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An Assessment of Redfish in the Laurentian Channel management unit

by

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ABSTRACT

Prior to 1992 redfish in Subarea 4 and Div. 3P were managed as three units (Div. 3P, 4RST and 4VWX). The integrity of these units was questioned in 1989 and in the following years an examination of applicable data resulted in a proposal of new management units. This paper presents information relevant to the provision of advice for the proposed "Laurentian Channel" unit which comprises Subdiv. 3Ps4Vs4Wfgj and Subdiv. 3Pn4Vn (Jun-Dec).

Since 1984 landings have steadily increased from about 8,000 t to 20,000 in 1991. Maritime vessels generally account for the majority of landings in Div. 4V while Newfoundland vessels take the majority of their catch in Div. 3P. In 1991 the majority of the catch corresponded to the year classes of the early 1980s. Standardized commercial catch rates indicate dramatic changes in recent years and are not considered reflective of stock abundance. Research vessel bottom trawl surveys suffer from considerable variability and only adequately cover Div. 3P. An acoustic survey conducted in 1989 estimated a biomass in the range of 300,000 t in Div. 3P4V which may be conservative. The prospect for recruitment in the future appears good. There is no analysis applicable to determine an appropriate reference catch.

RÉSUMÉ

Avant 1992, les stocks de sébaste de la sous-zone 4 et de la division 3P étaient gérés en trois unités distinctes (divisions 3P, 4RST et 4VWX). L'intégrité de ces unités a été remise en question en 1989 et, dans les années qui suivirent, un examen des données pertinentes a abouti à une proposition de découpage en nouvelles unités de gestion. Le présent document fournit des données applicables à la formulation d'avis pour l'unité du «chenal Laurentien», qui comprend les subdivisions 3Ps4Vs4Wfgj et les subdivisions 3Pn4Vn (juin-décembre).

Depuis 1984, les débarquements ont constamment augmenté, passant d'environ 8 000 t à 20 000 t en 1991. Ce sont les navires des Maritimes qui capturent la majorité des prises dans la division 4 V, tandis que l'essentiel des débarquements de la division 3P est attribuable aux navires terre-neuviens. En 1991, la majorité des prises correspondaient aux classes d'âge du début des années 80. Les données sur les prises commerciales normalisées dénotent des changements très nets ces dernières années et ne sont pas jugées révélatrices de l'abondance des stocks. Les campagnes d'évaluation au chalut de fond effectués par les navire scientifiques se caractérisent par des variations considérables et ne fournissent des résultats adéquats que pour la division 3P. Selon une étude acoustique effectuée en 1989, la biomasse estimée était de l'ordre de 300 000 t dans la division 3P4V. Il pourrait s'agir là d'une estimation prudente. Les perspectives de recrutement futur semblent bonnes. On ne dispose pas d'analyse permettant d'établir des prises de références adéquates.

INTRODUCTION

Prior to 1992 redfish in Divisions 3P4RST4VWX were managed as three units, namely Div. 3P, Div 4RST and Div. 4VWX. In 1989 the integrity of these units as closed populations for management purposes was questioned and an examination of applicable data and pertinent published studies ensued. This resulted in the proposal of new management units believed to have a firmer biological basis than the former units (see CAFSAC (1991); Atkinson and Power (1991)). This paper presents information relevant to the provision of advice for the proposed Laurentian Channel unit which comprises Subdiv. 3Ps4Vs4Wfgj and Subdiv. 3Pn4Vn (Jun-Dec).

DESCRIPTION OF THE FISHERY

Partitioning of catches into unit areas of Div. 4W presented a problem as this information was not available for all fleets which have reported catches. Catches by unit area were obtained for USA and Can(M) fleets (Table 1). Those catches that could not be further partitioned into unit area were assigned to 4Wfgj based on the proportion of those catches where this information was recorded as follows:

USA
Catches from 1960 to 1963 were assigned to 4Wfgj based on the average proportion taken from 1964 to 1978 (about 5.6%).

Can(M)
Catches from 1960 to 1969 were assigned to 4Wfgj based on the average proportion taken from 1970 to 1991 (about 25.3%).

Catches from 1970 to 1991 were assigned to 4Wfgj based on the proportion taken within each year where the catches could be split out by unit area.

Can(N)
All catches arbitrarily assigned to 4Wfgj.

USSR and Others
There was not enough information available to assign catches prior to 1977. Catches from 1977 to 1991 were arbitrarily assigned to 4Wfgj because of restrictions to the seaward side of the Small Mesh Gear Line for countries fishing silver hake.

Under the above scenario catches have ranged between 8,100 t in 1984 and 58,000 t in 1971 (Table 1, Fig.1). Catches were at a level of 20,000 t from 1960-1968 primarily from Subdiv. 3Ps and increased to an average of 43,000 from 1969 to 1975 mainly from Subdiv. 3Ps and 4Vs. Landings declined consistently from 38,000 t

in 1975 to the lowest on record in 1984 at 8,100 t mainly from decreases in Subdiv. 3Ps. Since 1984 landings have steadily increased to about 20,000 t in 1991.

Since the implementation of the 200-mile exclusive economic zone in 1977, catches have been primarily by Newfoundland and Maritime fleets. Since 1981, the majority of catches have come from Subdivisions 4Vs and 4Vn (Table 3, Fig. 1). Maritime vessels generally account for the majority of landings in Subdiv. 4Vs and 4Vn while Newfoundland vessels concentrate in Subdiv. 3Ps and 3Pn (Table 3, Fig. 1).

Monthly catches since 1981 indicate prosecution of the fishery generally occurs throughout the year in all subdivisions (Table 4). In recent years a higher proportion of landings have been taken from Jan-Apr in 3Ps, Jun-Jul in 4Vn and Apr-Jun in 4Vs.

Otter trawling is the predominant method of fishing, primarily with bottom trawls (Table 5). Since 1986 there has been an increase in the proportion of catch taken with midwater trawls in all subdivisions except 4Wfgj. There is also a substantial proportion of the 3Ps catch taken with gillnets and longlines.

In 1991, the provisional catch of 20,000 t is a 5,500 t increase from 1990. The increase is primarily accounted for in increased landings in 4Vn by the Maritime fleet.

DATA

Commercial fishery sampling

Length frequencies sampled from landings by port samplers or at sea by observers (Fig. 2) indicate the majority of the catch was composed of fish in the 27-32 cm range. These lengths correspond to the year classes of the early 1980s. Additional information recorded with the length frequencies indicate fishing occurred generally in the 300-450m depth range.

Commercial catch rates

Catch and effort data from 1960 to 1988 from ICNAF/NAFO Statistical Bulletins and were combined with provisional 1989-90 NAFO data and 1991 Atlantic region data compiled by various DFO regional statistics branches. In addition to this, information for 4Wfgj from the Scotia Fundy regional database for 1970-1990 was also incorporated into a catch/effort database. Initially selected from this database were observations where redfish comprised more than 50% of the total catch and were therefore considered to reflect redfish directed fishing.

These data were analyzed with a multiplicative model (Gavaris 1980) to derive a standardized catch rate series. 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. For this effect five groups were arbitrarily established : (>50 <=60), ((>60 <=70), (>70 <=80), (>80 <=90) and (>90) where each group corresponds to the percentage of redfish relative to the total catch associated with each observation. 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.

The model explained 51% of the variability in the catch rates (Table 6). All category types are highly significant. Estimated coefficients from the regression show catch rates are generally higher during the first half of the year. Residual plots (Fig. 3) did not signal that the model was inappropriate. The standardized catch rate series (Table 7, Fig. 4) shows a steady increase from 1960 to 1966 followed by a systematic decrease to the lowest rate on record in 1979. The rate increased again until 1983 to about the same magnitude of the 1960 catch rate. From 1983 to 1987 catch rate declined to the level of the 1979 rate. In 1988 there was a marginal increase followed by successive large increases in 1989 and again in 1990 to the highest rate observed over the time series. The catch rate declined abruptly in 1991 but is still relatively high in the series.

Research vessel surveys

Stratified random groundfish surveys have been conducted in Subdiv. 3Ps since 1973 and usually in the spring. These surveys generally cover strata down to depths of 730m. Since coverage was not complete in all years, a multiplicative model was used to obtain estimates of mean number and weight for strata which were missed in various surveys.

The historical series of mean numbers and weights per standard tow show some rather dramatic fluctuations between some years (Tables 8-9, Fig. 5). In addition the indices sometimes show opposite trends in adjacent years. In spite of these caveats there appears to be a general decline from 1975 to 1984 to the lowest density estimates observed in both number and weight followed by an increase to 1991, more exemplified in the number index than the weight. The 1992 survey indicates a decline in both number and weight. It is considered that large fluctuations which have occurred between some years are too dynamic to reflect year to year changes in stock abundance. Some of the observed fluctuation may be due to fish movement between Div. 3P and Div. 4V.

Stratified random groundfish surveys have been conducted in

July since 1970 in Div. 4VW and cover strata down to 200 fathoms. A comparative analysis with redfish directed surveys conducted in the fall of 1985 and 1986 covering the 100-500 fathom depth contours indicated that from 44%-72% of the biomass occurred below 200 fathoms in 4Vn and 4Vs (Zwanenburg and Hurley, 1987). Consequently, these surveys would be of limited value as indicators of stock abundance.

Length frequencies and numbers at age represented as numbers per thousand from the Subdiv. 3Ps surveys reflect the relatively strong year class of the early 1980s that was first captured in the 1981 survey (Figs 6-8). Similar observations were made from the July groundfish surveys primarily for 4Vs and 4W (Zwanenburg and Hurley, 1987). These year classes constitute the main component of the commercial fishery. The yearly length frequency distributions from the Subdiv. 3Ps surveys also indicate a pulse in the 1988 survey (perhaps the 1984-1985 year classes), and a relatively large pulse of recruitment observed in 1991 corresponding to 1987-88 year classes. The 1984-1985 and 1987-1988 year classes dominated the research catch in the 1991 survey which may be regarded as a positive sign for the future.

ESTIMATION OF STOCK PARAMETERS

Production model

Catch and standardized effort values were utilized in a non-equilibrium version of the Schaefer general production model (Rivard and Bledsoe, 1978). Only data since 1977 were utilized because of the problem of allocating catches in 4Wfgj prior to this. A number of runs of the model were tried with starting values of B_∞=500,000 and MEY=30,000, and fixing catchability coefficient (q) equal to $3x10^{-6}$, $5x10^{-6}$ and $7x10^{-6}$. Each run converged but the parameter estimates were not significant. A subsequent run allowing the model to estimate catchability coefficient would not converge.

PROGNOSIS

The standardized commercial catch rate indicates a doubling of the catch rate since 1988 and a substantial decline in 1991. Relative to the entire series, the changes over this time short time frame are considered too dramatic to be explained solely by the dynamics of the stock.

Research bottom trawl surveys conducted in Subdiv. 3Ps are plagued with considerable variability between some years to be reliable indicators of year to year changes in abundance. They do show a trend of increase since 1984 but whether this is representative of the whole stock cannot be assumed since Subdiv. 3Ps is the only portion of the management unit surveyed with

sufficient spacial and temporal coverage. Acoustic survey estimates from 1988 and 1989 indicate the biomass in Div. 3P to be about 200,000 t. A point estimate for Div. 4V in 1989 is about 100,000 t. These estimates did not include sections of the surveyed area where the bottom depth was shallower than 300 m (Atkinson and Power, 1990). Although the target strength used was based on previous studies and no in situ estimates were available, an estimate of the biomass in the range of 300,000 t may be conservative for Div. 3P4V.

As an interim measure in 1991, CAFSAC suggested a TAC of 25,000 t for the Laurentian Channel unit. This would imply an exploitation rate of about 8% on 300,000 t which does not include any biomass residing in Div. 4Wfgj. The prospect for recruitment in the future appears good given that the research catch in 1991 was dominated by fish of the 1984-1985 and 1987-1988 years classes, both of which are not fully recruited to the commercial fishery. There is no analysis applicable to determine an appropriate reference catch. The limited sources of information available indicate positive prospects for the future.

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Table 1. Nominal catches (t) in Div. 4W categorized by stock area and country for 1960 to 1991. [4WLC = "Laurential Channel" unit areas (4Wfgj), 4WSS = "Scotian Shelf" unit areas (4Wdehklm), 4WNK = cannot be further identified to unit area.]

	USA			Can(M)			Can(N)	USSR	Others[a]	
Year	4WLC	4WSS	4WNK	4WLC	4WSS	4WNK	4WNK	4WNK	4WNK	Total
1960			10951			176	0	0	0	11127
1961			9027			376	0	8	0	9411
1962			11872			433	0	3870	0	16175
1963			7682			459	0	12002	3	20146
1964	80	3172				278	0	2888	117	6535
1965	733	4956				727	0	1314	12	7742
1966	242	6852				291	0	8719	1	16105
1967	78	2257				395	31	51	4	2816
1968	16	751				379	0	23	187	1356
1969	0	606				1726	0	1272	115	3719
1970	249	1191		1852	1040	3132	7	8699	45	16215
1971	349	1681		985	1502	3339	177	11901	20	19953
1972	141	6298		1205	2865	3025	80	8513	96	22223
1973	168	4642		327	1870	1944	274	5451	33	14709
1974	329	4794		28	1463	958	0	3980	38	11587
1975	33	2546		4	1541	1405	24	3665	279	9497
1976	42	682		275	1120	741	52	261	54	3225
1977	0	580		245	1184	45	32	171	17	2274
1978	0	124		593	553	189	3	93	66	1621
1979	0	0		666	1069	35	10	152	16	1948
1980	0	0		817	1433	94	16	58	23	2441
1981	0	0		430	2044	172	5	392	3	3045
1982	0	0		128	355	2	1	96	17	598
1983	0	0		489	937	2	0	43	20	1491
1984	0	0		140	1504	26	2	22	14	1708
1985	0	0		194	1436	0	0	111	103	1844
1986	0	0		15	1051	136	0	9	47	1258
1987	0	0		195	1082	141	0	92	56	1566
1988	0	0		156	671	66	0	93	16	1002
1989[b]	0	0		81	1236	157	0	199	43	1716
1990[b]	0	0		73	268	52	0	239	46	678
1991[b]	0	0		98	274	280	0	5	109	766

[a]Others are a number of distant water fleets that have reported catches but are primarily Cuba and Japan.

[b]Provisional.

Table 2. Summary of nominal catches (t) of redfish in NAFO Divisions and Subdivisions comprising the "Laurentian Channel" management unit.

Year	3Pn (Jun-Dec)	3Ps	4Vn (Jun-Dec)	4Vs	4Wfgj	4Wfgj (assigned)[a]	Total	4W (unknown)
1960	14	9211	5277	8122	-	663	23287	0
1961	1058	8340	4157	4170	-	604	18685[b]	8
1962	2127	11306	2710	4372	-	780	21347[c]	3870
1963	2154	11150	2166	6270	-	550	22290	12005
1964	4445	9119	1849	7629	80	70	23192	3005
1965	5570	9931	2097	3319	733	184	21850[d]	1326
1966	2444	16543	6022	3067	242	74	28392	8720
1967	3531	28465	7976	1989	78	131	42170	55
1968	1974	11764[e]	4097	2222	16	96	20169	210
1969	1412	29460	4726	10241	0	437	46276	1387
1970	2169	33581	2849	6694	2101	2013	49407	8744
1971	373	26534	4762	23698	1334	1499	58200	11921
1972	358	25398	2272	14580	1346	976	44930	8609
1973	2133	14714	2709	11213	495	563	31827	5484
1974	2759	17894	4898	8112	357	18	34038	4018
1975	4722	20345	6548	6791	37	28	38471	3944
1976	1409	13235	3832	4718	317	198	23709	315
1977	1713	14678	4763	7123	245	228	28750	
1978	1975	12203	3661	7856	593	260	26548	
1979	1975	6459	4500	4979	666	192	18771	
1980	1845	5192	3713	5431	817	131	17129	
1981	3283	4685	6134	6789	430	430	21751	
1982	3757	2090	6350	4585	128	115	17025	
1983	2607	2996	3559	3758	489	64	13473	
1984	1460	2005	2129	2367	140	40	8141	
1985	1587	1854	3143	4502	194	214	11494	
1986	958	3651	3347	2736	15	58	10765	
1987	1348	2169	6423	3651	195	170	13956	
1988	484	2386	4856	2725	156	121	10728	
1989[g]	1953	2874	5236	4990	81	252	15386	
1990[g]	189	5438	2471	6324	73	296	14791	
1991[g]	953	4244	8367	5739	98	188	20069[f]	

[a]These catches were assigned to 4Wfgj based on: (1) information from catches that could be split between the "Laurentian Channel" unit and the "Scotian Shelf" unit; (2) USSR and "others" fishing since 1977 (see text).
[b]Includes 356 t from Div. 3P that could not be disaggregated by subdivision.
[c]Includes 52 t from Div. 4V that could not be disaggregated by subdivision.
[d]Includes 11 t from Div. 3P and 5 t from Div. 4V that could not be disaggregated by subdivision.
[e]Includes 522 t from Div. "3P" by Japan (generally the fleet fished in 3Ps).
[f]Includes 500 t that could not be disaggregated by subdivision.
[g]Provisional.

Table 3a. Nominal catches (t) of redfish in Subdivision 3Pn (Jun-Dec) by fleet/country since 1981. (1989-91 are provisional.)

Country	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Canada (M)	103	311	502	65	325	143	577	39	825	0	466
Canada (N)	3180	3446	2105	1395	1262	815	770	445	1128	189	487
Canada (Q)	-	-	-	-	-	-	1	-	-	-	-
Total	3283	3757	2607	1460	1587	958	1348	484	1953	189	953

Table 3b. Nominal catches (t) of redfish in Subdivision 3Ps by fleet/country since 1981. (1989-91 are provisional.)

Country	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Canada (M)	391	515	670	396	313	606	421	836	1038	1252	348
Canada (N)	4123	1553	2316	1608	1529	2915	1645	1441	1823	4186	3896
Canada (Q)	-	-	-	-	-	88	-	-	-	-	
France (M)	124	5	-	-	-	-	67	95	-	-	
France (SPM)	47	17	-	-	-	42	36	14	13	-	
France	-	-	10	1	12	-	-	-	-	-	
Total	4685	2090	2996	2005	1854	3651	2169	2386	2874	5438	4244

Table 3c. Nominal catches (t) of redfish in Subdivision 4Vn (Jun-Dec) by fleet/country since 1981. (1989-91 are provisional.

Country	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Canada (M)	3332	2356	2710	1133	1368	1237	2544	2327	3245	1874	7152
Canada (N)	2802	3993	849	153	1677	1790	3682	2345	1909	579	998
Canada (Q)	-	-	-	-	38	63	-	-	1	-	217
France (SPM)	-	1	-	-	-	-	-	-	-	-	-
Japan	-	-	-	843	60	257	197	184	81	18	-
Total	6134	6350	3559	2129	3143	3347	6423	4856	5236	2471	8367

Table 3d. Nominal catches (t) of redfish in Subdivision 4Vs by fleet/country since 1981. (1989-91 are provisional.

Country	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Canada (M)	6119	4109	3208	1735	2924	1081	2279	2111	3452	3997	3828
Canada (N)	641	476	539	148	724	465	428	335	1139	1852	1911
USSR	29	-	1	-	-	-	-	-	-	-	-
Portugal	-	-	10	-	-	-	-	-	-	-	-
Japan	-	-		484	854	1190	944	279	399	475	-
Total	6789	4585	3758	2367	4502	2736	3651	2725	4990	6324	5739

Table 4a. Nominal catches (t) of redfish in Subdivision 3Pn portion of the "Laurentian Channel" management unit by month since 1981. (1989–91 are provisional.)

Year	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1981	160	969	540	498	753	272	91	3283
1982	153	502	288	923	652	959	280	3757
1983	217	294	622	791	144	356	183	2607
1984	87	305	258	173	435	130	72	1460
1985	131	272	527	206	135	122	194	1587
1986	69	169	94	84	188	282	72	958
1987	77	97	242	74	13	45	800	1348
1988	120	39	123	74	40	69	19	484
1989	7	44	153	878	611	131	129	1953
1990	4	36	64	55	7	5	18	189
1991	8	58	46	43	242	345	211	953

Table 4b. Nominal catches (t) of redfish in Subdivision 3Ps by month since 1981. (1989–91 are provisional.)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1981	21	537	763	157	217	897	465	937	134	150	224	183	4685
1982	4	5	27	127	154	133	220	580	193	398	205	44	2090
1983	8	11	25	28	82	61	133	462	667	957	168	394	2996
1984	9	126	179	39	114	470	804	141	40	37	22	24	2005
1985	32	27	102	50	126	127	361	413	367	150	63	36	1854
1986	13	37	685	281	499	433	754	213	343	111	186	96	3651
1987	41	94	110	139	172	268	439	244	189	92	74	307	2169
1988	73	557	208	129	135	180	128	179	200	97	126	374	2386
1989	263	174	353	356	116	402	185	376	522	60	37	30	2874
1990	141	2152	1105	371	60	278	299	436	358	160	50	28	5438
1991	211	1174	359	653	73	67	359	360	392	446	54	96	4244

Table 4c. Nominal catches (t) of redfish in Subdivision 4Vn portion of the "Laurentian Channel" management unit by month since 1981. (1989–91 are provisional.)

Year	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1981	807	1900	1636	568	165	836	222	6134
1982	737	608	1579	1420	917	685	404	6350
1983	688	412	768	792	137	577	185	3559
1984	393	375	295	164	440	63	399	2129
1985	705	517	1123	244	114	197	243	3143
1986	480	1502	474	428	155	162	146	3347
1987	2041	1611	941	603	132	327	768	6423
1988	1339	1285	799	656	284	325	168	4856
1989	1700	857	881	602	250	42	904	5236
1990	696	822	335	176	56	33	335	2471[a]
1991	3733	1957	482	725	183	541	746	8367

[a]Includes 18 t by Japan that could not be disaggregated by month.

Table 4d. Nominal catches (t) of redfish in Subdivision 4Vs by month since 1981. (1989–91 are provisional.)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1981	28	21	171	93	1034	1795	1378	1064	539	467	105	94	6789
1982	11	30	68	136	224	309	1450	738	402	912	191	114	4585
1983	9	86	176	31	131	300	564	561	446	1255	17	182	3758
1984	10	105	595	86	138	91	418	290	91	353	48	142	2367
1985	98	510	242	207	187	469	940	615	126	410	341	357	4502
1986	34	62	209	206	233	357	409	256	356	236	319	59	2736
1987	35	27	187	477	330	806	529	616	304	115	150	75	3651
1988	9	34	94	77	580	331	425	138	617	257	103	60	2725
1989	30	31	170	35	800	2651	388	376	248	191	68	2	4990
1990	40	71	120	454	1714	2040	81	529	55	182	514	49	6324[a]
1991	59	55	55	823	3972	334	117	9	224	47	34	10	5739

[a]Includes 475 t by Japan that could not be disaggregated by month.

Table 4e. Nominal catches (t) of redfish in Division 4Wfgj by month since 1981. (1989–91 are provisional.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1981	2	0	2	30	45	174	160	0	12	2	2	1	430
1982	0	0	2	5	66	3	7	25	1	0	18	1	128
1983	0	0	2	26	4	26	20	169	106	116	16	4	489
1984	0	1	0	42	2	8	30	11	43	3	0	0	140
1985	6	1	2	3	0	0	139	10	1	12	2	18	194
1986	0	0	1	1	4	0	2	0	0	0	7	0	15
1987	0	1	16	17	5	60	55	1	1	32	7	0	195
1988	0	0	1	0	4	5	24	34	67	5	16	0	156
1989	1	6	5	0	11	10	16	9	11	3	9	0	81
1990	6	8	20	3	10	0	2	3	0	0	21	0	73
1991	0	11	4	4	14	0	37	13	2	5	2	6	98

Table 5a. Nominal catches (t) of redfish in Division 3P by gear since 1981. (1989-91 are provisional.)

	3Pn				3Ps			
Year	Bottom trawl	Midwater trawl	Other	Total	Bottom trawl	Midwater trawl	Other	Total
1981	3279	-	4	3283	3990	65	630	4685
1982	3755	-	2	3757	1777	-	313	2090
1983	2591	-	16	2607	2630	-	377	2996
1984	1445	-	15	1460	1130	-	275	2005
1985	1584	-	3	1587	1533	-	321	1854
1986	953	5	-	958	2920	152	579	3651
1987	1057	285	6	1348	1311	35	823	2169
1988	413	62	9	484	1389	467	530	2386
1989	1440	499	14	1953	1527	747	600	2874
1990	147	40	2	189	923	3162	1353	5438
1991	417	457	79	953	1549	1563	1132	4244

Table 5b. Nominal catches (t) of redfish in Division 4V by gear since 1981. (1989-91 are provisional.)

	4Vn				4Vs			
Year	Bottom trawl	Midwater trawl	Other	Total	Bottom trawl	Midwater trawl	Other	Total
1981	6134	-	-	6134	6789	-	-	6789
1982	6345	-	5	6350	4585	-	-	4585
1983	3557	-	2	3559	3743	1	14	3758
1984	1811	315	3	2129	2267	100	-	2367
1985	3131	-	12	3143	4502	-	-	4502
1986	3153	182	12	3347	2731	5	-	2736
1987	5338	1049	36	6423	3615	35	1	3651
1988	4506	314	36	4856	2720	5	-	2725
1989	2853	2350	33	5236	2911	2075	4	4990
1990	1905	444	104	2471[a]	3054	2789	6	6324[b]
1991	4685	3490	192	8367	1737	3993	9	5739

[a]Includes 18 t by Japan that could not be disaggregated by gear.
[b]Includes 475 t by Japan that could not be disaggregated by gear.

Table 6. Anova table and regression coefficients from a multiplicative analysis of catch rate data for redfish from the Laurentian Channel management unit.

REGRESSION OF MULTIPLICATIVE MODEL

MULTIPLE R..... 0.715
MULTIPLE R SQUARED..... 0.512

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	5.843E2	5.843E2	
REGRESSION	81	5.430E2	6.704E0	36.990
CGT	31	2.328E2	7.508E0	41.430
MONTH	11	1.850E1	1.682E0	9.282
DIVISION	4	1.262E1	3.154E0	17.404
PCT	4	5.800E1	1.450E1	80.005
YEAR	31	1.583E2	5.107E0	28.182
RESIDUALS	2859	5.181E2	1.812E-1	
TOTAL	2941	1.645E3		

Table 6. (continued)

REGRESSION COEFFICIENTS

CATEGORY	CODE	VARIABLE	COEFFICIENT	STD. ERROR	NO. OBS.
1	3114	INTERCEPT	¯0.509	0.099	2941
2	7				
3	37				
4	95				
5	60				
1	2114	1	0.082	0.031	311
	2124	2	¯0.062	0.058	65
	2125	3	0.358	0.047	107
	2154	4	0.304	0.060	61
	2155	5	0.673	0.067	46
	3124	6	0.097	0.040	153
	3125	7	0.251	0.030	346
	3126	8	0.363	0.155	9
	3144	9	0.417	0.084	29
	3154	10	0.376	0.066	48
	3155	11	0.654	0.054	78
	3156	12	1.043	0.143	11
	9114	13	¯0.129	0.060	58
	9125	14	0.262	0.073	38
	11115	15	0.350	0.141	10
	11116	16	0.614	0.138	10
	11126	17	0.721	0.103	19
	11127	18	0.753	0.195	5
	14125	19	0.557	0.133	11
	14126	20	0.507	0.088	27
	14127	21	0.933	0.059	62
	16127	22	0.385	0.104	18
	20114	23	¯0.606	0.070	44
	20127	24	1.461	0.078	34
	20157	25	1.527	0.133	11
	27114	26	0.344	0.042	166
	27124	27	0.463	0.049	109
	27125	28	0.564	0.037	290
	27154	29	0.673	0.139	10
	27155	30	0.805	0.075	40
	28154	31	0.542	0.113	16
2	1	32	0.208	0.064	53
	2	33	0.206	0.055	79
	3	34	0.099	0.046	126
	4	35	0.005	0.045	127
	5	36	0.120	0.042	149
	6	37	0.108	0.030	375
	8	38	¯0.055	0.030	409
	9	39	¯0.053	0.031	361
	10	40	¯0.082	0.032	325
	11	41	¯0.113	0.033	283
	12	42	0.023	0.036	230

Table 6. (continued)

REGRESSION COEFFICIENTS

CATEGORY	CODE	VARIABLE	COEFFICIENT	STD. ERROR	NO. OBS.
3	36	43	¯0.065	0.030	402
	44	44	¯0.137	0.023	983
	45	45	¯0.152	0.024	721
	71	46	¯0.271	0.051	98
4	55	47	¯0.599	0.043	119
	65	48	¯0.423	0.038	160
	75	49	¯0.297	0.029	293
	85	50	¯0.199	0.023	492
5	61	51	¯0.030	0.124	27
	62	52	0.199	0.121	31
	63	53	0.160	0.116	39
	64	54	0.204	0.118	36
	65	55	0.454	0.116	40
	66	56	0.519	0.107	66
	67	57	0.515	0.107	81
	68	58	0.381	0.108	66
	69	59	0.370	0.105	89
	70	60	0.273	0.103	115
	71	61	0.178	0.102	139
	72	62	0.081	0.102	133
	73	63	0.062	0.102	127
	74	64	¯0.144	0.101	148
	75	65	¯0.118	0.101	147
	76	66	¯0.276	0.104	101
	77	67	¯0.199	0.101	134
	78	68	¯0.161	0.101	151
	79	69	¯0.303	0.103	143
	80	70	¯0.214	0.104	120
	81	71	¯0.264	0.104	106
	82	72	¯0.050	0.105	99
	83	73	0.027	0.107	82
	84	74	¯0.123	0.113	53
	85	75	¯0.193	0.104	110
	86	76	¯0.226	0.105	110
	87	77	¯0.219	0.105	103
	88	78	¯0.210	0.105	101
	89	79	0.243	0.108	83
	90	80	0.662	0.113	58
	91	81	0.404	0.112	82

Table 7. Standardized catch rate series from a multiplicative analysis of catch rate data for redfish in the Laurentian Channel management unit.

	PREDICTED CATCH RATE					
	LN TRANSFORM		RETRANSFORMED			
YEAR	MEAN	S.E.	MEAN	S.E.	CATCH	EFFORT
1960	-0.5091	0.0097	0.655	0.064	22624	34547
1961	-0.5386	0.0079	0.636	0.056	18081	28410
1962	-0.3096	0.0068	0.801	0.066	20567	25690
1963	-0.3493	0.0056	0.770	0.057	21740	28235
1964	-0.3046	0.0058	0.805	0.061	23122	28723
1965	-0.0554	0.0055	1.033	0.077	21666	20974
1966	0.0099	0.0037	1.104	0.067	28318	25657
1967	0.0058	0.0036	1.099	0.066	42039	38241
1968	-0.1284	0.0037	0.961	0.058	19551	20340
1969	-0.1390	0.0031	0.951	0.053	45839	48186
1970	-0.2357	0.0026	0.864	0.044	47394	54864
1971	-0.3315	0.0024	0.785	0.038	56701	72233
1972	-0.4282	0.0024	0.713	0.035	43954	61677
1973	-0.4472	0.0024	0.699	0.034	31264	44711
1974	-0.6532	0.0023	0.569	0.027	34020	59779
1975	-0.6273	0.0022	0.584	0.028	38443	65819
1976	-0.7855	0.0029	0.498	0.027	23511	47171
1977	-0.7085	0.0024	0.538	0.026	28522	52968
1978	-0.6699	0.0022	0.560	0.026	26288	46967
1979	-0.8124	0.0025	0.485	0.024	18579	38284
1980	-0.7233	0.0026	0.531	0.027	16998	32041
1981	-0.7726	0.0027	0.505	0.026	21321	42227
1982	-0.5595	0.0029	0.625	0.034	16910	27063
1983	-0.4822	0.0033	0.675	0.039	13409	19869
1984	-0.6319	0.0046	0.581	0.039	8101	13951
1985	-0.7021	0.0027	0.542	0.028	11280	20819
1986	-0.7349	0.0028	0.524	0.028	10707	20420
1987	-0.7278	0.0030	0.528	0.029	13786	26109
1988	-0.7189	0.0030	0.533	0.029	10607	19909
1989	-0.2661	0.0036	0.838	0.050	15134	18069
1990	0.1526	0.0045	1.272	0.086	14495	11391
1991	-0.1050	0.0044	0.984	0.065	19903	20236

AVERAGE C.V. FOR THE RETRANSFORMED MEAN: 0.060

Table 8. Mean number of redfish caught per standard tow in Division 3Ps during Canadian research surveys, 1973-1991. (Numbers in brackets are number of successful sets, * indicates those strata estimated with a multiplicative model.)

Stratum	Depth range (m)	Area (sq. n.mi.)	1973 ATC 207	1974 ATC 221	1975 ATC 234	1976 ATC 247-248	1977 ATC 261	1978 ATC 275	1979 ATC 287	1980 ATC 302	1981 ATC 316	1982 ATC 330
306	185-274	419	844.56 *	573.67(6)	3198.00(6)	2284.67(6)	2159.20(6)	2177.33(6)	408.40(5)	1051.50(2)	1830.67(3)	934.67(3)
307	93-183	395	288.80(5)	200.71(7)	4067.03(4)	1861.25(4)	1252.50(4)	234.25(4)	20.50(4)	83.50(2)	924.67(3)	150.00(4)
309	185-274	296	3647.00(3)	1386.75(4)	8421.66(6)	5836.57(7)	1955.48(6)	1019.33(6)	2540.33(6)	24599.00(2)	7772.50(2)	522.00(2)
310	185-274	170	95.00(1)	175.00(3)	2981.52(6)	5497.80(5)	110.50(6)	622.33(6)	316.00(6)	240.00(2)	252.50(2)	5677.00(3)
311	93-183	317	3.78(9)	495.00(8)	7.00(4)	805.67(6)	1022.00(4)	0.00(4)	19.50(4)	0.00(2)	6.50(2)	7.67(3)
313	185-274	165	1.50(2)	133.00(5)	1010.33(3)	990.50(6)	78.90(10)	130.00(2)	80.00(5)	95.50(2)	187.00(2)	4397.00(2)
316	185-274	189	228.33(3)	150.00(6)	1471.00(1)	1368.25(4)	86.42(6)	119.00(6)	110.67(3)	384.00(2)	175.00(2)	457.00(1)
317	93-183	193	1.57(7)	217.62(8)	558.00(4)	466.50(4)	691.37(4)	3.25(4)	16.33(3)	3.50(2)	1.00(2)	112.00(3)
318	185-274	123	999.00(1)	169.50(2)	2034.29(4)	2087.00(7)	228.00(6)	480.50(2)	292.50(2)	1403.50(2)	807.29 *	6077.00(2)
319	93-183	984	174.20(5)	411.00(2)	432.43(4)	92.25(4)	83.17(6)	1241.00(4)	156.00(2)	3.00(4)	8455.00(2)	260.57(7)
705	275-366	195	476.50(2)	56.75(4)	154.94(2)	256.20(5)	79.50(4)	251.67(3)	73.50(4)	161.00(2)	162.00(2)	644.00(2)
706	275-366	476	640.00(2)	226.57(7)	165.00(1)	73.75(4)	112.28(4)	71.00(2)	312.00(3)	97.00(2)	86.00(2)	118.00(4)
707	275-366	93	568.73 *	590.00(2)	785.25(4)	1893.67(6)	210.01(4)	649.50(2)	740.50(2)	211.00(2)	554.88 *	221.53 *
708	367-549	117	444.99 *	574.52 *	185.00(3)	520.33(3)	364.21(4)	473.00(1)	592.50(2)	89.00(2)	434.29 *	173.32 *
709	550-731	96	7.07 *	9.27 *	14.03 *	102.50(2)	8.80 *	7.26 *	4.83 *	1.39 *	6.89 *	2.46 *
710	550-731	36	6.73 *	8.83 *	13.37 *	10.34 *	8.38 *	6.91 *	4.59 *	1.30 *	6.56 *	2.32 *
711	367-549	961	202.08 *	260.97 *	388.34 *	169.50(2)	248.46 *	207.22 *	142.21 *	25.50(2)	32.50(2)	11.50(2)
712	367-549	973	182.57 *	235.78 *	350.89 *	151.50(2)	224.48 *	187.24 *	104.00(2)	71.00(2)	150.50(2)	23.00(3)
713	367-549	950	132.38 *	171.01 *	39.43(3)	87.50(2)	162.81 *	135.76 *	93.11 *	15.00(2)	65.33(6)	11.50(2)
714	367-549	1195	228.90 *	295.59 *	439.79 *	248.50(2)	281.43 *	127.00(2)	145.00(1)	64.00(2)	50.50(8)	39.67(6)
715	275-366	132	588.00(1)	62.75(4)	318.00(2)	811.40(5)	124.00(4)	343.75(4)	717.00(3)	2417.50(2)	1015.50(2)	20.00(2)
716	275-366	539	412.00(1)	108.00(3)	1367.39 *	252.00(3)	127.50(6)	473.50(4)	173.00(4)	43.00(2)	207.75(4)	122.00(2)
Strap:												
Upper			1113.7	1499.3	2576.9	1009.5	746.4	1157.1	415.8	9026.0	14082.20	698.3
Mean			563.1	357.4	1561.4	750.2	585.0	566.7	313.0	978.9	1459.9	432.1
Lower			12.5	-784.6	545.9	490.8	423.7	-23.6	210.2	-7068.2	-11162.5	165.9
Multiplicative analysis:												
Mean			385.3	303.9	987.3	747.2	417.0	432.6	244.8	964.6	1407.0	420.8
Total (x 10^{-6})			260.7	205.6	668.0	505.6	282.2	292.7	165.7	652.7	952.0	284.7

Table 8. (Cont'd.)

Stratum	Depth range (m)	Area (sq. n.mi.)	1983 AN 9	1984 AN 26	1985 WT 26	1986 WT 45	1987 WT 55–56	1988 WT 68	1989 WT 81	1990 WT 91	1991 WT 103	1992 WT 118
306	185–274	419	421.50(4)	15.50(2)	313.00(2)	623.67(3)	231.25(4)	493.50(4)	137.33(3)	819.33(3)	870.75(4)	65.50(2)
307	93–183	395	121.25(4)	127.00(2)	53.33(3)	17.00(3)	36.33(3)	44.50(4)	14.33(3)	37.67(3)	6.00(3)	1.50(2)
309	185–274	296	981.33(3)	50.50(2)	453.00(3)	618.50(2)	1142.50(2)	535.00(3)	398.50(2)	363.00(2)	1898.67(3)	32.50(2)
310	185–274	170	547.00(3)	70.50(2)	1225.33(3)	303.00(2)	33.50(2)	801.33(3)	326.00(2)	85.50(2)	8716.00(2)	3.50(2)
311	93–183	317	0.00(3)	41.00(2)	11.00(4)	0.00(3)	0.00(3)	1.50(4)	2.67(3)	0.00(3)	0.00(3)	1.00(2)
313	185–274	165	829.33(3)	35.00(2)	1033.50(2)	988.00(2)	150.50(2)	181.00(2)	507.50(2)	61.50(2)	4682.50(2)	757.00(2)
316	185–274	189	653.75(4)	127.00(2)	140.00(3)	57.50(2)	313.67(3)	210.00(3)	76.40(3)	151.00(2)	731.50(2)	661.00(2)
317	93–183	193	7980.66(3)	882.50(2)	0.00(2)	0.00(2)	0.00(3)	2.00(2)	0.00(2)	0.00(2)	0.00(2)	0.00(2)
318	185–274	123	1688.33(3)	138.00(2)	216.16 *	958.00(2)	5547.50(2)	58.50(2)	658.50(2)	410.35 *	564.00(2)	216.80(2)
319	93–183	984	27.29(7)	11.67(6)	0.00(2)	15.88(8)	9.11(9)	99.38(8)	11.50(8)	37.65 *	7.33(9)	2.60(10)
705	275–366	195	5.67(3)	28.50(2)	78.00(2)	424.00(2)	247.50(2)	121.00(2)	30.00(2)	22.00(2)	54.00(2)	178.00(2)
706	275–366	476	77.80(5)	75.00(2)	465.25(4)	308.25(4)	181.92(5)	429.75(4)	91.00(4)	38.50(4)	201.00(4)	69.20(5)
707	275–366	93	306.33(3)	226.00(2)	148.46 *	265.50(2)	200.50(2)	634.00(2)	302.13(2)	281.98 *	1389.50(2)	2203.50(2)
708	367–549	117	722.00(2)	113.00(2)	116.11 *	278.75(2)	354.50(2)	432.50(2)	549.00(2)	220.65 *	435.50(2)	881.50(2)
709	550–731	96	0.50(2)	4.50(2)	1.48 *	0.00(1)	14.29(1)	6.83 *	12.50(2)	3.26 *	18.00(2)	1.71 *
710	550–731	36	3.75(3)	1.00(2)	8.00(2)	78.00(2)	2.51 *	114.50(2)	3.74 *	3.09 *	11.00(2)	34.00(1)
711	367–549	961	68.13(8)	20.40(5)	121.75(8)	280.78(9)	154.00(7)	181.43(7)	315.43(7)	312.67(3)	265.88(8)	189.20(10)
712	367–549	973	67.86(7)	31.85 *	44.33(6)	120.78(9)	117.00(4)	115.71(7)	347.50(8)	180.80(5)	71.75(8)	123.10(10)
713	367–549	950	23.71(7)	22.98 *	55.50(8)	66.80(5)	197.00(4)	954.43(7)	212.88(8)	113.43(7)	279.19(8)	72.10(10)
714	367–549	1195	62.30(10)	40.03 *	69.00(1)	89.40(5)	66.25(4)	488.33(9)	394.90(10)	301.29(7)	236.36(11)	285.14(7)
715	275–366	132	71.33(3)	43.50(2)	2448.00(1)	569.00(2)	463.00(2)	307.50(2)	1542.00(2)	1476.50(2)	9797.50(2)	624.50(2)
716	275–366	539	54.50(4)	18.67(3)	84.60(5)	207.00(4)	226.00(3)	240.80(5)	123.25(4)	45.80(5)	25.40(5)	175.67(3)
Strap:												
Upper			843.1	238.3	225.8	282.5	1299.6	531.3	358.6	374.8	1658.2	217.5
Mean			339.7	74.0	164.0	206.8	240.6	334.4	240.1	225.4	650.9	178.0
Lower			-163.8	-90.2	102.3	131.0	-818.5	137.6	121.7	76.0	-356.5	138.6
Multiplicative analysis:												
Mean			339.7	59.6	183.1	204.5	237.2	331.1	239.2	204.7	650.9	175.6
Total (x 10^{-6})			229.8	40.3	123.9	138.4	160.5	224.0	161.8	138.5	440.4	118.8

Table 9. Mean weight (kg) of redfish caught per standard tow in Division 3Ps during Canadian research surveys, 1973–1991. (Numbers in brackets indicate number of sets; * indicates strata estimated using a multiplicative model.)

Stratum	Depth range (m)	Area (sq. n.mi.)	1973 ATC 207	1974 ATC 221	1975 ATC 234	1976 ATC 247–248	1977 ATC 261	1978 ATC 275	1979 ATC 287	1980 ATC 302	1981 ATC 316	1982 ATC 33	1983 AN 9
306	185–274	419	83.09 *	56.09(6)	175.99(6)	188.85(6)	137.59(6)	298.47(6)	48.90(5)	165.71(2)	44.93(3)	54.93(3)	81.13(4)
307	93–183	395	12.25(5)	8.55(7)	34.34(4)	58.91(4)	47.29(4)	17.69(4)	3.06(4)	12.38(2)	21.17(3)	4.05(4)	49.00(4)
309	185–274	296	541.59(3)	135.85(4)	666.33(6)	939.79(7)	224.35(6)	108.48(6)	337.55(6)	3908.91(2)	264.50(2)	42.50(2)	101.92(3)
310	185–274	170	2.27(1)	34.62(3)	256.09(6)	416.67(5)	29.22(6)	96.61(6)	59.35(6)	35.64(2)	17.50(2)	529.11(3)	34.67(3)
311	93–183	317	0.30(9)	30.53(8)	0.11(4)	17.69(6)	61.12(4)	0.00(4)	3.69(4)	0.00(2)	1.50(2)	0.17(3)	0.00(3)
313	185–274	165	0.90(2)	16.51(5)	153.62(3)	168.74(6)	12.60(10)	24.94(2)	11.25(5)	15.55(2)	29.00(2)	158.50(2)	44.33(3)
316	185–274	189	25.71(3)	20.26(6)	48.99(1)	290.30(4)	13.61(6)	14.17(6)	10.89(3)	51.30(2)	21.00(2)	36.50(1)	55.88(4)
317	93–183	193	0.52(7)	16.22(8)	49.05(4)	8.16(4)	41.94(4)	0.21(4)	1.74(3)	3.40(2)	0.25(2)	1.07(3)	110.70(3)
318	185–274	123	97.07(1)	23.13(2)	373.83(4)	324.71(7)	32.51(6)	56.70(2)	22.46(2)	94.89(2)	48.53 *	148.50(2)	88.50(3)
319	93–183	984	12.91(5)	64.41(2)	70.35(4)	8.96(4)	5.62(6)	86.64(4)	6.58(2)	0.79(4)	46.00(2)	3.86(7)	4.79(7)
705	275–366	195	241.31(2)	19.28(4)	90.15(2)	123.38(5)	22.34(4)	115.21(3)	44.03(4)	62.65(2)	49.50(2)	317.00(2)	4.33(3)
706	275–366	476	91.18(2)	53.27(7)	37.19(1)	33.90(4)	31.91(4)	28.12(2)	60.18(3)	26.33(2)	17.00(2)	42.25(4)	11.50(5)
707	275–366	93	136.99 *	93.89(2)	237.12(4)	469.55(6)	58.59(4)	100.24(2)	126.60(2)	38.82(2)	77.86 *	37.05 *	80.83(3)
708	367–549	117	157.57 *	189.83 *	82.25(3)	210.02(3)	124.44(4)	192.00(1)	201.03(2)	15.43(2)	89.61 *	42.68 *	358.75(2)
709	550–731	96	4.52 *	5.54 *	7.42 *	96.39(2)	4.40 *	5.41 *	3.24 *	1.31 *	2.36 *	0.87 *	0.10(2)
710	550–731	36	7.67 *	9.34 *	12.40 *	12.67 *	7.48 *	9.12 *	5.58 *	2.45 *	4.16 *	1.73 *	2.27(3)
711	367–549	961	90.88 *	109.52 *	143.78 *	128.37(2)	88.78 *	107.05 *	67.50 *	15.66(2)	13.50(2)	5.40(2)	28.21(8)
712	367–549	973	112.77 *	135.88 *	178.34 *	121.11(2)	110.17 *	132.82 *	83.91(2)	40.18(2)	112.00(2)	15.00(3)	49.50(7)
713	367–549	950	87.61 *	105.59 *	30.50(3)	68.04(2)	85.59 *	103.21 *	65.07 *	10.44(2)	41.33(6)	8.25(2)	16.86(7)
714	367–549	1195	144.85 *	174.50 *	228.98 *	206.62(2)	141.52 *	89.36(2)	110.67(1)	41.09(2)	32.69(8)	30.08(6)	49.85(10)
715	275–366	132	201.40(1)	26.99(4)	99.79(2)	339.65(5)	39.12(4)	70.31(4)	383.81(3)	472.84(2)	183.84(2)	11.40(2)	12.50(3)
716	275–366	539	258.55(1)	25.93(3)	101.59 *	106.90(3)	32.66(6)	155.13(4)	73.26(4)	22.02(2)	22.25(4)	25.25(2)	15.50(4)
Strap:													
Upper			168.2	218.7	198.1	182.2	65.0	145.4	87.0	1285.3	185.7	72.6	54.1
Mean			85.2	45.7	125.2	151.8	52.4	89.2	67.6	166.7	48.8	39.6	40.1
Lower			2.2	−127.3	52.4	121.4	39.8	33.0	48.3	−951.9	−88.1	6.7	26.0
Multiplicative analysis:													
Mean			107.8	86.9	137.3	151.3	77.1	97.4	72.1	164.3	49.0	39.0	40.1
Biomass (t)			72952	58800	92910	102343	52193	65903	48801	111141	33130	26401	27099

Table 9. (Cont'd.)

Stratum	Depth range (m)	Area (sq. n.mi.)	1984 AN 26	1985 WT 26	1986 WT 45	1987 WT 55-56	1988 WT 68	1989 WT 81	1990 WT 91	1991 WT 103	1992 WT 118
306	185-274	419	3.51(2)	37.00(2)	39.67(3)	24.63(4)	190.77(4)	10.33(3)	212.48(3)	32.64(4)	1.70(2)
307	93-183	395	69.25(2)	3.70(3)	2.00(3)	5.67(3)	3.95(4)	3.00(3)	25.63(3)	0.44(3)	0.04(2)
309	185-274	296	12.25(2)	85.33(3)	69.25(2)	127.00(2)	86.17(3)	69.00(2)	44.80(2)	235.25(3)	2.15(2)
310	185-274	170	4.75(2)	95.83(3)	43.00(2)	4.00(2)	46.17(3)	16.25(2)	2.75(2)	132.77(2)	0.85(2)
311	93-183	317	4.00(2)	1.97(4)	0.00(3)	0.00(3)	0.05(4)	0.13(3)	0.00(3)	0.00(3)	0.02(2)
313	185-274	165	3.50(2)	89.50(2)	93.75(2)	20.25(2)	31.00(2)	25.00(2)	1.92(2)	42.26(2)	21.14(2)
316	185-274	189	9.75(2)	12.83(3)	10.50(2)	40.50(3)	24.33(3)	4.87(3)	2.65(2)	7.97(2)	25.23(2)
317	93-183	193	31.25(2)	0.00(2)	0.00(2)	0.00(3)	0.20(2)	0.00(2)	0.00(2)	0.00(2)	0.00(2)
318	185-274	123	21.25(2)	27.04 *	149.75(2)	671.00(2)	13.00(2)	105.75(2)	48.70 *	14.23(2)	7.36(2)
319	93-183	984	2.90(6)	0.00(2)	1.45(8)	1.19(9)	13.82(8)	1.00(8)	4.44 *	0.28(9)	0.05(10)
705	275-366	195	13.50(2)	29.50(2)	90.50(2)	102.25(2)	65.00(2)	11.00(2)	5.50(2)	4.58(2)	34.33(2)
706	275-366	476	8.50(2)	60.13(4)	45.88(4)	35.10(5)	114.35(4)	23.88(4)	10.78(4)	24.70(4)	10.84(5)
707	275-366	93	96.75(2)	43.51 *	61.50(2)	69.50(2)	153.25(2)	108.28(2)	78.12 *	93.25(2)	321.02(2)
708	367-549	117	40.50(2)	50.11 *	73.25(2)	101.75(2)	156.00(2)	228.00(2)	89.91 *	70.72(2)	338.30(2)
709	550-731	96	1.75(2)	1.11 *	0.00(1)	5.70(1)	5.43 *	6.25(2)	2.37 *	4.65(2)	0.79 *
710	550-731	36	0.50(2)	5.25(2)	53.50(2)	3.74 *	68.63(2)	4.55 *	4.18 *	4.70(2)	16.70(1)
711	367-549	961	16.10(5)	31.27(8)	119.11(9)	52.71(7)	84.71(7)	149.36(7)	165.15(3)	73.04(8)	75.35(10)
712	367-549	973	30.09 *	27.97(6)	70.78(9)	77.63(4)	68.00(7)	163.06(8)	83.46(5)	29.91(8)	64.88(10)
713	367-549	950	23.29 *	41.19(8)	45.10(5)	110.13(4)	651.84(7)	119.06(8)	57.26(7)	127.50(8)	38.22(10)
714	367-549	1195	38.75 *	31.00(1)	58.60(5)	48.38(4)	312.92(9)	204.10(10)	160.49(7)	104.55(11)	138.29(7)
715	275-366	132	22.00(2)	1137.00(1)	97.25(2)	127.50(2)	133.00(2)	735.43(2)	353.00(2)	4253.50(2)	105.01(2)
716	275-366	539	10.07(3)	27.50(5)	71.63(4)	147.50(3)	100.06(5)	52.88(4)	17.10(5)	8.30(5)	17.37(3)
Strap:											
Upper			75.3	38.7	72.1	116.6	301.0	245.8	133.4	915.7	65.40
Mean			15.8	30.6	54.5	65.9	163.1	98.4	87.5	117.4	50.9
Lower			-43.8	22.5	36.8	15.2	25.1	-49.0	41.6	-681.0	36.46
Multiplicative analysis:											
Mean			21.1	46.9	53.9	65.0	161.4	98.0	76.6	117.4	50.3
Biomass (t)			14304	31721	36472	44002	109193	66325	51820	79423	34006

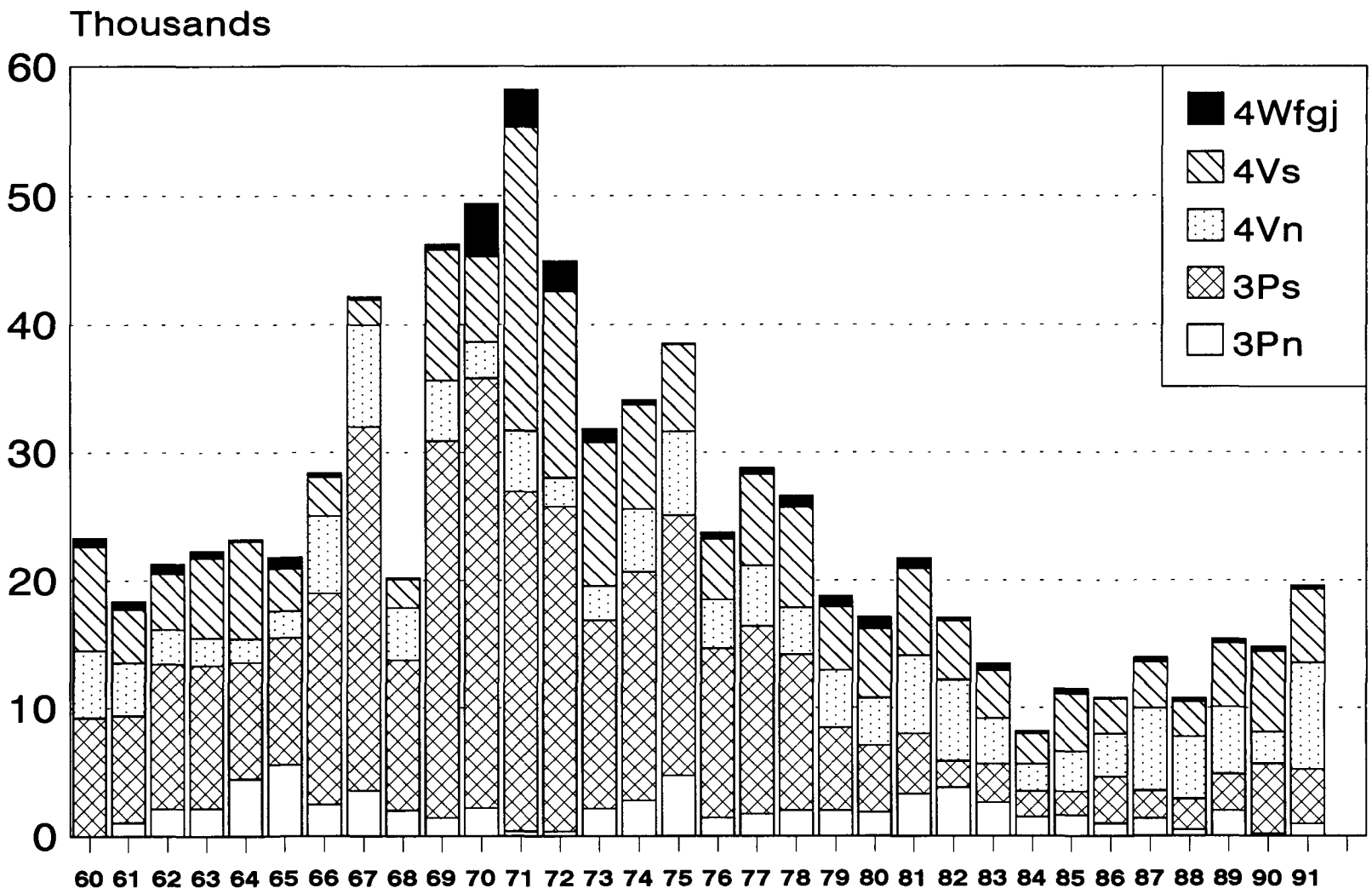

Fig. 1. Nominal catches ('000 t) of redfish from the "Laurentian Channel" management unit for the period 1960-1991 (3Pn and 4Vn from Jun-Dec).

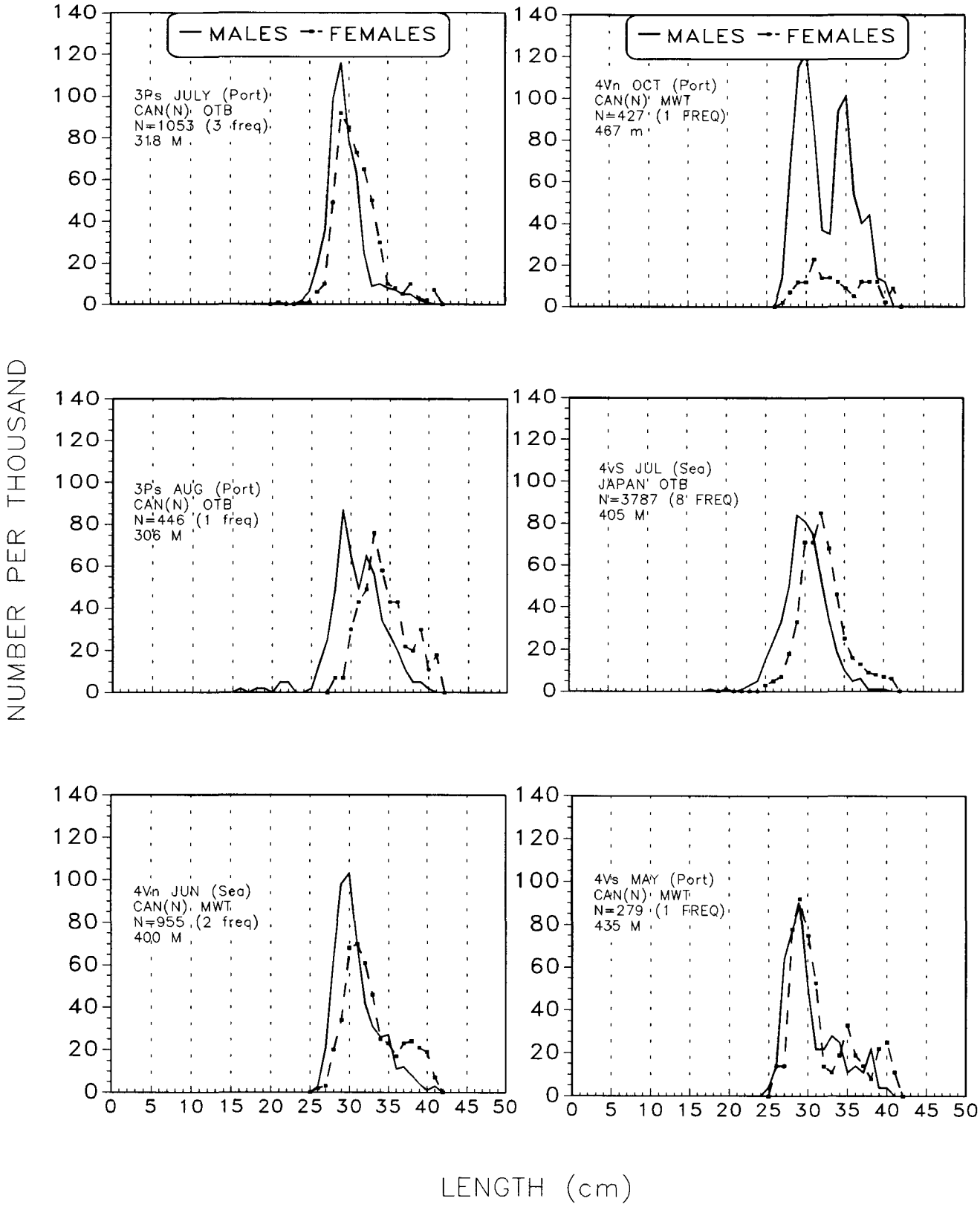

Fig. 2. Length frequencies from the commercial fishery in the Laurentian Channel management unit by port and observer sampling.

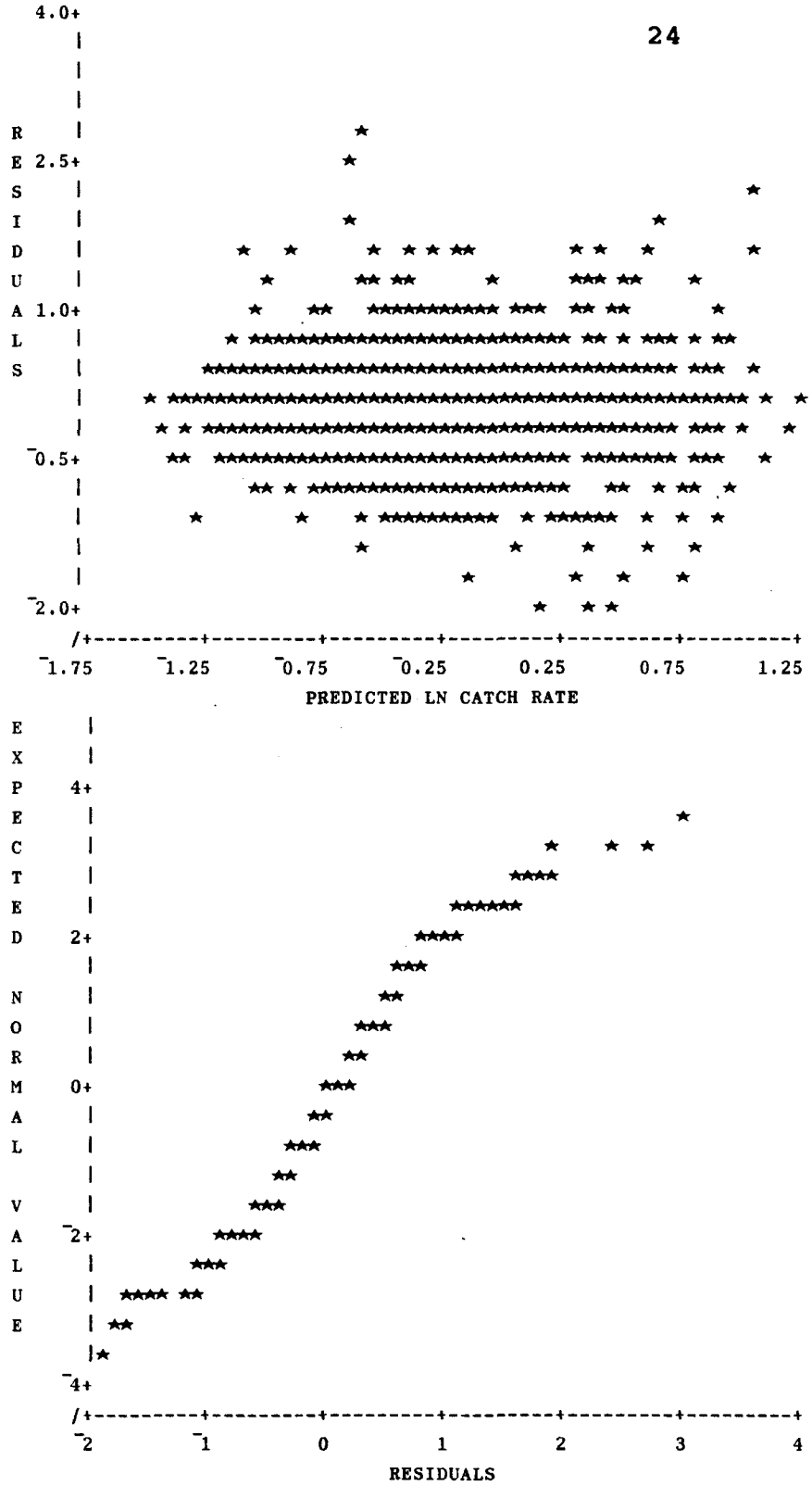

Fig. 3 . Residual plots from a multiplicative analysis of catch rate data for redfish from the Laurentian Channel management unit.

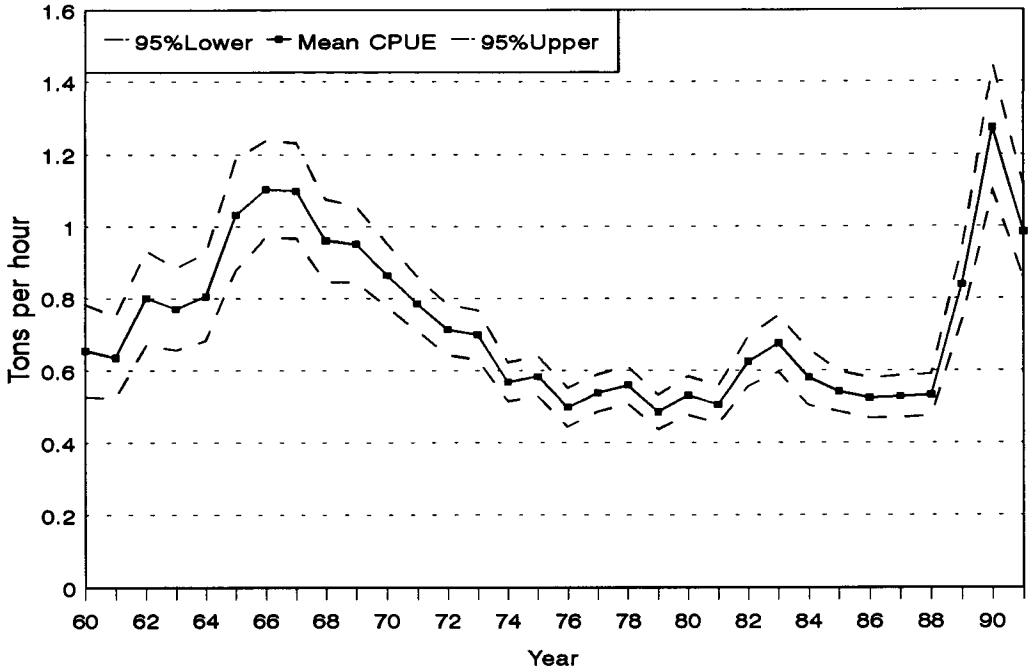

Fig. 4. Standardized catch rate series from a multiplicative analysis of catch rate data for redfish from the "Laurentian Channel" management unit from 1960-91.

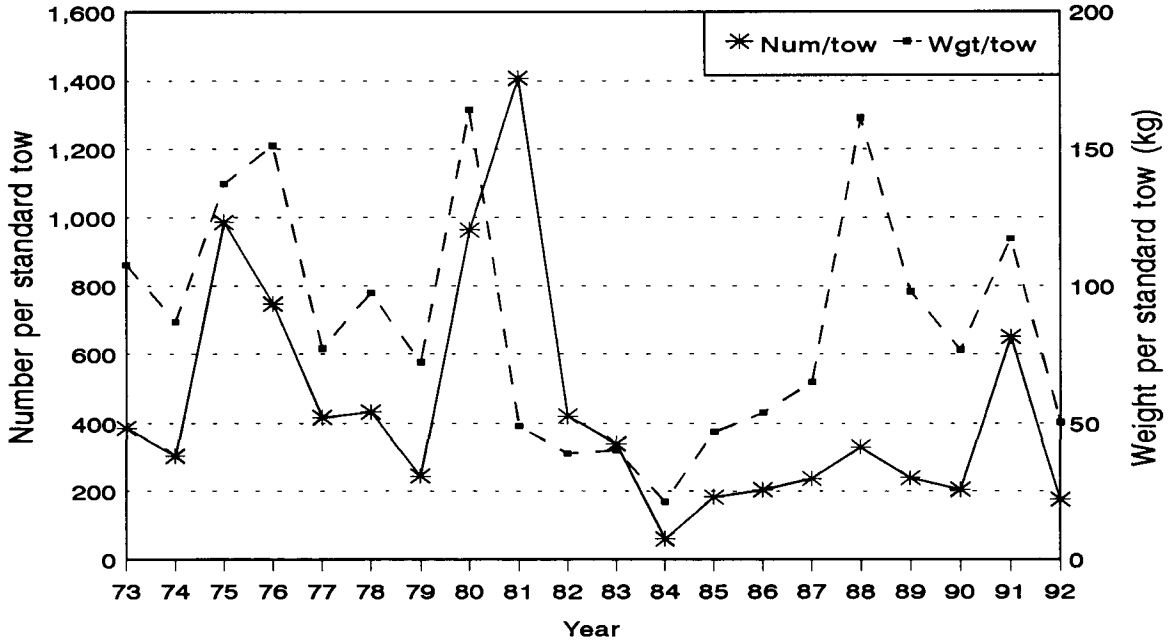

Fig. 5. RV stratified mean number and weight per standard tow in Div. 3Ps derived from a multiplicative analysis to impute values for various strata that were not sampled during the survey in certain years.

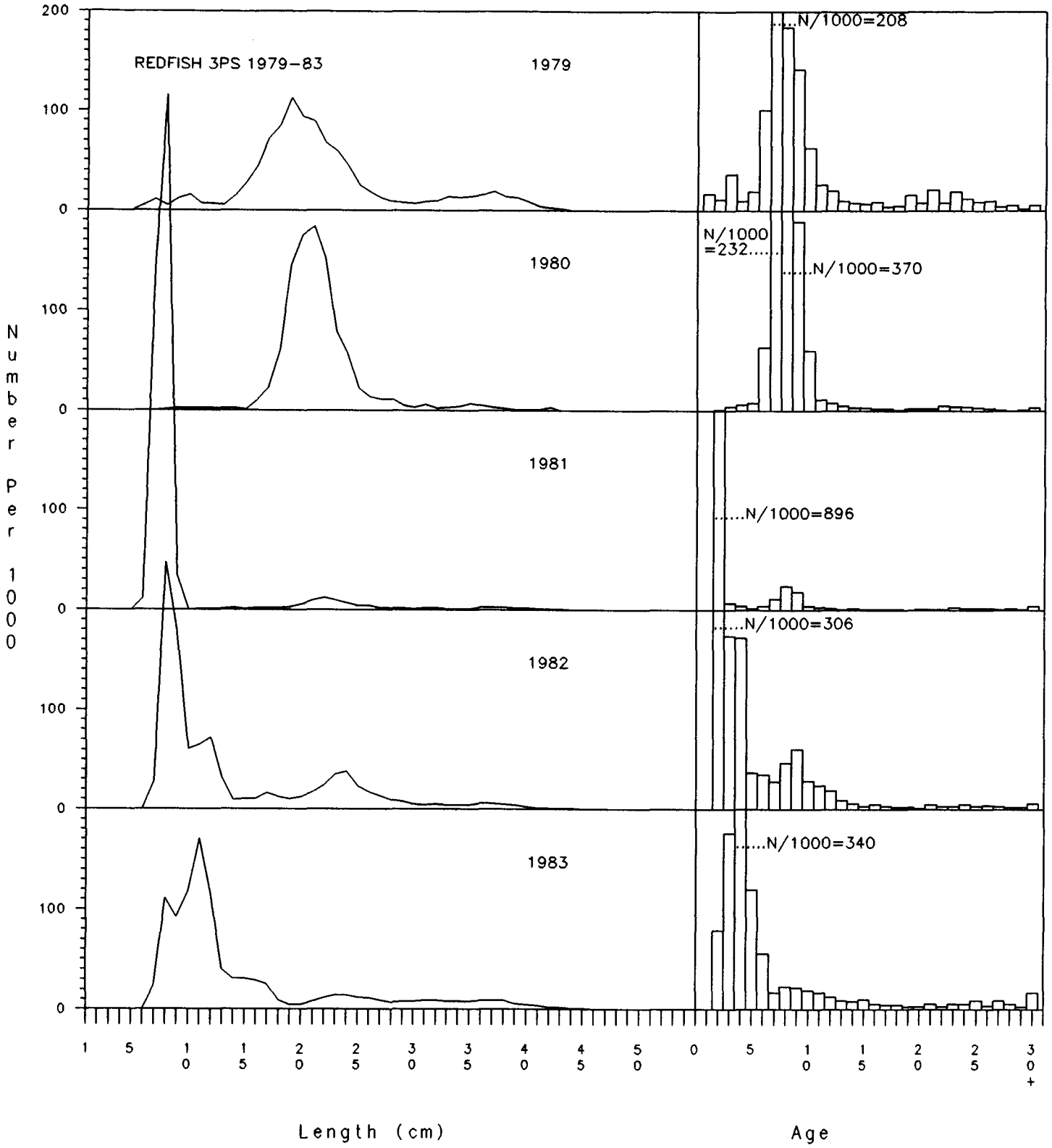

Figure 6 : Redfish length frequencies and corresponding age distribution from stratified random research surveys in Div. 3Ps for the 1979-1983 period.

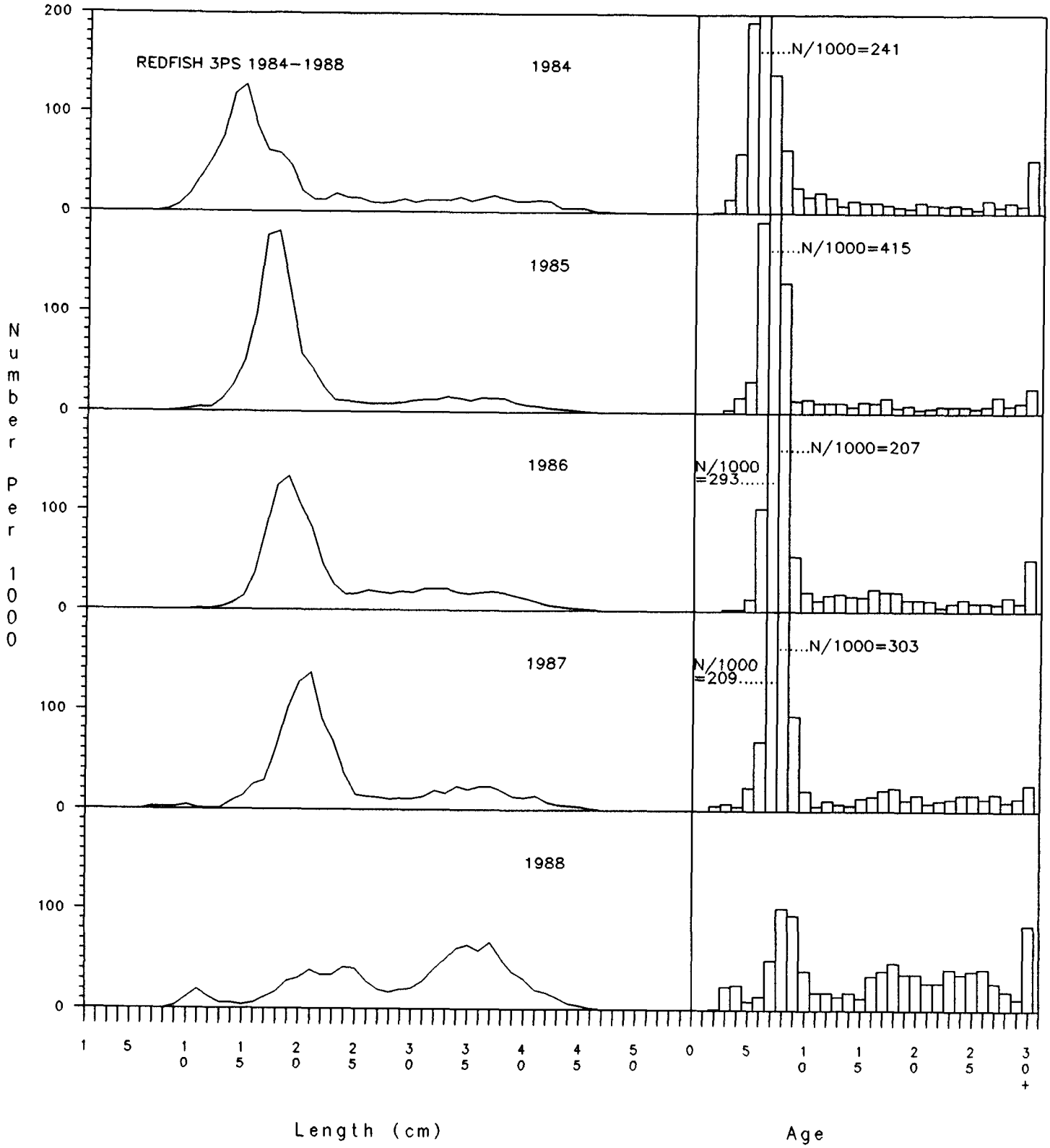

Figure 7 : Redfish length frequencies and corresponding age distribution from stratified random research surveys in Div. 3Ps for the 1984-1988 period.

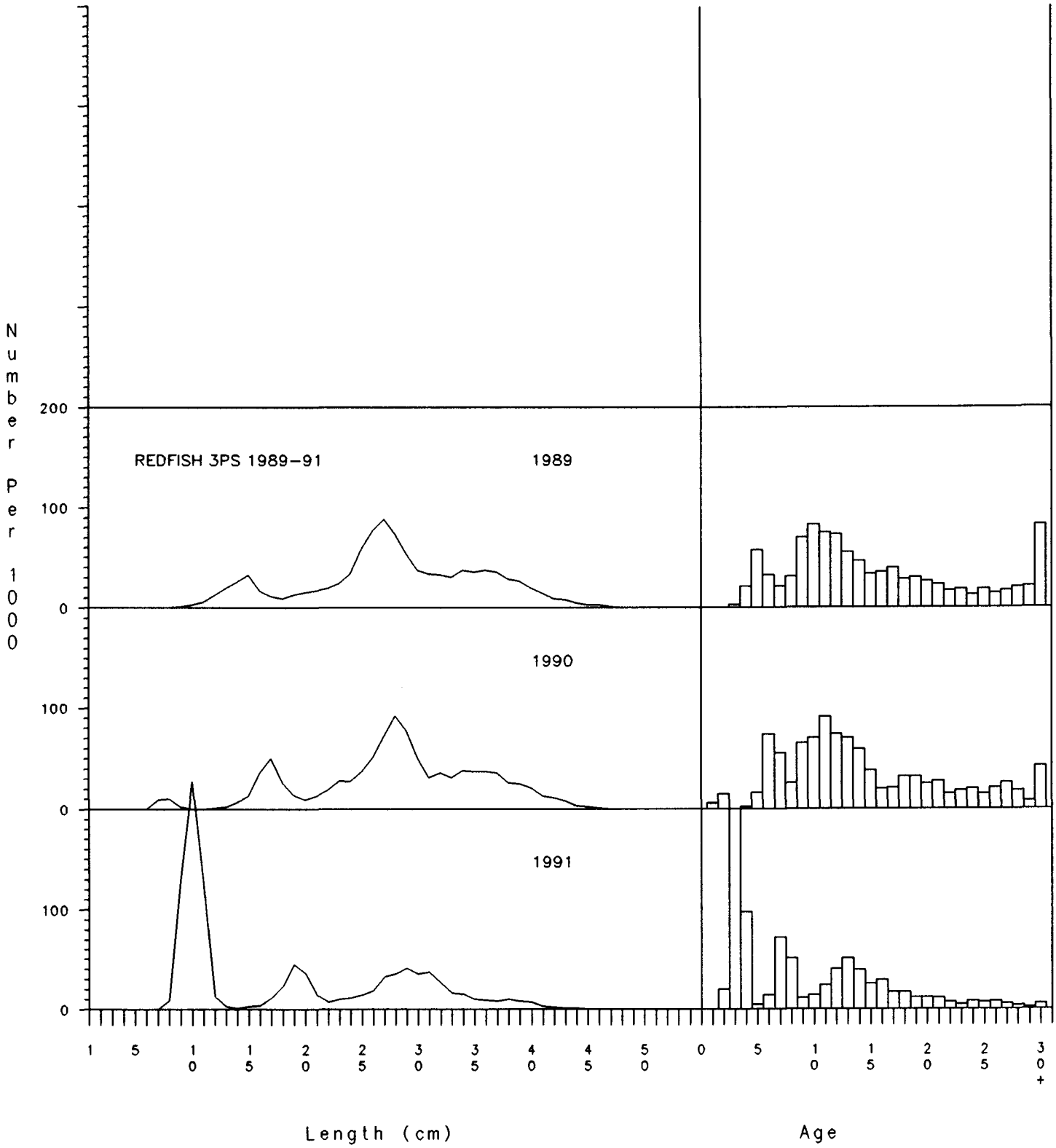

Figure 8 : Redfish length frequencies and corresponding age distribution from stratified random research surveys in Div. 3Ps for the 1989-1991 period.