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Division 3O Redfish - status update

by

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ABSTRACT

Nominal catches have ranged between 3,000 t and 35,000 since 1960. Up to 1986, catches averaged 13,000 , increased to 35,000 t by 1988,. and have declined subsequently to about 3,000 t in 1995. TACs were exceeded in 1987 (by 7,000 t) and 1988 (by 21,000 t) due primarily to increased activity outside the 200-mile Exclusive Economic Zone (EEZ) by countries who were not contracting parties of NAFO (primarily Panama and South Korea) and didn't have bilateral agreements with Canada. Foreign fleets, which predominantly fish outside the EEZ account for most of the catch. Canada fishes inside the EEZ and has taken less that 200 t each year since 1982, but has increased landings in recent years. Standardized commercial catch rate indices are not considered reflective of stock abundance inside the EEZ. For fleets fishing outside the EEZ where most of the effort is located, they show a declining trend since the early-to-mid 1980s. RV surveys show different trends seasonally, and are difficult to interpret, but indicate there are more small redfish of recruiting sizes (17 cm - 22 cm) available in Division 3O than previous years. Based on stock stability in the past with average catches of about 15,000 t and the recent increase in survey estimates of trawlable abundance indicating substantially improved recruitment, it is believed that catches at this level do not appear to have altered the dynamics that occur in the area and will be harmful to the resource.

RÉSUMÉ

Les prises nominales ont varié entre 3 000 t et 35 000 t depuis 1960. Jusqu'en 1986, les prises étaient en moyenne de 13 000 t; elles ont presque triplé pour atteindre 35 000 t en 1988; elles ont ensuite chuté à environ 3 000 t en 1995. Le TAC a été dépassé en 1987 (de 7 000 t) et en 1988 (de 21 000 t) essentiellement en raison d'une augmentation des activités à l'extérieur de la zone économique exclusive de 200 milles par les pays qui n'étaient pas partie contractante de l'OPANO (surtout Panama et Corée du Sud) et qui n'avaient pas conclu d'entente bilatérale avec le Canada. La majeure partie des captures est attribuable aux flottes étrangères, qui pêchent essentiellement à l'extérieur de la zone économique exclusive. Le Canada pêche à l'intérieur de cette zone et a capturé moins de 200 t chaque année depuis 1982, quoique les débarquements aient augmenté au cours des dernières années. Les indices normalisés des captures commerciales n'illustrent pas l'abondance réelle du stock à l'intérieur de la zone économique exclusive. Pour les flottes qui pêchent à l'extérieur de cette zone, où est déployée la plus grande partie de l'effort, les captures montrent une tendance décroissante depuis le début ou le milieu des années 80. Les relevés de recherche présentent des tendances saisonnières différentes, sont difficiles à interpréter, mais indiquent que le nombre de petits sébastes de taille suffisante pour être recrutés (17-22 cm) dans la division 3O est supérieur à celui des années précédentes. D'après la stabilité antérieure des stocks avec des captures moyennes d'environ 15 000 t, et étant donné l'accroissement récent des estimations de l'abondance de poisson chalutable indiquant une nette amélioration du recrutement, on peut penser que les captures à ce niveau ne semblent pas avoir modifié la dynamique de la région et qu'elles ne seront pas nuisibles pour la ressource.

Description of management regulations and the fishery

Management regulations

A TAC of 16,000 t was first implemented on this stock in 1974. The TAC was increased in 1978 to 20,000 t on the assumption that the stock was healthy and generally remained at that level through to 1987. The TAC for 1988 was reduced to 14,000 t and remained unchanged until 1994 when it was reduced to 10,000 t as a precautionary measure and maintained at that level to 1996. In addition to catch regulation, a small fish protocol at 22 cm was implemented inside the 200 mile limit for this stock in 1995. The 1996 TAC (10,000 t) is divided into a Canadian quota (5,590 t), a French quota (1,500 t) and a Foreign Quota (2,910 t). About 10% of the stock area lies outside Canada's 200 mile Exclusive Economic Zone (EEZ).

Nominal Catches and the fishery

Nominal catches have ranged between 3,000 t and 35,000 t since 1960 (Table 1, Fig. 1). Up to 1986 catches averaged 13,000 t, increased to 27,000 t in 1987 with a further increase to 35,000 t in 1988, exceeding TACs by 7,000 t and 21,000 respectively. Catches declined to 13,000 t in 1989, and were about this amount annually through to 1993. The 1994 catch, at about 5,400 t, represented an 11,000 t reduction from 1993. Catches declined further to about 3,000 t in 1995 and up to September 1996 less than 1,000 t had been taken. Reductions since 1994 are partly due to reductions in foreign allocations. The increased catches in 1987 and 1988 were due primarily to increased activity outside the 200 mile EEZ by countries who were not contracting parties of NAFO (primarily Panama and South Korea) and had no bilateral agreements with Canada. Canadian surveillance estimates of non-reported catch, which have ranged from 200 t to 23,500 t are included in catch statistics since 1983 (Table 2). A further explanation of these are given in Shelton and Atkinson (1994).

Russia predominated in this fishery up until 1993 and generally caught its share (about 50%) of the total non-Canadian allocation, which accounted for about 2/3 of the TAC. From 1982 to 1993 Russian catches were between 3,800 t to 8,700 t. Since 1993 Russia has taken less than 500 t. Cuba, has not participated in the fishery in this area since 1993. Russia, Cuba and Japan fished throughout the stock area after the implementation of the EEZ through agreements with Canada. Portugal, which began fishing outside the EEZ in 1992 took 2,900 t in 1994, a reduction of 2,000 t from their 1993 catch, and about 2,500 t in 1995. Canada, which landed less than 200 t from 1983-1991, took 1,600 t in 1994 due to improved markets related to lobster bait, but declined to about 100 t in 1995. Canadian catches have increased again in 1996, with about 400 t being reported to September.

The fishery has occurred primarily in the second and third quarters of the year since 1983 (Table 3a). The prominent means of capture from the mid-1970s to the early 1980s was the bottom otter trawl (Table 3b). Since 1984 there has been an increase in the use of the midwater trawl but the bottom trawl catches still dominate.

Available Data

Commercial catch rates

Catch and effort data for 1959 to 1992 were extracted from ICNAF/NAFO Statistical Bulletins and were combined with provisional 1993-1994 NAFO data and 1993-1995 Atlantic region data compiled by various DFO regional statistics branches. Initially selected from this database were observations where redfish comprised more than 50% of the total catch and were therefore considered to be redfish directed.

These data were analysed with a multiplicative model (Gavaris 1980) to derive a standardized catch rate series. The effects included in the model were a combination country-gear-tonnage class category type (CGT), 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 manner, catch or effort data of less than 10 units were eliminated prior to analysis in addition to any categories with less than five samples except in the year category type. For all analyses hours fished was the measure of effort and an unweighted regression was run because of unknown percentages of prorating prior to 1984.

Previous catch rate analyses of this stock (Power et al., 1995) suggested different trends in the catch rate series derived for Canada only and for countries that have only fished outside the EEZ. Accordingly, separate standardizations of available catch rate data were conducted as follows: (i) Canada only, (ii) countries which have fished both inside and outside the EEZ (Russia and Cuba) and (iii) countries which have only fished outside the EEZ (Japan, Poland, Portugal and South Korea).

The analysis of Canadian catch rates (Table 4) resulted in a significant overall regression explaining 69% of the variability in the data, however, the month category type was not significant ($P > .05$). The catch rate index (Table 5, Fig. 2a) shows much interannual variability over the 1959-1995 period but without any discernible trend with time. These catch rates have fluctuated particularly wide in recent years, dropping dramatically between 1990 and 1992, increasing substantially from 1993 to 1994 and declining steeply between 1994 and 1995.

The regression analysis conducted on catch rates for Russia and Cuba was significant ($P < .05$) and explained 65% of the variability in catch rates (Table 6). The catch rate index (Table 7, Fig. 2b) again shows much interannual variability prior to 1977. The index shows a steady increase from 1978 to 1982 and a general decline to 1994.

The annual update to the databases did not provide any further information than was available for last year's assessment for those countries that have fished outside the EEZ. The catch rate index (Fig. 2c, reproduced from Power et al. 1995) shows a steady decline from 1984 to 1993. Fishing was sporadic by these countries prior to 1984.

In summary, the analysis of catch rates by the Canadian fleet are not considered indicative of overall trends in the resource. Canada has not accounted for a major portion of the reported catches from Division 3O and has only fished within the 200 mile EEZ. The recent dramatic fluctuations cannot be accounted for by the biology of redfish. The trend in the two foreign fleet catch rate series are similar and indicate a general decline since the early to mid 1980s to the more recent period. The catch rates of the fleets that have fished outside is probably indicative of a decline in the proportion of the stock outside the EEZ where most of the effort occurs.

Catch at Length

Length distributions sampled from 1995-1996 fisheries from Canadian port sampling and observer data, and data available from the 1995 Portuguese fishery by Portuguese observers (Godhino et al., 1996) were weighted by the monthly landings to derive a catch-at-length by country for Div. 3O. For 1996, only the Nfld. data that was available in time for the assessment in September were used.

The length-weight relationships used were:

$$WT\ (males) = 0.01659\ Forklength^{2.9548}$$

$$WT\ (females) = 0.013272\ Forklength^{3.0210}$$

The data (Fig. 3) indicate a mode at about 22 cm in the Canadian and Japanese catches in 1995. Portuguese catches for 1995 were bimodal with peaks at about 29 cm and 38 cm. These fish were much larger than the 'traditional' smaller sizes taken in Division 3O relative to other divisions. Additional sampling information indicates the samples were obtained from 200-800 m. It is likely that the larger fish taken by Portuguese vessels were from deeper water. It is also reported the Portuguese fleet fishes in the vicinity of the border with Div. 3N which, to some extent, may also account for the distribution differences with Japanese and Canadian samples.

Research vessel surveys

Stratified random groundfish surveys have been conducted in the spring and autumn in Division 3O since 1991, with coverage of depths to 730 m. In addition, a summer survey was conducted in 1993. From 1991 to spring 1995 an Engel 145 otter trawl was used (1.75 n. mi. standard tow) and from 1995 fall onwards a Campelen 1800 shrimp trawl (0.75 n. mi. standard tow). Comparative fishing trials have been conducted between the two gears but the analysis has not been finalized to apply conversion factors to the pre-Campelen data. This new gear has a similar catchability for large redfish (>20 cm), but a much greater catchability for smaller redfish.

The series of mean weight per standard tow (Table 8) exhibits a typical situation of sometimes large fluctuations in estimates between seasons and years for some strata. The spring survey biomass index (Table 8, Fig. 4) increased steadily from about 7,000 t in 1992 to 112,000 t in 1996. Over half the 1995 spring estimate of 84,000 t was accounted for by two large catches of about 5,000 kg each in a relatively small stratum. Similarly, about 70,000 t of the 1996 spring estimate of 118,000 was due to the influence of one large set of about 10,000 kg. The 1993 summer survey index, at 52,000 t, was similar to the level estimated from the 1993 spring survey (42,000 t). The autumn survey biomass index has ranged between 16,000 t and 126,000 t from 1991 to 1995, although the 1992 autumn survey only covered depths down to 370 m (200 fathoms).

These results are difficult to interpret. Stratum by stratum estimates indicate that the increases during the spring surveys occurred over a great deal of the area and depths where redfish generally reside. However, in all surveys, the densities outside the 200 mile EEZ were generally lower than

inside. Differences between the spring and fall surveys may be related to changes in availability within the Division at different times of the year.

Size distribution in terms of mean number per tow at length (Fig. 5) indicate a bimodal distribution in the 1991 spring survey with modes at 11 cm and 20 cm corresponding to about the 1988 and 1984 year classes respectively. These modes progress in the surveys up to the 1992 autumn survey when the modes were at 17 cm and 22 cm. The corresponding peaks in surveys up to autumn 1995 show little progression. The autumn 1995 survey shows peaks at 9-10 cm and 19 cm. In the three year period from autumn 1992 to autumn 1995 the 17 cm mode progressed to 19 cm and the 22 cm mode could only be followed to autumn 1994 when it was 23 cm. It is unknown how this apparent relatively slow growth after the fall of 1992 relates to the increases in the biomass index over the same period. The prominent mode of the 1996 spring survey was 21 cm. It is difficult to track year classes beyond a length of 25 cm, their fate is unknown.

Overall, size distributions of the survey catches indicate only a narrow range of sizes caught each year in Division 3O. Generally fish smaller than about 10 cm and larger than about 25 cm are absent in survey catches. It is well documented that the Engel survey gear (eg. Power MS 1994, Power MS 1995) and the Campelen survey gear (e.g. Power et al. MS 1996) can catch both smaller and larger redfish. In addition, length sampling from the commercial fisheries reveal a higher proportion of fish greater than 25 cm compared to the survey catches. Therefore, it appears that fish sizes outside this range are generally unavailable to the gear in this area. The reasons for this are unknown but may be related to distribution relative to trawlable bottom.

PROGNOSIS

Research survey indices have shown an increasing trend in recent years but it is still not possible to relate this to trends in total stock size because of the restricted size range of fish taken during the surveys compared to what is believed to be present in the area. There are indications that larger fish do reside in the division, but in generally untrawlable areas. Therefore it is difficult to determine exactly what the survey data are measuring. Based on these limitations, it is not possible to determine current fishing mortality, nor the possible fishing mortality generated by catching the TAC of 10,000 t in 1996. Based on an analysis in 1995 of available commercial catch rate at age data from 1987-1990 (Power et al. MS 1995), there are indications that fishing mortality was somewhat above $F_{0.1}$ during the 15 years prior to the 1990s when catches averaged about 15,000 t.

Recently, more small redfish of recruiting sizes (17 cm - 22 cm) appear to be available in Division 3O based on research vessel surveys. Based on stock stability in the past with average catches of about 15,000 t and the recent increase in survey estimates of trawlable abundance indicating substantially improved recruitment, it is believed that catches at this level do not appear to have altered the dynamics that occur in the area and will not be harmful to the resource. The length at which half the females are sexually mature (L_{50}) is about 29 cm (11 inches). Given that generally the shallower the depth fished the smaller the size composition, caution is warranted because a greater proportion of immature females may be captured if fishing is concentrated in shallower water (less than 375 m (205 fathoms)).

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Table 1. Nominal catches (t) and TACs of redfish in Div. 3O.

Year	Canada	Non-Canadian	Total	TAC
1960	100	4,900	5,000	
1961	1,000	10,000	11,000	
1962	1,046	6,511	7,557	
1963	2,155	7,025	9,180	
1964	1,320	14,724	16,044	
1965	203	19,588	19,791	
1966	107	15,198	15,305	
1967	645	18,392	19,037	
1968	52	6,393	6,445	
1969	186	15,692	15,878	
1970	288	12,904	13,192	
1971	165	19,627	19,792	
1972	508	15,609	16,117	
1973	133	8,664	8,797	
1974	91	13,033	13,124	16,000
1975	103	15,007	15,110	16,000
1976	3,664	11,684	15,348	16,000
1977	2,972	7,878	10,850	16,000
1978	1,841	5,019	6,860	16,000
1979	6,404	11,333	17,737	20,000
1980	1,541	15,765	17,306	21,900
1981	2,577	10,027	12,604	20,000
1982	491	10,869	11,360	20,000
1983	7	7,333	7,340	20,000
1984	167	16,811	16,978	20,000
1985	104	12,756	12,860	20,000
1986	141	10,914	11,055	20,000
1987	183	26,987	27,170	20,000
1988	181	34,611	34,792	14,000
1989	27	13,229	13,256	14,000
1990	155	14,087	14,242	14,000
1991	28	8,433	8,461	14,000
1992	1,219	14,049	15,268	14,000
1993 [a]	698	15,022	15,720	14,000
1994 [a]	1,624	3,804	5,428	10,000
1995 [a]	121	3,064	3,185	10,000
1996				10,000

[a] Provisional

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

Country	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993[a]	1994[a]	1995[a]
Canada (M)	47	4	29	48	5	24	5	18	27	4	27	21	779	4
Canada (N)	444	3	138	56	136	159	176	9	128	24	1192	677	845	117
France	-	2	-	-	-	-	-	-	-	-	-	-	-	-
Japan	496	1	1258	661	1162	1074	1606	1724	1406	226	125	159	-	264
Portugal	5	-	-	-	-	-	22	12	83	3	1468	4794	2918	-
Spain	-	-	25	630	45	26	4	-	4	-	-	-	26	-
Russia	8717	5670	7262	5905	6099	7152	4921	4517	3811	4427	5845	6887	60	483
Cuba	1651	1460	1316	806	3006	2859	2753	2138	2750	2748	2776	665	-	-
USA	-	-	-	104	2	-	-	-	-	-	-	-	-	-
Korea(S)	-	-	-	-	-	1726	1805	2638	833	129	1935	17	-	-
EEC/EU	-	-	-	-	-	-	-	-	-	-	-	-	-	1917
OTHER[b]	-	200	6950	4650	600	14150	23500	2200	5200	900	1900	2500	800	400
Total	11360	7340	16978	12860	11055	27170	34792	13256	14242	8461	15268	15720	5428	3185
TAC	20000	20000	20000	20000	20000	20000	14000	14000	14000	14000	14000	14000	10000	10000

[a] Provisional
[b] Estimates of non-reported catch (by Canadian Surveillance)

Table 3a. Nominal reported catches (t) of redfish in Div. 3O by month and year (not including surveillance estimates).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1982	-	1	1121	1258	545	652	4555	2245	661	233	89	-	11360
1983	254	355	2904	1227	71	156	576	938	319	1	73	266	7140
1984	219	155	2	32	85	257	446	3210	2799	1882	435	506	10028
1985	1522	-	453	239	118	252	227	1711	1486	350	35	1817	8210
1986	707	-	427	593	69	710	3491	3712	58	1	319	368	10455
1987	102	40	1052	37	1010	757	2001	4142	429	344	1326	1780	13020
1988	15	1	493	684	915	1	1755	3922	1286	1057	915	248	11292
1989	228	585	224	6	674	1411	1143	3311	2737	666	51	20	11056
1990	108	23	257	26	1220	2474	1534	1571	1002	686	28	113	9042
1991	17	47	96	1	713	2054	2346	1118	830	338	-	1	7561
1992	0	57	14	10	635	3262	2520	1808	896	1261	797	2108	13368
1993[a]	226	14	754	817	2089	1601	1887	2068	1809	829	630	496	13220
1994[a]	60	93	710	1605	272	83	-	68	1000	540	19	178	4628

[a] Provisional.

Table 3b. Nominal reported catches (t) of redfish in Div. 3O by gear (not including surveillance estimates).

	Otter Trawls				
Year	Bottom	Midwater	Gillnets	Misc	Total
1982	9394	1966	-	-	11360
1983	5217	1923	-	-	7140
1984	7451	2577	-	-	10028
1985	4431	3778	-	1	8210
1986	5231	5224	-	-	10455
1987	8601	4419	-	-	13020
1988	6692	4596	-	4	11292
1989	7026	4030	-	-	11056
1990	5501	3537	-	4	9042
1991	4625	2936	-	-	7561
1992	10046	3292	1	29	13368
1993[a]	11997	1214	-	9	13220
1994[a]	3085	1498	26	19	4628

[a] Provisional.

TABLE 4 . ANOVA results and regression coefficients from a multiplicative utilized to derive a standardized catch rate series for Redfish in Div. 3O. Effort is measured in hours fished. Only Canadian data were utilized in the analysis.

REGRESSION OF MULTIPLICATIVE MODEL

MULTIPLE R..... 0.833

MULTIPLE R SQUARED..... 0.694

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	4.344E0	4.344E0	
REGRESSION	50	4.297E1	8.595E-1	5.256
Country¦Gear¦TC	5	5.218E0	1.044E0	6.382
Month	9	2.325E0	2.584E-1	1.580
Bycatch PCT	4	2.637E0	6.593E-1	4.032
Year	32	1.738E1	5.433E-1	3.322
RESIDUALS	116	1.897E1	1.635E-1	
TOTAL	167	6.629E1		

REGRESSION COEFFICIENTS

CATEGORY	CODE	VARIABLE	COEFFICIENT	STD. ERROR	NO. OBS.
Country¦Gear¦TC	3125	INTERCEPT	0.184	0.223	167
Month	7				
Bycatch PCT	95				
Year	59				
1	2114	1	-0.051	0.167	20
	2125	2	0.202	0.150	18
	3114	3	0.040	0.107	74
	3155	4	1.114	0.211	10
	27125	5	0.264	0.160	11
2	3	6	-0.320	0.226	6
	4	7	-0.235	0.241	5
	5	8	-0.200	0.149	15
	6	9	0.009	0.140	17
	8	10	0.076	0.124	24
	9	11	-0.131	0.120	24
	10	12	-0.327	0.129	25
	11	13	-0.321	0.168	13
	12	14	-0.308	0.221	5
4	55	15	-0.629	0.173	12
	65	16	-0.317	0.176	9
	75	17	-0.070	0.168	9
	85	18	-0.088	0.107	32
5	60	19	-0.125	0.332	2
	61	20	0.076	0.245	6
	62	21	-0.366	0.222	7
	63	22	-0.406	0.219	8
	64	23	-0.188	0.285	4
	65	24	0.092	0.339	2
	66	25	-0.620	0.446	1
	67	26	0.045	0.229	7
	69	27	-0.696	0.353	2
	70	28	-0.211	0.304	3
	71	29	0.010	0.446	1
	72	30	-0.384	0.249	6
	73	31	-0.239	0.453	1
	74	32	-0.703	0.300	3
	75	33	-0.813	0.264	4
	76	34	-0.407	0.215	12
	77	35	-0.447	0.205	15
	78	36	-0.416	0.199	13
	79	37	0.173	0.211	16
	80	38	-0.298	0.224	10
	81	39	-0.213	0.218	10
	82	40	-0.395	0.306	3
	84	41	-0.148	0.334	2
	85	42	0.258	0.314	3
	86	43	-0.176	0.462	1
	87	44	0.087	0.345	2
	88	45	0.385	0.449	1
	90	46	0.185	0.461	1
	92	47	-1.281	0.284	6
	93	48	-0.513	0.371	2
	94	49	0.798	0.349	4
	95	50	-0.812	0.525	1

TABLE 5 . Standardized catch rate series for Div. 30 redfish from a multiplicative model utilizing hours fished as a measure of effort. Only Canadian data were utilized in the analysis.

	PREDICTED CATCH RATE					
	LN TRANSFORM		RETRANSFORMED			
YEAR	MEAN	S.E.	MEAN	S.E.	CATCH	EFFORT
1959	0.1837	0.0497	1.273	0.281	59	46
1960	0.0590	0.1057	1.092	0.347	60	55
1961	0.2596	0.0658	1.362	0.345	61	45
1962	-0.1819	0.0434	0.886	0.183	62	70
1963	-0.2221	0.0433	0.851	0.176	63	74
1964	-0.0042	0.0785	1.039	0.287	64	62
1965	0.2757	0.1236	1.344	0.460	65	48
1966	-0.4366	0.1928	0.637	0.268	66	104
1967	0.2287	0.0384	1.339	0.261	67	50
1969	-0.5126	0.1254	0.611	0.210	69	113
1970	-0.0270	0.0648	1.023	0.257	70	68
1971	0.1942	0.1915	1.197	0.502	71	59
1972	-0.1999	0.0626	0.862	0.213	72	84
1973	-0.0548	0.2140	0.923	0.407	73	79
1974	-0.5188	0.0721	0.623	0.165	74	119
1975	-0.6293	0.0611	0.561	0.137	75	134
1976	-0.2234	0.0254	0.858	0.136	76	89
1977	-0.2636	0.0302	0.822	0.142	77	94
1978	-0.2327	0.0332	0.846	0.154	78	92
1979	0.3567	0.0261	1.531	0.247	79	52
1980	-0.1141	0.0294	0.955	0.163	80	84
1981	-0.0294	0.0285	1.039	0.175	81	78
1982	-0.2118	0.0577	0.853	0.203	82	96
1984	0.0358	0.1000	1.070	0.331	84	78
1985	0.4420	0.0628	1.637	0.406	85	52
1986	0.0078	0.1635	1.008	0.393	86	85
1987	0.2708	0.1086	1.348	0.434	87	65
1988	0.5689	0.1966	1.737	0.737	88	51
1990	0.3687	0.1788	1.435	0.583	90	63
1992	-1.0970	0.0476	0.354	0.077	92	260
1993	-0.3292	0.1138	0.738	0.243	93	126
1994	0.9813	0.0937	2.764	0.830	94	34
1995	-0.6283	0.2477	0.511	0.240	95	186

AVERAGE C.V. FOR THE RETRANSFORMED MEAN: 0.282

TABLE 6 . ANOVA results and regression coefficients from a multiplicative model utilized to derive a standardized catch rate series for Redfish in Div. 3O. Countries which have fished both inside and outside the EEZ (Russia and Cuba) were used in the analysis.

REGRESSION OF MULTIPLICATIVE MODEL

MULTIPLE R..... 0.809

MULTIPLE R SQUARED..... 0.654

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	6.354E1	6.354E1	
REGRESSION	52	7.474E1	1.437E0	7.538
Country¦Gear¦TC	6	9.405E0	1.567E0	8.220
Month	11	7.291E0	6.628E-1	3.476
Bycatch PCT	4	9.602E0	2.400E0	12.589
Year	31	1.526E1	4.922E-1	2.581
RESIDUALS	207	3.947E1	1.907E-1	
TOTAL	260	1.778E2		

REGRESSION COEFFICIENTS

CATEGORY	CODE	VARIABLE	COEFFICIENT	STD. ERROR	NO. OBS.
Country¦Gear¦TC	20127	INTERCEPT	0.465	0.214	260
Month	7				
Bycatch PCT	95				
Year	59				
1	4127	1	-0.052	0.124	19
	4157	2	-0.083	0.110	32
	20114	3	-1.402	0.210	14
	20157	4	-0.143	0.079	55
	34127	5	-0.060	0.376	3
	34157	6	-0.553	0.416	3
2	1	7	-0.335	0.148	15
	2	8	-0.400	0.166	11
	3	9	-0.229	0.125	25
	4	10	-0.681	0.125	23
	5	11	-0.147	0.129	22
	6	12	-0.065	0.121	27
	8	13	-0.057	0.110	33
	9	14	-0.113	0.119	26
	10	15	-0.185	0.163	11
	11	16	-0.304	0.159	12
	12	17	-0.225	0.135	21
4	55	18	-0.818	0.147	19
	65	19	-0.521	0.117	29
	75	20	-0.420	0.100	33
	85	21	-0.404	0.087	45
5	60	22	0.549	0.500	1
	62	23	0.706	0.431	2
	63	24	1.005	0.428	2
	64	25	0.520	0.541	1
	65	26	0.264	0.433	2
	69	27	0.535	0.306	4
	70	28	0.254	0.296	6
	71	29	0.627	0.279	7
	72	30	0.256	0.259	8
	73	31	0.553	0.309	4
	74	32	0.644	0.347	3
	75	33	0.577	0.389	2
	76	34	0.878	0.246	11
	77	35	0.710	0.262	8
	78	36	0.335	0.251	10
	79	37	0.695	0.239	15
	80	38	0.806	0.232	16
	81	39	0.875	0.237	13
	82	40	1.090	0.231	16
	83	41	0.747	0.231	17
	84	42	0.613	0.232	16
	85	43	0.564	0.243	12
	86	44	0.548	0.248	12
	87	45	0.598	0.238	14
	88	46	0.601	0.237	14
	89	47	0.399	0.246	12
	90	48	0.196	0.252	9
	91	49	-0.070	0.261	7
	92	50	0.425	0.341	8
	93	51	0.237	0.386	2
	94	52	0.358	0.648	1

TABLE 7 . Standardized catch rate series for Div. 30 redfish from a multiplicative model utilizing hours fished as a measure of effort. Only countries which have fished inside and outside the EEZ were utilized in the analysis.

	PREDICTED CATCH RATE					
	LN TRANSFORM		RETRANSFORMED			
YEAR	MEAN	S.E.	MEAN	S.E.	CATCH	EFFORT
1959	0.4655	0.0457	1.713	0.363	59	34
1960	1.0146	0.2226	2.714	1.215	60	22
1962	1.1712	0.1562	3.282	1.251	62	19
1963	1.4703	0.1510	4.438	1.665	63	14
1964	0.9852	0.2629	2.583	1.245	64	25
1965	0.7293	0.1573	2.109	0.806	65	31
1969	1.0004	0.0615	2.902	0.710	69	24
1970	0.7200	0.0547	2.200	0.509	70	32
1971	1.0929	0.0493	3.202	0.704	71	22
1972	0.7211	0.0347	2.224	0.412	72	32
1973	1.0188	0.0588	2.959	0.709	73	25
1974	1.1092	0.0907	3.188	0.941	74	23
1975	1.0421	0.1199	2.938	0.990	75	26
1976	1.3433	0.0297	4.155	0.712	76	18
1977	1.1753	0.0367	3.500	0.666	77	22
1978	0.8009	0.0305	2.414	0.419	78	32
1979	1.1602	0.0265	3.465	0.561	79	23
1980	1.2714	0.0220	3.881	0.573	80	21
1981	1.3409	0.0244	4.156	0.647	81	19
1982	1.5559	0.0185	5.168	0.701	82	16
1983	1.2129	0.0214	3.662	0.534	83	23
1984	1.0787	0.0204	3.203	0.457	84	26
1985	1.0297	0.0275	3.040	0.502	85	28
1986	1.0136	0.0280	2.990	0.498	86	29
1987	1.0632	0.0232	3.150	0.478	87	28
1988	1.0669	0.0216	3.164	0.463	88	28
1989	0.8641	0.0261	2.577	0.414	89	35
1990	0.6616	0.0292	2.102	0.357	90	43
1991	0.3953	0.0336	1.607	0.293	91	57
1992	0.8904	0.0802	2.575	0.717	92	36
1993	0.7027	0.1106	2.102	0.682	93	44
1994	0.8233	0.3898	2.061	1.173	94	46

AVERAGE C.V. FOR THE RETRANSFORMED MEAN: 0.243

Table 8. Mean weight (kg) of redfish caught per standard tow in Division 3O during Canadian research surveys 1991-1996. ("-" indicates strata not sampled)

STRATUM	Depth (m)	Area* sq. n. mi	1991 Spring	1991 Autumn	1992 Spring	1992 Autumn	1993 Spring	1993 Summer	1993 Autumn	1994 Spring	1994 Autumn	1995 Spring	1995 Autumn	1996 Spring
329	093-183	1721	0.08	0.00	0.00	0.00	0.00	0.00	0.00	4.70	0.00	0.07	0.98	0.00
332	093-183	1047	0.13	0.00	0.24	14.12	0.00	0.00	0.97	0.00	14.90	129.68	31.46	11.90
333	185-274	151(147)	84.18	16.75	303.73	125.93	1195.53	0.00	29.15	3859.26	216.43	83.51	107.01	120.42
334	275-366	92(96)	95.99	1168.88	32.75	420.61	234.80	0.00	348.03	152.82	175.26	30.98	506.80	219.97
335	275-366	58	2.77	393.74	59.00	755.40	134.54	3845.49	301.02	1260.90	806.07	184.85	187.70	2445.79
336	185-274	121	6.68	6.00	60.30	284.58	557.00	134.57	291.29	699.95	204.57	5194.17	49.73	161.82
337	093-183	948	4.44	37.95	1.77	38.30	0.95	0.00	7.77	0.00	4.30	198.92	55.45	0.05
339	093-183	585	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
354	093-183	474	0.00	0.00	0.00	214.50	221.80	149.61	0.00	0.00	0.00	0.00	785.26	0.01
355	185-274	103	0.64	70.30	0.36	193.90	851.25	55.10	39.13	392.48	392.40	99.88	237.04	4916.31
356	275-366	61	9.90	40.15	104.43	673.55	494.82	2287.02	47.70	120.13	231.30	333.29	387.60	515.78
717	367-549	93(166)	597.91	---	87.75	---	110.03	0.00	1539.17	489.23	400.90	113.34	588.78	191.18
718	550-731	111(134)	49.39	---	8.30	---	101.90	0.00	203.82	208.85	---	7.65	409.37	27.15
719	367-549	76	27.68	318.02	11.85	---	192.85	1815.75	993.30	887.30	555.71	79.65	413.97	79.53
720	550-731	105	12.44	---	68.18	---	10.18	35.87	57.63	19.12	146.35	17.10	16.48	129.06
721	367-549	76	21.65	55.13	49.03	---	143.25	1247.77	106.00	25.40	18.95	1114.63	1666.67	68.23
722	550-731	93	149.13	8.80	13.37	---	39.94	56.22	202.57	159.32	28.90	6.20	125.80	25.38
Upper			120.04	274.18	79.25	163.42	243.40	1008.21	127.90	779.24	111.33	284.29	971.94	1209.99
Mean			18.20	37.19	15.22	65.24	93.50	597.47	64.02	164.87	51.46	186.74	151.87	135.27
Lower			-83.63	199.80	-48.81	-32.93	-56.38	126.72	0.13	-449.50	-8.42	89.19	-668.20	-939.44
TOTAL BIOMASS (metric tons)			8082	15649	6759	26256	41518	52338	28423	74391	22700	84261	125579	111854

*NOTE: In brackets are revised areas based on a redrawn stratification scheme implemented in 1994.

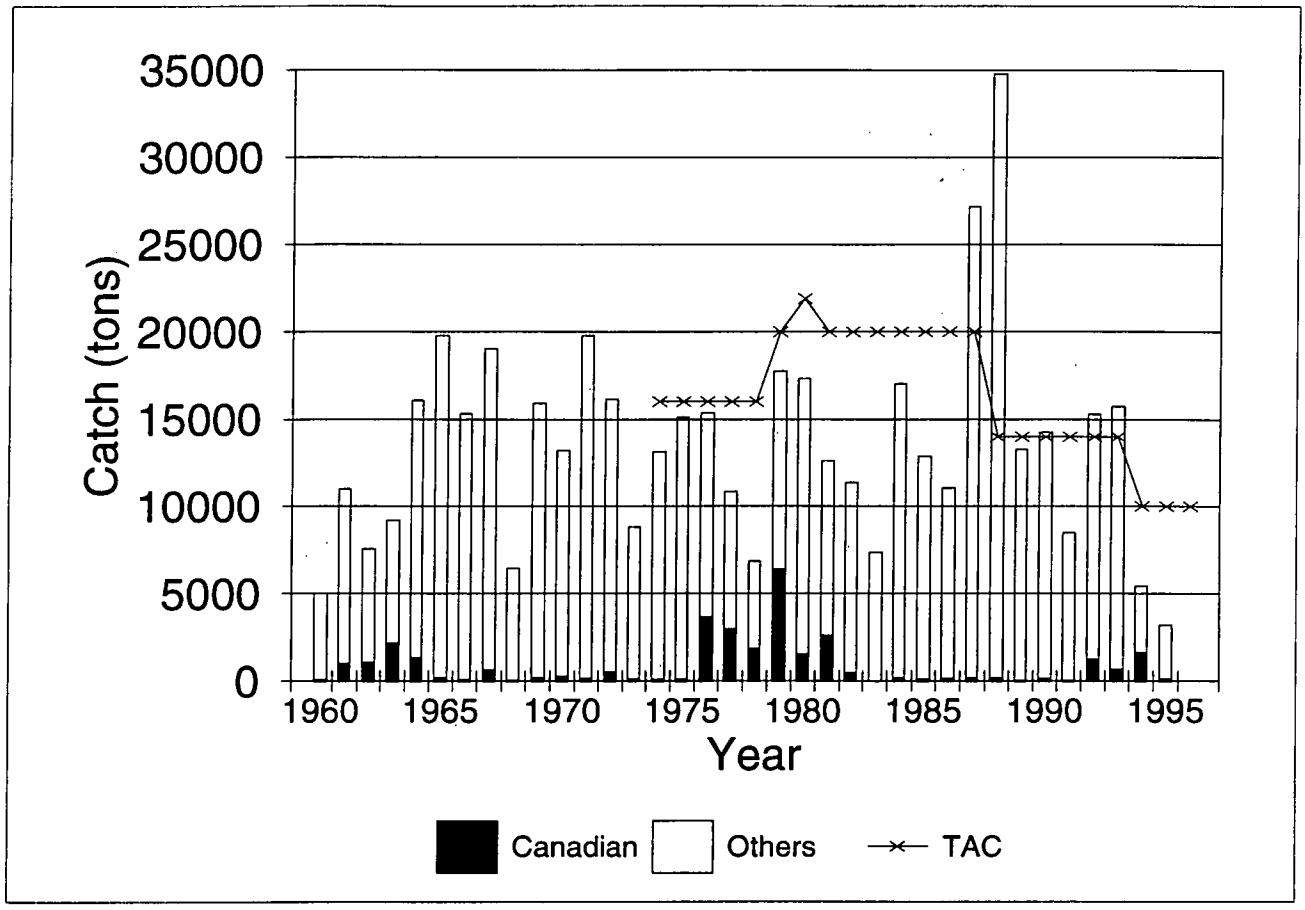


Fig. 1. Nominal catches and TACs of Division 3O redfish

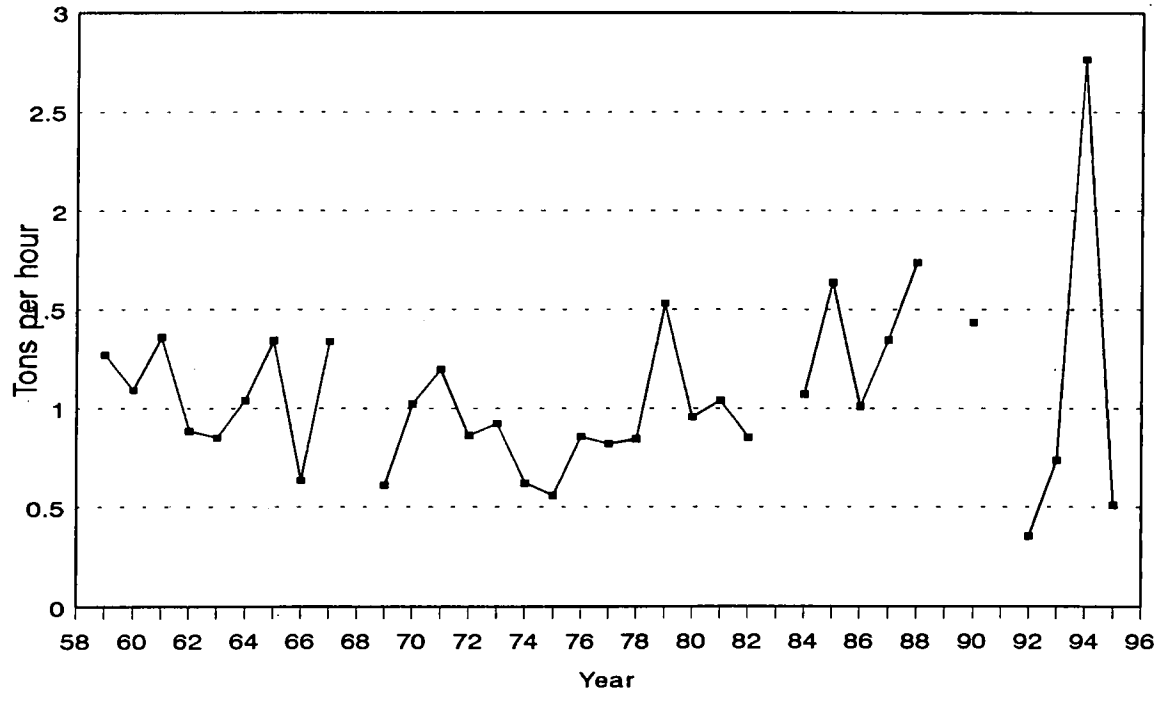


Fig. 2a. Standardized CPUE for redfish Div. 3O for Canada fishing inside the EEZ based on hours fished.

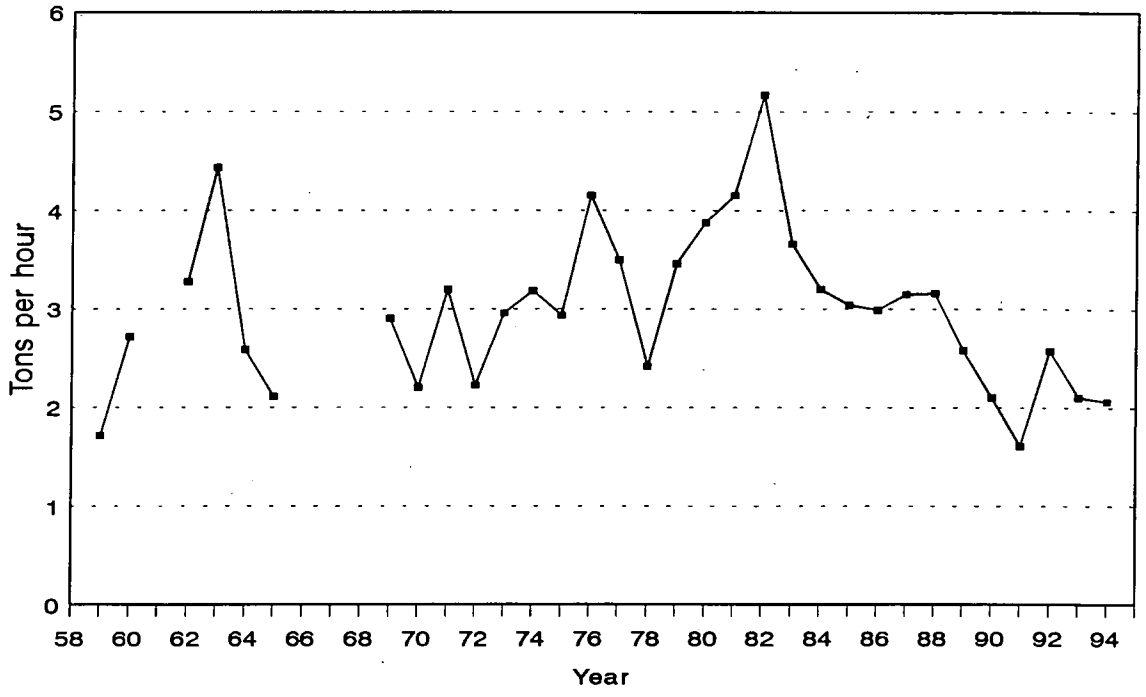


Fig. 2b. Standardized CPUE for redfish Div. 3O for countries that fished inside and outside the EEZ (Russia and Cuba) based on hours fished.

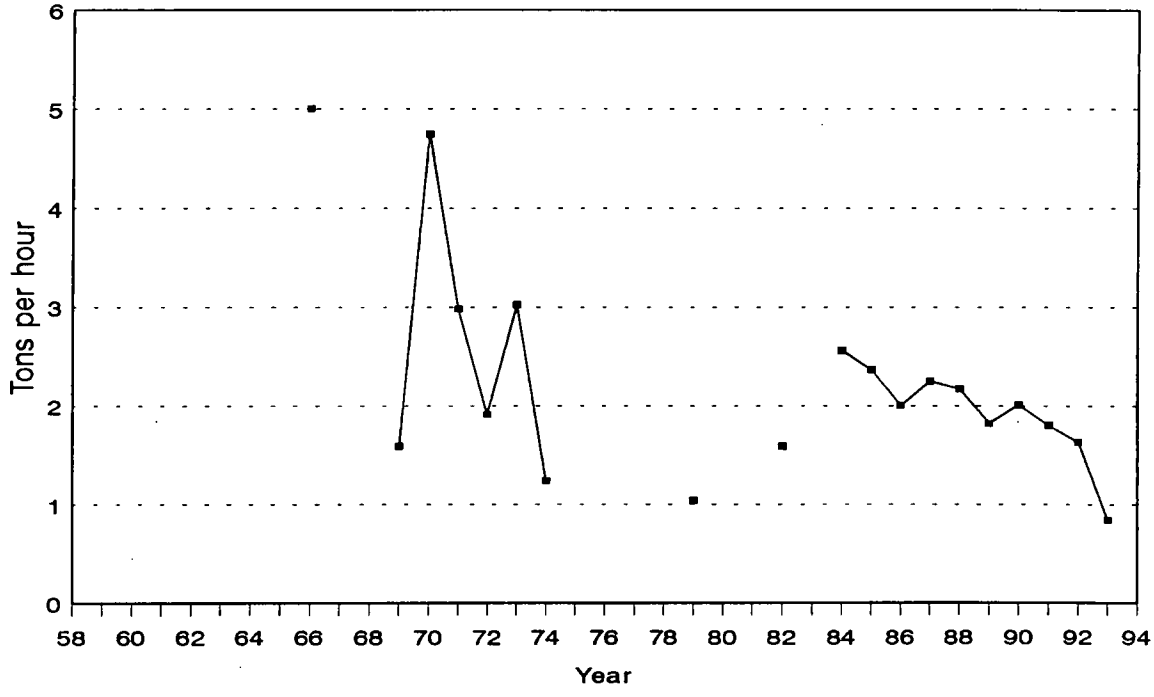
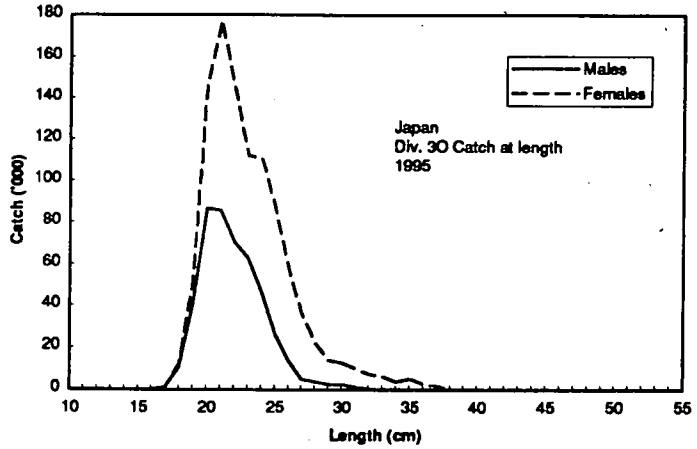
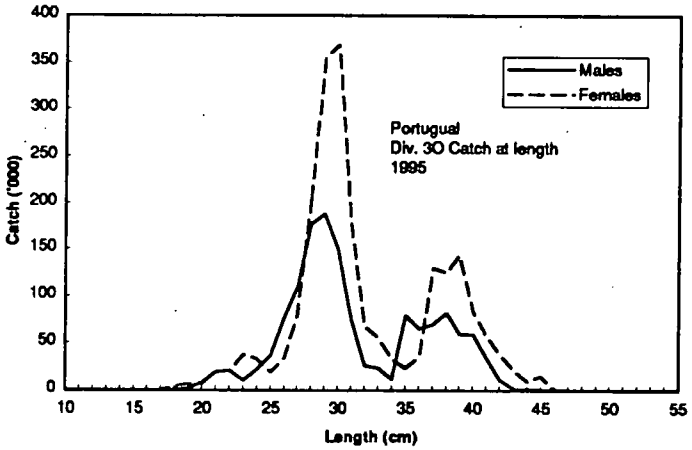
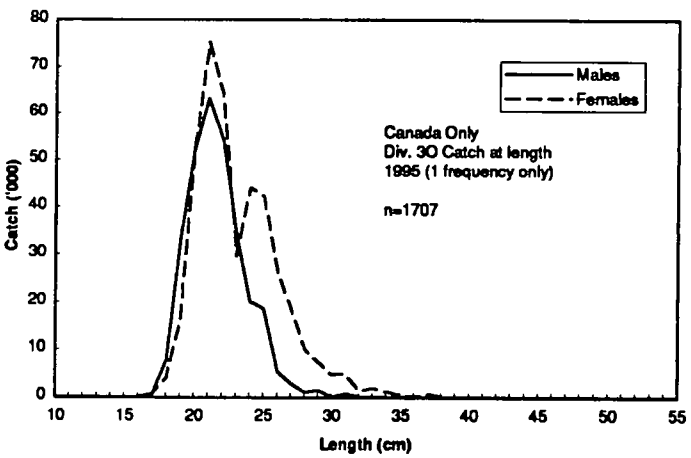


Fig. 2c. Standardized CPUE for redfish Div. 3O for countries that fished outside the EEZ based on hours fished.







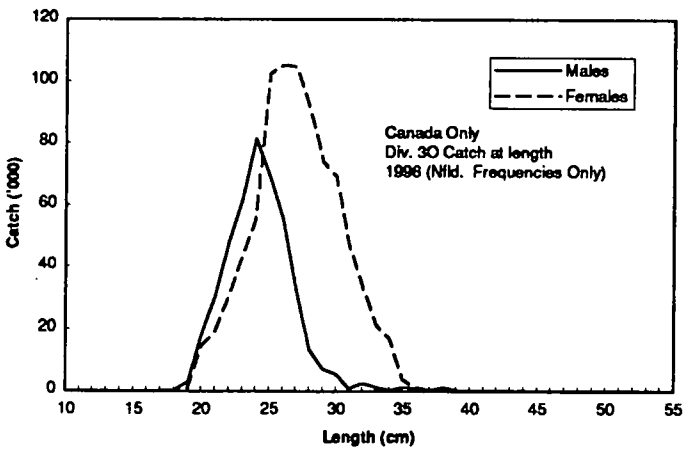


Figure 3 : Estimated commercial catch-at-length of Div. 3O redfish.

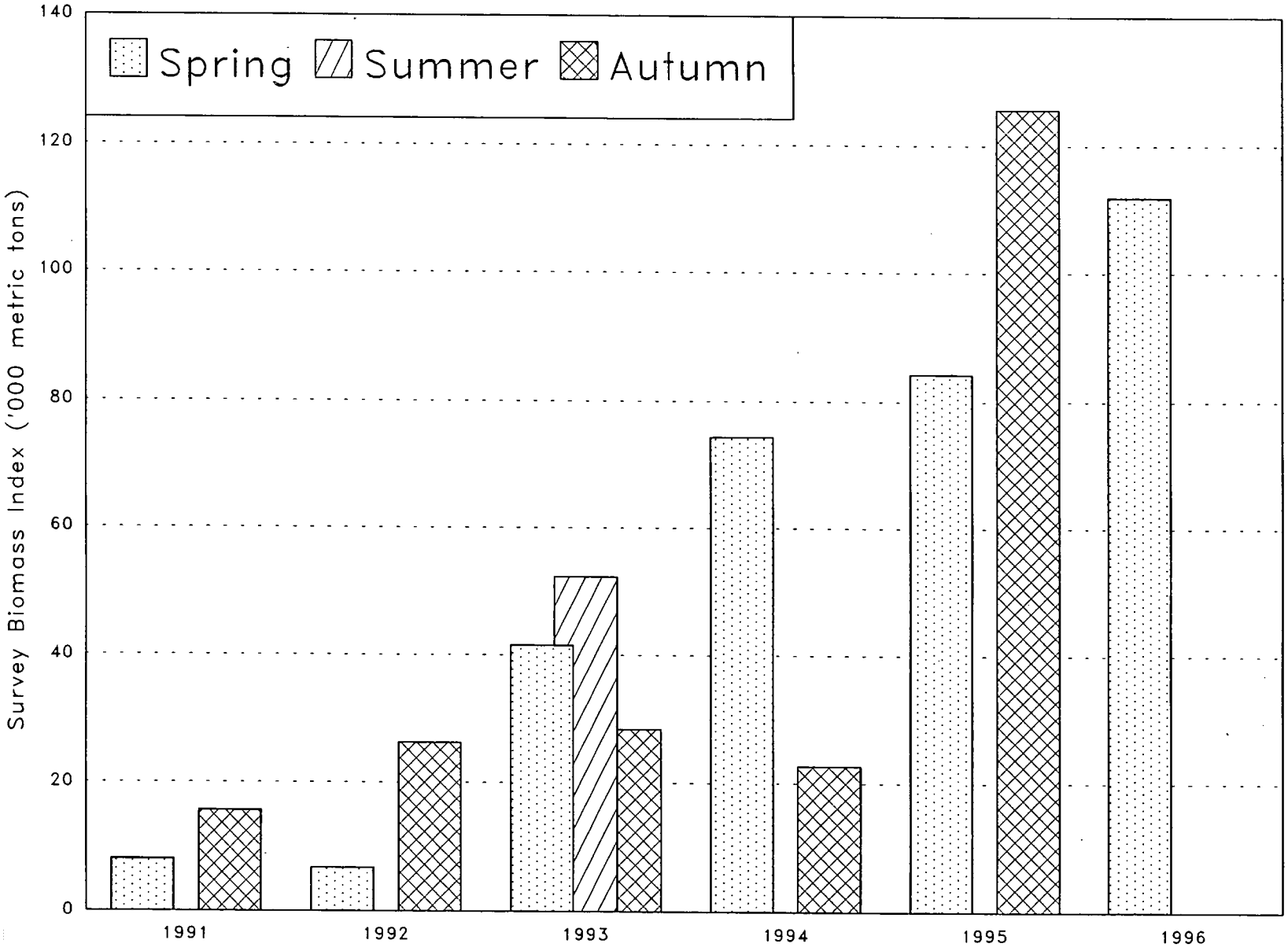


Fig. 4. Research survey biomass index for Div. 30 redfish from 1991–1996. (1991–1995 Spring surveys used Engel 145 trawl; 1995 Autumn –1996 survey used Campelen 1800 trawl (see text for details).

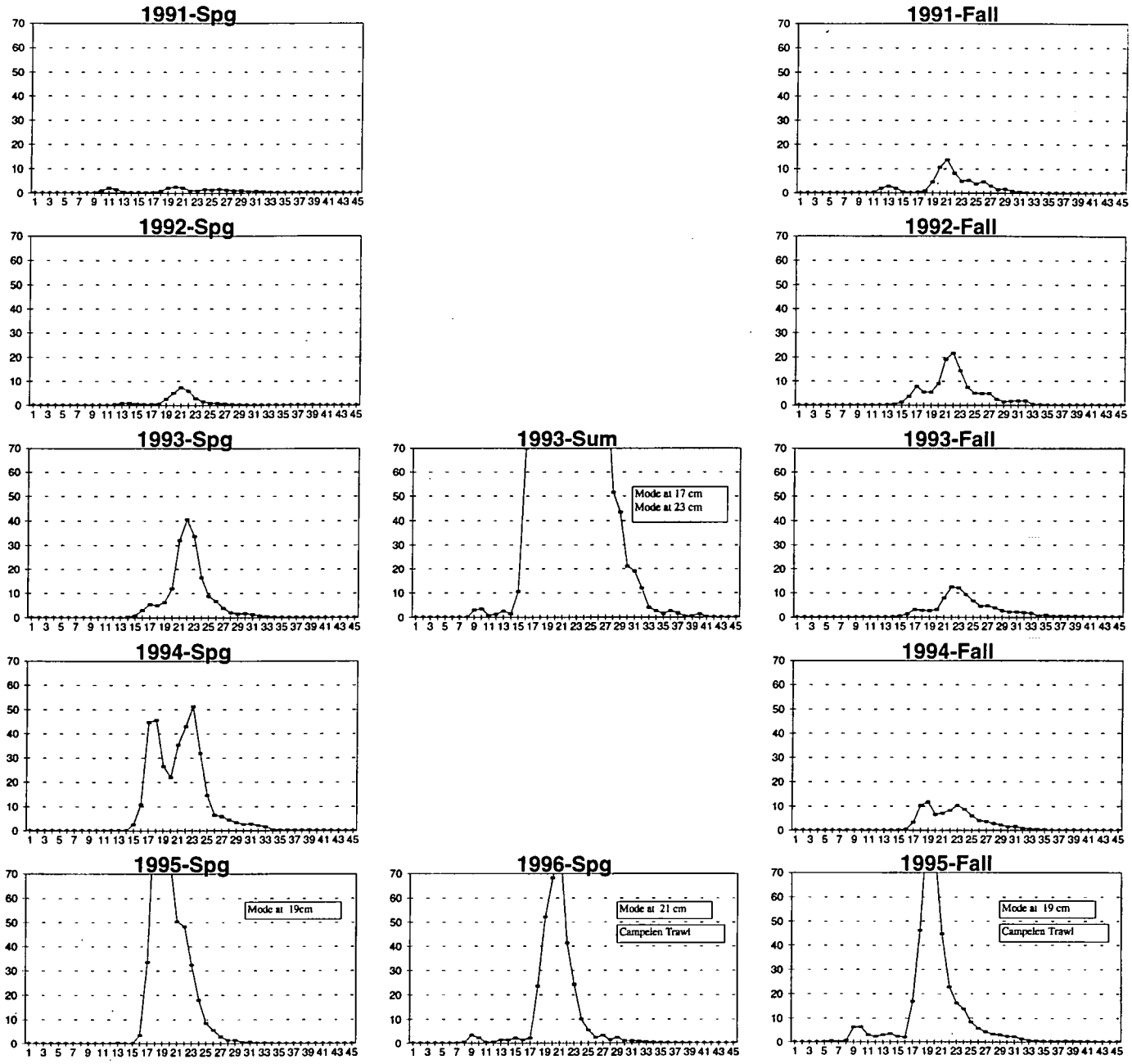


Fig. 5. Length frequencies from stratified-random research to Div. 3O for 1991-1996. Plotted are mean number per standard tow. X-axis unit is centimetres. The 1991-1995 Spring survey was conducted with an Engels 145 trawl (1.75 n. mi. tow). The 1995 Fall surveys and onward were conducted with a Campelen trawl (0.75 n. mi. tow).