.39(2)	0.75(2)	0.08(2)	0.03(2)	0.00(2)	0.00(2)	0.00(2)	4.00(2)
392	275–366	145	–	304.24(3)	7.50(3)	146.75(2)	1118.44(2)	1.40(2)	1.50(2)	45.75(2)	451.50(2)
729	367–549	186	–	199.53(3)	24.00(1)	413.50(2)	203.43(2)	1249.00(2)	7.25(2)	560.00(2)	1213.50(2)
730	550–731	170	509.74(2)	238.85(3)	96.75(2)	263.25(2)	57.25(2)	408.00(2)	4710.00(2)	195.50(2)	19.75(2)
731	367–549	216	289.42(2)	255.57(3)	112.25(2)	69.00(2)	120.00(2)	29.17(3)	16.00(2)	121.50(2)	275.50(2)
732	550–731	231	47.44(2)	29.94(2)	30.25(2)	30.50(2)	49.25(2)	217.50(2)	56.00(2)	33.00(2)	22.00(2)
733	367–549	468	460.96(2)	647.34(3)	18.83(3)	754.00(2)	280.63(4)	895.28(3)	623.43(3)	1023.50(2)	353.76(3)
734	550–731	228	1084.93(2)	357.43(3)	1187.45(2)	430.64(2)	350.00(3)	119.75(2)	146.75(2)	598.50(2)	387.13(2)
735	367–549	272	603.98(2)	252.05(3)	14.50(2)	348.00(2)	442.00(3)	4.50(2)	20.50(2)	186.00(2)	127.75(2)
736	550–731	175	61.59(2)	116.73(3)	28.00(1)	42.25(2)	11.00(1)	–	152.00(2)	17.25(2)	107.75(2)
Weighted mean (by area) (incl. strata with 1 sample)			163.53	114.57	34.42	124.40	255.47	78.70	107.33	138.31	88.81
Biomass of surveyed area (t)			133724	96536	29001	104817	215259	65282	90432	116543	74828

Table 11. (Cont'd.)

Stratum	Depth range (m)	Area (sq. n. mi)	Jan 22–Feb 27 1986–1 (W.T. 42–44)	Nov 13–Nov 30 1986–4 (A.N. 72)	Jan 17–Jan 25 1990–1 (W.T. 90)	Aug 7–Aug 19 1990–3 (W.T. 98)	Oct 18–Nov 18 1990–4 (W.T. 101)
345	275–366	1432	0.04(3)	5.21(4)	0.02(5)	8.66(6)	0.53(5)
346	275–366	865	1.08(4)	16.80(3)	3.22(3)	172.19(7)	38.98(3)
347	184–274	983	0.08(4)	0.00(4)	0.06(4)	0.63(4)	0.00(2)
366	184–274	1394	0.01(2)	2.13(4)	0.04(5)	2.56(4)	0.00(6)
368	275–366	334	1.70(1)	7.25(2)	5.10(2)	737.95(7)	14.25(2)
369	184–274	961	0.00(3)	0.71(3)	0.00(4)	0.79(4)	0.00(4)
386	184–274	983	0.45(7)	0.34(4)	3.21(4)	0.09(7)	0.05(4)
387	275–366	718	8.00(4)	3.10(2)	75.92(3)	115.68(10)	35.05(3)
388	275–366	361	5.33(3)	–	2.85(2)	47.46(7)	3.30(2)
389	184–274	821	0.15(4)	0.84(4)	0.00(3)	0.85(3)	0.54(3)
391	184–274	282	0.00(3)	3.50(2)	0.01(2)	0.26(5)	0.00(2)
392	275–366	145	4.10(3)	113.25(2)	2.08(2)	35.49(9)	2.32(2)
729	367–549	186	1118.30(2)	480.88(2)	121.20(2)	175.09(7)	94.00(2)
730	550–731	170	767.81(1)	–	59.68(2)	107.15(4)	25.90(1)
731	367–549	216	69.00(1)	105.60(1)	18.38(2)	66.18(6)	116.86(2)
732	550–731	231	850.50(1)	–	37.75(2)	31.32(9)	118.85(2)
733	367–549	468	238.22(2)	–	30.00(2)	314.42(9)	59.60(2)
734	550–731	228	296.90(2)	–	80.68(2)	164.97(5)	23.00(2)
735	367–549	272	–	63.50(2)	51.22(2)	417.61(6)	70.45(1)
736	550–731	175	–	14.38(2)	65.63(2)	51.32(6)	156.25(2)
Weighted mean (by area) (incl. strata with 1 sample)			68.62	18.51	14.87	80.05	19.66
Biomass of surveyed area (t)			55514	13568	12525	67453	16563

Table 12. Comparisons of illustrative SPA (sequential population analysis) for Div. 3LN based on catch at age available in Vaskov and Oganin (MS 1991). Percentage differences in historic population estimates given relative to F_t=.25.

YEAR	% Difference between F_t=.25 and F_t=.75	$F_{weighted}$ (ages 11-17)	Catch ('000 t)
1968	0	0.084	17.6
1969	0	0.121	23.1
1970	0	0.116	14.4
1971	0	0.165	34.4
1972	0	0.186	28.9
1973	0.04	0.259	33.3
1974	0.12	0.248	22.3
1975	0.14	0.113	17.9
1976	0.17	0.431	20.5
1977	0.23	0.356	16.5
1978	0.35	0.178	12.0
1979	0.60	0.173	14.1
1980	0.86	0.29	16.0
1981	1.03	0.31	24.3
1982	1.30	0.15	21.5
1983	1.84	0.14	19.7
1984	2.17	0.13	14.8
1985	2.53	0.10	20.6
1986	4.51	0.30	42.8
1987	20.08	1.089-1.156	71.3
1988	66.70	1.151-1.456	45.4
1989	114.89	0.463-0.891	31.8
1990	170.16	0.250-0.750	24.8

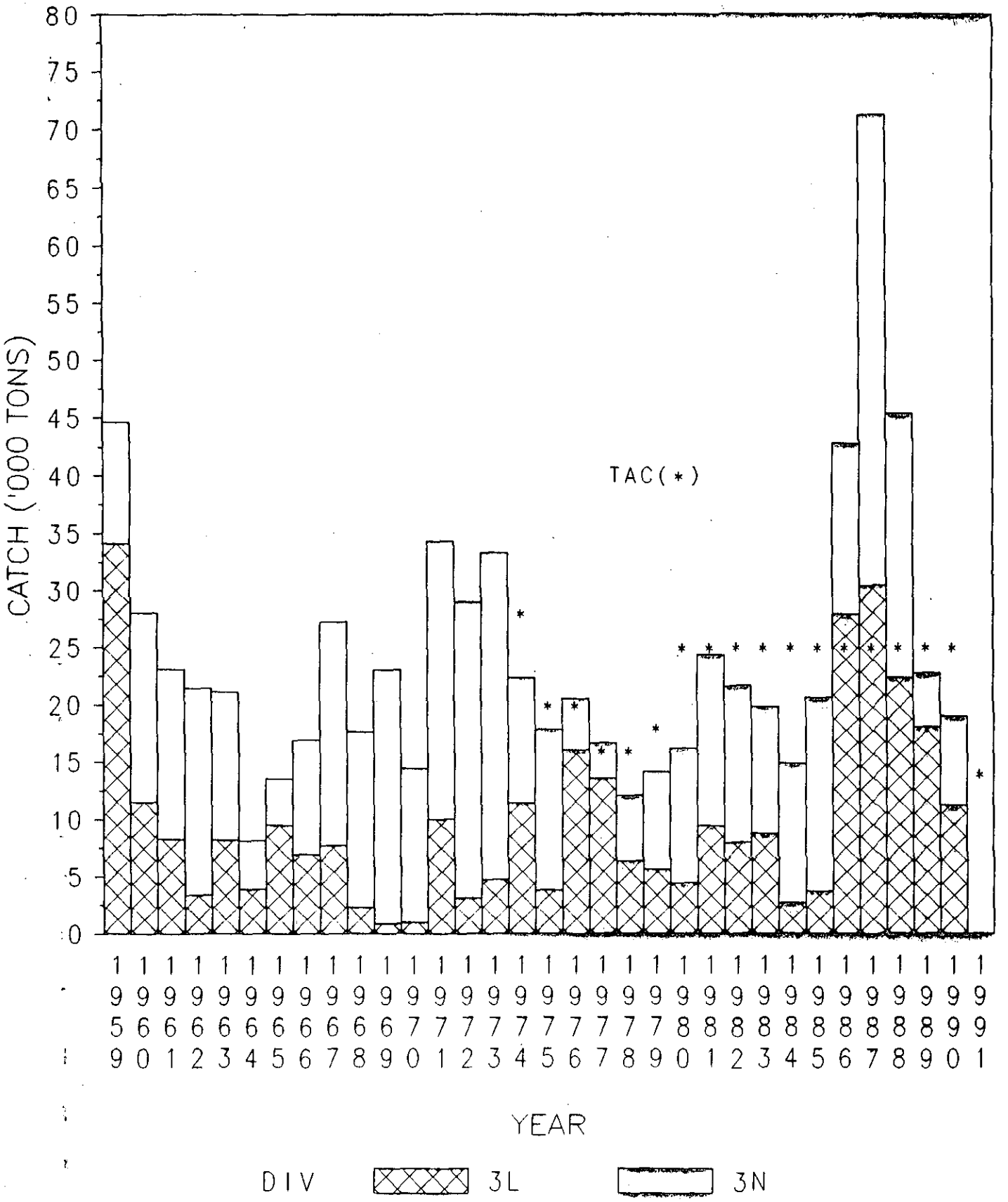


Fig. 1. Nominal catches for redfish in NAFO Div. 3LN (1989–90 are provisional).

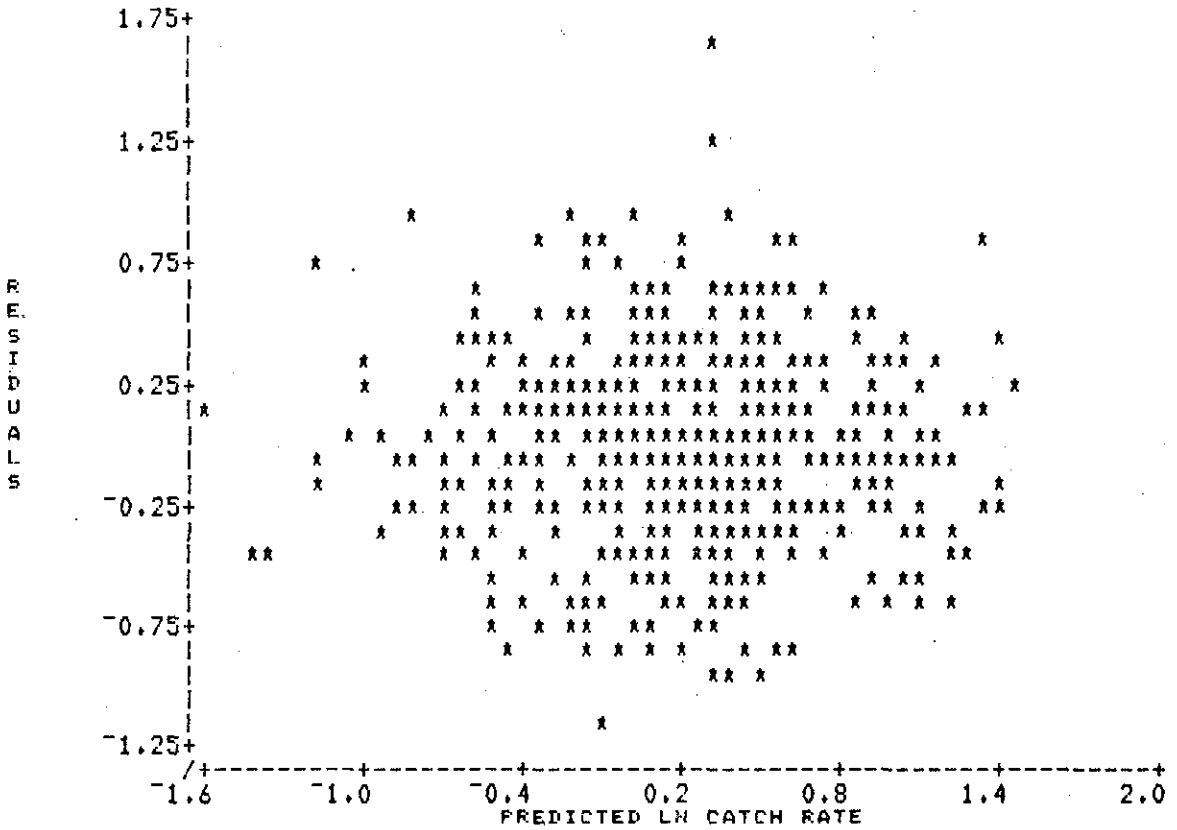


Fig. 2a. Plot of residuals versus ln(predicted catch rate) from a multiplicative model of Div. 3L CPUE data.

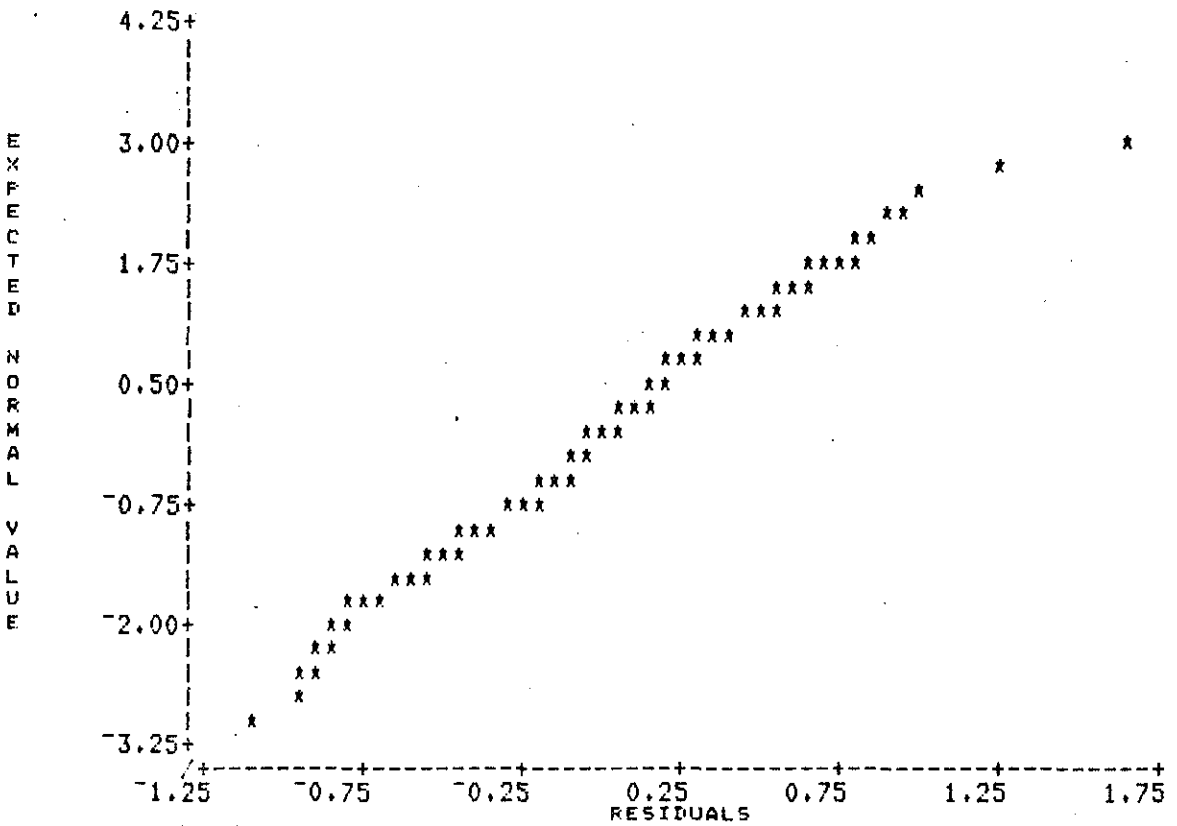


Fig. 2b. Plot of expected normal versus residuals from a multiplicative model of Div. 3L CPUE data.

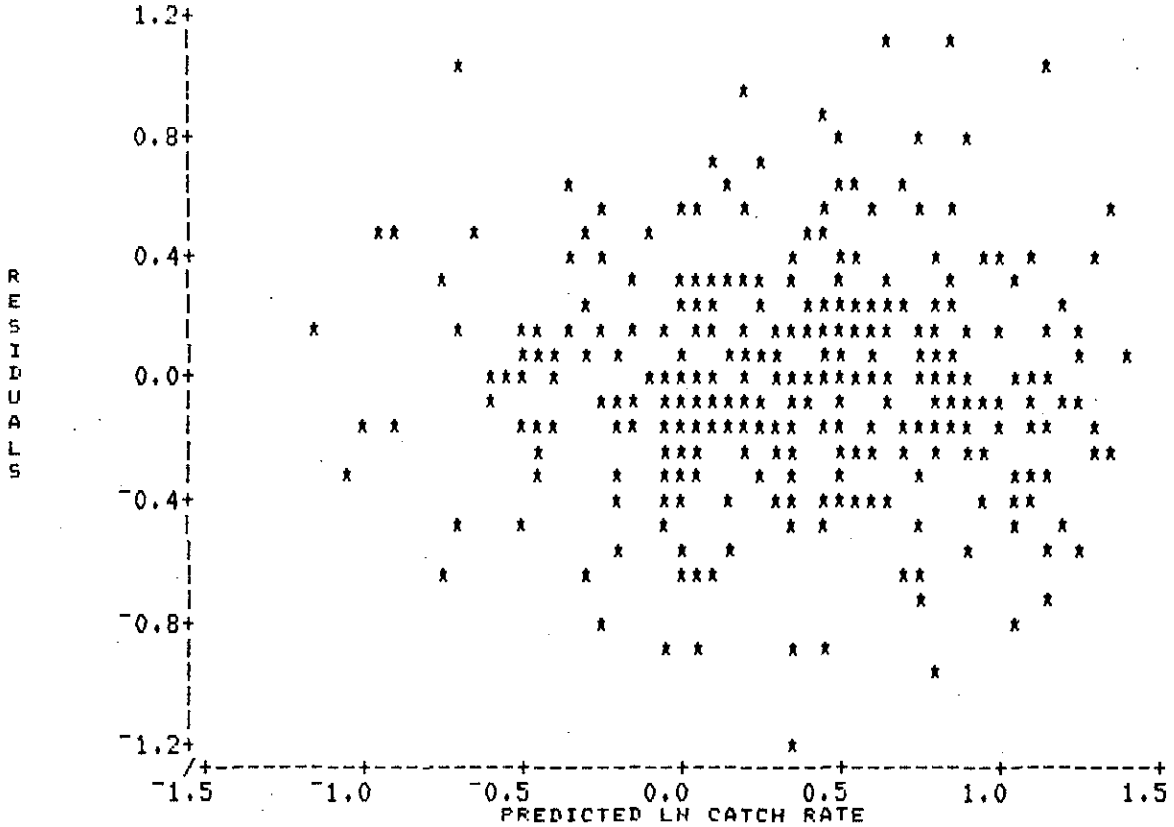


Fig. 3a. Plot of residuals versus ln(predicted catch rate) from a multiplicative model of Div. 3N CPUE data.

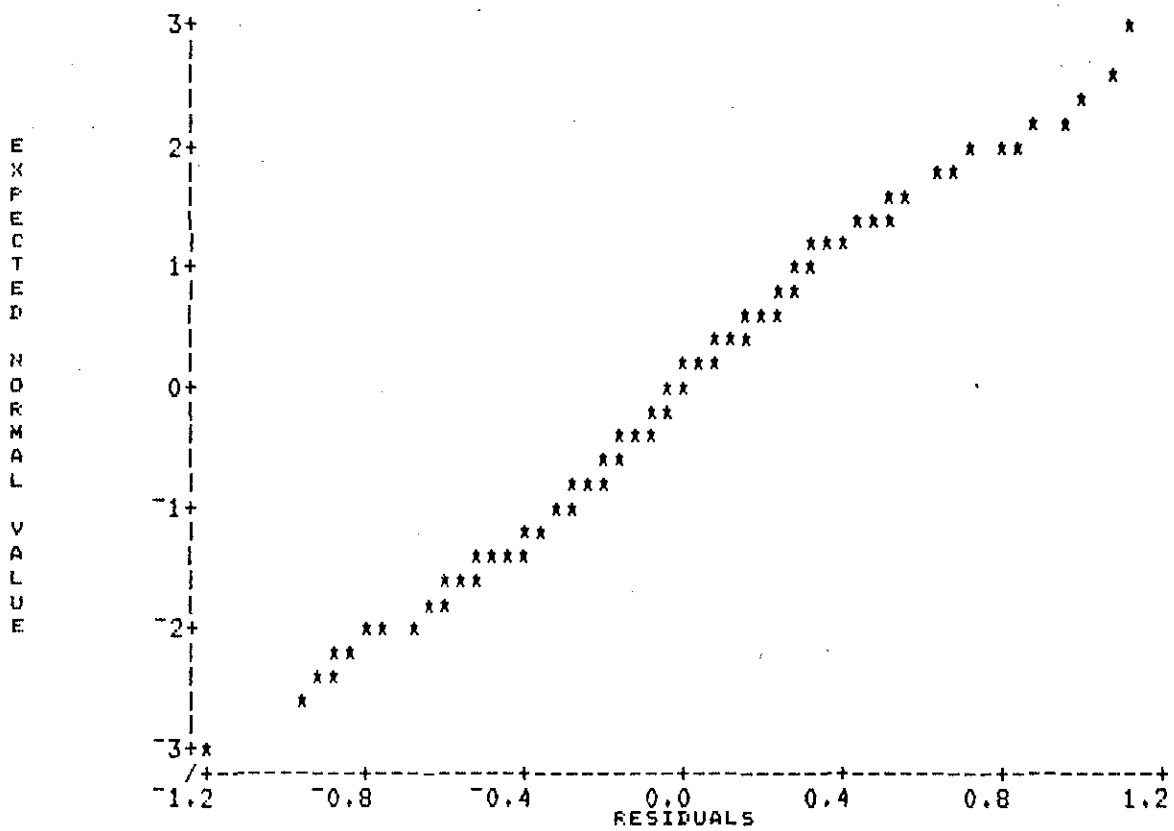
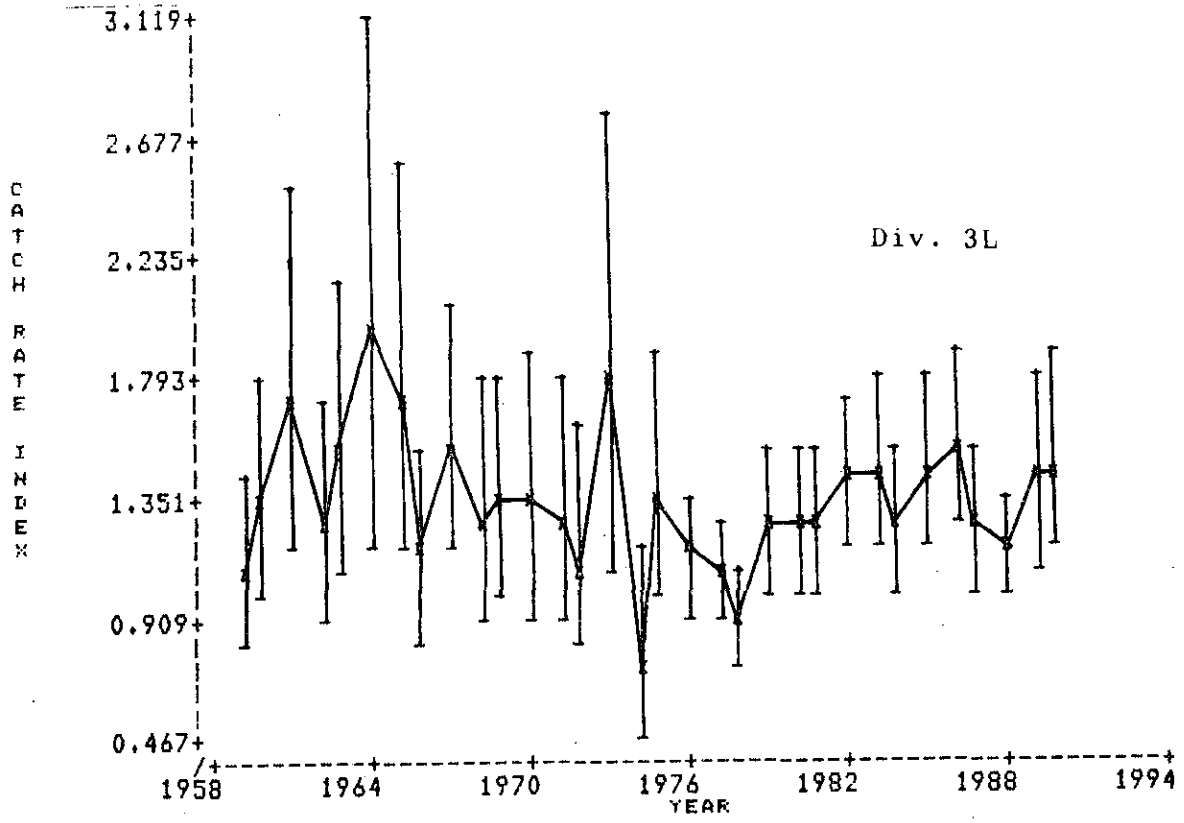


Fig. 3b. Plot of expected normal versus residuals from a multiplicative model of Div. 3N CPUE data.



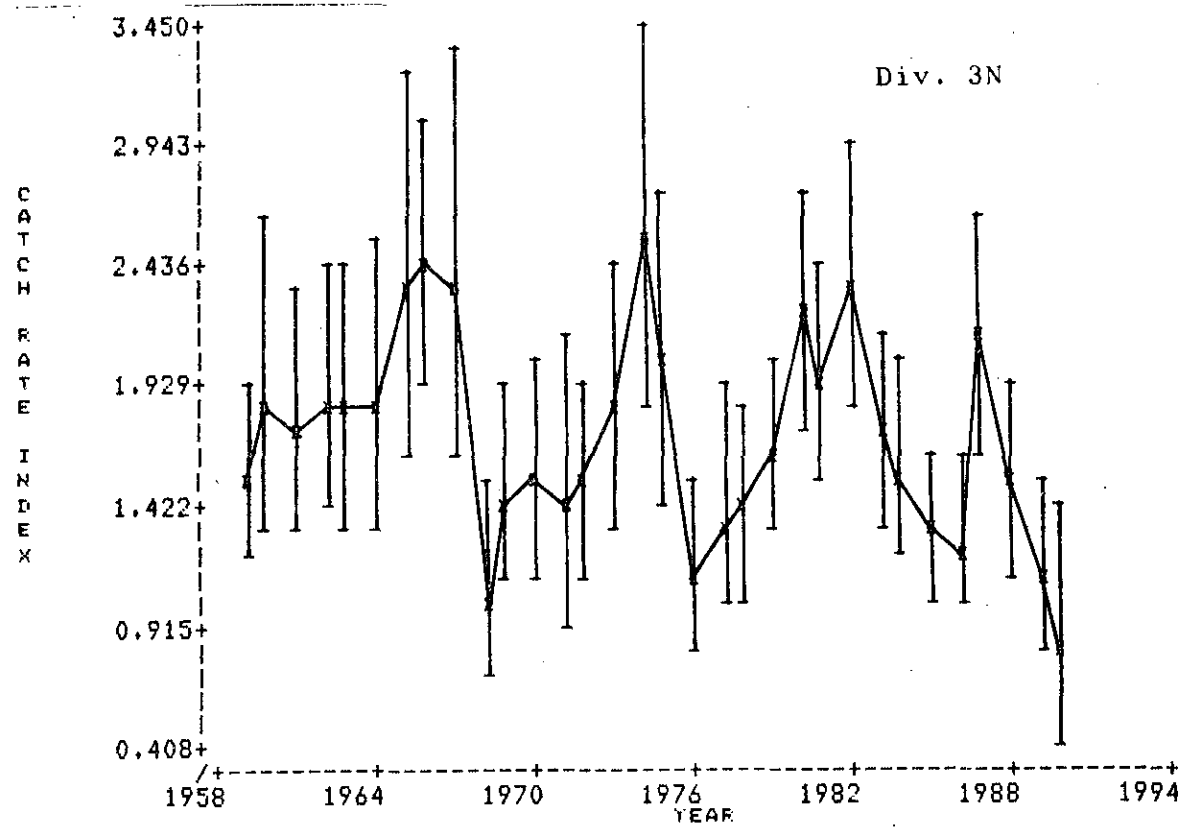
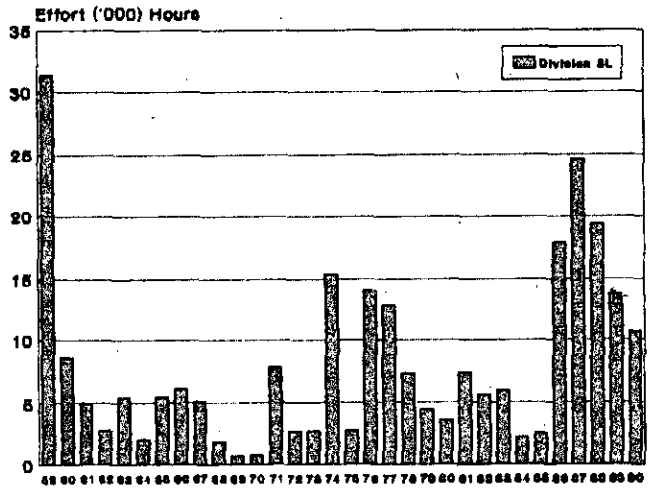


Fig. 4. Standardized catch rate indices for Div. 3L and Div. 3N derived from a multiplicative model for each division separately (1989-1990 based on preliminary data).



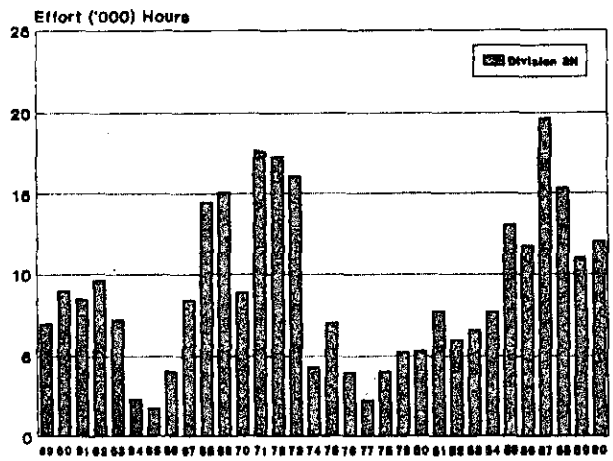


Fig. 5. Standardized effort for redfish in NAFO Div. 3L and Div. 3N from multiplicative analyses for each division.

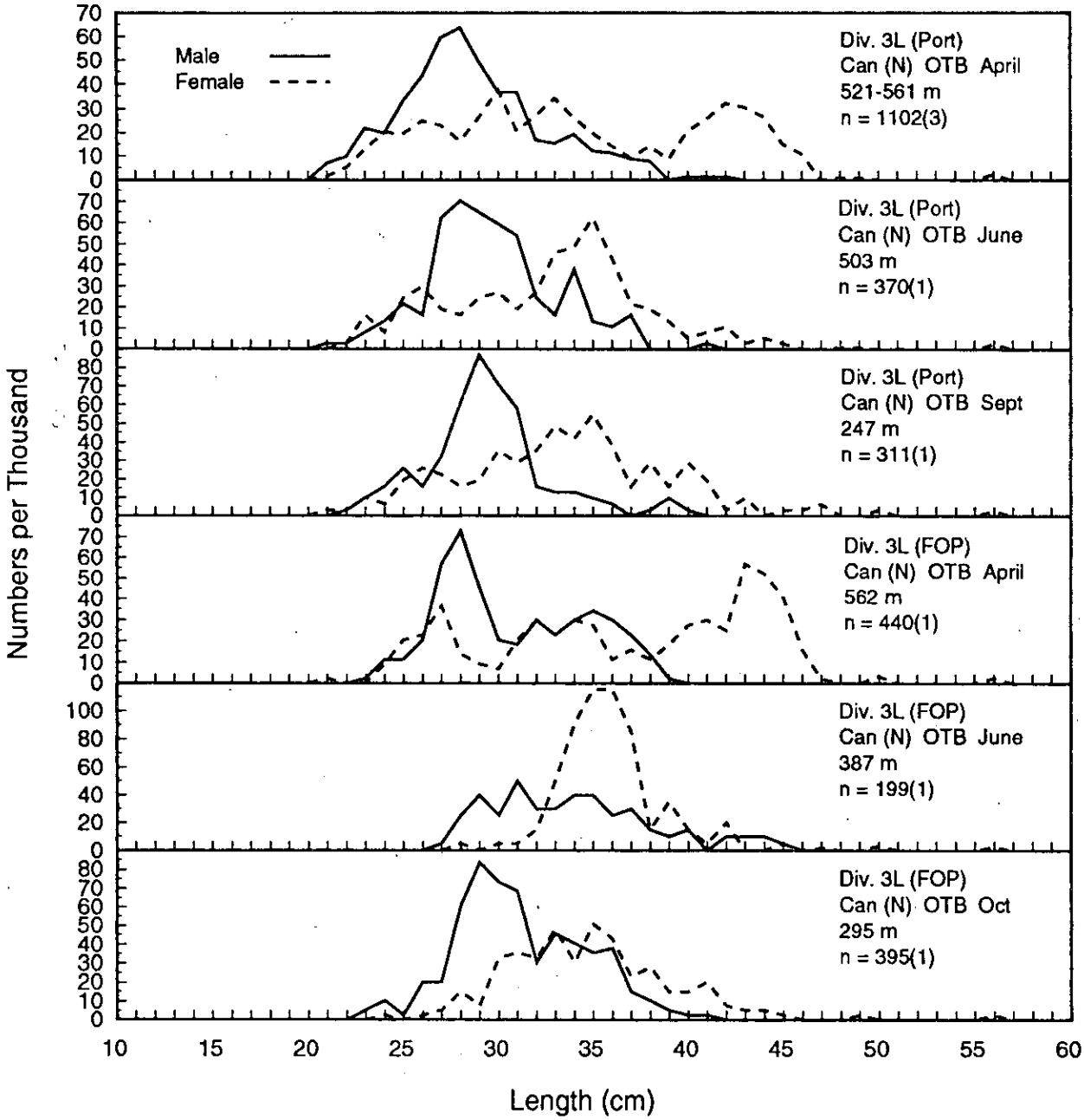


Fig. 6. Commercial length frequencies from Div. 3L in 1990 (port & observer sampling).

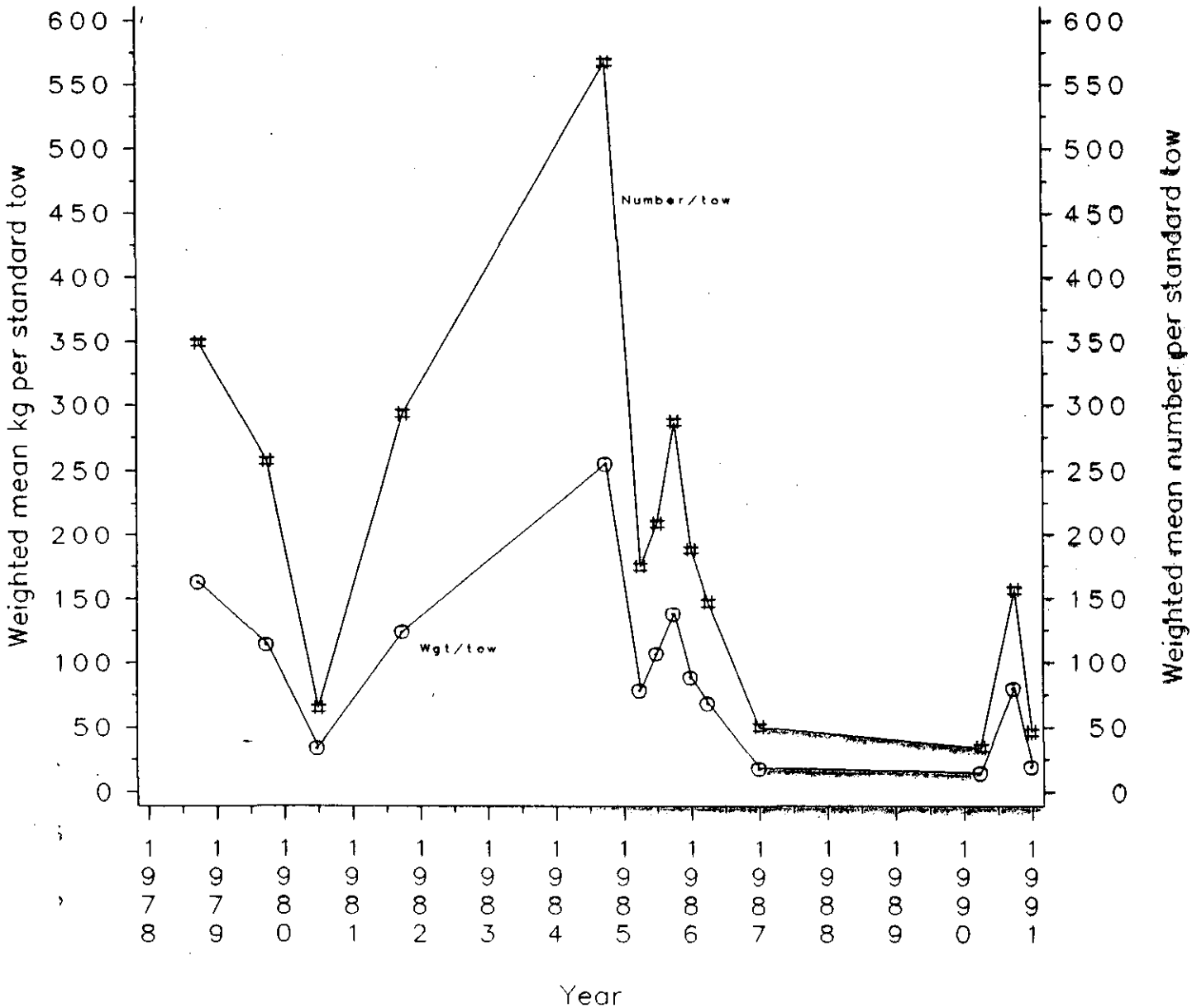


Fig. 7. Stratified mean numbers and weight per standard tow in Div. 3L from various Canadian surveys where strata greater than 366 m were surveyed

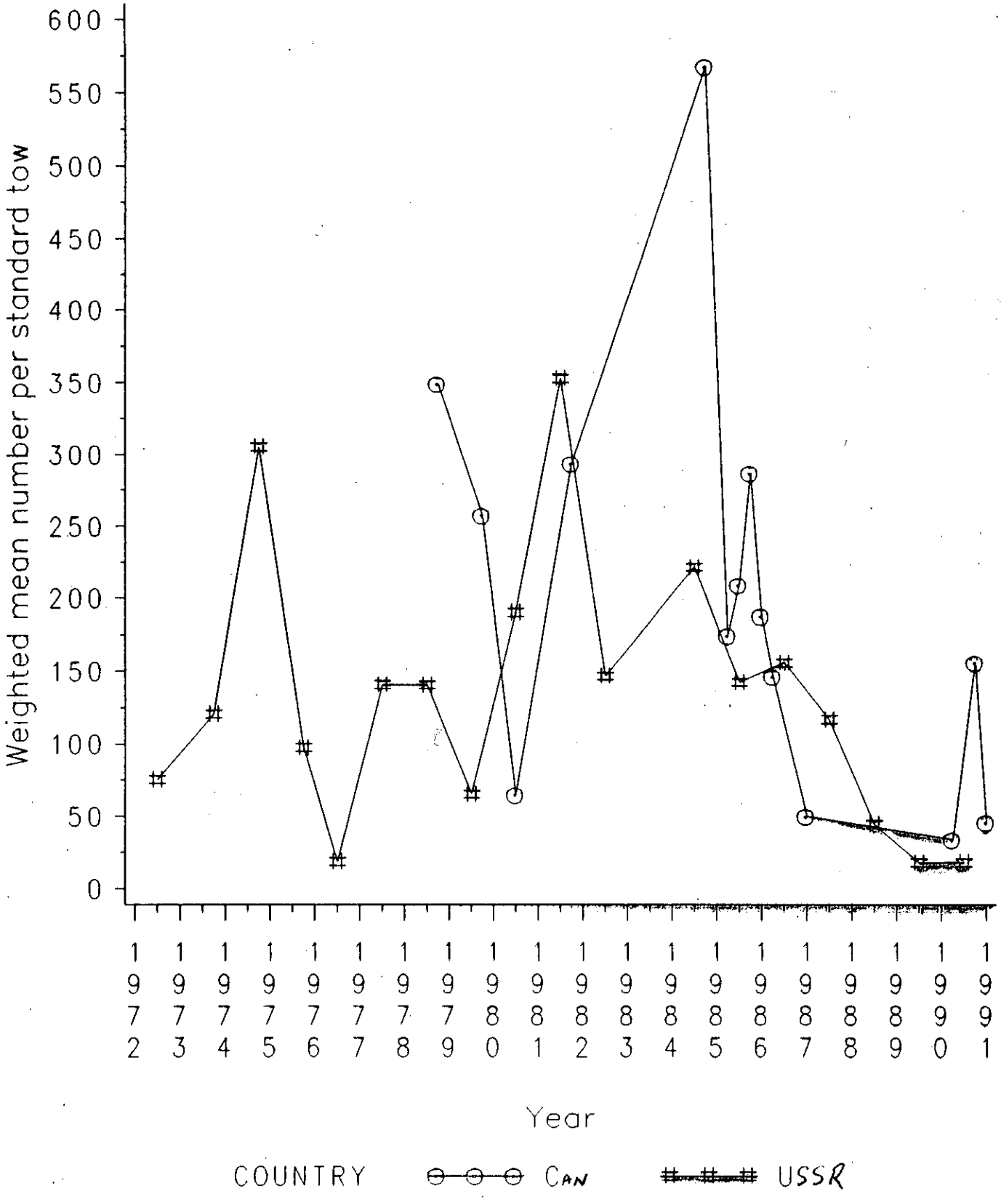


Fig. 8. Stratified mean number per standard tow in Div. 3L from Canadian and USSR surveys where strata greater than 366 m were surveyed

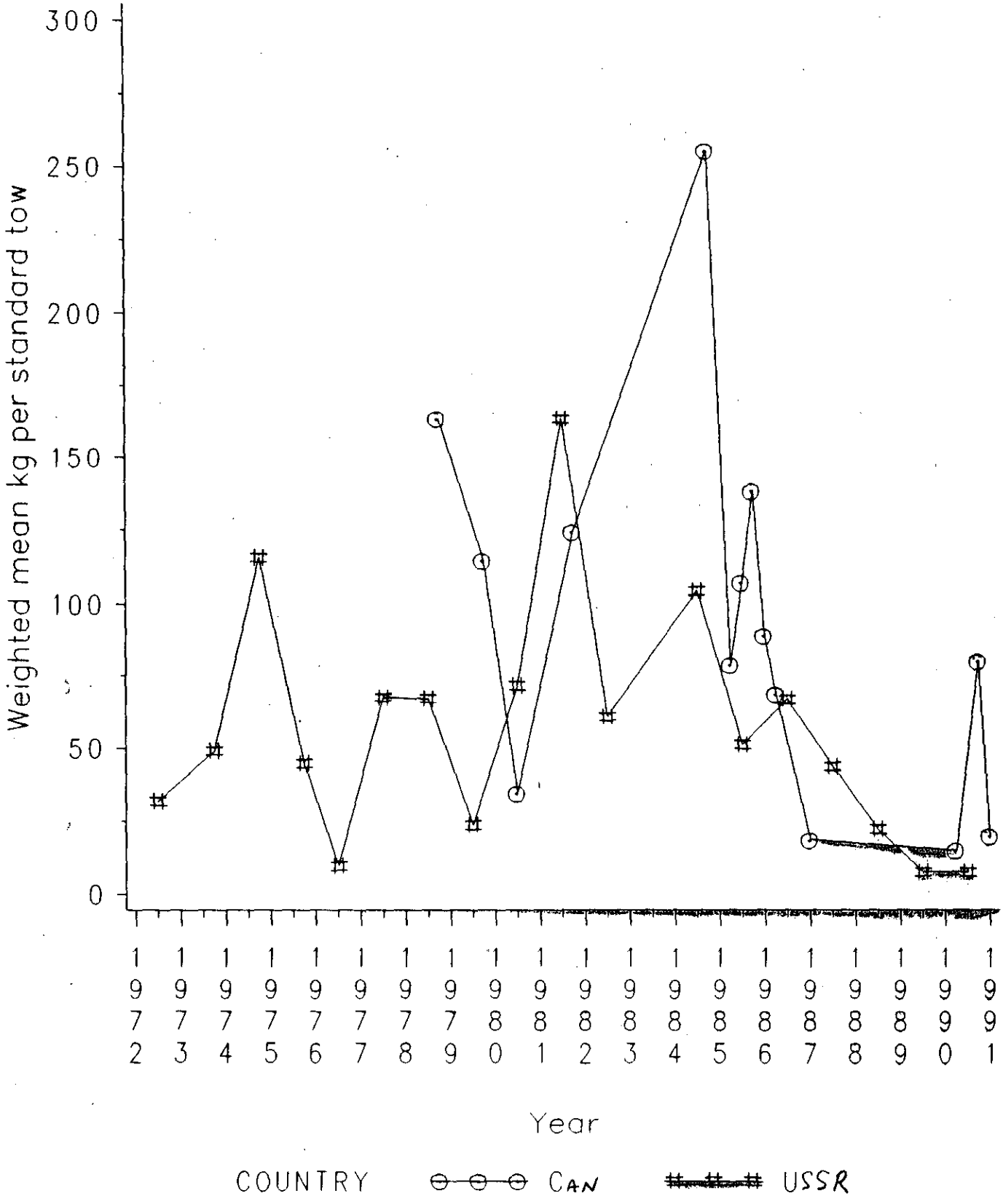


Fig. 9. Stratified mean weight per standard tow in Div. 3L from Canadian and USSR surveys where strata greater than 366 m were surveyed

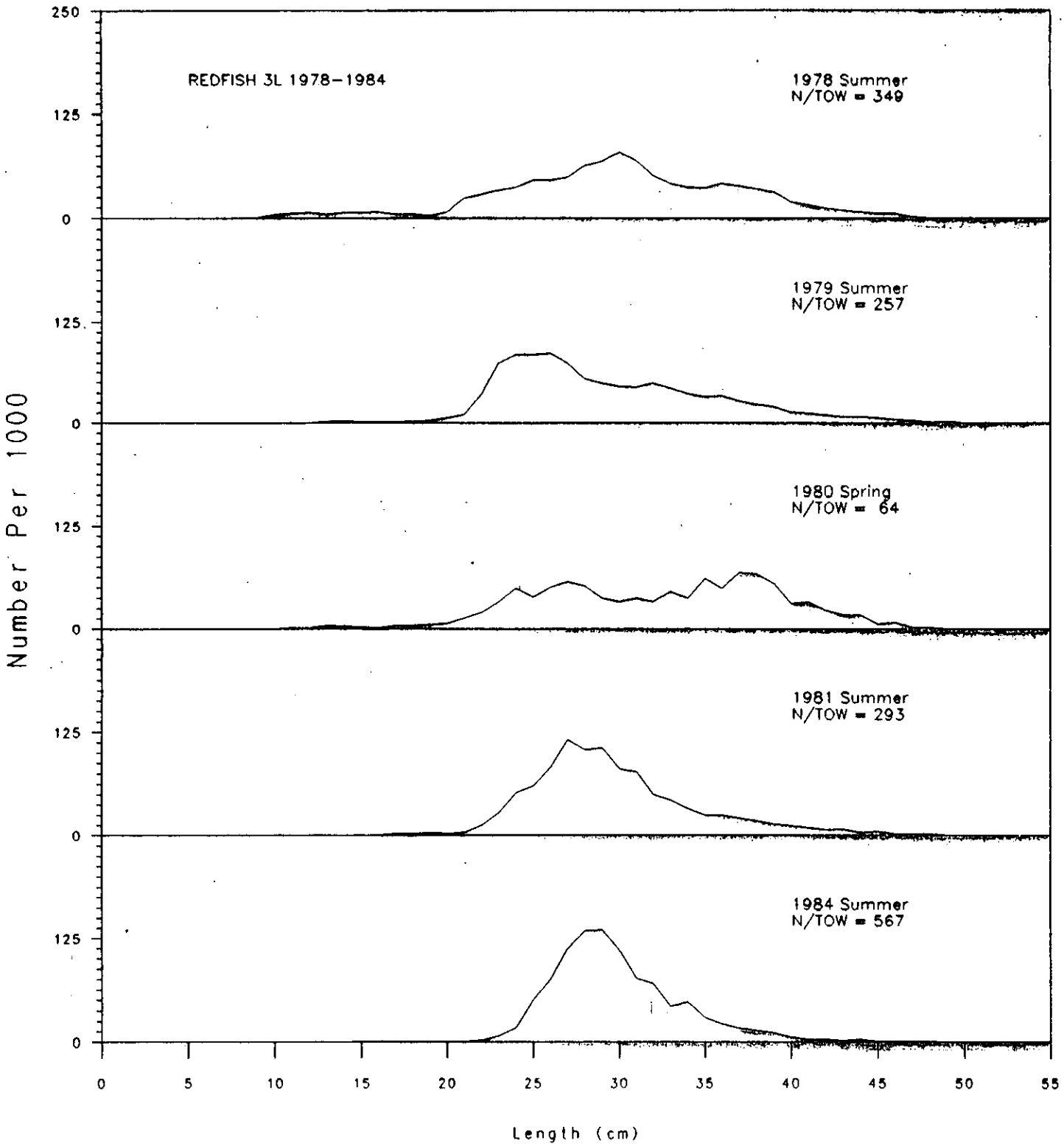


Fig. 10. Redfish length frequencies from stratified-random research surveys where strata greater than 366 m (200 fathoms) were sampled for the 1978-1984 period.

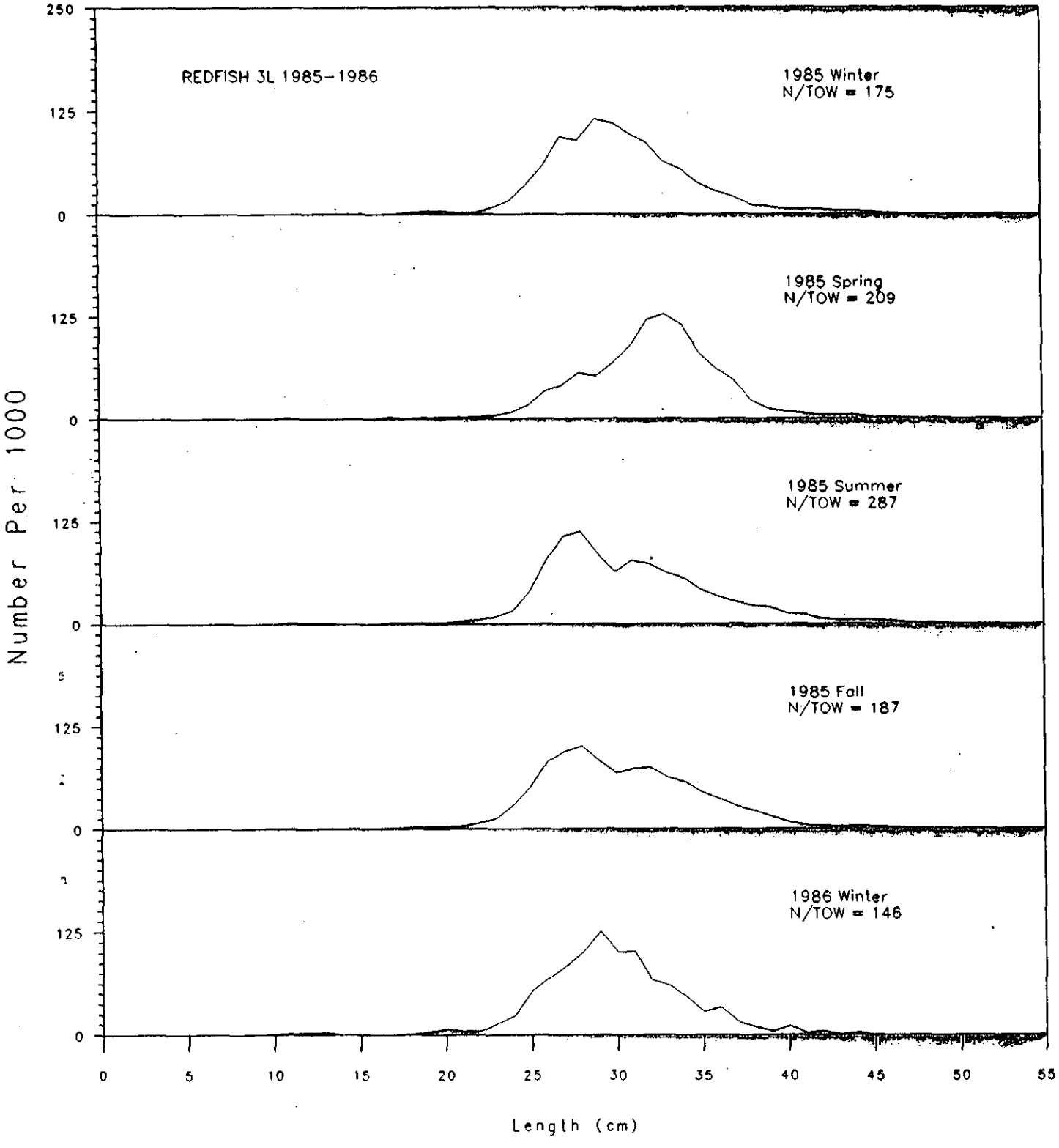


Fig. 11. Redfish length frequencies from stratified-random research surveys where strata greater than 366 m (200 fathoms) were sampled for the 1985-1986 period.

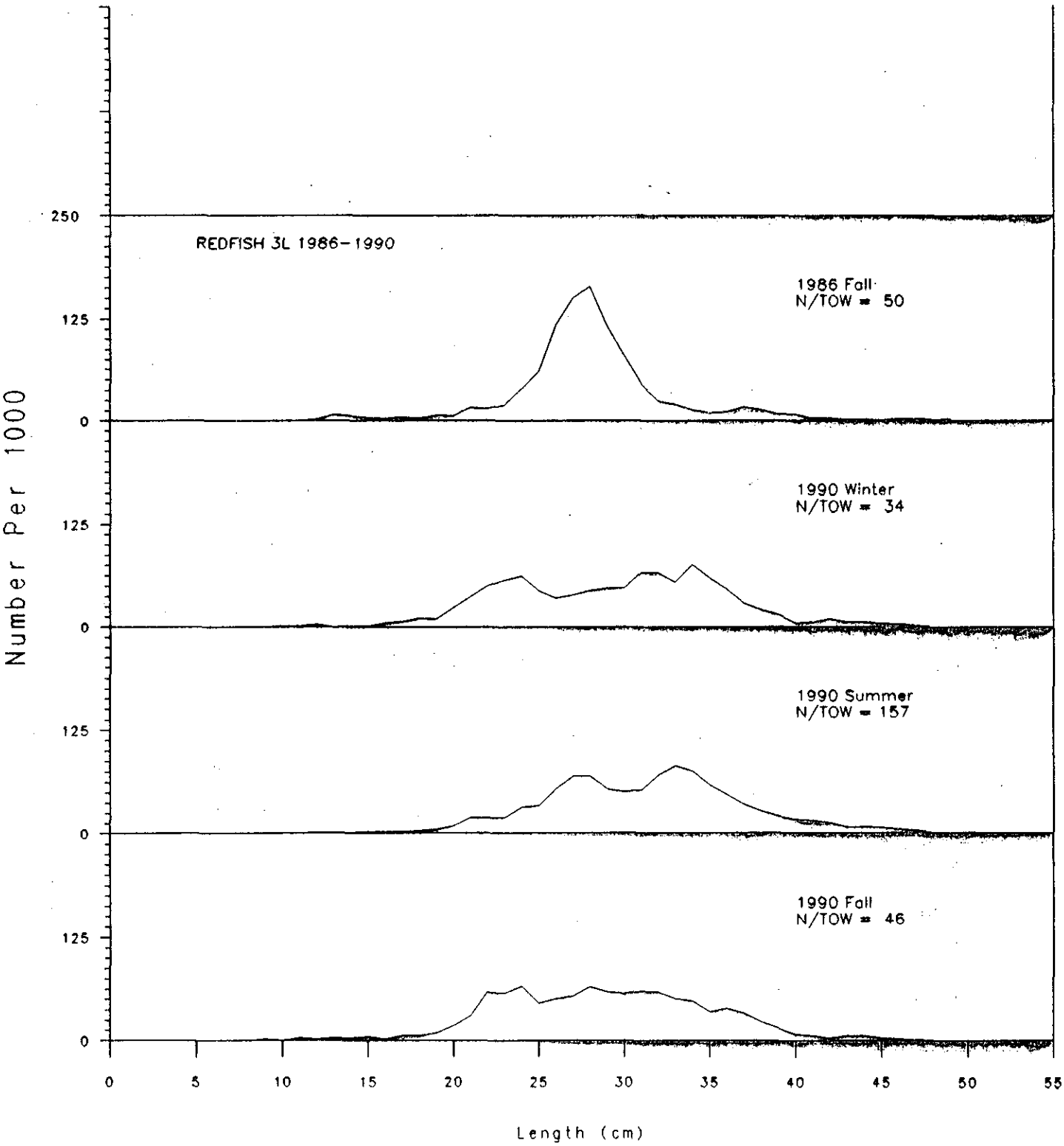


Fig. 12. Redfish length frequencies from stratified-random research surveys where strata greater than 366 m (200 fathoms) were sampled for the 1986-1990 period.

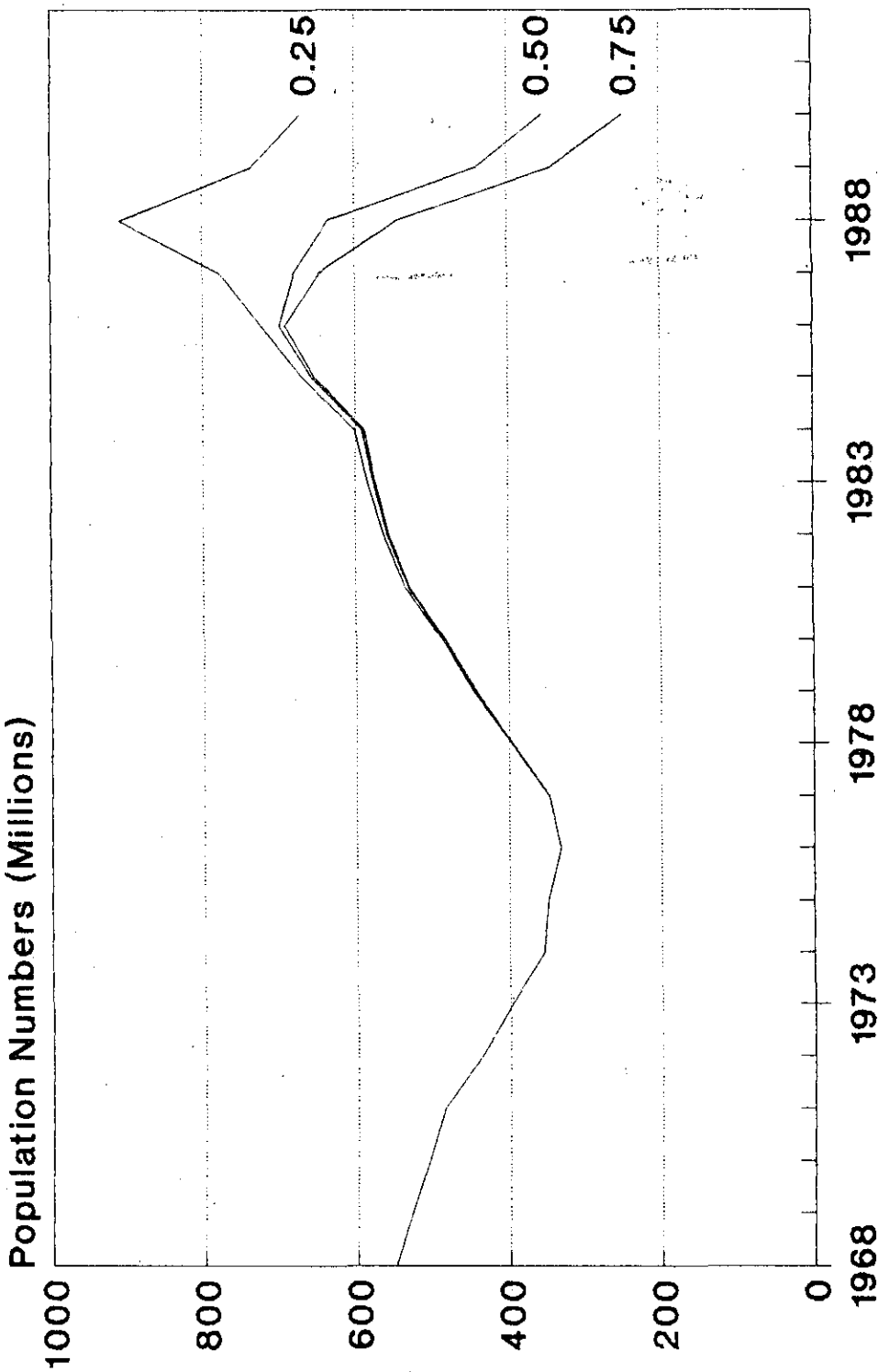


Fig. 13. Trends in abundance from SPA for Redfish in Div. 3LN over a range of terminal fishing mortalities.

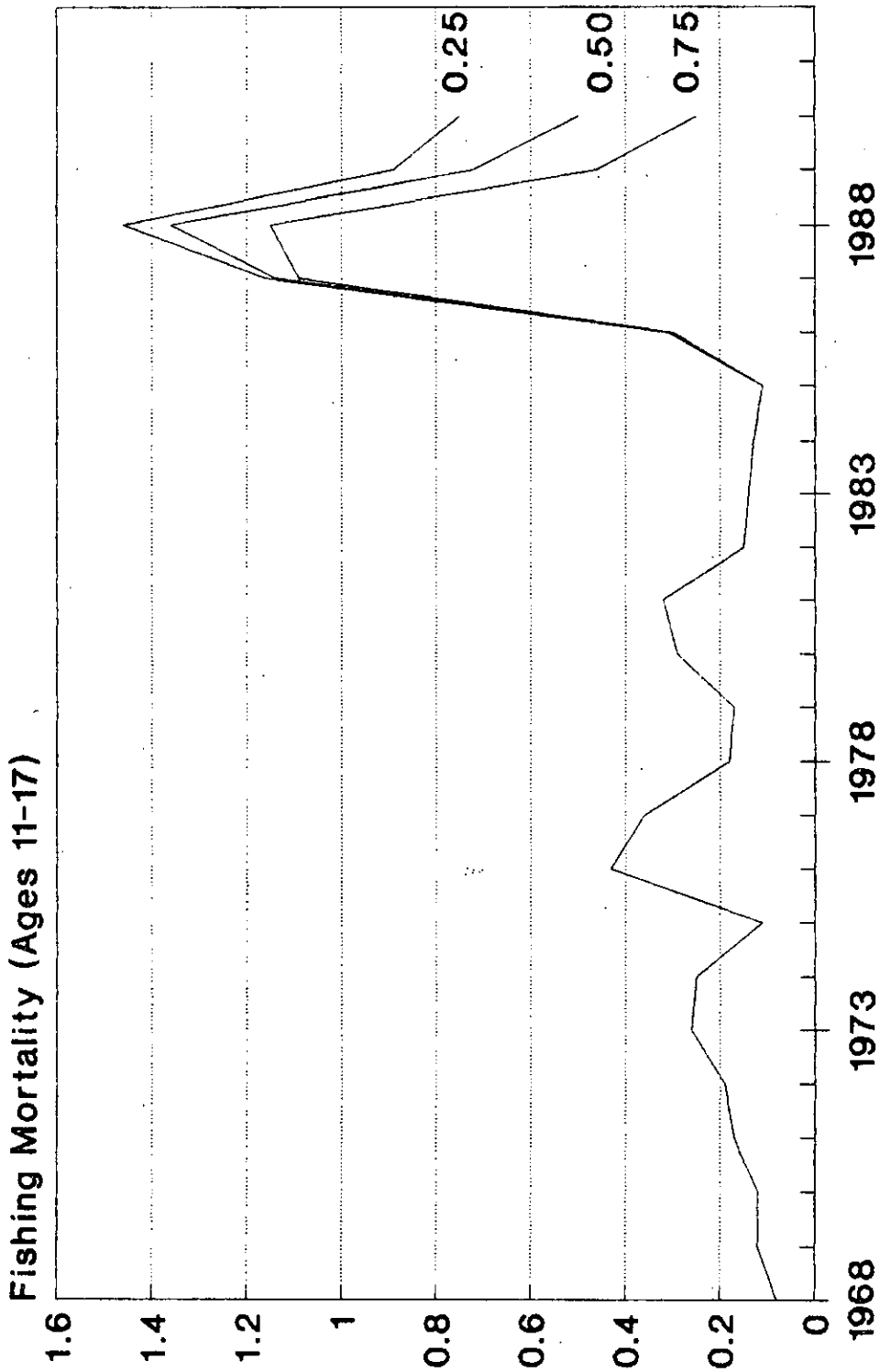


Fig. 14. Trends in fishing mortality for Redfish in Div. 3LN over a range of terminal fishing mortalities.

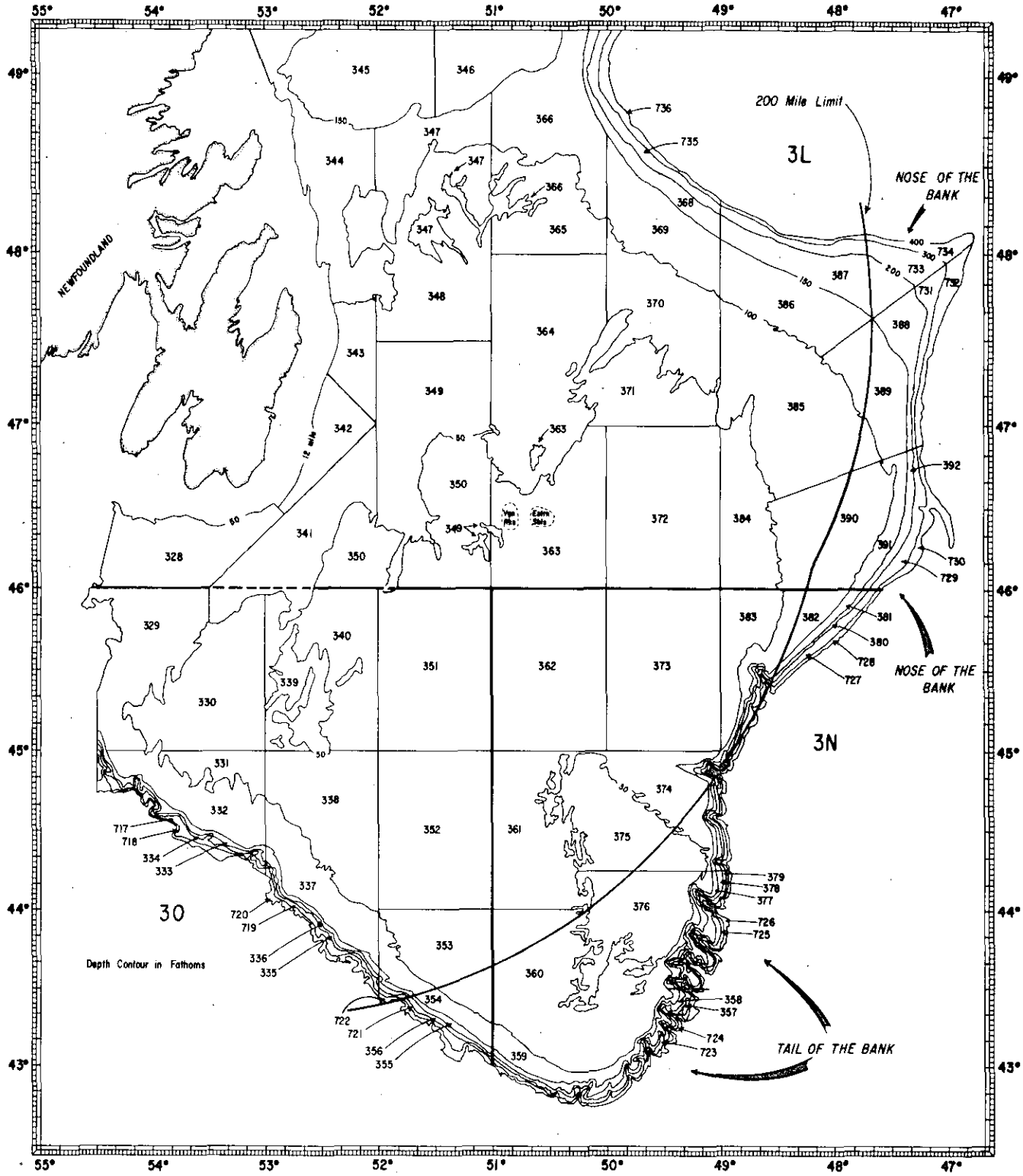


Fig. 15. Stratification scheme employed in stratified-random surveys in Div. 3LN.