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Canadian Stock Assessment Secretariat
Research Document 98/110
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Secrétariat canadien pour líévaluation des stocks
Document de recherche 98/110
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Update on the status of Redfish in 3O

by

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ISSN 1480-4883
Ottawa, 1998

Canada

ABSTRACT

Nominal catches have ranged between 3,000 t and 35,000 t since 1960. Up to 1986 catches averaged 13,000 t, increased to 35,000 t by 1988 and declined subsequently to 3,000 t in 1995 due to reductions in foreign allocations. Foreign fleets historically accounted for most of catch but Canada has increased its activity in the area since 1995 accounting catches of about 7,000 t catch in 1996 and 1998. Standardized commercial catch rate indices are not considered reflective of stock abundance for Canadian fleets inside the 200 mile limit. It is difficult to reconcile year to year changes in seasonal RV survey, but generally, the spring survey biomass index suggests the stock may have increased since the early 1990s, but has stabilized at around 100,000 t since 1994. The autumn RV survey, while more stable in the early 1990s, generally supports this. RV surveys do not adequately size greater than 25 cm which up to 1997 have generally comprised the main portion the fishery which makes it is difficult to interpret survey estimates in relation to what is happening to the stock as a whole. The fishery in 1998 appeared to target the relatively strong 1988 year class that has grown sufficiently to exceed the small fish protocol of 22 cm. There is concern that there has been little sign in recent surveys of size groups smaller than 17 cm despite using a shrimp trawl which is very effective at catching small fish.

RÉSUMÉ

Les prises nominales ont varié entre 3 000 et 35 000 t depuis 1960. Elles se sont élevées en moyenne à 13 000 t jusqu'en 1986, ont atteint 35 000 t en 1988 et ont ensuite décliné à 3 000 t en 1995 suite à la réduction des allocations aux pêcheurs étrangers. Historiquement, les flottilles étrangères étaient responsables de la plupart des prises, mais le Canada a accru ses activités dans cette zone depuis 1995, ses prises atteignant 7 000 t environ en 1996 et 1998. Les indices des taux de capture commerciaux normalisés ne sont pas jugés être représentatifs de l'abondance du stock exploité par les flottilles canadiennes à l'intérieur de la limite de la zone des 200 milles. Il est difficile de faire concorder les variations interannuelles des relevés saisonniers par navire de recherche mais, de façon générale, l'indice de biomasse du relevé de printemps porte à croire à une augmentation du stock depuis le début des années 1990 qui a été suivie d'une stabilisation, à 100 000 t environ, à partir de 1994. Le relevé d'automne par navire de recherche qui est plus stable pour le début des années 1990, appuie généralement cette notion. Les relevés par navire de recherche ne permettent pas de déterminer adéquatement les tailles de plus de 25 cm qui, jusqu'en 1997, étaient celles des poissons constituant la plus grande partie de la pêche, ce qui rend donc difficile d'interpréter les estimations des relevés dans le contexte de ce qui advient au stock dans son entier. Il semble que la pêche de 1998 ait porté sur la classe d'âge relativement importante de 1988 dont les poissons avaient suffisamment grossi pour dépasser la limite de 22 cm fixée pour protéger les poissons de petite taille. On s'inquiète du fait que les derniers relevés n'ont permis de déceler que peu de poissons des groupes inférieurs à 17 cm, cela en dépit de l'utilisation d'un chalut à crevettes très efficace pour la capture des petits poissons.

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 1998. 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 1998 TAC (10,000 t) is divided into a Canadian quota (8,500 t), and a French quota (1,500 t). About 10% of the stock area lies outside Canada's 200 mile Exclusive Economic Zone (EEZ).

Nominal Catches

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, increased gradually to about 16,000 t in 1993 and decline subsequently to about 3,000 t in 1995, partly due to reductions in foreign allocations since 1993. In 1996, catch increased sharply to about 10,000 t due to increased Canadian activity and dropped to 5,000 t in 1997. Up to the end of the third quarter in 1998, total catch was at 9,300 t.

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. A further explanation of these is given in Shelton and Atkinson (1994). There hasn't been any activity in the area outside the 200 mile EEZ by non-NAFO fleets since 1994.

Russia predominated in this fishery up until 1993 (Table 2) and generally caught its share (about 50%) of the total non-Canadian allocation, which accounted for about 2/3 of the TAC. From 1985 to 1993 Russian catches ranged from 3,800 t to 7,200 t. Russia and Cuba, impacted by the reduction and eventual elimination of foreign allocations by Canada, have not fished since 1995 and 1993 respectively. Catches by Portugal, which began fishing in the limited stock area outside the EEZ in 1992, peaked at 4,700 t in 1995 and declined to 900 t by 1997.

Canada, which has had limited interest in a fishery in Div. 3O because of small sizes of redfish encountered in trawlable areas, landed less than 200 t annually from 1983-1991. In 1994, Canada took 1,600 t due to improved markets related to lobster bait, but declined to about 200 t in 1995. The Canadian catch increased to about 7,200 t in 1996 as a result of a successful undertaking by a number of enterprises to discover areas of prime market fish (>28 cm). The 1997 catch declined to 2,200 tons because of poor markets. Up to the end of October 1998 the Canadian catch was at 7,300 t.

The fishery has occurred primarily in the second and third quarters of the year since 1985 (Table 3a). The prominent means of capture from the mid-1970s to the early 1980s was the bottom

otter trawl (Table 3b). The use of midwater trawls from 1985 to 1993 was primarily by Russia and Cuba. The Canadian and Portuguese fleets primarily uses bottom trawling.

COMMERCIAL DATA

CPUE Index of Abundance

In past assessments a standardized commercial catch rate index based on data since 1959 had been developed routinely for evaluation. The analysis of catch rates by the Canadian fleet are not considered indicative of overall trends in the resource. Until recently, Canada has not accounted for a major portion of the reported catches from Division 3O and has only fished within the 200 mile EEZ. Large interannual variability in the catch rates and recent changes in the composition of the domestic fleets participating in this fishery makes it difficult to draw inferences about stock status.

The annual update to the databases did not provide any further information on catch rate of foreign countries than was available for the 1995 assessment. The trend in two foreign fleet catch rate series are similar (Power et. al. 1995) and indicate a general decline from the early to mid 1980s to about 1994. It is considered that 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 that effort had occurred.

Catch at Length

Length distributions sampled from 1995-1996 fisheries from Canadian port sampling and observer data, and sampled from Portuguese fisheries in 1995 (Godhino et al., 1996) and 1996 (Alpoim et. al., 1997) by Portuguese observers were weighted by monthly landings to derive a catch-at-length by country for Div. 3O. Revisions to these distributions and samples from the 1997 fishery were unable to be completed in time for the November 1998 assessment, therefore the catch-at-length plots are identical to those presented in last years assessment. The length-weight relationships used were:

$$\text{WT (males)} = 0.01659\ \text{Forklength}^{2.9548}$$
$$\text{WT (females)} = 0.013272\ \text{Forklength}^{3.0210}$$

The data (Fig. 2) 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. The 1996 Canadian samples indicated a preponderance of fish greater than 22 cm with a mode at about 25 cm. The 1996 Portuguese samples showed a much broader range of lengths from about 25 cm to 42 cm with modes at 30 cm and 38 cm. The only information available at the assessment on size distribution for 1998 was for the FPI fleet (B. Smith, Fishery Products International, pers. comm.) which indicated that about 54% of the FPI catch occurred between 22-25 cm, 29% between 26-30 cm and the remainder equally split between 18-22 cm and over 31 cm categories.

RESEARCH SURVEY DATA

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).

Multispecies comparative fishing trials were carried out in 1995 and 1996 for the purpose of deriving conversion factors between an Engel 145 survey trawl and a recently adopted *Campelen 1800* shrimp trawl by the Science Branch of the Department of Fisheries and Oceans (DFO) Newfoundland region. The Engel survey gear with bobbin footgear had been the standard survey gear since on the FRV Gadus Atlantica from 1977-1994 primarily in Div. 2J3K and on the CCGS *Wilfred Templeman* from 1982 to 1995 primarily in Div. 3LNOP. The trials were necessary to provide a means to maintain continuity with the previous time series.

There was also a change in vessel in the Div. 2J3K series with the change in survey gear to the Campelen 1800 with rockhopper footgear. Two sets of trials were conducted, one between the *Wilfred Templeman* using the new survey gear and its sister ship CCGS *Alfred Needler* using the previous survey gear and the second between the *CCGS* Teleost (new vessel, new survey gear) and the Gadus *Atlantica* (previous vessel, previous survey gear). Details of the fishing trials for both sets of trials and a formulation of the experimental design and the length-based data modeling are outlined in Warren (1996 and 1997). Six target species were investigated (including redfish) because of their commercial significance and management requirements.

For the applicable surveys in Div. 3O between 1991 and 1995, redfish length frequencies for each fishing set were first adjusted to a standardized for distance the net was towed and were then converted from Engel trawl catches to Campelen 1800 trawl catch equivalents. Conversion factors as presented in Warren et al. (1996 and 1997) for redfish were applied using weighted least squares as follows:

Wilfred Templeman conversion from Engel to Campelen:

A segmented model was used Warren (1997). The converted numbers at length $y_x = R_x * n_x$, where

R = ratio of Campelen numbers caught to Engels number caught at length X (in 1 cm length classes)
n = number at length in the Engel fishing set

and,
For X=X(0)=28, R=0.767082
For X<X(0) the Model used was : log R=a +b [X - X(0)log(X)]
For X>X(0) the Model used was: log R=a +bX(0) [1 - log(X(0))]

where a = 27.898086, b = 0.431279

Ratios for X<14 were fixed at X=14 because it was considered that the model was estimating beyond the range of the data.

For the Gadus Atlantica conversion from Engel to Campelen:

Warren (1997) describes the model as converted numbers at length $y_x = R_x * n_x$, where

R=ratio of Campelen numbers caught to Engels number caught at length X (in 1 cm length classes)
n = number at length in the Engels fishing set

where

Model used: $\log R = 6.7580137 + 0.006839 * X - 1.927210 \log (X)$

Ratios for X<10 were fixed at X=10 because it was again considered that the model was estimating beyond the range of the data.

Weights were applied in the modeling as the number of fishing sets used to estimate the ratio for a given length class.

The Engel length frequencies were converted to a Campelen trawl catch equivalent with the appropriate model, a sampling ratio was applied if necessary to each length group and then summed to provide total numbers of redfish caught per standard Campelen set (0.8 nautical mile tow distance in 15 minutes with a wing spread of 16.84 m). These numbers were used to calculate a set weight using the following standard length-weight relationship:

$$WT \quad (males) = 0.016590 \, Forklength^{2.9548}$$
$$WT \ (females) = 0.013272 \, Forklength^{3.0210}$$

This dataset was then used to generate mean number and weight (kg) per set by stratum and year for converted data. No adjustments have been made for differences in revisions to the stratum areas, however, changes are only minimal for this management area.

In general the conversion factors derived for each comparative fishing trial reflect the increased catchability for smaller redfish (≤ 20 cm). For the Teleost/Gadus trials, the model estimated a ratio of fish caught by the Campelen to the Engel at about 1.0 for 38 cm fish and increased gradually to about 2 as the length approached 25 cm. Ratios increased rapidly for fish length less than 25 cm, and the ratios for lengths less than 10 cm were fixed to the ratio at length 10 cm because there were few data for the smaller fish.

For the Wilfred Templeman/Alfred Needler trials, the segmented model estimated a ratio of fish caught by the Campelen to the Engel at about 1.0 for 23 cm fish and increased gradually to about a ratio of 7 as the length approached 14 cm. The model estimates of ratios increase rapidly for length less than 14 cm in which there were very few data. For lengths >23 cm the ratios decrease to about 0.77 for fish at length 50 cm. The ratio for lengths less than 14 cm was fixed at the 14 cm value because of the lack of data fitted in this region.

For illustration, a comparison of the stratified mean number per tow at length between the converted and unconverted data sets in Div. 3O is presented in Fig. 3. The result in all years was to magnify the estimates for fish less than 19 cm. There are also clear differences in the results of

Teleost/Gadus Atlantica trials versus the Wilfred Templeman/Alfred Needler trials. This can be seen in comparisons of the 1993 summer with the Gadus Atlantica and the 1993 autumn survey with the Wilfred Templeman.

The series of mean weight per standard tow for spring (Table 4) and autumn (Table 5) exhibits large fluctuations in estimates between seasons and years for some strata, not uncommon for bottom trawl surveys for redfish. This is usually accounted for by the influence of one or two large sets on the survey. It is difficult to reconcile year to year changes in the indices, but generally, the revised spring survey biomass index (Fig. 4) suggests the stock may have increased since the early 1990s, but has stabilized at around 100,000 t since 1994. The low 1997 value is considered a sampling anomaly. The autumn survey, while more stable in the early 1990s, generally supports this pattern. In most 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 from the spring surveys (Fig. 5) indicate a bimodal distribution in 1991 with modes at 11 cm and 20 cm corresponding to about the 1988 and 1984 year classes respectively. The 20 cm mode progresses at about a cm per year up to 1994 (at 23 cm) and cannot be traced any further. The 11 cm mode is not pronounced until it reaches 17-18 cm in 1994, after which it progresses by about 2 cm per year to 1996 (at 21 cm). The 1998 distribution also shows a predominant mode at 21 cm. Size distribution from the autumn surveys indicate a bimodal distribution in 1991, similar to the spring survey, with modes at 13 cm and 21 cm. The 21 cm mode only progresses to 23 cm by 1994 after which it is no longer discernible. The 13 cm mode progresses to a 17 cm mode in 1992 but only increments to 19 cm by the 1995 survey after which it progresses to 21 cm in the 1996 survey and thereafter to 22 cm in the 1998 survey.

The 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 from 1991-1998 which cover strata down to 732 m (400 fathoms). It is well documented that the Engel survey gear (e.g. Power MS 1995) and the Campelen survey gear (e.g. Power et al. MS 1998) can catch both smaller (than 10 cm) and larger (than 25 cm) redfish. Length sampling from the commercial fisheries in the mid-1990s reveals a higher proportion of fish greater than 25 cm compared to the survey catches. Therefore, it appears that fish sizes outside this range, especially fish greater than 25 cm, 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.

BIOLOGICAL CHARACTERISTICS

Size at Maturity Ogives

Maturity data for redfish were available from two sources: (1) set by set samples taken for length distribution, sex and maturity (LSM) during spring and autumn DFO research surveys to Div. 3O from 1996 to spring 1998, and, (2) otolith samples taken for age (A&G) determination during DFO research surveys to Div. 3O from 1972 to 1995. A logistic model with a logit link function and binomial error was fit to the data to estimate the length (cm) at 50% maturity (L_{50}). Estimation of parameters was conducted using the Probit procedure of SAS (SAS, 1989). Fish were classified as mature or immature based on a visual examination of the fresh gonad at sea. Determination of

maturity stage was consistent with that described by Ni and Templeman (1985). Data sources (1) and (2) were analyzed separately but within each data source, the data were combined for all years and surveys. There was no attempt to distinguish between *Sebastes fasciatus* and *S. mentella*. Sample sizes are given in the table below:

Data Source	Females	Males
A&G	6931	6033
LSM	12722	14605

The ogives derived for the LSM and A&G data were quite different, especially for males (Fig. 7). The estimation of L_{50} plus 95% fiducial limits was higher in the A&G data by at least 1 cm for males (20.12 ± .22 cm versus 21.36 ± .38 cm). The fitted curve for the LSM data for males does not show the typically sigmoid shape where the probability of maturity rises very quickly over a narrow length range. Estimation of L_{50} for females was 28.08 ± .13 cm for the A&G data and 28.25 ± .22 cm for the LSM data. The A&G data covers sampling each year back to 1972, which reflect a more historical perspective of size at maturity. A further investigation is warranted to see if there is a trend in size at maturity over time and to try to determine why an almost linear effect is predicted for the LSM male data. In any case, averaging between the two estimated values results in an L_{50} of 21.5 cm for males and 27.5 cm for females. Ni and Sandeman (1984) reported L_{50} values for *S. mentella* and/or *S. fasciatus* of 18.23 cm for males and 27.73 cm for females in Div. 3O. This was based on data collected between 1957 and 1969. It appears, based on the current data, that size at maturity for males has changed within areas of Div. 3O.

Industry Perspectives

The increased activity in 1996 for some Canadian enterprises was motivated by a need to find fish of marketable size in light of the moratorium in Unit 1 and a reduction of the Unit 2 TAC. The experience of this fishery was different from other Canadian fisheries but there was reasonable success in finding good concentrations of acceptable size fish, primarily from October to December. The knowledge from the Russian fishing experience in the area available to some Canadian enterprises suggests that water temperature influences fishing success. Catches and catch rates were considered relatively high in 1996, low in 1997 and high again in 1998. It was explained that changes were largely market driven and there were problems with small fish in 1997. The general intent of some fleets is to concentrate their fishing where they are confident of finding fish of sizes appropriate for market and sometimes take smaller fish to finish up a trip. In the 1998 fishery, there were reports of much fish in the landings close to the 22 cm small fish protocol. The targeting of fish sizes greater than 30 cm results in substantial reduction of catch rates. Although this fishery is still considered to be in the learning stage, the acceptability of fish near the small fish protocol will likely result in a targeting of effort for these sizes as catch rates are more cost effective.

PROGNOSIS

Before 1998, the surveys were considered to have been monitoring pre-recruits to the fishery and tracked a relatively strong year class which in recent years has caused problems for industry in

complying with the small fish protocol. This year class has now reached a size where it contributed to the 1998 commercial catches. It is anticipated that the Canadian fishery will target this year class in the future. There is concern, however, about the poor sign of subsequent recruitment less than 17 cm.

It is difficult to know for certain the fate of fish larger than 25 cm in Div. 3O as measured by the surveys. However, based on the size distributions from commercial fishery, particularly the deepwater Portuguese fisheries in the mid-1990s, it is assumed that those year classes that grow beyond the range measured by the survey remain in Div. 3O. Their catchability may be limited because of the amount of untrawlable bottom on the slope edge.

It is still not possible to provide an estimate of the absolute size of the total stock, the fishable portion of the stock, to estimate current fishing mortality rate nor describe overall trends in total stock size. Although variable, recent surveys indicate the current exploitable biomass to be about 100,000 t. Thus, catches of about 10,000 t are not likely to generate fishing mortality in excess of $F_{0.1}$.

An updated data analysis size at maturity suggests the size at which half the females are sexually mature (L_{50}) is about 28 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 (about 200 fathoms)).

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

Year	Canada	Others	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	698	15,022	15,720	14,000
1994 [a]	1,624	3,804	5,428	10,000
1995 [a]	177	3,037	3,214	10,000
1996 [a]	7,255	2,590	9,845	10,000
1997 [a]	2,229	2,559	4,788	10,000
1998 [b]	7,294	2,048	9,342	10,000
1999				

[a] Provisional

[b] Provisional to Oct. 28, 1998 (based on Canadian Atlantic Quota Reports and NAFO data)

Table 2. Nominal catches (t) of redfish in Div. 3O by country since 1985 (1994-1998 are provisional, 1998 to Oct. 28).

Country	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994a	1995a	1996a	1997a	1998a
Canada (M)	48	5	24	5	18	27	4	27	21	779	4	2124	669	2579
Canada (N)	56	136	159	176	9	128	24	1192	677	845	173	5131	1560	4715
France (SPM)	-	-	-	-	-	-	-	-	-	-	-	-	134	265
Japan	661	1162	1074	1606	1724	1406	226	125	159	-	264	417	285	355
Portugal	-	-	-	22	12	83	3	1468	4794	2918	1935	1635	894	-
Spain	630	45	26	4	-	4	-	-	-	26	22	338	1246	-
Russia	5905	6099	7152	4921	4517	3811	4427	5845	6887	60	416	-	-	-
Cuba	806	3006	2859	2753	2138	2750	2748	2776	665	-	-	-	-	-
USA	104	2	-	-	-	-	-	-	-	-	-	-	-	-
Korea(S)	-	-	1726	1805	2638	833	129	1935	17	-	-	-	-	-
EU	-	-	-	-	-	-	-	-	-	-	-	-	-	1428
OTHER[b]	4650	600	14150	23500	2200	5200	900	1900	2500	800	400	200	-	-
Total	12860	11055	27170	34792	13256	14242	8461	15268	15720	5428	3214	9845	4788	9342
TAC	20000	20000	20000	14000	14000	14000	14000	14000	14000	10000	10000	10000	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 since 1985 (not including surveillance estimates

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
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	226	14	754	817	2089	1601	1887	2068	1809	829	630	496	13220
1994[a]	60	93	742	1609	236	83	-	68	1000	540	19	178	4628
1995[a]	7	125	145	2	45	28	56	765	645	879	107	10	2814
1996[b]	-	-	88	119	166	46	704	783	1582	2814	1524	1481	9307
1997[a]	4	-	-	9	3	212	637	623	164	499	212		2363

[a] Provisional (1997 for Canada and France (SPM) only)
[b] Provisional (Not including EU/Spain)

Table 3b. Nominal reported catches (t) of redfish in Div. 3O by gear since 1985 (not including surveillance estimates).

	Otter Trawls				
Year	Bottom	Midwater	Gillnets	Misc	Total
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	11997	1214	-	9	13220
1994[a]	3085	1498	26	19	4628
1995[a]	2221	525	26	42	2814
1996[b]	8966	334	7	-	9307
1997[a]	2350	9	2	2	2363

[a] Provisional (1997 for Canada and France (SPM) only)
[b] Not including EU/Spain

Table 4. Mean weight (kg) of redfish caught per standard tow in Division 3O during spring and summer Canadian research surveys from 1991 - 1998. ("---" indicates strata not sampled). Estimates from 1991-1995 are Campelen trawl equivalent units based on a Comparative fishing experiment with an Engels 145 bottom trawl. Estimates from 1996-1998 are the actual Campelen trawl data.

STRATUM	Depth (m)	Area* sq. n. mi	1991 Spring	1992 Spring	1993 Spring	1993 Summer	1994 Spring	1995 Spring	1996 Spring	1997 Spring	1998 Spring
329	093-183	1721	0.27 (9)	0 (8)	0 (6)	---	11.2 (5)	0.49 (5)	0.00 (6)	1.01 (6)	0.00 (7)
332	093-183	1047	0.71 (6)	0.19 (5)	0 (4)	---	0 (4)	148.49 (4)	11.90 (4)	0.28 (3)	49.05 (4)
337	093-183	948	15.97 (5)	1.52 (4)	0.92 (2)	---	0 (3)	334.99 (4)	0.05 (3)	0.09 (3)	75.90 (4)
339	093-183	585	0 (3)	0 (2)	0 (2)	---	0 (2)	0 (2)	0.00 (2)	0.00 (2)	0.00 (2)
354	093-183	474	0 (3)	0 (2)	284.6 (2)	489.09 (3)	0 (2)	0 (3)	0.01 (2)	0.00 (2)	109.43 (2)
333	185-274	151(147)	120.82 (2)	404.03 (2)	1339.7 (2)	---	5428.5 (2)	113.46 (2)	120.42 (2)	20.23 (2)	696.32 (2)
336	185-274	121	11.57 (2)	81.2 (2)	630.9 (2)	431.18 (2)	1032.9 (2)	8543.1 (2)	161.82 (2)	7.73 (2)	5068.70 (2)
355	185-274	103	2.65 (2)	2.79 (2)	972.94 (2)	162.87 (3)	608.28 (2)	178.36 (2)	4916.31 (2)	7.49 (2)	741.55 (2)
334	275-366	92(96)	103.33 (2)	36.48 (2)	202.9 (2)	--- (3)	171.11 (2)	29.37 (2)	219.97 (2)	33.87 (2)	140.25 (2)
335	275-366	58	4.27 (3)	54.34 (3)	118.28 (2)	9874.39	1210.4 (2)	263.69 (2)	2445.79 (2)	58.72 (2)	1053.90 (2)
356	275-366	61	26.61 (2)	112.96 (2)	462.44 (2)	5750.33 (4)	135.84 (2)	467.99 (2)	515.78 (2)	7.50 (2)	651.61 (2)
717	367-549	93(166)	452.43 (2)	74.25 (2)	83.19 (2)	---	395.28 (2)	91.4 (2)	191.18 (2)	534.69 (2)	143.11 (2)
719	367-549	76	33.66 (2)	12.33 (2)	149.95 (2)	4258.21 (2)	669.65 (2)	71.78 (2)	79.53 (2)	59.59 (2)	291.57 (2)
721	367-549	76	24.71 (2)	183.57 (2)	110.51 (2)	2485.73 (4)	21.98 (2)	1220.5 (2)	68.23 (2)	20.90 (2)	152.95 (2)
718	550-731	111(134)	42.2 (2)	7.53 (2)	87.7 (2)	---	155.99 (2)	7.25 (2)	27.15 (2)	14.98 (2)	35.49 (3)
720	550-731	105	11.67 (2)	57.7 (2)	9.65 (2)	50.69 (3)	15.92 (2)	14.61 (2)	129.06 (2)	21.01 (2)	14.52 (2)
722	550-731	93	118.39 (2)	12.62 (2)	33.24 (2)	75.32 (3)	126.1 (2)	6.28 (2)	25.38 (2)	12.16 (2)	136.98 (2)
Upper			100.67	104.24	277.61	2689.90	848.59	450.96	1209.99	189.48	1504.14
Mean			18.77	19.62	103.08	1498.82	208.31	283.78	135.27	18.99	192.68
Lower			-63.16	-65.00	-71.45	307.74	-431.93	116.57	-939.44	-151.50	-1118.80
TOTAL BIOMASS (metric tons)			15278	15961	83874	240612	172264	234648	111854	15721	159313

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

	Unconverted Estimates of the Engels Trawl (1.75 n. mi. tow)					
Upper	120.04	79.25	243.40	1008.21	779.24	284.29
Mean	18.20	15.22	93.50	597.47	164.87	186.74
Lower	-83.63	-48.81	-56.38	126.72	-449.50	89.19
TOTAL BIOMASS (metric tons)	8082	6759	41518	52338	74391	84261

Table 5. Mean weight (kg) of redfish caught per standard tow in Division 3O during autumn Canadian research surveys from 1991 - 1998. ("---" indicates strata not sampled). Estimates from 1991-1994 are Campelen trawl equivalent units based on a Comparative fishing experiment with an Engels 145 bottom trawl. Estimates from 1995-1998 are the actual Campelen trawl data.

STRATUM	Depth (m)	Area* sq. n. mi	1991 Autumn	1992 Autumn	1993 Autumn	1994 Autumn	1995 Autumn	1996 Autumn	1997 Autumn	1998 Autumn
329	093-183	1721	0.02 (7)	0.00 (3)	0.00 (5)	0.00 (6)	0.98 (5)	0.00 (5)	22.59 (5)	0.01 (5)
332	093-183	1047	0.00 (4)	13.29 (3)	2.69 (3)	15.59 (3)	31.46 (3)	0.17 (2)	7.73 (3)	2.67 (3)
337	093-183	948	30.80 (4)	64.65 (2)	7.00 (3)	5.04 (2)	55.45 (2)	0.00 (2)	17.93 (3)	34.60 (3)
339	093-183	585	0.00 (2)	0.00 (2)	0.00 (2)	0.00 (2)	0.00 (2)	0.00 (3)	0.00 (2)	0.00 (2)
354	093-183	474	0.00 (2)	171.47 (2)	0.00 (2)	0.00 (2)	785.26 (3)	15.58 (2)	915.00 (2)	31.50 (2)
333	185-274	151(147)	27.06 (2)	167.95 (2)	46.53 (2)	257.68 (2)	107.01 (2)	--- (2)	26.45 (2)	20.90 (2)
336	185-274	121	18.46 (2)	374.31 (2)	378.73 (2)	357.75 (2)	49.73 (2)	9.05 (2)	117.42 (2)	114.37 (2)
355	185-274	103	352.16 (2)	450.70 (2)	77.86 (2)	264.21 (2)	237.04 (2)	37.85 (2)	25.85 (2)	11.85 (2)
334	275-366	92(96)	1317.90 (2)	480.72 (2)	380.53 (3)	171.11 (2)	506.80 (2)	--- (2)	289.50 (2)	188.27 (2)
335	275-366	58	512.56 (2)	850.90 (2)	351.81 (2)	877.11 (2)	187.70 (2)	332.17 (2)	1114.40 (2)	362.06 (2)
356	275-366	61	59.40 (2)	684.61 (2)	60.08 (2)	303.84 (2)	387.60 (2)	145.49 (2)	106.10 (2)	914.53 (2)
717	367-549	93(166)	---	---	1391.30 (2)	340.35 (2)	588.78 (2)	--- (2)	2281.80 (2)	1834.04 (2)
719	367-549	76	268.90 (2)	---	930.48 (2)	536.15 (2)	413.97 (2)	656.38 (2)	880.23 (2)	321.31 (2)
721	367-549	76	53.71 (2)	---	100.37 (2)	16.57 (2)	1666.67 (2)	87.32 (2)	732.51 (2)	410.54 (2)
718	550-731	111(134)	---	---	169.30 (2)	442.14 (2)	409.37 (2)	--- (2)	37.13 (2)	4.38 (2)
720	550-731	105	---	---	50.02 (2)	118.70 (2)	16.48 (2)	572.55 (2)	---	162.58 (2)
722	550-731	93	7.67 (2)	---	164.02 (2)	22.71 (2)	125.80 (2)	103.91 (2)	3.96 (2)	108.63 (2)
Upper			306.48	147.37	105.23	108.99	971.94	86.17	1182.13	702.19
Mean			44.89	76.27	63.64	64.49	151.87	30.54	190.31	91.72
Lower			-216.70	5.17	22.05	19.99	-668.20	-25.08	-801.49	-518.57
TOTAL BIOMASS (metric tons)			34618	56247	51782	53324	125579	22974	154622	75846

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

Unconverted Estimates of the Engels Trawl (1.75 n. mi. tow)

Upper	274.18	163.42	127.90	119.76
Mean	37.19	65.24	64.02	62.91
Lower	199.80	-32.93	0.13	6.06
TOTAL BIOMASS (metric tons)	15649	26256	28423	28387

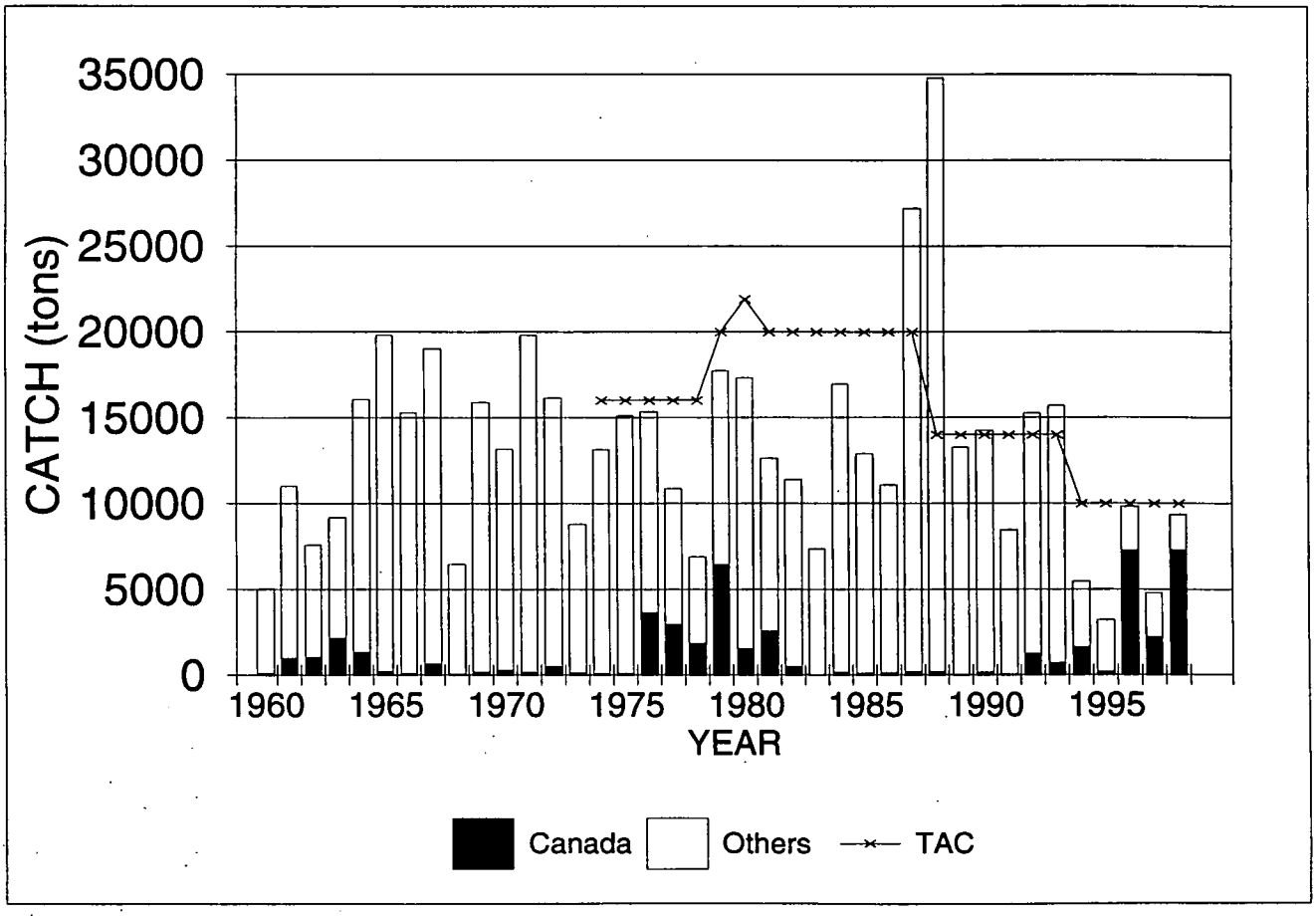


Fig. 1. Nominal catches and TACs for Division 3O redfish.

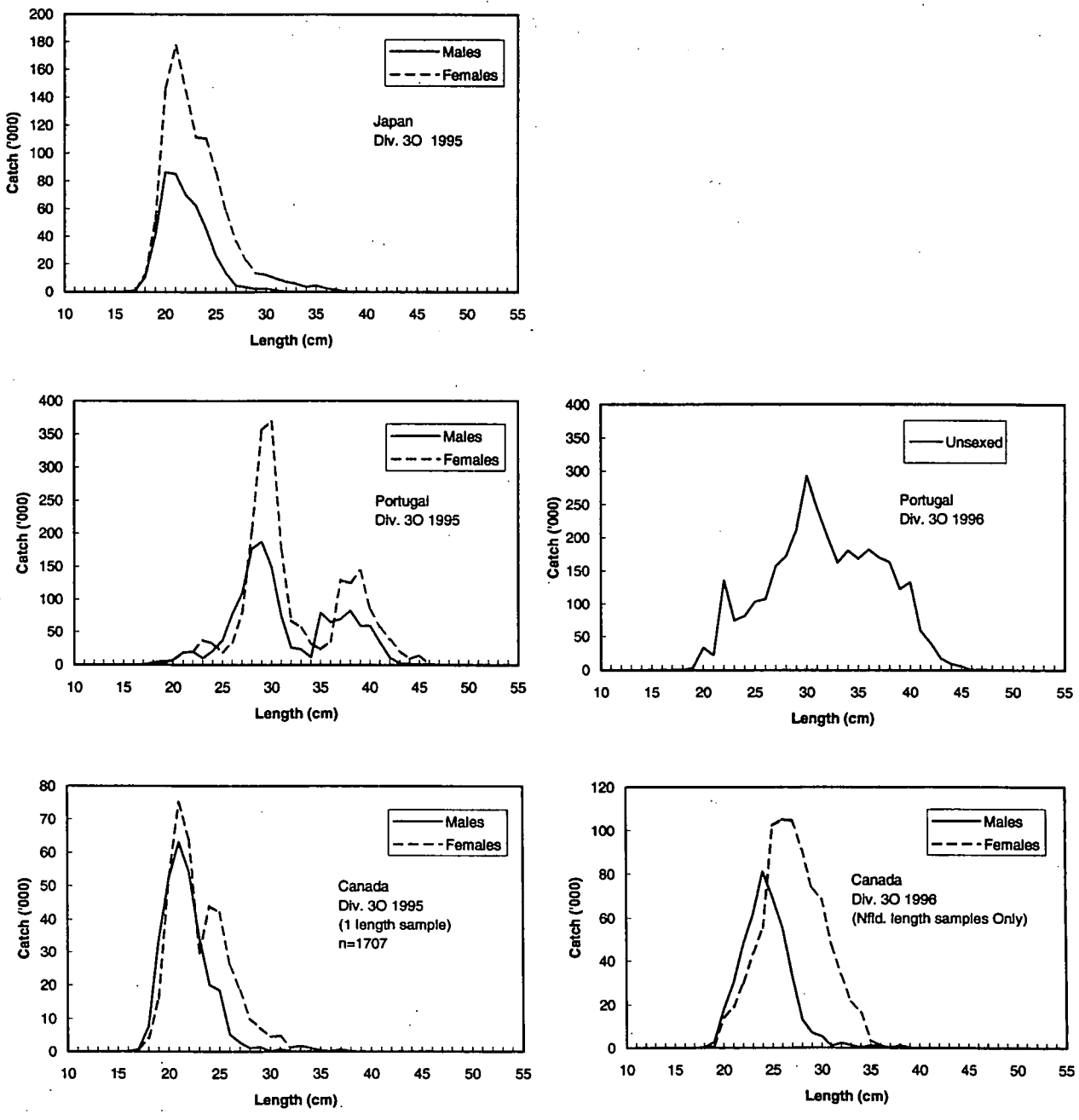


Fig. 2. Commercial catch-at-length for Div. 3O redfish estimated by available samples adjusted to landings by fleet, gear and month.

RV Survey Comparative fishing Conversions

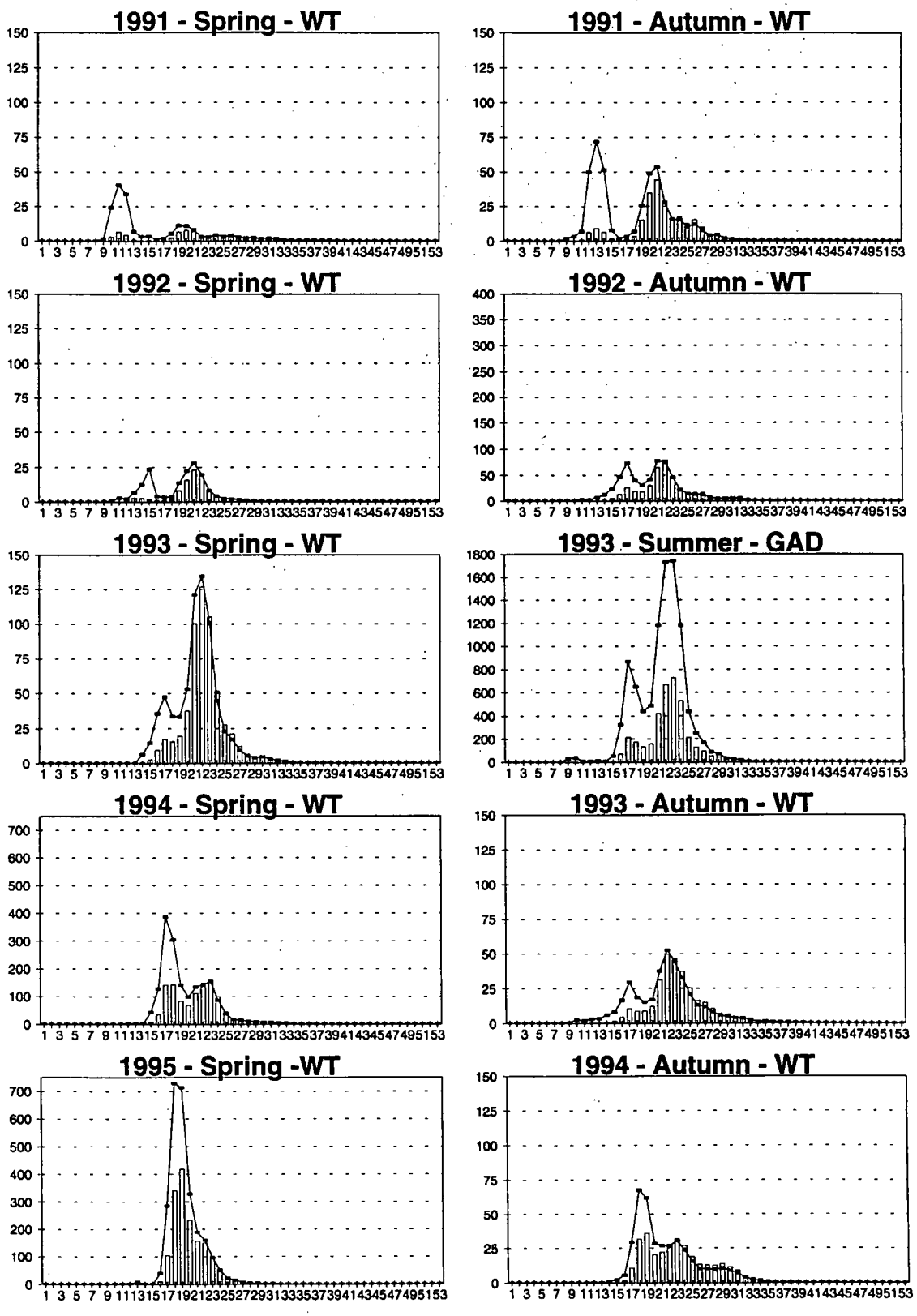
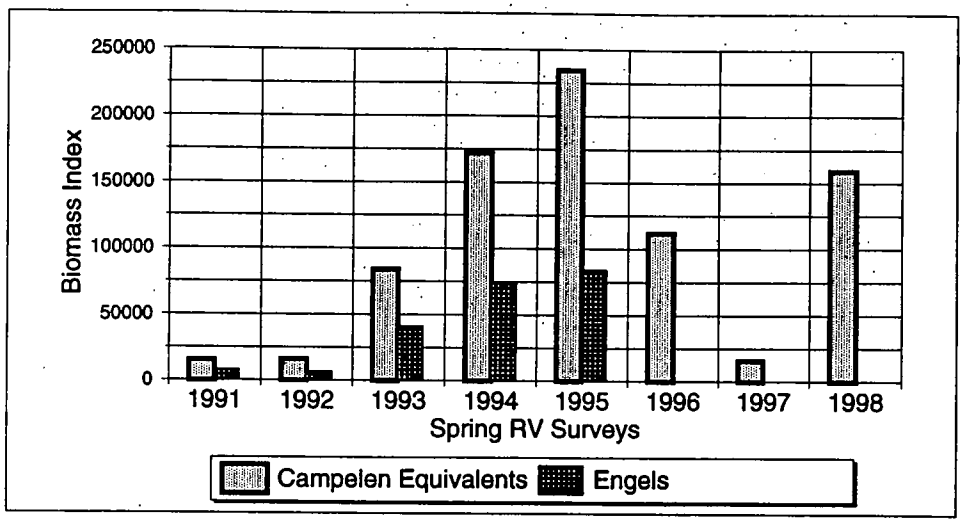


Fig. 3. Length distributions from stratified-random research surveys to Div. 3O from spring 1991 to spring 1995. Plotted are mean number per standard tow. The bar frequency represents the Engels trawl data and the line represents a conversion into Campelen equivalent units based on comparative fishing trials (see text).



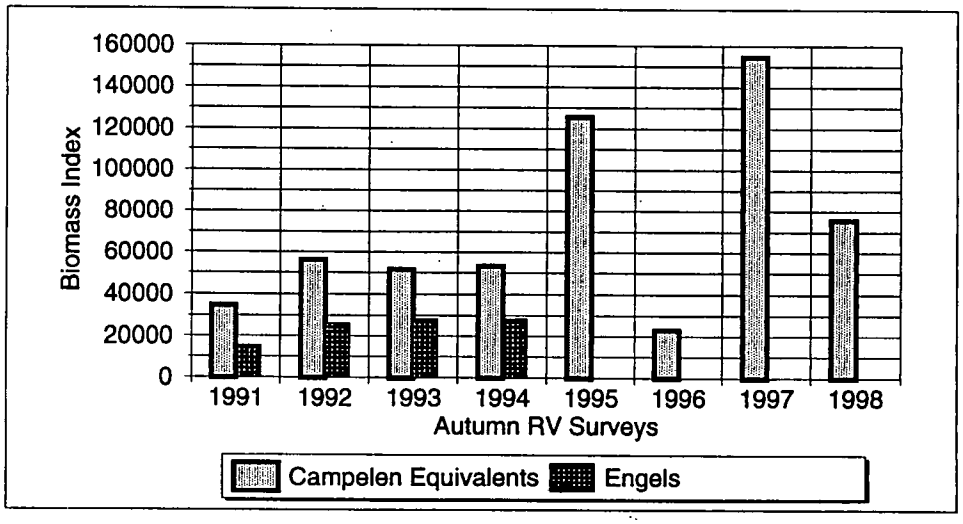


Fig. 4. Comparison of indices of relative biomass for redfish in Div. 3O between the Engels trawl derived estimates and its Campelen trawl equivalents for Spring and Autumn RV surveys.

Div. 3O RV Spring and Summer

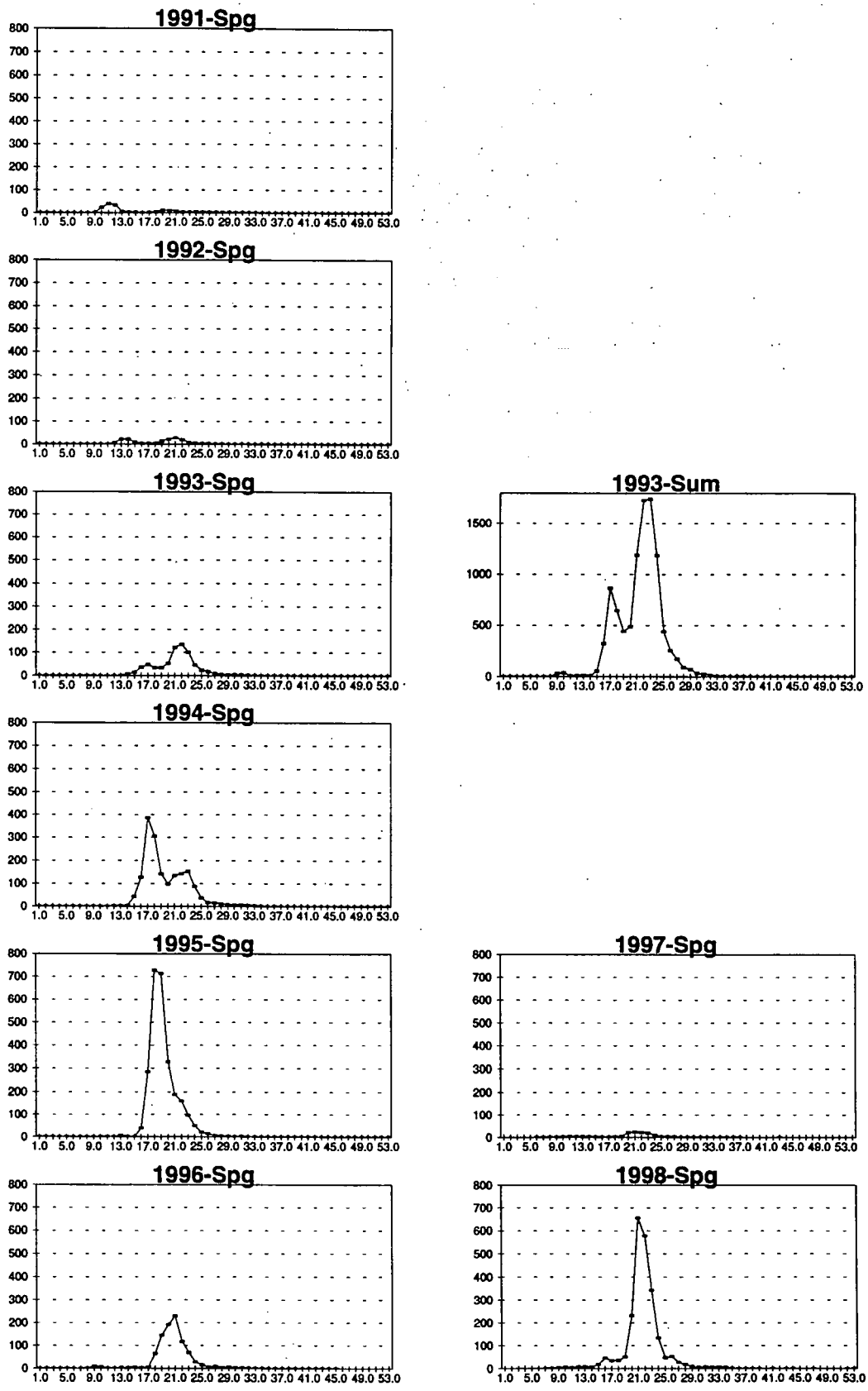


Fig. 5. Length distributions from RV surveys to Div. 3O in SPRING from 1991-1998. Plotted are mean per standard tow. The 1991-1995 data are convertions into Campelen equivalents based on a comparative fishing experiments.

Div. 3O RV Autumn

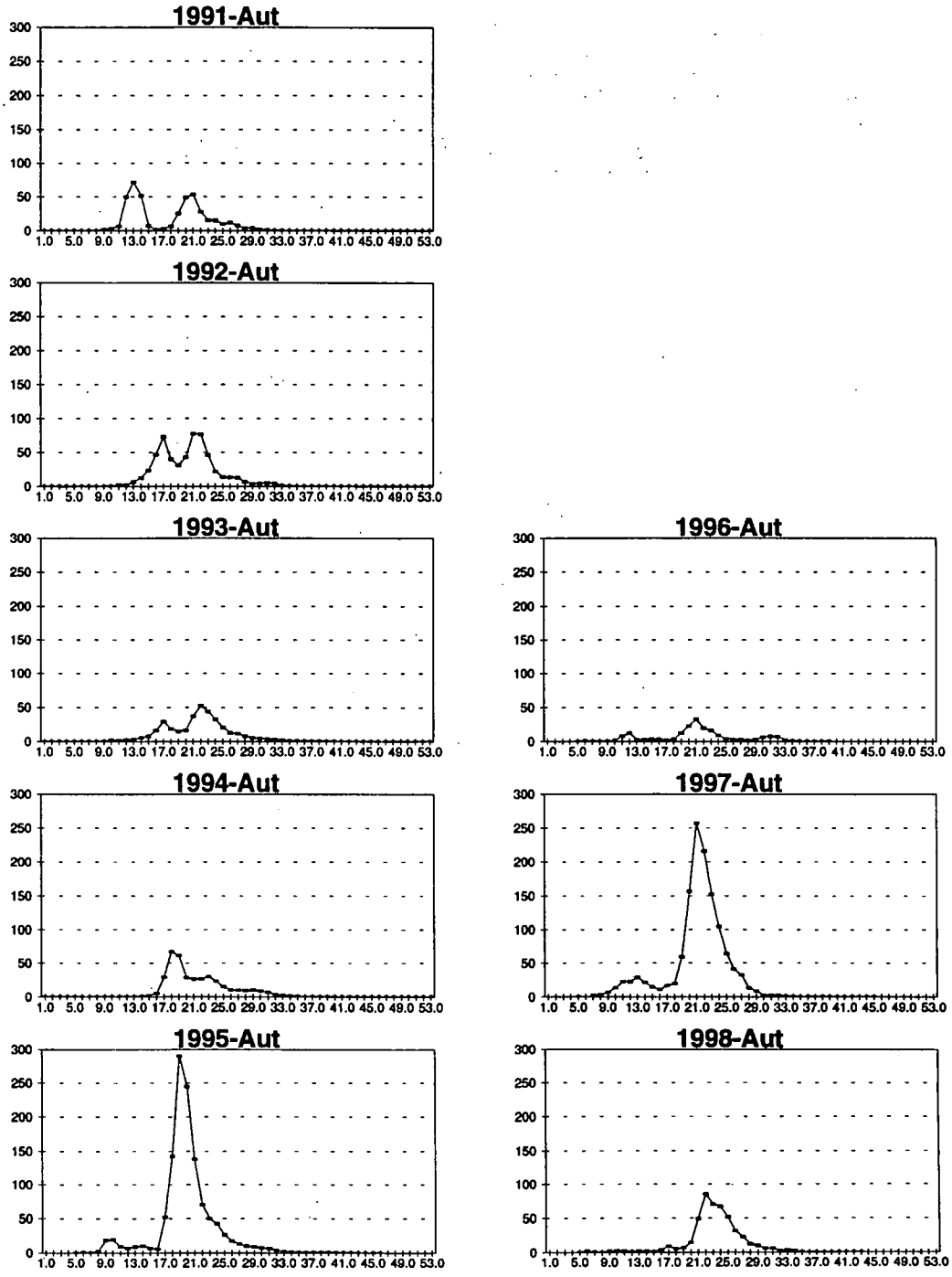
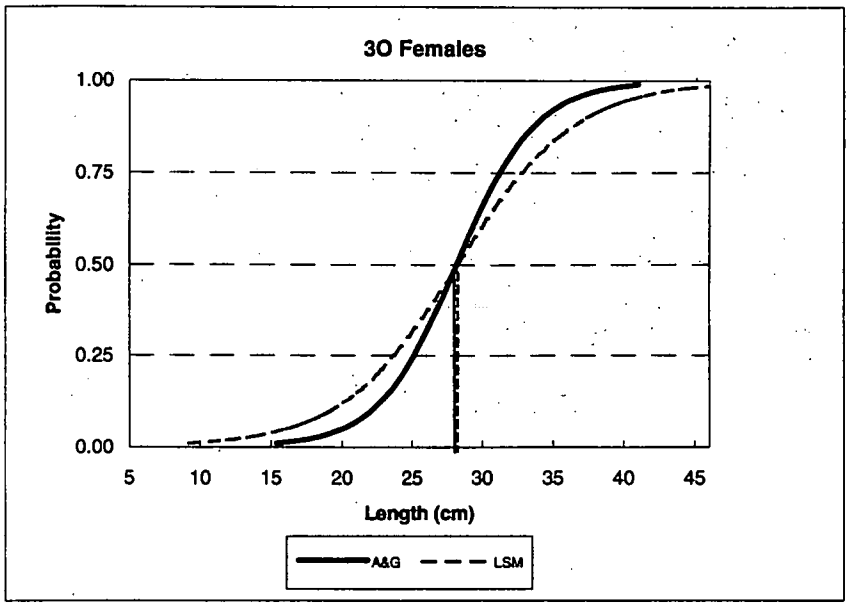
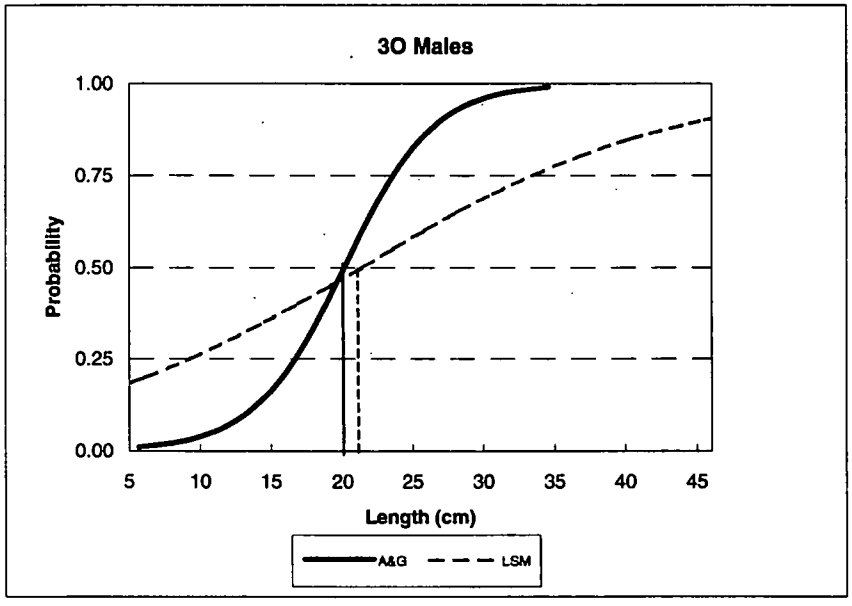


Fig. 6. Length distributions from RV surveys to Div. 3O in AUTUMN from 1991-1998. Plotted are mean per standard tow. The 1991-1994 data are convertions into Campelen equivalents based on a comparative fishing experiments.





	A&G Data		LSM Data		Average	
	Males	Females	Males	Females	Males	Females
L75	23.58	31.23	33.45	32.80	28.51	32.01
L50	20.12	28.17	21.37	28.25	20.74	28.21
L25	16.66	25.11	9.29	23.69	12.97	24.40

Fig. 7. Maturity ogives derived separately for otolith sampled (A&G) and LSM sampled data from surveys in Div. 3O