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Status of the Redfish Resource in NAFO Divisions 3LN

by

D. Power and D. B. Atkinson

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

Introduction

The average reported landings from this stock for the period 1959-1988 was about 24,000 t. In the early to mid-1980s landings averaged about 19,000 t and between 60%-80% of the total was taken in Div. 3N (Table 1, Fig. 1). In 1986, reported landings doubled to 43,000 t with 65% taken in Div. 3L. The increase in catches was due to the greater participation of EEC/Portugal in both Div. 3L and Div. 3N (Table 2). The USSR also took most of their landings from Div. 3L in 1986. Catches increased again in 1987 to the highest reported historically at 71,000 t. This can be attributed to further increased catches by EEC/Portugal in Div. 3L, increases by USSR in Div. 3N and substantial catches by South Korea. In 1988 landings declined to about 45,000 t and were split evenly between both divisions. Preliminary catches for 1989 indicate a further reduction to about 21,000 t with EEC/Portugal reporting about 6,000 t (Avila de Melo et al, MS 1990) and the USSR reporting 11,000 t (Chumakov and Borovkov, MS 1990). Canadian surveillance estimates for non-member countries fishing in the Regulatory Area (unpublished data available from the Newfoundland Region of DFO) indicate that in 1987 there was 4,500 t taken by Caymen Islands in Div. 3N and 3,000 t taken by Panama in Div. 3LN. In 1988, estimates from this source for Div. 3LN were 3,900 t for Panama, 3,000 t for Caymen Islands and 1,000 t for St. Vincent's. No estimates were available for 1989.

The TAC for this stock has been 25,000 t since 1980. According to reported landings, the fishery is prosecuted throughout the year in both divisions (Table 3). A separation of the catches for each division by gear type since 1976 (Table 4) shows bottom trawling has been the predominant method of capture. Midwater trawling has accounted for a portion of the reported catch in each division but appears to be employed more often in Div. 3N.

Commercial Fishery Data

Catch and effort data were obtained from ICNAF/NAFO Statistical Bulletins for the 1959-1987 period. These were combined with preliminary NAFO data for 1988 and preliminary Canadian data for 1988 and 1989. Only those data where redfish comprised more than 50% of the total catch were selected. The catch/effort data were analysed with 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 less than 10 units were deleted prior to the analysis as were category types with less than five observations. A category type consisting of five arbitrarily chosen

categories representing the amount of bycatch associated with an observation was included in the model consistent with last year's assessment (Atkinson and Power, MS 1989). The regression was run unweighted because of unknown percentages of prorating of effort prior to 1984.

The data were analysed separately for each division because of different trends in the catch rate series in recent years (Power and Atkinson, MS 1987) a fact which violates an assumption of the model if the data are combined.

An initial analysis of Div. 3L data revealed three outliers that were eliminated. Residual plots for the final run of the model (Fig. 2) did not show any patterns to suggest that the model was inappropriate. The final regression was highly significant, explaining 62% of the variation in the catch rates (Table 5). All category types were significant. For the year categories, the estimated coefficients for 1961, 1964, 1967 and 1986 are the only ones that are different from 1959 (within 2 s.e.). The standardized catch rate series (Table 7, Fig. 4) shows much within year variability from 1959 to 1974 but indicates stability in the trend. From 1974 to 1986 catch rates show a general increase followed by a decline to 1988. A preliminary estimate based on Canadian data indicates an increase in 1989.

An initial analysis of Div. 3N data revealed two outliers that were eliminated. Residual plots for the final analysis (Fig. 3) suggested the model was appropriate. The final regression was highly significant, explaining 66% of the catch rate variation (Table 6). Only the month category type was not significant ($p < .25$). For the year categories, the estimated coefficients for 1966, 1974, 1980, 1982 and 1987 are different from 1959 (within 2 s.e.). The standardized catch rate series shows much within year variability over time (Table 8; Fig. 4). Catch rates indicate a somewhat stable period from 1959 to 1979. There was a substantial increase in 1980 followed by a decline to 1986. This was followed by an increase to the 1980 level in 1987, followed by a substantial decline in 1988. Effort calculated using the standardized catch rate series show a dramatic increase in Div. 3L in recent years (noted above) as well as a steady increase in Div. 3N since the late 1970s (Fig. 5).

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

Length frequencies available from sampling the landings of the Div. 3L fishery for Canada suggest the main proportion of fish caught were in the 27-32 cm range (Fig. 6). Length compositions from the Portuguese fishery in Div. 3L indicate most of the catch was in the 30-37 cm. range while in Div. 3N the majority represented the 21-27 cm. range (Avila de Melo et al., MS 1990).

Research Survey Data

A survey conducted by Canada in Div. 3L in January of 1990 estimated the total biomass to be only about 13,000 t. The survey sampled all strata (minimum two sets) greater than 184 m (Table 9). This was below an estimate of 30,000 t based on an 1986 survey by Canada to the same area at the same time of year. Estimates of stock size from

USSR trawl surveys from 1983 to 1989 in Div. 3LN (Chumakov and Borovkov, MS 1990, Tables 8 and 9) show much interannual variability but indicate a decline since 1983. This trend is evident in both the abundance and biomass. Trawl-acoustic survey results for Div. 3LNO combined for 1988 and 1989 indicate a dramatic decline in both numbers and biomass from 1988 to 1989 (Chumakov and Borovkov, MS 1990, Table 10). Length compositions from the USSR bottom trawl surveys from 1983 to 1989 indicate quite different population structures for each division (Vaskov et al., MS 1990, Fig. 2). The data from Div. 3N from these surveys suggest relatively good recruitment in this portion of the stock with fish of 14-16 cm. present in 1989. A somewhat different length distribution exists in Div. 3L.

Discussion/Conclusions

The catch rate indices derived for each division show much between year variability. These are too dramatic to be explained by the population dynamics of redfish which are a long-lived species. It is therefore considered that these fluctuations are not reflective of any true changes in the population, especially considering the magnitude of catches which have been taken from this stock in recent years. Independent estimates of stock size from the USSR research vessel surveys, while associated with large between year variability, generally indicate a declining population. Limited Canadian survey data suggest a similar trend.

In the last assessment of this stock (NAFO Sci. Coun. Rep., 1989) illustrative SPAs were run at two different values of terminal fishing mortality (F =0.1 and F =0.5). A yield per recruit, also based on the results of these illustrative runs, indicated that long-term yield even at the F_{max} was about 22,000 t. Reported catches been at least double this figure in recent years and in 1987 were even three times higher. In view of the unknown catches of non-member countries and the substantial catches by member countries in recent years, the present TAC (25,000 t) may be too optimistic in terms of a rational management of this resource.

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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	71,291	25,000
1988*	22,194	22,467	44,661	25,000
1989*			20,646	25,000
1990				25,000

* Provisional.

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	1988*
Canada (M)+	18	934	554	1,696	1,003	2,663	52	342	2,597	2,352	5,021
Canada (N)	3,143	4,086	2,412	5,925	5,910	3,800	1,229	1,716	2,235	2,159	1,436
France (M)	45	4	3	-	-	-	-	-	-	5	-
France (SP)	8	-	11	-	-	-	-	-	-	-	-
FRG	-	7	-	-	-	-	89	309	54	-	33
GDR	918	168	375	509	12	586	849	672	486	696	661
Japan	522	-	26	128	159	-	105	129	135	114	152
Poland	-	4	2	-	-	2	1	4	-	-	-
Portugal	261	265	639	275	125	91	48	4	13,469	19,858	9,867
Spain	8	-	-	137	25	347	91	192	199	335	-
UK	-	2	-	-	-	-	-	-	-	-	-
USSR	1,395	114	345	737	607	1,168	232	309	8,658	4,459	5,004
Ireland	-	-	-	-	-	-	-	-	-	-	-
Cuba	-	-	-	-	-	-	-	-	-	-	-
Kor-S	-	-	-	-	29	-	-	-	-	364	20
TOTAL	6,318	5,584	4,367	9,407	7,870	8,657	2,696	3,677	27,833	30,342	22,194

* Provisional.

+ Maritimes and Quebec were combined prior to 1979.

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	1988*
Canada (M)+	1	198	683	442	-	-	13	311	-	-	1
Canada (N)	18	1,285	367	63	337	1	2	82	17	21	3
France (M)	-	25	-	-	-	-	-	-	-	8	-
FRG	12	-	-	-	-	-	-	-	-	-	-
GDR	11	-	-	58	-	-	-	-	-	-	-
Portugal	-	-	-	-	1	-	365	890	8,273	7,854	2,147
Japan	-	-	-	-	-	-	81	-	12	51	-
Romania	-	9	-	-	-	-	-	-	-	-	-
Spain	1	-	14	239	278	875	239	2,881	1,393	132	-
UK	-	-	-	-	-	-	-	-	-	-	-
USSR	4,532	5,904	8,944	12,762	10,414	7,844	9,045	10,576	2,227	14,397	6,735
Cuba	1,150	1,062	1,644	1,309	2,621	2,370	2,320	2,055	2,429	2,433	2,483
USA	-	-	11	-	-	-	-	85	4	-	-
Kor-S	-	-	-	-	26	-	-	-	617	16,053	11,098
TOTAL	5,725	8,483	11,663	14,873	13,677	11,090	12,065	16,880	14,972	40,949	22,467

* Provisional.

+ Maritimes and Quebec were combined prior to 1979.

Table 3a: 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*	2,840	1,620	863	1,465	180	1,349	1,705	5,441	2,053	1,933	674	2,071	22,194

* Provisional.

Table 3b: 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*	655	526	705	830	773	1,284	2,328	4,473	3,389	1,419	3,366	2,719	22,467	

* Provisional.

a includes a catch of 1 t in month 'unknown'.

Table 4: 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.	Totals
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	15,395	6,702	97	-	16,181	6,269	17	-	44,661 a

a Provisional.

Table 5. ANOVA results and regression coefficients from the multiplicative model to derive a standardized catch rate series for redfish in NAFO Division 3L.

REGRESSION OF MULTIPLICATIVE MODEL

MULTIPLE R..... 0.791
MULTIPLE R SQUARED..... 0.625

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	2.834E1	2.834E1	
REGRESSION	71	1.190E2	1.677E0	9.479
TYPE 1	26	5.293E1	2.036E0	11.510
TYPE 2	11	7.213E0	6.557E-1	3.707
TYPE 3	4	1.768E1	4.420E0	24.989
TYPE 4	30	9.814E0	3.271E-1	1.850
RESIDUALS	404	7.146E1	1.769E-1	
TOTAL	476	2.188E2		

REGRESSION COEFFICIENTS

CATEGORY	CODE	VARIABLE	COEFFICIENT	STD. ERROR	NO. OBS.
1	3125	INTERCEPT	0.040	0.159	476
2	6				
4	95				
5	59				
1	2114	1	-0.496	0.184	9
	2125	2	-0.088	0.171	8
	2155	3	-0.066	0.193	6
	3114	4	-0.381	0.169	15
	3124	5	0.014	0.153	9
	3154	6	-0.513	0.209	5
	3155	7	0.166	0.111	25
	10127	8	-0.667	0.208	5
	11115	9	-0.440	0.250	5
	11116	10	-0.391	0.196	10
	11125	11	0.043	0.110	19
	11126	12	-0.038	0.192	12
	11127	13	-0.032	0.128	17
	14126	14	-0.296	0.174	7
	14127	15	0.721	0.211	11
	16127	16	-0.014	0.174	26
	17116	17	-0.955	0.214	5
	17127	18	0.264	0.159	9
	20114	19	-1.166	0.183	11
	20116	20	-0.140	0.195	11
	20127	21	0.377	0.088	56
	20145	22	1.308	0.305	12
	20157	23	0.537	0.092	32
	27125	24	0.159	0.084	36
	27126	25	0.136	0.187	7
	27157	26	1.030	0.214	5

Table 5. (continued)

2	1	27	0.159	0.112	27
	2	28	0.204	0.106	31
	3	29	0.321	0.096	41
	4	30	0.400	0.092	47
	5	31	0.096	0.101	31
	7	32	0.139	0.088	51
	8	33	-0.048	0.091	47
	9	34	-0.090	0.094	40
	10	35	-0.034	0.092	44
	11	36	0.045	0.093	43
	12	37	-0.177	0.114	23
4	55	38	-0.664	0.099	27
	65	39	-0.660	0.083	37
	75	40	-0.318	0.072	55
	85	41	-0.072	0.059	93
5	60	42	0.193	0.179	13
	61	43	0.499	0.233	7
	62	44	0.145	0.213	10
	63	45	0.382	0.222	9
	64	46	0.626	0.300	3
	65	47	-0.057	0.272	4
	66	48	-0.065	0.254	5
	67	49	0.430	0.204	19
	68	50	0.175	0.236	8
	69	51	0.206	0.211	7
	70	52	0.243	0.225	8
	71	53	0.247	0.222	12
	72	54	0.116	0.225	6
	73	55	0.514	0.282	3
	74	56	-0.372	0.296	15
	75	57	0.067	0.241	5
	76	58	-0.035	0.151	32
	77	59	-0.029	0.157	33
	78	60	-0.179	0.162	25
	79	61	0.215	0.172	24
	80	62	0.152	0.176	18
	81	63	0.163	0.174	18
	82	64	0.266	0.168	23
	83	65	0.300	0.167	20
	84	66	0.145	0.181	15
	85	67	0.295	0.175	19
	86	68	0.376	0.164	30
	87	69	0.144	0.174	19
	88	70	0.040	0.160	34
	89	71	0.272	0.228	8

Table 6. ANOVA results and regression coefficients from the multiplicative model to derive a standardized catch rate series for redfish in NAFO Division 3N.

REGRESSION OF MULTIPLICATIVE MODEL

MULTIPLE R.....	0.811
MULTIPLE R SQUARED.....	0.657

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	4.602E1	4.602E1	
REGRESSION	56	8.292E1	1.481E0	10.332
TYPE 1	12	2.158E1	1.799E0	12.550
TYPE 2	11	1.716E0	1.560E-1	1.088
TYPE 3	4	1.102E1	2.754E0	19.216
TYPE 4	29	1.279E1	4.411E-1	3.077
RESIDUALS	302	4.328E1	1.433E-1	
TOTAL	359	1.722E2		

REGRESSION COEFFICIENTS

CATEGORY	CODE	VARIABLE	COEFFICIENT	STD. ERROR	NO. OBS.
1	3125	INTERCEPT	0.362	0.143	359
2	6				
4	95				
5	59				
1	2114	1	-0.333	0.139	17
	3114	2	-0.055	0.112	73
	4127	3	0.399	0.135	18
	4157	4	0.574	0.134	22
	16127	5	-0.133	0.199	5
	20114	6	-0.860	0.183	8
	20116	7	-0.137	0.180	8
	20127	8	0.625	0.101	80
	20157	9	0.684	0.111	59
	25126	10	0.074	0.168	11
	25127	11	0.628	0.141	24
	27125	12	0.344	0.189	6
2	1	13	-0.263	0.113	27
	2	14	-0.261	0.118	23
	3	15	-0.284	0.112	29
	4	16	-0.211	0.120	22
	5	17	-0.183	0.118	20
	7	18	-0.178	0.099	44
	8	19	-0.187	0.099	45
	9	20	-0.203	0.099	46
	10	21	-0.256	0.108	31
	11	22	-0.198	0.112	26
	12	23	-0.370	0.122	20
4	55	24	-0.621	0.089	33
	65	25	-0.512	0.080	39
	75	26	-0.395	0.073	47
	85	27	-0.262	0.064	59

Table 6. (continued)

5	60	28	0.163	0.205	5
	61	29	0.086	0.161	11
	62	30	0.205	0.135	23
	63	31	0.068	0.158	13
	64	32	0.089	0.187	8
	65	33	0.343	0.194	7
	66	34	0.484	0.144	15
	67	35	0.207	0.257	3
	68	36	-0.400	0.232	4
	69	37	-0.068	0.178	8
	70	38	-0.025	0.175	8
	71	39	-0.117	0.248	3
	72	40	-0.005	0.167	9
	73	41	-0.094	0.203	5
	74	42	0.489	0.191	7
	75	43	0.212	0.198	6
	76	44	-0.342	0.175	8
	77	45	0.017	0.212	5
	78	46	-0.093	0.178	8
	79	47	-0.027	0.146	14
	80	48	0.354	0.144	16
	81	49	0.202	0.151	17
	82	50	0.298	0.142	17
	83	51	0.110	0.149	15
	84	52	0.025	0.163	12
	85	53	-0.181	0.156	15
	86	54	-0.211	0.164	12
	87	55	0.322	0.134	38
	88	56	-0.006	0.146	24

Table 7. Predicted standardized catch rate series for Division 3L as derived from the multiplicative model (1988-89 are from preliminary data).

PREDICTED CATCH RATE

YEAR	LN TRANSFORM MEAN	LN TRANSFORM S.E.	RETRANSFORMED MEAN	RETRANSFORMED S.E.	CATCH	EFFORT
1959	0.0405	0.0254	1.123	0.178	34107	30359
1960	0.2334	0.0302	1.359	0.235	11463	8433
1961	0.5392	0.0548	1.823	0.421	8349	4580
1962	0.1860	0.0446	1.287	0.269	3425	2661
1963	0.4223	0.0491	1.626	0.357	8191	5037
1964	0.6666	0.0881	2.036	0.592	3898	1914
1965	0.0970	0.0725	1.161	0.307	9451	8140
1966	-0.0246	0.0634	1.033	0.256	6927	6707
1967	0.4706	0.0339	1.720	0.314	7684	4468
1968	0.2157	0.0478	1.324	0.286	2348	1774
1969	0.2463	0.0362	1.373	0.259	927	675
1970	0.2835	0.0493	1.416	0.311	1029	727
1971	0.2870	0.0434	1.425	0.294	10043	7049
1972	0.1566	0.0466	1.248	0.267	3095	2479
1973	-0.5547	0.0729	1.835	0.487	4709	2567
1974	-0.3312	0.0800	0.754	0.209	11419	15148
1975	0.1073	0.0430	1.191	0.245	3838	3224
1976	0.0755	0.0133	1.171	0.135	15971	13643
1977	0.0111	0.0133	1.098	0.126	13452	12256
1978	-0.1387	0.0140	0.945	0.111	6318	6689
1979	0.2558	0.0174	1.399	0.184	5584	3992
1980	0.1928	0.0156	1.315	0.164	4367	3322
1981	0.2033	0.0157	1.329	0.166	9407	7081
1982	0.3064	0.0127	1.475	0.166	7870	5336
1983	0.3402	0.0143	1.525	0.182	8657	5678
1984	0.1858	0.0175	1.304	0.172	2696	2067
1985	0.3353	0.0151	1.516	0.186	3677	2425
1986	0.4164	0.0120	1.647	0.180	27833	16898
1987	0.1841	0.0161	1.303	0.165	30342	23287
1988	0.0810	0.0123	1.178	0.130	22194	18847
1989	0.3124	0.0367	1.466	0.279	13534	9231

AVERAGE C.V. FOR THE RETRANSFORMED MEAN: 0.178

Table 8. Predicted standardized catch rate series for Division 3N as derived from the multiplicative model (1988 is from preliminary data).

PREDICTED CATCH RATE

YEAR	LN TRANSFORM MEAN	LN TRANSFORM S.E.	RETRANSFORMED MEAN	RETRANSFORMED S.E.	CATCH	EFFORT
1959	0.3618	0.0204	1.527	0.218	10478	6861
1960	0.5244	0.0463	1.774	0.378	16547	9329
1961	0.4482	0.0309	1.656	0.290	14826	8951
1962	0.5669	0.0231	1.872	0.283	18009	9618
1963	0.4295	0.0310	1.625	0.285	12906	7940
1964	0.4506	0.0407	1.652	0.331	4206	2546
1965	0.7047	0.0436	2.127	0.440	4042	1900
1966	0.8460	0.0192	2.480	0.343	10047	4051
1967	0.5691	0.0653	1.837	0.463	19504	10616
1968	-0.0382	0.0502	1.009	0.224	15265	15135
1969	0.2942	0.0318	1.419	0.252	22142	15601
1970	0.3367	0.0332	1.480	0.268	13359	9027
1971	0.2449	0.0666	1.328	0.338	24310	18312
1972	0.3566	0.0299	1.512	0.260	25838	17087
1973	0.2677	0.0393	1.377	0.271	28588	20761
1974	0.8505	0.0382	2.467	0.479	10867	4404
1975	0.5740	0.0406	1.869	0.374	14033	7508
1976	0.0202	0.0336	1.078	0.196	4541	4212
1977	0.3791	0.0440	1.536	0.319	3064	1995
1978	0.2686	0.0316	1.384	0.244	5725	4138
1979	0.3351	0.0218	1.486	0.219	8483	5709
1980	0.7157	0.0210	2.175	0.314	11663	5362
1981	0.5640	0.0220	1.868	0.276	14873	7962
1982	0.6599	0.0202	2.058	0.291	13677	6646
1983	0.4715	0.0234	1.702	0.259	11090	6517
1984	0.3867	0.0282	1.560	0.261	12065	7736
1985	0.1806	0.0256	1.271	0.202	16880	13283
1986	0.1508	0.0280	1.232	0.205	14972	12152
1987	0.6839	0.0194	2.109	0.293	40949	19419
1988	0.3556	0.0238	1.515	0.233	22467	14827

AVERAGE C.V. FOR THE RETRANSFORMED MEAN: 0.178

Table 9. Estimates of density and stock size from Canadian Research surveys conducted in Div. 3L in Jan-Feb of 1986 and 1990 (numbers of sets made in brakets).

Stratum	Depth Range (m)	Area sq. n. mi.	MEAN NUMBER (per standard tow) 1986	1990	MEAN WEIGHT 1986	1990
328	2	1519	0.00(12)	*	0.00	*
341	2	1574	0.00(9)	*	0.00	*
342	2	585	0.00(2)	*	0.00	*
343	2	525	0.00(2)	*	0.00	*
344	3	1494	0.20(5)	0.00(5)	0.01	0.00
345	4	1432	1.33(3)	0.40(5)	0.04	0.02
346	4	865	4.25(4)	14.67(3)	1.07	3.22
347	3	983	1.50(4)	0.50(4)	0.07	0.06
348	2	2120	0.00(12)	*	0.00	*
349	2	2114	0.00(9)	*	0.00	*
350	1	2071	0.00(14)	*	0.00	*
363	1	1780	0.00(14)	*	0.00	*
364	2	2817	0.00(8)	*	0.00	*
365	2	1041	0.00(2)	*	0.00	*
366	3	1394	1.50(2)	1.00(5)	0.01	0.04
368	4	334	*	21.00(2)	*	5.10
369	3	961	0.00(3)	0.00(4)	0.00	0.00
370	2	1320	0.00(4)	*	0.00	*
371	1	1121	0.00(8)	*	0.00	*
372	1	2460	0.00(19)	*	0.00	*
384	1	1120	0.00(9)	*	0.00	*
385	2	2356	0.00(16)	*	0.00	*
386	3	983	0.86(7)	5.50(4)	0.45	3.21
387	4	718	12.00(4)	135.00(3)	8.00	75.92
388	4	361	15.67(3)	13.00(2)	5.33	2.85
389	3	821	1.50(4)	0.00(3)	0.15	0.00
390	2	1481	0.00(11)	*	0.00	*
391	3	282	0.00(3)	0.50(2)	0.00	0.01
392	4	145	9.67(3)	4.00(2)	4.10	2.08
729	5	186	2690.00(2)	206.50(2)	1118.30	121.20
730	6	170	*	109.50(2)	*	59.58
731	5	216	*	68.00(2)	*	18.38
732	6	231	*	68.00(2)	*	37.75
733	5	468	452.07(2)	72.00(2)	238.22	30.00
734	6	22	735	5 272	*	223.2
736	6	175	*	208.50(2)	*	65.63
TOTALS			63.20×10^6	28.58×10^6	29808 t	12525 t

Format for depth zones:
1= 57m-91m 2= 92m-183m 3=184-274m
4=275m-366m 5=367m-549m 6=550-731

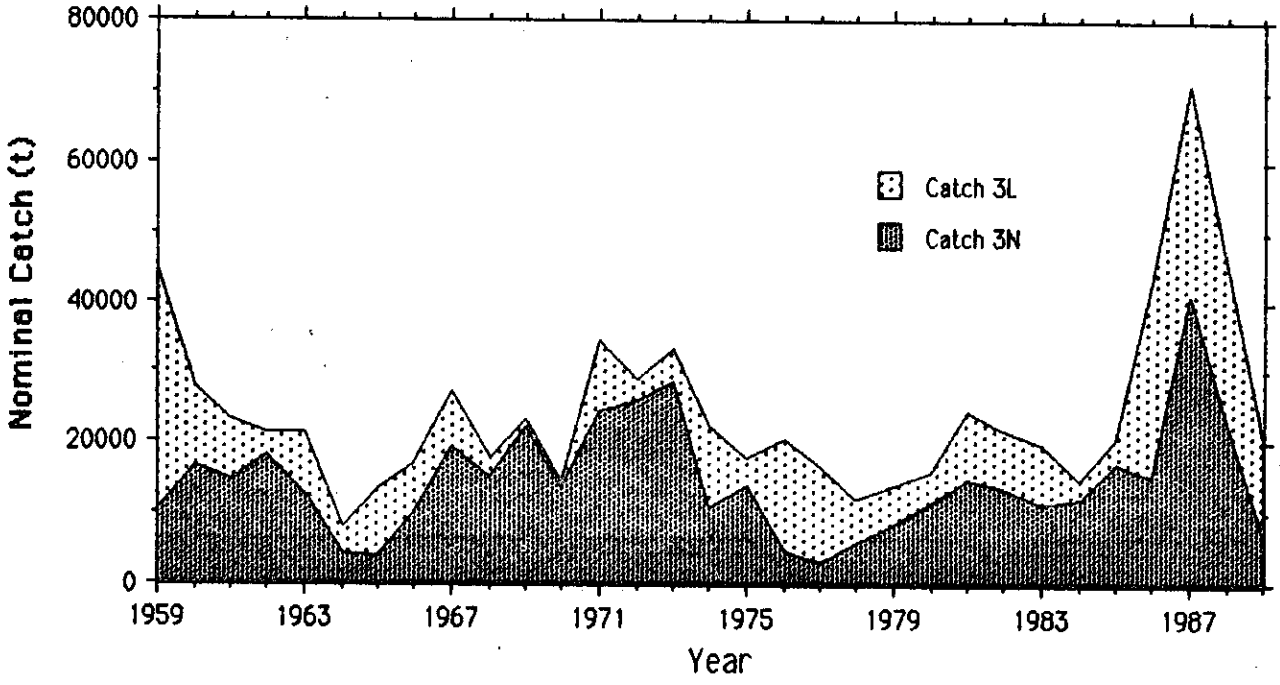

Figure 1: Nominal catch of redfish in NAFO Div. 3LN, 1959-1989 (1988 and 1989 are provisional).

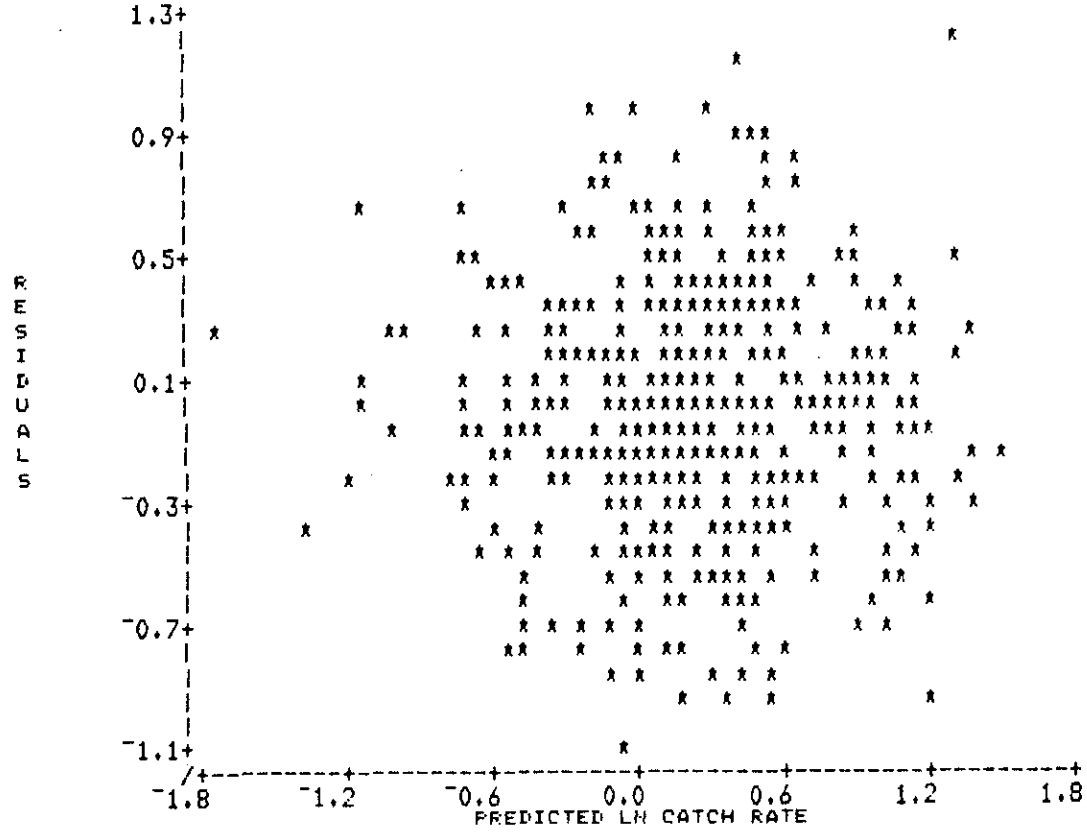

Figure 2a. Plot of residuals versus ln(predicted catch rate) from the multiplicative model of Division 3L CPUE data.

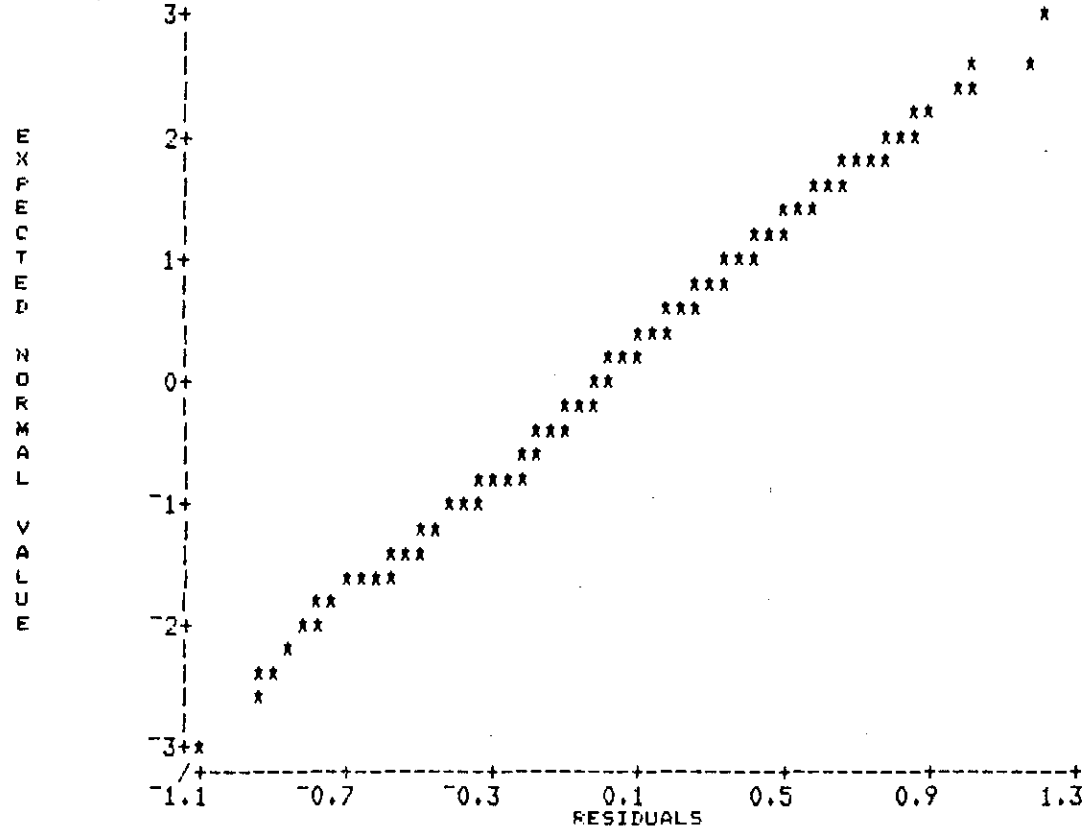

Figure 2b. Plot of expected normal versus residuals from the multiplicative model of Division 3L CPUE data.

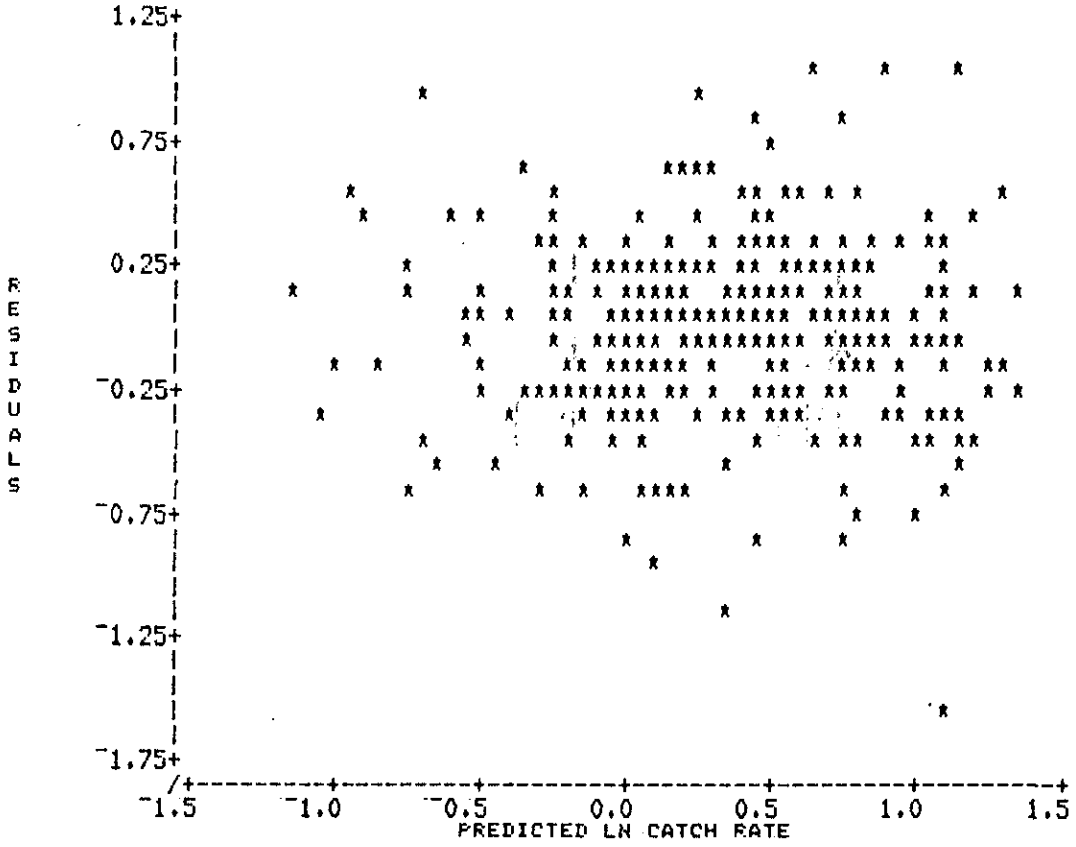

Figure 3a. Plot of residuals versus ln(predicted catch rate) from the multiplicative model of Division 3N CPUE data.

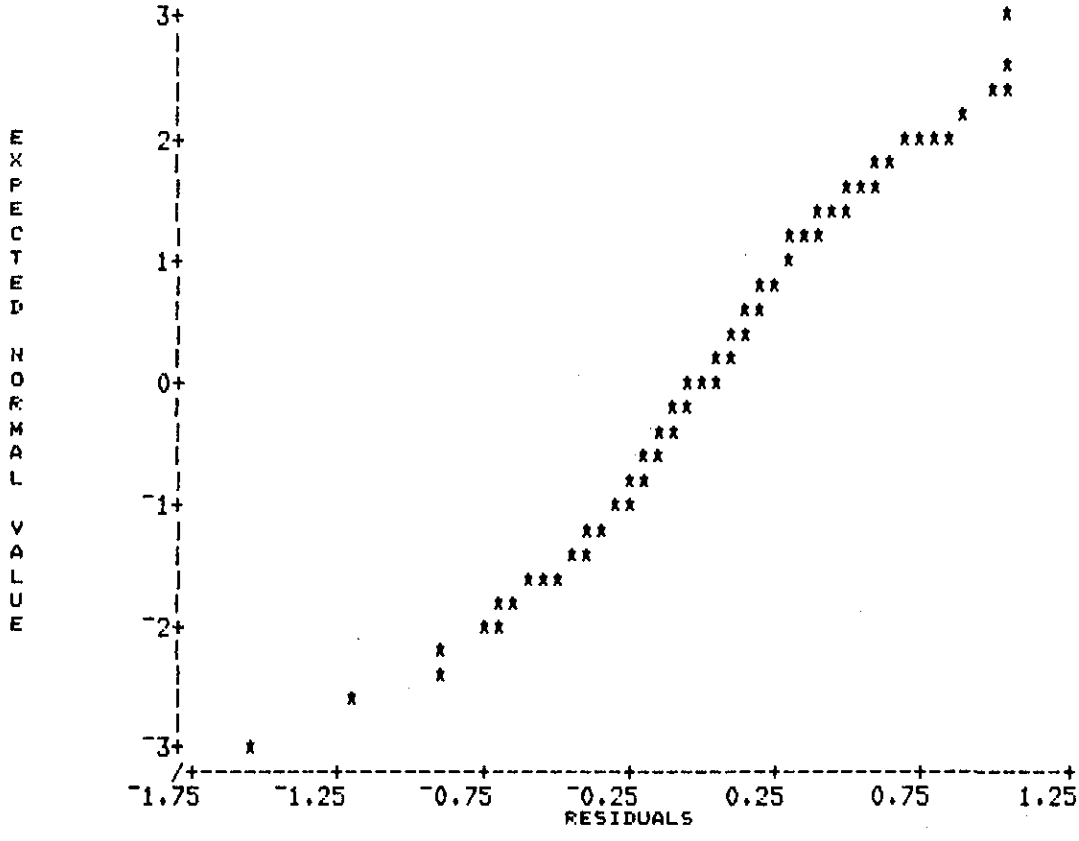

Figure 3b. Plot of expected normal versus residuals from the multiplicative model of Division 3N CPUE data.

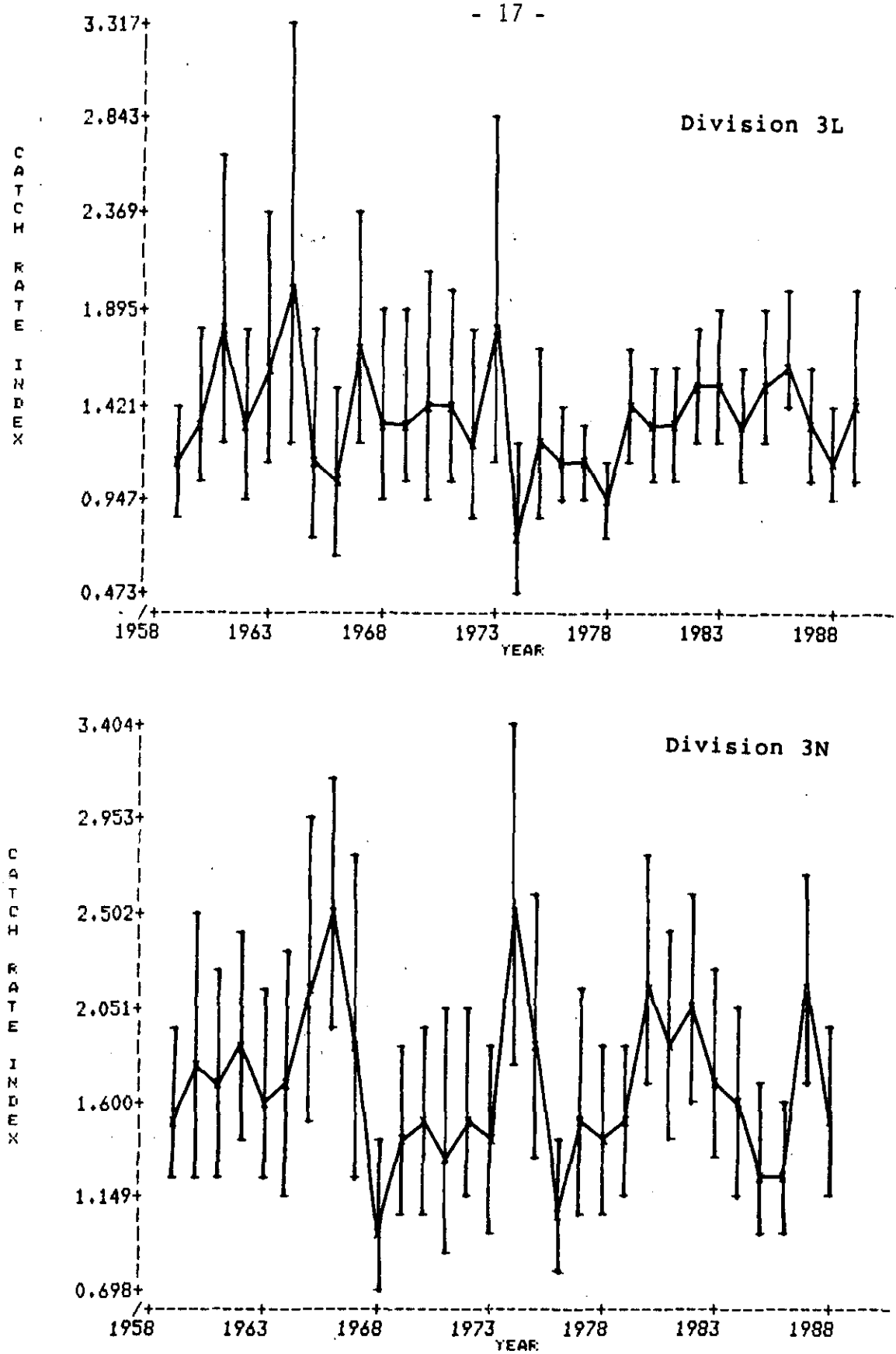

Figure 4. Standardized catch rates in Division 3L and 3N derived from the multiplicative model for each division separately (1988 preliminary and 1989 for 3L from preliminary Canadian data only).

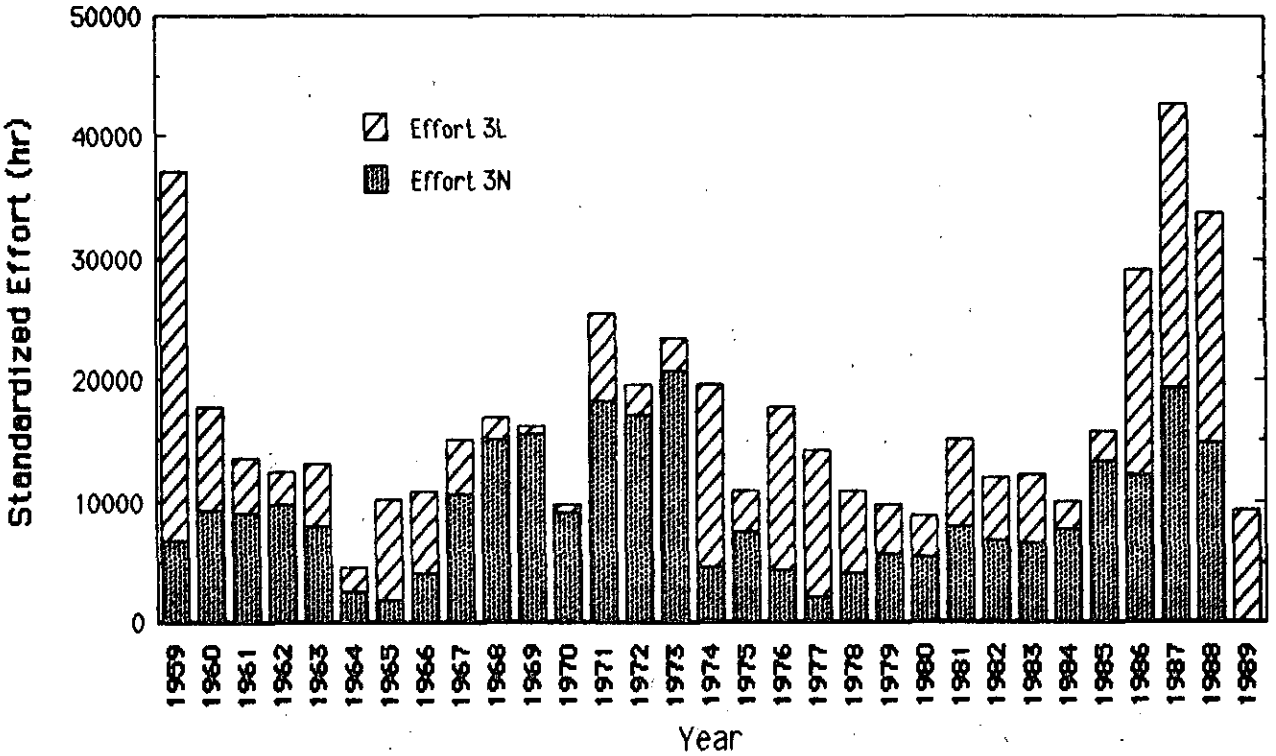

Figure 5: Standardized effort for redfish in NAFO Div. 3LN derived from multiplicative analyses for each division.

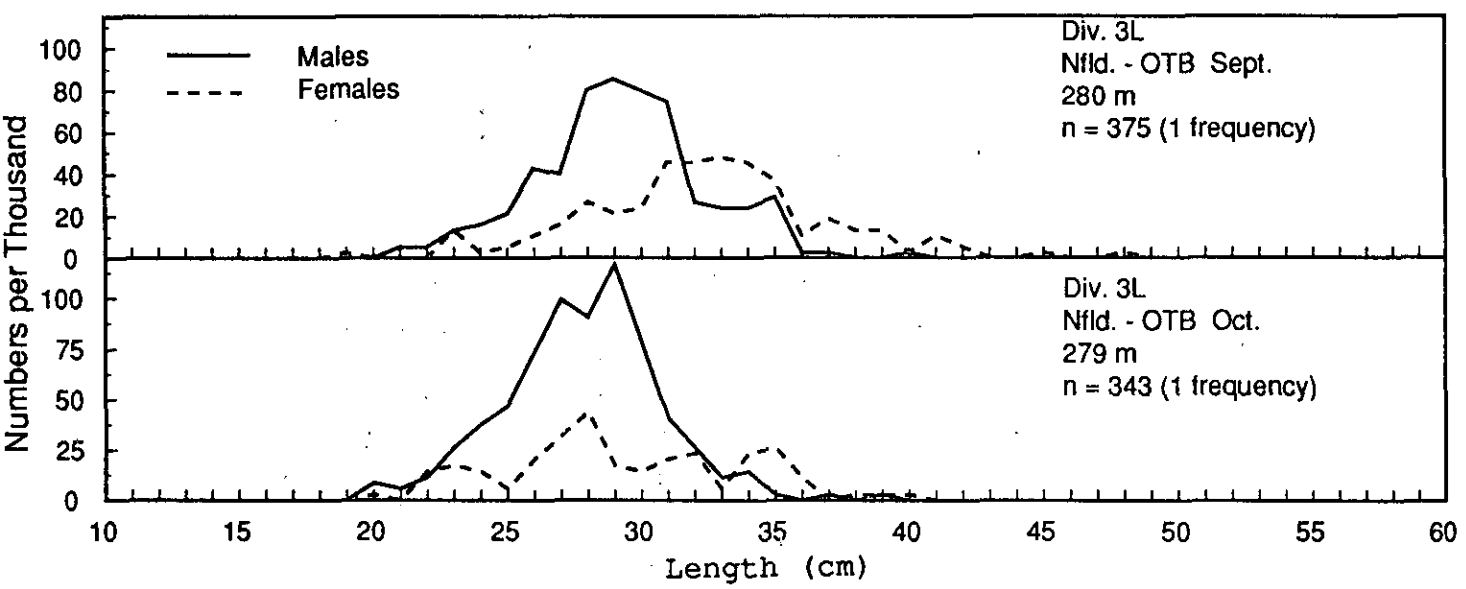

Fig.6: Length frequencies of redfish caught in NAFO Div. 3L by Canadian vessels in 1989.