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Redfish in NAFO Divisions 3LN

by

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Introduction

From 1960 through 1985, catches averaged just over 20,000 t, ranging between 8000 and 33,000 t. During this same period, about 60% were taken from Div. 3N (Table 1, Figure 1). In 1986, the total catch increased to about 43,000 t with 65% being taken in Div. 3L. Catches increased again in 1987 to over 70,000 t (57% from Div. 3N) then decreased to about about half that (34,000 t) in 1988. The increases in Div. 3L were the result of increased catches by Portugal (Table 2a) while the increased landings from Div. 3N in 1987 were the result of increased catches by USSR and South Korea (Table 2b). For 1988, Portugal has reported catches of only 8667 t from Div. 3L and 1827 t from Div. 3N (Godinho MS 1989). Most of the 1988 catch was taken by the USSR.

As in the past, catches are spread throughout the year (Table 3). Bottom trawl is the predominant gear in the redfish fishery in divisions 3LN but midwater trawls have always accounted for a portion of the catch (Table 4). Use of midwater trawls was not prevalent in Div. 3L during the early 1980's, but their use has increased in this area in the past few years.

Analytical analyses are not possible by the authors at present due to a lack of commercial catch-at-age data within Canada.

Methods and Results

Catch and effort data were obtained from ICNAF/NAFO Statistical Bulletins for the 1959-1985 period. These were combined with preliminary NAFO data for 1986 and 1987, and preliminary Canadian statistics for 1988. Only those data where redfish comprised >50% of the total catch were used.

Catch and effort 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 the multiplicative analysis as were country-gear-tonnage class or month category types with <5 data points. As was done last year, side and stern trawlers were separated for the analyses. In addition this year, a new category type was added, percent redfish. Catches were divided int 5 categories corresponding to >50-60%, >60-70%, >70-80%, >80-90% and >90%. No groupings of similar categories within each category type were done, and no weighting of the regression was carried out because of unknown levels of pro-rating of the effort data.

It was noted previously (Power and Atkinson MS 1987), that because there were apparent differing trends in the catch rates in Div. 3L and 3N in recent years, it is not appropriate to combine the data from the two divisions in a multiplicative analysis as the assumption of proportionality is violated. Data from the two divisions were analysed separately again this year.

An initial multiplicative analysis of the Div. 3L data revealed a few outliers (Figure 2a) which were removed prior to the final analysis. The final analysis explained 64% of the variation (Table 5). The new 'percent' category type is very significant (F=24.691) and alone explains about 20% of the variation. Residual plots indicate no problematic outliers (Figure 2b). Outliers were also detected from an initial analysis of Div. 3N data (Figure 3a) and were removed. Final analysis (Table 6) explained about 70% of the variation. Once again, the 'percent' category type was very significant and accounted for about 15% of the variation. Residual plots from the final analysis did not reveal any outliers (Figure 3b).

Catch rates in both Div. 3L and Div. 3N do not show any overall trends with time (Tables 7 & 8, Figure 4). The variation observed over the time period is thought to reflect variation in the data rather than any changes in stock status. Total effort has increased in 1986-1988, corresponding to increased catches (Figure 7) and, the proportion exerted in Div. 3L has increased, reflective of the increased proportion of landings from this division over the same period

Because multiplicative analyses indicated that there was no great contrast in the catch rate series over time in either Div. 3L or Div. 3N, general production analysis is not considered appropriate. It should be noted that general production has been carried out previously with the Div. 3N data (Atkinson and Power MS 1988)

Some commercial frequencies are available from the fishery in 1988 (Figures 6 & 7), although only one of these is available from Div. 3N. In Div. 3L, a wide range of sizes were caught.

Commercial catch-at-age data for 1975-1986 were available from Vaskov *et al.* (MS 1987). These were adjusted by simple ratio to result in the reported catches for each year since the closeness of the sum of products (catch-at-age x weight-at-age) varied from year to year by 5-20%. Catch curves were derived from these adjusted data for ages 10-23 (Table 9, Figure 8). The results give historic Zs varying from 0.15 to 0.51. Assuming M=0.10, this suggests Fs of 0.05 to 0.41. Some of the variation observed may be the result of variation in recruitment and it is difficult to separate this from actual Fs. It can be seen that Fs $\geq$ 0.15 (approximately $F_{0.1}$) consistently result from the catch-at-age for 1980-1986.

Vaskov *et al.* (MS 1989) provide estimates of commercial catch-at-age for 1979-1988. For 1979-1983, these are similar to those provided by Vaskov *et al.* (MS 1987) up until 1984. The estimates for 1984-1988 (again adjusted to the reported catch for 1984 and 1987 since the sum of products differed by 13 and 20% respectively) for ages 10-23 were examined in conjunction with estimates of effort from the multiplicative analyses (1988 CPUE assumed the same for divisions 3L and 3N) to derive Paloheimo Zs (Rivard MS 1980). The results for ages 10+ are:

	1984	1985	1986	1987
10+ Z	0.382	0.326	0.078	0.949
M	0.100	0.100	0.100	0.100
F	0.282	0.226	-0.022	0.849

The estimates Fs are consistently above 0.20, and are close to or greater than F_{MAX} ($F_{0.1}$=0.15 and F_{MAX}=0.25). The estimate for 1986 is low while that for 1987 may be somewhat high indicating possible problems with the 1987 catch-at-age. The average over the two years is about 0.40, much greater than F_{MAX}.

Discussion

Catch rates in divisions 3L and 3N do not show any major trends with time. Rather, the changes from year to year are probably more reflective of variation in the data than changes in stock status. If this is so, then it is difficult to predict the magnitude of stock change required before it could be discerned within the catch rate data. The distribution of redfish (aggregations of high density interspersed with low densities) may be such that considerable changes must occur in stock abundance before they are reflected in the catch rates; the number of 'commercial density' aggregations may have to change considerably before catch rates change. Paloheimo Zs suggest that recent catches in excess of the TACs (25,000 t) have generated Fs in the range of F_{MAX} and it is expected that these would effect catch rates although the number of years of fishing at these levels required to generate a detectable change is unknown. If fishing in excess of that which the stock can sustain must occur for a number of years before it can be detected from catch rates, and given the number of ages involved in the fishery, recovery from overfishing will be slow.

Another interpretation of the catch rate data could be that catch rates have not changed because improvements in technology have kept pace with a decline in the stock. It is not possible for us to examine this except with Canadian data, and Canadian catches constitute too small a proportion of the total to provide any insights.

A further interpretation of the data, of course, is that catches in the range of 20,000 t over the history of the fishery have not impacted on the stock, general production analyses done in the past have not given a true picture of yields, and the stock can maintain higher catches. If this is the case, however, then the reason for the decline in catches between 1987 and 1988 must be addressed.

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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*	27,825	14,971	42,796	25,000
1987*	30,335	40,940	71,275	25,000
1988*			33,692	25,000
1989				25,000

* Provisional.

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

Country	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986*	1987*
Canada (M)	1,671	18	934	554	1,696	1,003	2,663	52	342	2,597	2,352
Canada (N)	7,686	3,143	4,086	2,412	5,925	5,910	3,800	1,229	1,716	2,227	2,157
France (M)	6	45	4	3	-	-	-	-	-	-	-
France (SP)	-	8	-	11	-	-	-	-	-	-	-
FRG	-	-	7	-	-	-	-	89	309	54	-
GDR	144	918	168	375	509	12	586	849	672	486	696
Japan	87	522	-	26	128	159	-	105	129	135	114
Poland	-	-	4	2	-	-	2	1	4	-	-
Portugal	299	261	265	639	275	125	91	48	4	13,469	19,858
Spain	141	8	-	-	137	25	347	91	192	199	335
UK	4	-	2	-	-	-	-	-	-	-	-
USSR	3,231	1,395	114	345	737	607	1,168	232	309	8,658	4,459
Ireland	160	-	-	-	-	-	-	-	-	-	-
Cuba	23	-	-	-	-	-	-	-	-	-	364
Kor-S	-	-	-	-	-	29	-	-	-	-	-
TOTAL	13,452	6,318	5,584	4,367	9,407	7,870	8,657	2,696	3,677	27,825	30,335

* Provisional.

+ Maritimes and Quebec were combined prior to 1979.

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

Country	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986*	1987*
Canada (M)	43	1	198	683	442	-	-	13	311	-	-
Canada (N)	137	18	1,285	367	63	337	1	2	82	16	20
France (M)	-	-	25	-	-	-	-	-	-	-	-
FRG	-	12	-	-	-	-	-	-	-	-	-
GDR	-	11	-	-	58	-	-	-	-	-	-
Portugal	-	-	-	-	-	1	-	365	890	8,273	7,854
Japan	-	-	-	-	-	-	-	81	-	12	51
Romania	-	-	9	-	-	-	-	-	-	-	-
Spain	59	1	-	14	239	278	875	239	2,881	1,393	132
UK	-	-	-	-	-	-	-	-	-	-	-
USSR	2,645	4,532	5,904	8,944	12,762	10,414	7,844	9,045	10,576	2,227	14,397
Cuba	180	1,150	1,062	1,644	1,309	2,621	2,370	2,320	2,055	2,429	2,433
USA	-	-	-	11	-	-	-	-	85	4	-
Kor-S	-	-	-	-	-	26	-	-	-	617	16,053
TOTAL	3,064	5,725	8,483	11,663	14,873	13,677	11,090	12,065	16,880	14,971	40,940

* 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
1977	170	275	1,764	1,034	498	920	2,016	1,339	820	2,069	1,406	981	13,452 a
1978	41	535	301	356	466	669	272	48	19	224	933	2,454	6,318
1979	76	1	1,084	1,391	116	132	492	466	5	22	1,290	509	5,584
1980	271	112	396	119	373	261	80	10	718	311	22	1,694	4,367
1981	280	61	137	1,120	2,286	532	73	90	404	161	1,980	2,283	9,407
1982	1,126	672	1,232	1,225	295	289	459	37	643	1,367	173	352	7,870
1983	1,304	496	672	1,080	934	708	274	642	562	1,070	799	116	8,657
1984	243	135	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	3,670	7,258	3,662	503	975	2,196	544	3,964	2,166	1,819	28,025
1987*	2,439	1,631	5,281	1,424	1,762	74	1,232	3,868	3,285	4,211	3,712	1,382	30,335 b

* Provisional.

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

b includes a catch of 34 t by Canada (M) 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
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	1,668	420	1,665	676	784	541	230	1,223	16,880 a
1986*	392	665	406	533	454	915	4,392	81	1,196	110	4,131	1,696	14,971
1987*	3,787	3,118	1,877	2,203	2,698	2,383	4,339	6,280	7,286	2,431	1,004	3,534	40,940

* 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*	18,956	8,624	122	123	10,422	3,405	-	1,144	42,796
1987*	25,289	4,441	186	419	32,382	8,527	-	31	71,275

* Provisional

Table 5: Regression results from multiplicative analysis for redfish in NAFO Div. 3L.

multiple r..... 0.801
multiple r squared..... 0.641

analysis of variance

source of variation	df	sums of squares	mean squares	f-value
intercept	1	2.551e1	2.551e1	
regression	68	1.088e2	1.600e0	10.022
CGT 1	24	4.279e1	1.783e0	11.168
Month 2	11	8.302e0	7.547e-1	4.727
Percent 3	4	1.577e1	3.942e0	24.691
Year 4	29	8.325e0	2.871e-1	1.798
residuals	381	6.083e1	1.596e-1	
total	450	1.951e2		

regression coefficients

category	code	variable	coefficient	std. error	no. obs.
1	3125	intercept	0.012	0.154	450
2	8				
4	95				
5	59				
1	2114	1	-0.508	0.176	9
	2125	2	-0.111	0.163	8
	2155	3	-0.079	0.184	6
	3114	4	-0.389	0.160	15
	3124	5	0.017	0.145	9
	3154	6	-0.492	0.199	5
	3155	7	0.105	0.107	24
	11115	8	-0.435	0.227	5
	11116	9	-0.376	0.176	10
	11125	10	0.062	0.117	15
	11126	11	0.001	0.143	16
	11127	12	-0.029	0.118	17
	14126	13	-0.349	0.177	6
	14127	14	0.726	0.194	11
	16127	15	-0.025	0.164	26
	17116	16	-0.907	0.204	5
	17127	17	0.274	0.151	9
	20114	18	-1.168	0.173	11
	20116	19	-0.162	0.187	11
	20127	20	0.344	0.088	53
	20145	21	1.277	0.291	12
	20157	22	0.493	0.095	27
	27125	23	0.154	0.081	36
	27126	24	0.438	0.192	5
2	1	25	0.246	0.111	25
	2	26	0.301	0.106	27
	3	27	0.388	0.093	41
	4	28	0.470	0.090	47
	5	29	0.158	0.098	30
	7	30	0.220	0.086	48
	8	31	-0.003	0.090	44
	9	32	0.155	0.095	35
	10	33	0.019	0.090	42
	11	34	0.108	0.090	42
	12	35	0.236	0.110	23
4	55	36	-0.645	0.101	23
	65	37	-0.630	0.078	38
	75	38	-0.345	0.071	51
	85	39	-0.097	0.057	88

Table 5: Continued

5	60	40	0.186	0.170	13
	61	41	0.476	0.221	7
	62	42	0.128	0.203	10
	63	43	0.350	0.211	9
	64	44	0.610	0.285	3
	65	45	0.054	0.258	4
	66	46	-0.087	0.242	5
	67	47	0.384	0.186	19
	68	48	0.131	0.218	8
	69	49	0.236	0.201	7
	70	50	0.226	0.212	8
	71	51	0.211	0.206	12
	72	52	0.076	0.211	6
	73	53	0.251	0.309	2
	74	54	-0.375	0.283	15
	75	55	0.077	0.230	5
	76	56	0.042	0.144	32
	77	57	-0.030	0.150	33
	78	58	-0.193	0.155	25
	79	59	0.131	0.166	23
	80	60	0.121	0.169	18
	81	61	0.146	0.167	18
	82	62	0.241	0.162	23
	83	63	0.282	0.159	20
	84	64	0.151	0.176	14
	85	65	0.276	0.169	18
	86	66	0.339	0.159	29
	87	67	0.123	0.167	20
	88	68	0.049	0.167	20

Table 6: Regression results from multiplicative analysis for redfish in NAFO Div. 3N

multiple r..... 0.835
multiple r squared..... 0.698

analysis of variance

source of variation		df	sums of squares	mean squares	f-value
intercept		1	3.763e1	3.763e1	
regression		55	7.811e1	1.420e0	11.542
CGT	1	12	2.164e1	1.803e0	14.654
Month	2	11	2.379e0	2.163e-1	1.758
Percent	3	4	9.696e0	2.424e0	19.700
Year	4	28	1.241e1	4.433e-1	3.603
residuals		275	3.384e1	1.230e-1	
total		331	1.496e2		

Table 6: Continued

regression coefficients

category	code	variable	coefficient	std. error	no. obs.
1	3125	intercept	0.286	0.134	331
2	6				
4	95				
5	59				
1	2114	1	-0.308	0.129	17
	3114	2	-0.040	0.104	73
	4127	3	0.337	0.128	17
	4157	4	0.566	0.129	19
	16127	5	-0.115	0.184	5
	20114	6	-1.060	0.181	7
	20116	7	-0.047	0.169	8
	20127	8	0.665	0.095	76
	20157	9	0.658	0.105	53
	25126	10	0.151	0.173	8
	25127	11	0.703	0.148	14
	27125	12	0.335	0.175	6
2	1	13	-0.275	0.108	25
	2	14	-0.253	0.112	22
	3	15	-0.292	0.106	28
	4	16	-0.190	0.112	22
	5	17	-0.120	0.116	17
	7	18	-0.212	0.094	40
	8	19	-0.205	0.095	41
	9	20	-0.230	0.095	41
	10	21	-0.282	0.103	30
	11	22	-0.231	0.110	23
	12	23	-0.483	0.120	17
4	55	24	-0.604	0.087	31
	65	25	-0.517	0.077	38
	75	26	-0.396	0.071	45
	85	27	-0.291	0.063	54
5	60	28	0.249	0.191	5
	61	29	0.204	0.153	11
	62	30	0.315	0.129	23
	63	31	0.176	0.149	13
	64	32	0.183	0.177	8
	65	33	0.450	0.182	7
	66	34	0.570	0.136	15
	67	35	0.317	0.240	3
	68	36	-0.313	0.217	4
	69	37	0.015	0.168	8
	70	38	0.109	0.168	8
	71	39	-0.055	0.231	3
	72	40	0.067	0.157	9
	73	41	0.004	0.190	5
	74	42	0.433	0.188	6
	75	43	0.278	0.186	6
	76	44	-0.250	0.164	8
	77	45	0.118	0.199	5
	78	46	-0.022	0.168	8
	79	47	0.062	0.139	14
	80	48	0.448	0.135	16
	81	49	0.316	0.142	17
	82	50	0.489	0.137	16
	83	51	0.107	0.142	14
	84	52	0.108	0.154	12
	85	53	-0.072	0.148	15
	86	54	-0.115	0.156	12
	87	55	0.370	0.130	38

Table 7: Standardized catch rate (t/hr) and effort (hr) for redfish in NAFO Div. 3L as derived from the multiplicative model.

standards used variable numbers: 3125 6 95

predicted catch rate

	ln transform		retransformed			
year	mean	s.e.	mean	s.e.	catch	effort
59	0.0123	0.0236	1.084	0.166	34107	31468
60	0.1980	0.0276	1.302	0.215	11463	8802
61	0.4883	0.0490	1.722	0.377	8349	4847
62	0.1399	0.0399	1.221	0.242	3425	2804
63	0.3627	0.0440	1.523	0.317	8191	5379
64	0.6228	0.0788	1.941	0.535	3898	2008
65	0.0662	0.0651	1.120	0.282	9451	8436
66	-0.0744	0.0566	0.977	0.230	6927	7086
67	0.3962	0.0256	1.589	0.253	7684	4834
68	0.1432	0.0383	1.226	0.238	2348	1915
69	0.2480	0.0322	1.366	0.243	927	679
70	0.2382	0.0433	1.345	0.277	1029	765
71	0.2230	0.0351	1.330	0.247	10403	7820
72	0.0882	0.0404	1.159	0.231	3095	2669
73	0.2631	0.0945	1.344	0.404	4709	3503
74	-0.3624	0.0727	0.727	0.193	11419	15707
75	0.0892	0.0391	1.161	0.228	3838	3305
76	0.0543	0.0123	1.137	0.126	15971	14050
77	-0.0176	0.0123	1.058	0.117	13452	12716
78	-0.1812	0.0129	0.898	0.102	6318	7036
79	0.1438	0.0167	1.240	0.160	5584	4502
80	0.1333	0.0144	1.229	0.147	4367	3554
81	0.1587	0.0145	1.260	0.151	9407	7463
82	0.2531	0.0118	1.387	0.150	7870	5674
83	0.2946	0.0132	1.445	0.166	8657	5992
84	0.1729	0.0172	1.277	0.167	2696	2112
85	0.2880	0.0142	1.435	0.171	3677	2563
86	0.3510	0.0114	1.530	0.163	27825	18186
87	0.1350	0.0147	1.231	0.149	30335	24648
88	0.0616	0.0147	1.144	0.138	21986	19154

average c.v. for the retransformed mean: 0.171

Table 8: Standardized catch rate (t/hr) and effort (hr) for redfish in NAFO Div. 3N as derived from the multiplicative model.

standards used variable numbers: 3125 6 95

predicted catch rate

	ln transform		retransformed			
year	mean	s.e.	mean	s.e.	catch	effort
59	0.2858	0.0181	1.403	0.188	10478	7469
60	0.5343	0.0402	1.779	0.354	16547	9303
61	0.4898	0.0271	1.712	0.280	14826	8658
62	0.6009	0.0202	1.920	0.272	18009	9378
63	0.4614	0.0272	1.664	0.273	12906	7754
64	0.4687	0.0359	1.669	0.314	4206	2519
65	0.7359	0.0382	2.178	0.422	4042	1856
66	0.8561	0.0168	2.483	0.321	10047	4047
67	0.6032	0.0568	1.890	0.445	19504	10321
68	0.0273	0.0437	1.013	0.210	15265	15075
69	0.3009	0.0279	1.417	0.236	22142	15625
70	0.3945	0.0297	1.555	0.266	13359	8592
71	0.2304	0.0579	1.301	0.309	24310	18687
72	0.3527	0.0261	1.494	0.240	25838	17296
73	0.2893	0.0343	1.396	0.257	28588	20474
74	0.7183	0.0362	2.142	0.405	10867	5073
75	0.5636	0.0357	1.836	0.344	14033	7644
76	0.0357	0.0294	1.086	0.185	4541	4181
77	0.4036	0.0382	1.562	0.303	3064	1961
78	0.2634	0.0276	1.365	0.226	5725	4194
79	0.3474	0.0192	1.491	0.206	8483	5689
80	0.7333	0.0183	2.194	0.296	11663	5315
81	0.6016	0.0193	1.923	0.267	14873	7736
82	0.7749	0.0183	2.287	0.309	13677	5979
83	0.3929	0.0208	1.559	0.224	11090	7113
84	0.3941	0.0249	1.558	0.245	12065	7744
85	0.2138	0.0227	1.302	0.196	16880	12961
86	0.1710	0.0247	1.246	0.195	14971	12010
87	0.6560	0.0177	2.032	0.270	40940	20152

average c.v. for the retransformed mean: 0.168

Table 9: Catch curve results for redfish in NAFO Div. 3LN using catch-at-age data from NAFO SCR Doc. 86/20 for ages 10 - 23.

Regression

Dep var: **LN75** N: 14 Multiple R: .787 Squared Multiple R: .619

Adjusted Squared Multiple R: .587 Standard Error of Estimate: 0.5110

Variable	Coefficient	Std Error	Std Coef	Tolerance	T	P(2 tail)
CONSTANT	9.2896	0.5755	0.0000	.	16.1426	0.0000
AGE	-0.1495	0.0339	-0.7866	.100E+01	-4.4126	0.0008

Analysis of Variance

Source	Sum-of-Squares	DF	Mean-Square	F-Ratio	P
Regression	5.0848	1	5.0848	19.4712	0.0008
Residual	3.1337	12	0.2611		

Regression

Dep var: **LN76** N: 14 Multiple R: .945 Squared Multiple R: .893

Adjusted Squared Multiple R: .884 Standard Error of Estimate: 0.4664

Variable	Coefficient	Std Error	Std Coef	Tolerance	T	P(2 tail)
CONSTANT	12.1621	0.5252	0.0000	.	23.1577	0.0000
AGE	-0.3099	0.0309	-0.9451	.100E+01	-10.0216	0.0000

Analysis of Variance

Source	Sum-of-Squares	DF	Mean-Square	F-Ratio	P
Regression	21.8442	1	21.8442	100.4330	0.0000
Residual	2.6100	12	0.2175		

Regression

Dep var: **LN77** N: 14 Multiple R: .861 Squared Multiple R: .742

Adjusted Squared Multiple R: .720 Standard Error of Estimate: 0.4813

Variable	Coefficient	Std Error	Std Coef	Tolerance	T	P(2 tail)
CONSTANT	10.1950	0.5419	0.0000	.	18.8118	0.0000
AGE	-0.1873	0.0319	-0.8612	.100E+01	-5.8705	0.0001

Analysis of Variance

Source	Sum-of-Squares	DF	Mean-Square	F-Ratio	P
Regression	7.9818	1	7.9818	34.4629	0.0001
Residual	2.7793	12	0.2316		

Table 9: Continued

Regression

Dep var: **LN78** N: 14 Multiple R: .838 Squared Multiple R: .702

Adjusted Squared Multiple R: .677 Standard Error of Estimate: 0.4944

Variable	Coefficient	Std Error	Std Coef	Tolerance	T	P(2 tail)
CONSTANT	9.3846	0.5567	0.0000	.	16.8564	0.0000
AGE	-0.1742	0.0328	-0.8377	.100E+01	-5.3143	0.0002

Analysis of Variance

Source	Sum-of-Squares	DF	Mean-Square	F-Ratio	P
Regression	6.9027	1	6.9027	28.2415	0.0002
Residual	2.9330	12	0.2444		

Regression

Dep var: **LN79** N: 14 Multiple R: .925 Squared Multiple R: .856

Adjusted Squared Multiple R: .844 Standard Error of Estimate: 0.3747

Variable	Coefficient	Std Error	Std Coef	Tolerance	T	P(2 tail)
CONSTANT	9.9672	0.4220	0.0000	.	23.6192	0.0000
AGE	-0.2101	0.0248	-0.9253	.100E+01	-8.4549	0.0000

Analysis of Variance

Source	Sum-of-Squares	DF	Mean-Square	F-Ratio	P
Regression	10.0386	1	10.0386	71.4861	0.0000
Residual	1.6851	12	0.1404		

Regression

Dep var: **LN80** N: 14 Multiple R: .929 Squared Multiple R: .864

Adjusted Squared Multiple R: .853 Standard Error of Estimate: 0.4240

Variable	Coefficient	Std Error	Std Coef	Tolerance	T	P(2 tail)
CONSTANT	10.8811	0.4774	0.0000	.	22.7904	0.0000
AGE	-0.2453	0.0281	-0.9294	.100E+01	-8.7265	0.0000

Analysis of Variance

Source	Sum-of-Squares	DF	Mean-Square	F-Ratio	P
Regression	13.6887	1	13.6887	76.1521	0.0000
Residual	2.1570	12	0.1798		

Table 9: Continued

Regression

Dep var: **LN81** N: 14 Multiple R: .917 Squared Multiple R: .841

Adjusted Squared Multiple R: .828 Standard Error of Estimate: 0.4463

Variable	Coefficient	Std Error	Std Coef	Tolerance	T	P(2 tail)
CONSTANT	10.7957	0.5026	0.0000	.	21.4787	0.0000
AGE	-0.2358	0.0296	-0.9171	.100E+01	-7.9697	0.0000

Analysis of Variance

Source	Sum-of-Squares	DF	Mean-Square	F-Ratio	P
Regression	12.6536	1	12.6536	63.5168	0.0000
Residual	2.3906	12	0.1992		

Regression

Dep var: **LN82** N: 14 Multiple R: .973 Squared Multiple R: .947

Adjusted Squared Multiple R: .943 Standard Error of Estimate: 0.4719

Variable	Coefficient	Std Error	Std Coef	Tolerance	T	P(2 tail)
CONSTANT	12.9003	0.5314	0.0000	.	24.2756	0.0000
AGE	-0.4589	0.0313	-0.9732	.100E+01	-14.6685	0.0000

Analysis of Variance

Source	Sum-of-Squares	DF	Mean-Square	F-Ratio	P
Regression	47.9147	1	47.9147	215.1657	0.0000
Residual	2.6722	12	0.2227		

Regression

Dep var: **LN83** N: 14 Multiple R: .967 Squared Multiple R: .936

Adjusted Squared Multiple R: .930 Standard Error of Estimate: 0.5782

Variable	Coefficient	Std Error	Std Coef	Tolerance	T	P(2 tail)
CONSTANT	13.5264	0.6511	0.0000	.	20.7740	0.0000
AGE	-0.5069	0.0383	-0.9674	.100E+01	-13.2223	0.0000

Analysis of Variance

Source	Sum-of-Squares	DF	Mean-Square	F-Ratio	P
Regression	58.4489	1	58.4489	174.8291	0.0000
Residual	4.0118	12	0.3343		

Table 9: Continued

Regression

Dep var: **LN84** N: 14 Multiple R: .976 Squared Multiple R: .952

Adjusted Squared Multiple R: .948 Standard Error of Estimate: 0.5486

Variable	Coefficient	Std Error	Std Coef Tolerance		T	P(2 tail)
CONSTANT	14.7248	0.6178	0.0000	.	23.8341	0.0000
AGE	-0.5605	0.0364	-0.9756	.100E+01	-15.4089	0.0000

Analysis of Variance

Source	Sum-of-Squares	DF	Mean-Square	F-Ratio	P
Regression	71.4634	1	71.4634	237.4356	0.0000
Residual	3.6118	12	0.3010		

Regression

Dep var: **LN85** N: 14 Multiple R: .944 Squared Multiple R: .890

Adjusted Squared Multiple R: .881 Standard Error of Estimate: 0.5699

Variable	Coefficient	Std Error	Std Coef Tolerance		T	P(2 tail)
CONSTANT	12.2641	0.6418	0.0000	.	19.1094	0.0000
AGE	-0.3732	0.0378	-0.9436	.100E+01	-9.8772	0.0000

Analysis of Variance

Source	Sum-of-Squares	DF	Mean-Square	F-Ratio	P
Regression	31.6872	1	31.6872	97.5601	0.0000
Residual	3.8976	12	0.3248		

Regression

Dep var: **LN86** N: 14 Multiple R: .988 Squared Multiple R: .977

Adjusted Squared Multiple R: .975 Standard Error of Estimate: 0.2552

Variable	Coefficient	Std Error	Std Coef Tolerance		T	P(2 tail)
CONSTANT	13.1086	0.2873	0.0000	.	45.6204	0.0000
AGE	-0.3813	0.0169	-0.9884	.100E+01	-22.5390	0.0000

Analysis of Variance

Source	Sum-of-Squares	DF	Mean-Square	F-Ratio	P
Regression	33.0750	1	33.0750	508.0064	0.0000
Residual	0.7813	12	0.0651		

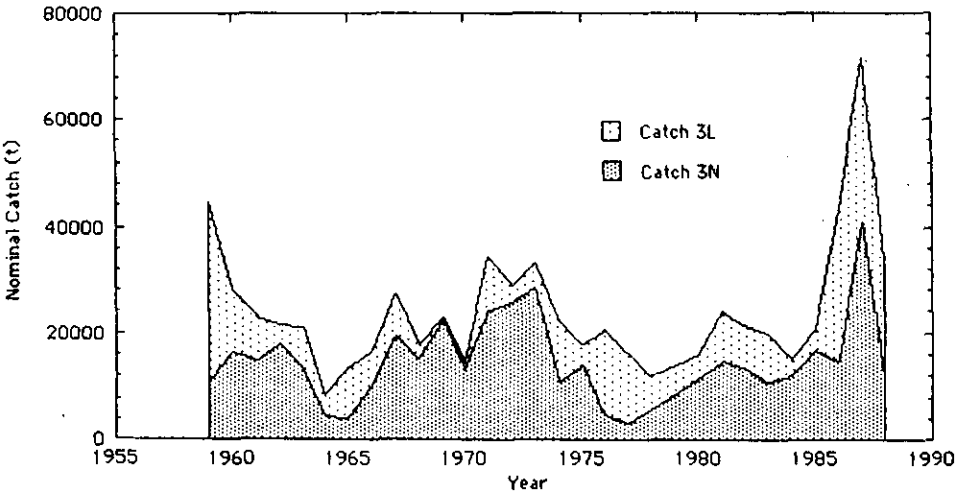


Figure 1 : Nominal catches of redfish in NAFO Divisions 3LN, 1959-1988 (1986 - 1988 are provisional).

Figure 2a: Residual plots from a preliminary multiplicative analysis of catch and effort data for Div. 3L redfish (residuals shown as 0 were deleted for the final analysis).

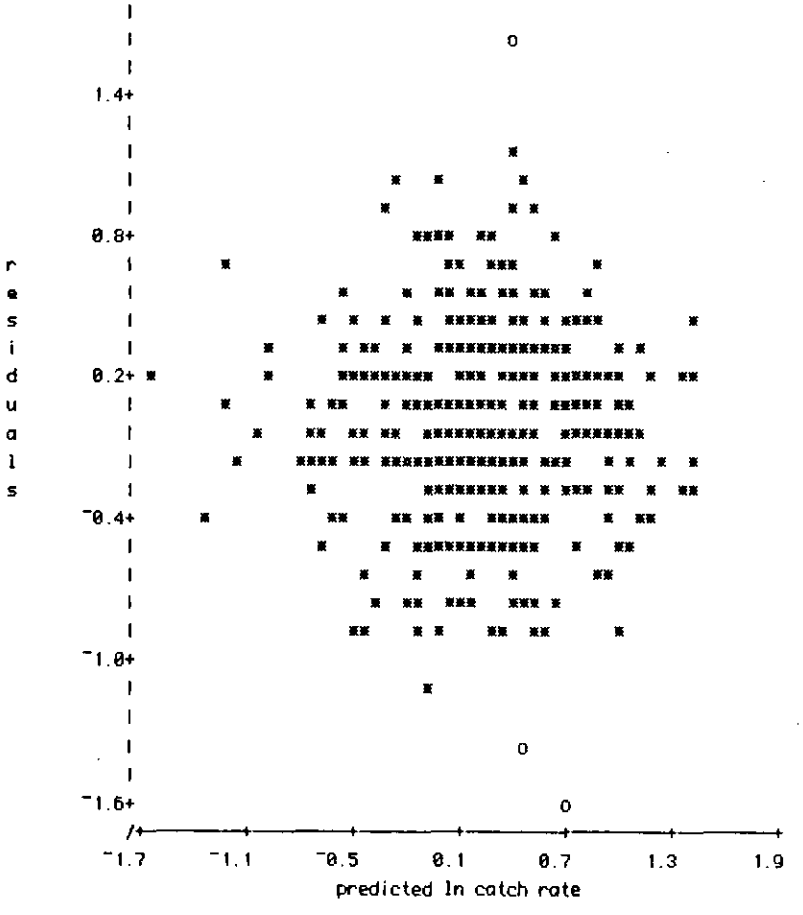


Figure 2a: Continued

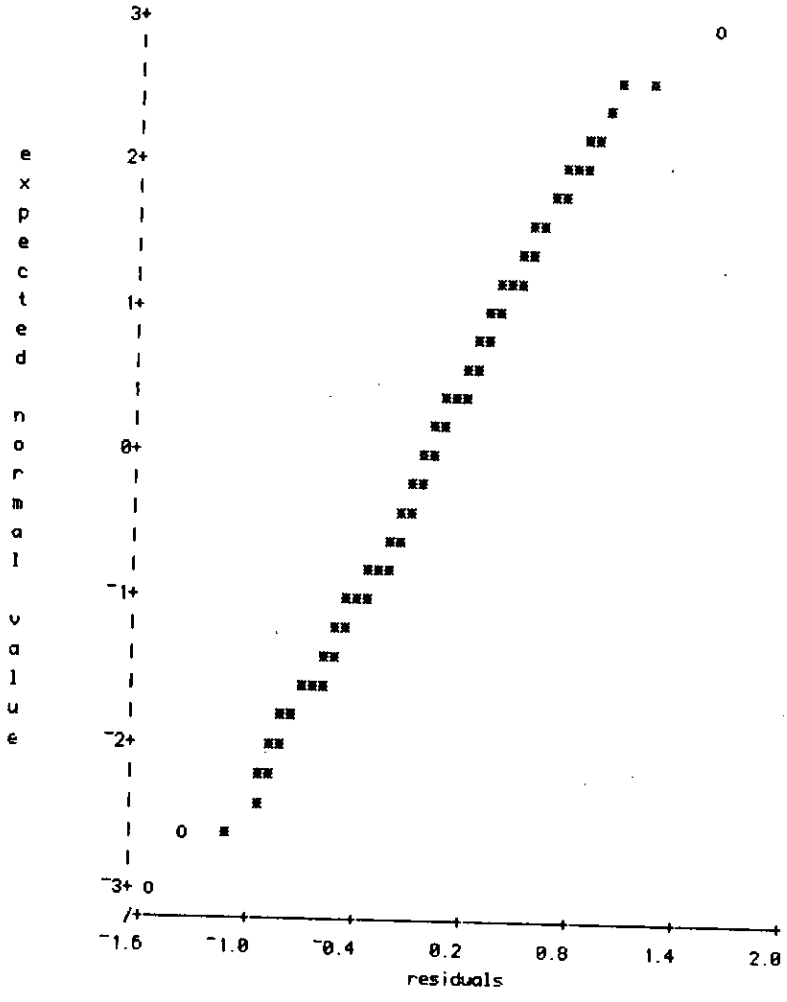


Figure 2b: Residual plots from the final multiplicative analysis of catch and effort data for redfish in NAFO Div. 3L.

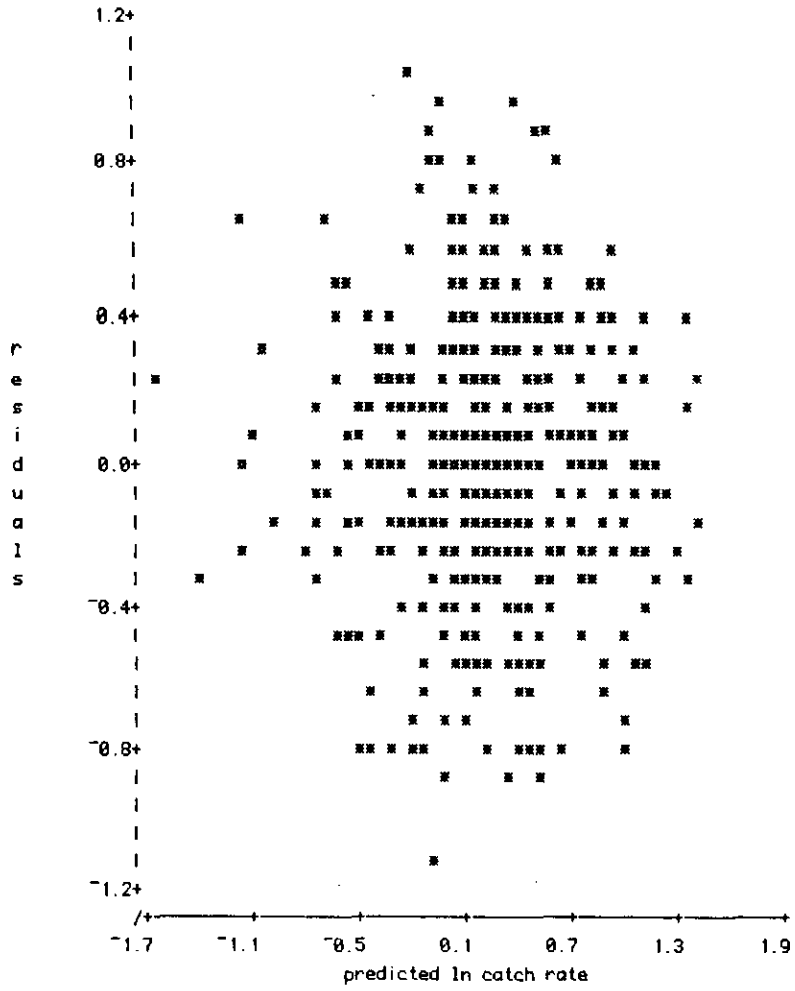


Figure 2b: Continued

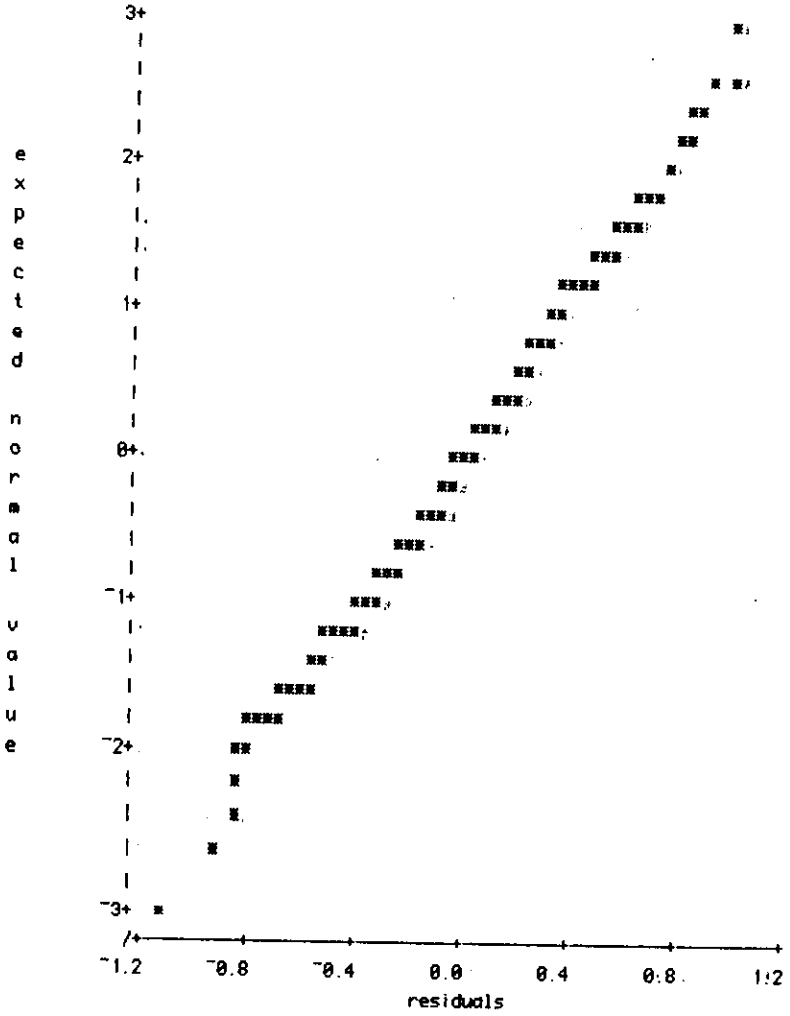


Figure 3a: Residual plots from a preliminary multiplicative analysis of catch and effort data for redfish in NAFO Div. 3N (points shown as 0 were eliminated from the final analysis).

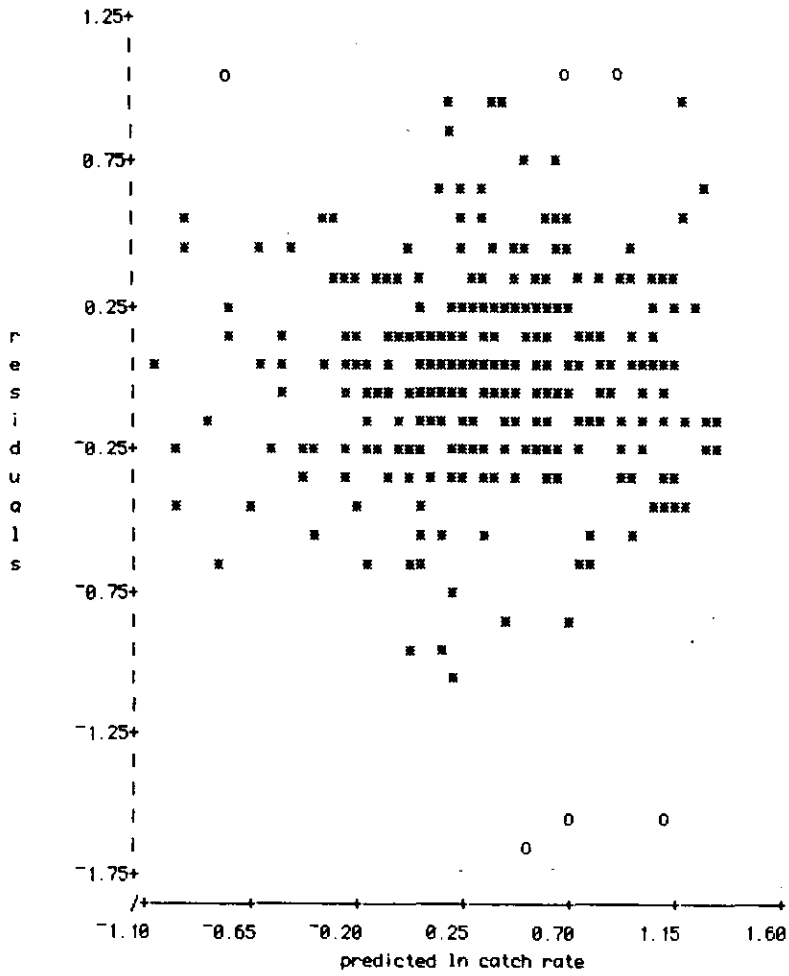


Figure 3a: Continued

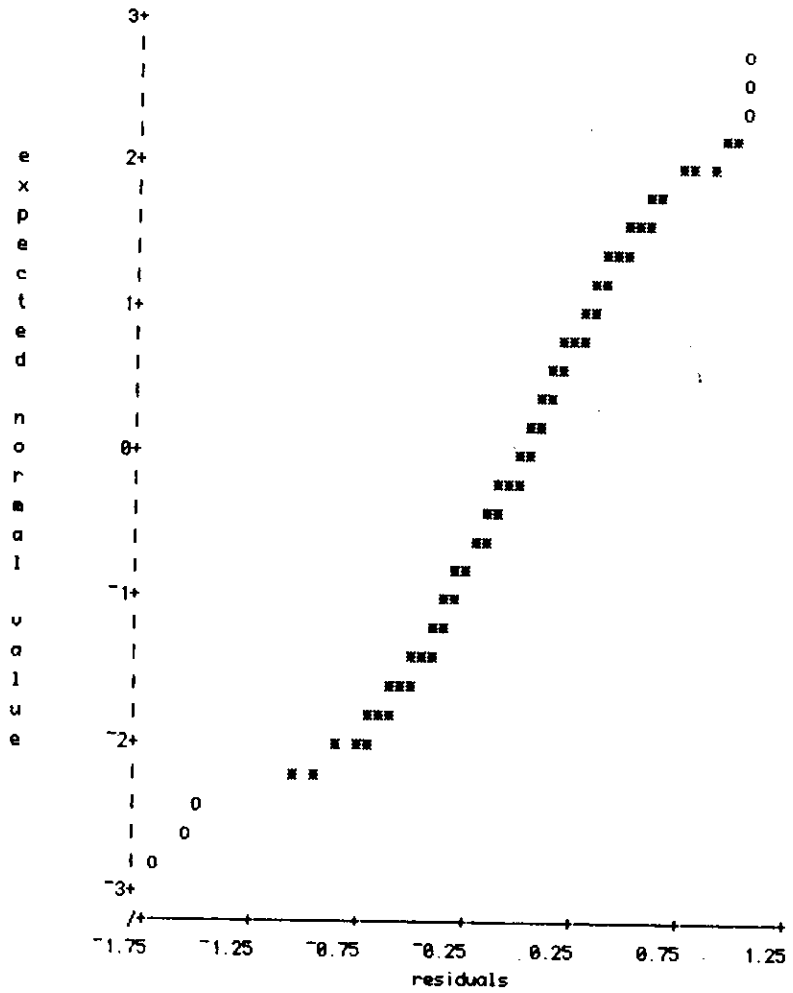


Figure 3b: Residual plots from the final multiplicative analysis of catch and effort data for redfish in NAFO Div. 3N.

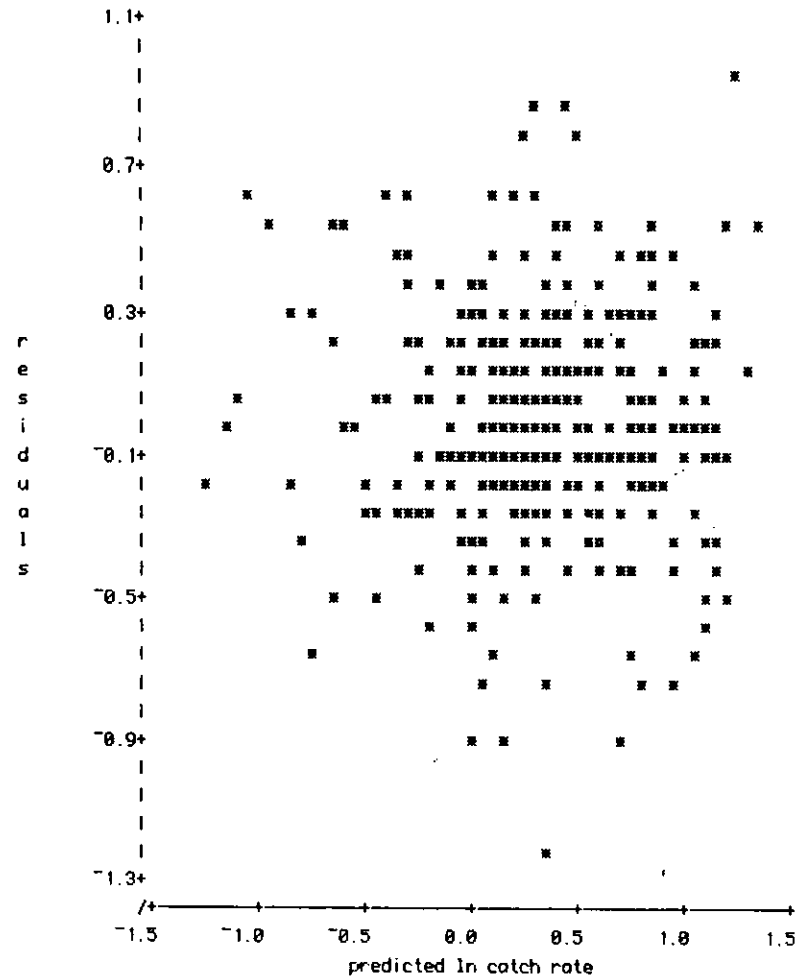
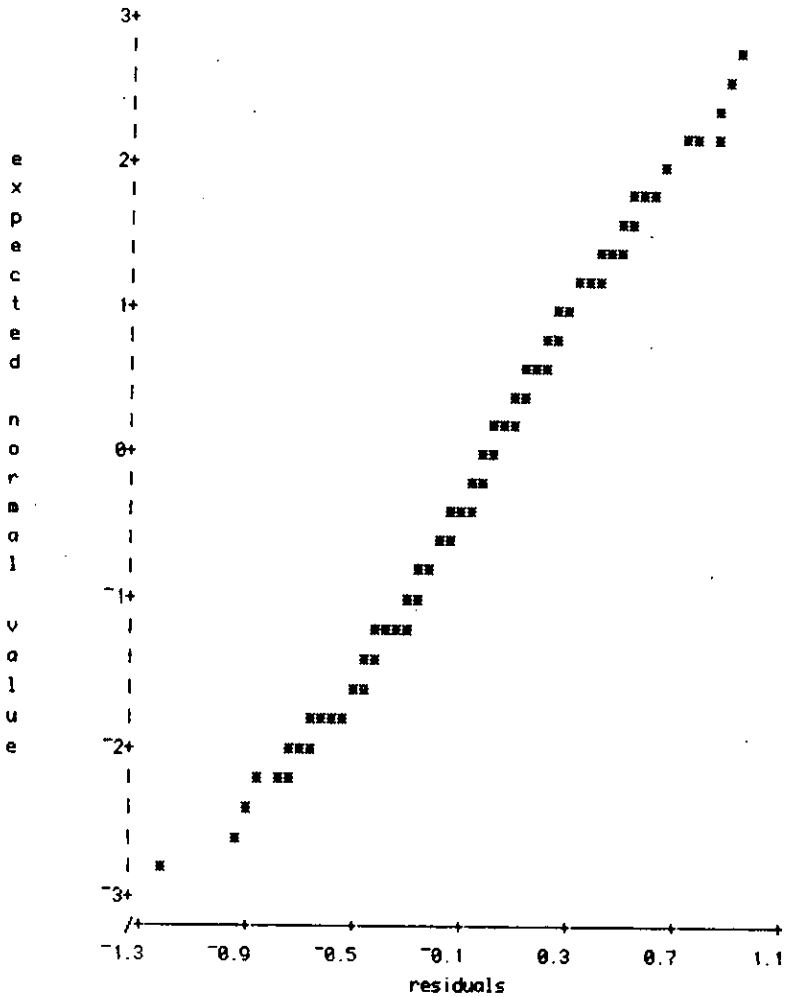


Figure 3b: Continued



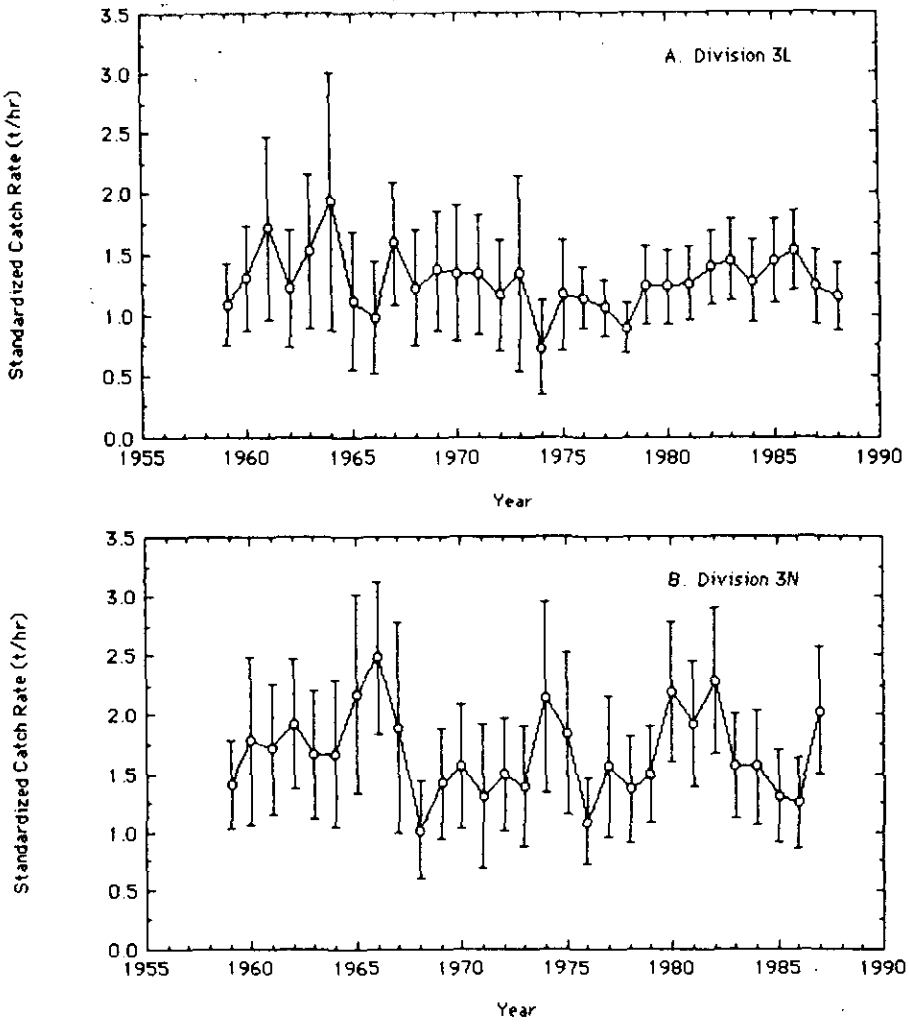


Figure 4: Standardized catch rates for redfish in NAFO Div. 3LN derived from the multiplicative model (1986 - 1988 are preliminary).

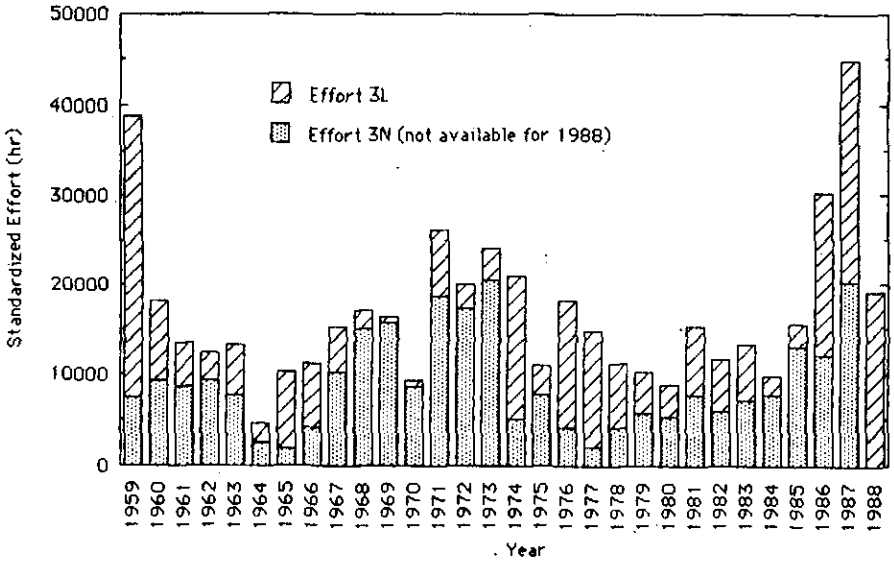


Figure 5: Standardized effort for redfish in NAFO Divisions 3LN derived from the multiplicative model (1986 - 1988 are preliminary).

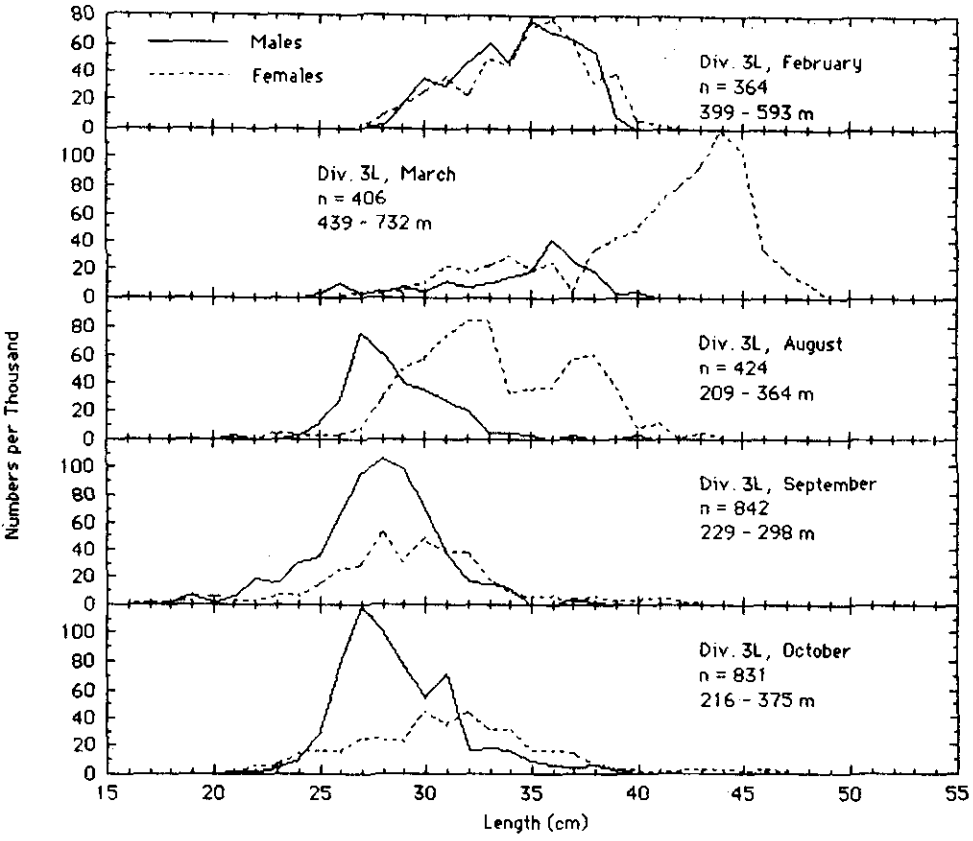


Figure 6 : Commercial frequencies of redfish caught by Canada (Nfld.) in NAFO Div. 3LN in 1988 collected by Canadian port samplers.

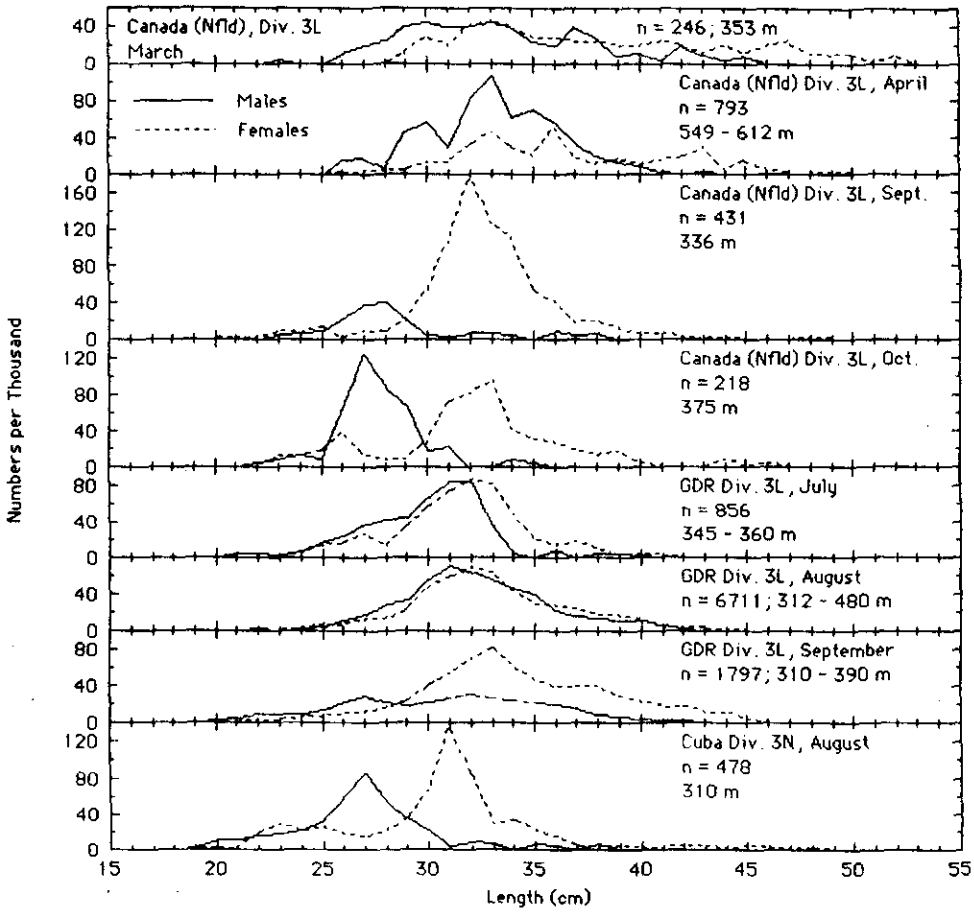


Figure 7 : Commercial frequencies of redfish caught by various countries in NAFO Div. 3LN in 1988 collected by Canadian Observers.

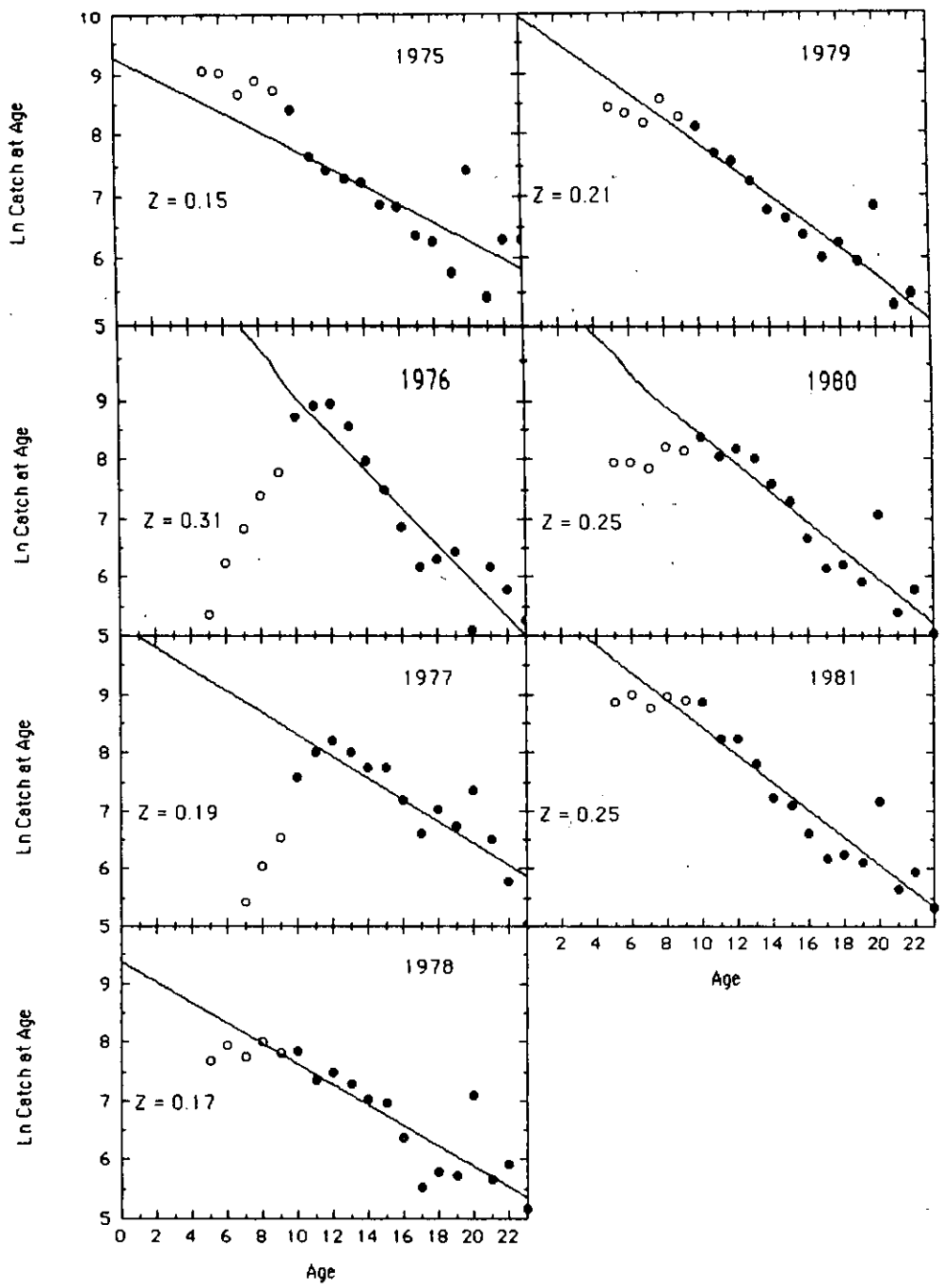


Figure 8: Catch curves for redfish in NAFO Div. 3LN derived from age 10-23 catch-at-age as reported in NAFO SCR Doc. 86/20.

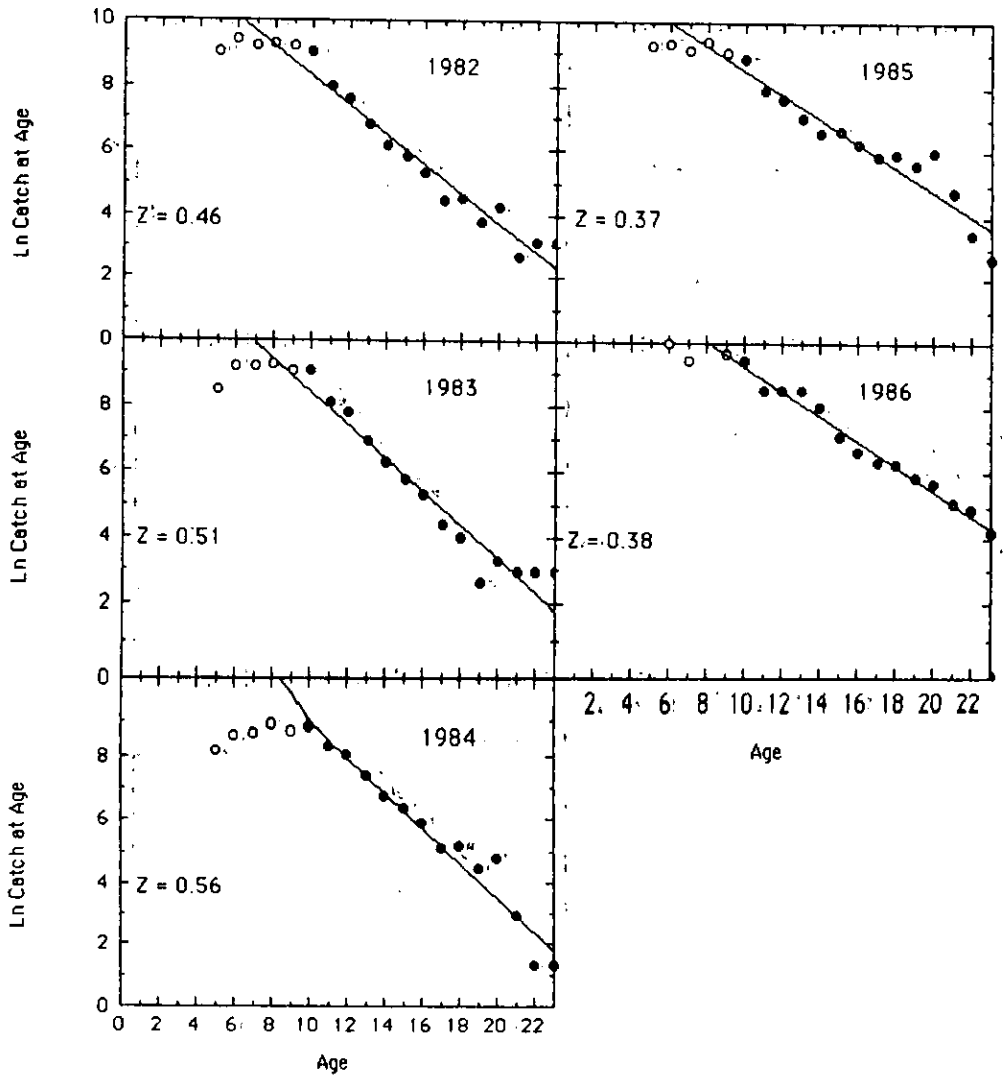


Figure 8: Continued