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The status of Redfish in Division 3O

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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 to 3,000 t by 1995 and ranged between 10,000 t and 14,000 t from 1996-1999. Foreign fleets historically accounted for most of catch but Canada has increased its activity in since 1995. From 1996-1999 Canadian catches have alternated between levels of about 8,000 t and 2,500 t due to the lack of market for redfish near the 22cm size limit. Assessment of this stock has been primarily based on research data due to variable commercial indices and fleets prosecuting different areas of the stock. It is difficult to reconcile year to year changes in seasonal research vessel (RV) surveys, 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. The 2000 survey information for both spring and autumn continues to indicate that stock status has not improved, and may be declining. RV surveys do not adequately sample fish greater than 25 cm which up to 1997 have generally comprised the main portion of 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 since 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

Depuis 1960, les prises nominales varient entre 3 000 t et 35 000 t. Jusqu'à 1986, les captures annuelles étaient de 13 000 t en moyenne; elles ont augmenté à 35 000 t en 1988, puis baissé à 3 000 t en 1995; de 1996 à 1999, elles variaient entre 10 000 t et 14 000 t. Par le passé, la plupart des captures étaient effectuées par des flottilles étrangères, mais les pêcheurs canadiens pêchent le sébaste plus activement depuis 1995. De 1996 à 1999, les prises canadiennes ont oscillé entre 8 000 t et 2 500 t environ à cause du manque de demande de sébaste dont la taille légèrement supérieure à la limite de 22 cm. Compte tenu de la variabilité des indices fondés sur la pêche commerciale et du fait que les flottilles pêchent le stock dans différentes zones, le stock a été évalué principalement à partir de données de recherche. Bien qu'il soit difficile d'expliquer les variations annuelles des relevés saisonniers effectués par des navires de recherche (NR), les indices de biomasse des relevés printaniers laissent croire que le stock aurait augmenté au début des années 1990, puis se serait stabilisé à près de 100 000 t depuis 1994. Malgré leur plus grande constance au début des années 1990, les résultats des relevés de NR d'automne indiquent généralement la même tendance. Les données obtenues lors des relevés de printemps et d'automne de 2000 indiquent encore que l'état du stock ne s'est pas amélioré et qu'il pourrait être en déclin. Les relevés de NR ne permettent pas d'échantillonner adéquatement les poissons dont la taille dépasse 25 cm, lesquels constituaient généralement la majeure partie des captures jusqu'en 1997. Il est donc difficile d'interpréter les estimations faites à partir des relevés par rapport à ce qui se passe réellement dans l'ensemble du stock. Depuis 1998, la pêche semble cibler la classe d'âge relativement abondante de 1988 dont les poissons ont suffisamment grossi pour ne plus être touchés par le protocole de protection des juvéniles de moins de 22 cm. On s'inquiète du fait que peu de poissons dans les classes de taille de moins de 17 cm ont été échantillonnés lors de relevés récents en dépit de l'utilisation d'un chalut à crevettes qui est pourtant très efficace pour capturer le petit poisson.

DESCRIPTION OF MANAGEMENT REGULATIONS AND THE FISHERY

Management regulations

Redfish in Div. 3O have been subject to management regulation since 1974, but, has only applied to that portion of Div. 3O within Canada's 200 mile Exclusive Economic Zone (EEZ). About 10% of the habitable redfish area within Div. 3O lies outside Canada's 200 mile limit and is unregulated.

A TAC of 16,000 t was first implemented by Canada within the 200-mile limit in 1974. The TAC was increased in 1978 to 20,000 t 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 1999. During 1999 a shift was implemented from a calendar year based TAC to a fiscal year based TAC currently in effect from April 1, 2000 to March 31, 2001 at 10,000 t. To facilitate this temporal shift in TAC, the 1999 calendar year TAC was extended to March 31, 2000 and increased from 10,000 tons to 10,200 tons to accommodate the extension. 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 2000 TAC (10,000 t) is divided into a Canadian quota (8, 500 t), and a French quota (1,500 t).

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 declined further to about 3,000 t in 1995, partly due to reductions in foreign allocations within the Canadian zone since 1993. Catches increased to 10,000 t in 1996 and ranged between 10,000 t and 14,000 t to 1999 with the exception of 5,000 t in 1997. The total reported catch by mid-November in 2000 was at 9,000 t.

The catches in 1987 and 1988, primarily by Panama and South Korea, were due mainly to increased activity outside the 200 mile limit by countries who were not contractual members of the Northwest Atlantic Fisheries Organization (NAFO), and, did not have bilateral fisheries agreements with Canada. Canadian surveillance estimates of unreported catch, which have ranged from 200 t to 23,500 t, are included in catch statistics tables since 1983 in this document. 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 1987 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 directed for redfish since 1995 and 1993 respectively, but Russia has resumed fishing in 2000. Portugal, which began fishing in the limited stock area outside the EEZ in 1992, peaked at 4,700 t in 1995, declined to 900 t by 1997 and increased to 1,900 t in 1998 and 5,400 t in 1999. Spain, who had taken less than 50 tons before 1995, increased catches sequentially from 1,200 t in 1997 to 4,500 t in 1999. Up to the end of September 2000, provisional catch for foreign fleets (primarily Portugal, Spain and Russia) was 7,500 t.

Canada has had limited interest in a fishery in Div. 3O because of small sizes of redfish encountered in trawlable areas. Canadian landings were 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. Between 1996 and 1999 Canadian catches have alternated between levels of about 8,000 t and 2,500 t based on market acceptability for redfish near the 22cm size limit. Up to mid-November in the 2001-2002 TAC year, Canada has taken 1,500 t.

In general, the fishery has occurred primarily from May to October since 1987 (Table 3a). The prominent means of capture from the mid-1970s to the early 1980s was the bottom otter trawl. The use of midwater trawls from 1987 to 1993 (Table 3b) was primarily by Russia and Cuba. Canadian, Portuguese and Spanish fleets primarily use bottom trawling.

COMMERCIAL DATA

CPUE Index of Abundance

In past assessments a standardized commercial catch rate index based on data since 1959 had been presented 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, recent changes in the composition of the domestic fleets participating in this fishery, and the small fish protocol regulation 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 data from Portugal and Spain since 1995 do not have effort available in hours fished. Previous analyses of catch rate series for foreign fleets indicate a general decline from the mid 1980s to about 1994 (Power et. al. MS 1995). 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 were sampled from the following fisheries: Canadian fisheries 1995-1996 and 1998-2000 from port sampling and observer programs, Portuguese fisheries in 1998-1999 by Portuguese observers (R. Alpoiem, pers. comm.) and the Japanese fishery in 1998 by Canadian observers. These samples were combined by month and quarter weighted by appropriate landings to derive a catch-at-length by country for Division 3O. The length-weight relationships used in the compilation were:

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

The data (Fig. 2) indicate that in 1998 there was a mode at about 23 cm for both males and females in the Portuguese fishery , a peak at 25 for males and 27 for females in the Japanese fishery and a peak of 21 cm for males and 24cm for females in the Canadian fishery. The general size range was consistent between the Canadian and Portuguese fisheries for 1998 and it was evident that Japanese fishery in 1998 consisted of somewhat larger fish. The Japanese samples illustrate the differences in growth rates between males and females. This was not evident in the Portuguese samples in 1998.

Sampling for 1999 suggests the Portuguese fishery was very similar to 1998 by a dominant mode at 23 cm (unsexed). Canadian catches for 1999 were dominated by modes at 23cm for males and 26cm for females. Generally, the Canadian catches were comprised of a larger range of sizes than the Portuguese fishery. The size distribution from the 1998 and 1999 Portuguese fisheries (range 19cm-35cm, mode at 23cm) compared to 1995 and 1996 (range 21cm-42cm, various modes greater than 29cm, see Power and Atkinson (MS 1998a)) suggest that the pattern of the fleet has changed to fishing in shallower water, given the general observation that fish size increases with depth for redfish.

The only information available prior to the assessment meeting in November for 2000 was from the Canadian fleet. The limited sampling suggests overall the bulk of the catches in 2000 were between 22cm-27cm, whereas the majority of the 1999 Canadian catches ranged from 25cm-32cm.

RESEARCH SURVEY DATA

Abundance Estimates

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 autumn 1995 onwards a Campelen 1800 shrimp trawl (0.75 n. mi. standard tow). The 1991 to spring 1995 Engel 145 data were converted into Campelen 1800 trawl equivalent data. Details of the comparative fishing trials and data modelling can be found in Power and Atkinson (MS 1998a).

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. 3) 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 surveys, while more stable in the early 1990s, generally supports this pattern. It should also be noted that the 1996 autumn estimate did not include important strata that could not be sampled due to problems on the survey. The additional 2000 survey information for both spring and autumn continues to indicate that stock status has not improved, and may be declining somewhat.

In most surveys, stratum by stratum density estimates “outside” the 200-mile EEZ (denoted in Tables 4 and 5 as strata 354, 355, 356, 721, 722) were generally lower than inside, although there is a portion of these strata that actually occurs inside. The distribution of the survey catches in spring (Fig. 4) and autumn (Fig. 5) generally illustrate this point more clearly. The spring series has full coverage of the strata and it is obvious that the largest catches are taken inside the EEZ. It is also evident that catches increased in magnitude from the early 1990s and this is generally supported by the autumn series. Differences between the spring and fall surveys may be related to changes in availability within the Division at different times of the year.

Recruitment

Size distribution in terms of mean number per tow at length from the spring surveys (Fig. 6) indicates 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 progresses at about 2-3 cm per year until it reaches 21 cm in 1996. From 1996 to 1998 the mode remains at 21cm but is dominant. It appears to have increased to 22cm in 1999 and 23 cm in the 2000 survey. Size distribution from the autumn surveys (Fig. 7) indicates 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 up to the 1995 survey. The mode progresses about 1 cm per year to 23 cm in the 1999 and 2000 surveys. There has been little sign in the surveys since 1995 of size groups smaller than 17cm.

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 1991-2000 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 and Atkinson, MS 1998b) 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.

Stratified random groundfish surveys have been conducted in the spring in Division 3O from 1973 to 1990, with coverage of depths to 367m. The surveys used a Yankee 41.5 trawl with a liner from 1973-1982 and an Engel 145 trawl with a liner from 1983-1990. Size distributions were plotted to get an indication of historical recruitment pattern and size range in depths from 93m-367m which is considered the shallower end of redfish distribution. It is clear from the varied scales on the y-axis (Fig. 8) that estimates of abundance from these surveys fluctuated greatly from year to year. In general, the upper limit of the size range was 29cm in this depth range. The 1990 survey shows a dominant mode at 24 cm. This mode could be followed back to the 1981 survey at 9cm. The next tractable pulse of recruitment occurred in the 1975 survey at 9-10cm.

Environmental Considerations

Bottom temperatures throughout much of 3O, including the shelf break where survey catches of redfish are highest, were as much as a full degree C below the historic average in the early 1990s (E. Colbourne, DFO Science, Oceans and Environment Branch, pers. comm). Bottom temperatures below 0°C were widespread in waters less than 100 m, and temperatures along the shelf break were frequently as low as 0°C. Incursions of water of about average (1-3°C) along the shelf break were noted in 1993 and 1995, and even warmer bottom waters, up to 4°C, became established along the shelf break in 3O by fall of 1996. These warmer waters expanded widely across 3O in 1998 and 1999, and conditions continued warmer than average in 2000.

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. Fluctuations in catch 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 reduced Canadian catch in 1999 is again primarily a result of market conditions for smaller sized fish (22cm to 25cm) predominantly harvested from this area. Some industry participants have expressed concern that the small fish protocol (at 22cm) is too small and should be raised. This is related to possible connections of redfish in this area as recruitment to fisheries in adjacent UNIT 2.

In 2000 one fleet's commercial fishery concentrated in 3Oe, a statistical area which overlaps the 200-mile limit. Catch rates for some vessels were as high as 8,000 lbs per hour, more than three times 1998 catch rates. The majority of past catches came from 3Oc and 3Oe with some from 3Od, now essentially all the 2000 catch came from 3Oe. Historically, there were four small areas where it was possible for this fleet to find commercial concentrations, and now only one area. The characteristically small perch, which have made up this fishery in the past, continued to be present in catches. One vessel operator noted increased numbers of small fish less than 22cm in catches during October and November. Total landings were below quota levels because of limited markets for 3O perch. One vessel reported average water temperatures during October in 3Oe of 5.5 degrees C on the bottom and surface temperatures of 15.5 degrees C that is generally higher than previous years, especially for the surface temperature.

SOURCES OF UNCERTAINTY

Although survey length frequencies detect the presence of above average year-classes, such as the 1988 year-class, at small sizes, for other year classes there is little evidence of recruitment until redfish show up at 17-19 cm, despite using the same trawl that has detected fish at 8-9 cm in other areas and tracked them yearly. Hence variation in recruitment is poorly understood and poorly predicted. Likewise surveys and commercial fisheries rarely take redfish greater than 30 cm. It is unknown whether the larger redfish become unavailable to trawl gears, migrate into other areas, or simply cease growing once they reach lengths of 25-30 cm. Together these limitations on survey data mean there is significant uncertainty about the size of the spawning biomass of this stock, and its medium term prospects due to incoming recruitment.

Because it is not possible to describe overall trends in absolute stock size, or estimate the current size of the fishable portion of the population, it is not possible to determine current fishing mortality rate.

This means that two common bases for sustainable management of fisheries are not available for this stock.

Current data suggest that redfish in this area are predominantly *S. fasciatus*. However, this needs further study. In addition, the affiliation of redfish in Div. 3O to those in adjacent areas remains unclear.

PROGNOSIS

Historically, the stock has been able to support catches of 10,000 t or more, and biomass has increased under normal recruitment patterns. Although variable, recent survey results suggest that catches of about 10,000 t have been sustainable.

Before 1998, the surveys were considered to have been monitoring pre-recruits to the fishery. The surveys tracked a relatively strong year class which in recent years caused problems for industry in complying with the small fish protocol. In 1998 the last strong year-class reached a size where it began to contribute to commercial catches. The Canadian fishery will continue to target this year-class in the near future. There is concern, however, about the poor sign of subsequent recruitment (less than 17 cm). Careful monitoring of the frequency of redfish between 17 and 22 cm in survey and commercial catches should give advance warning if recruitment to this stock changes either upward or downward sufficiently that management should adjust harvests in response to changed productivity of the stock.

It is also important to consider that 50% of the males are mature at length of about 21 cm, whereas 50% of females do not reach maturity until about 28 cm.

The expanded fishery outside the 200 mile limit means that the TAC may no longer limit total catches at 10,000 t. This could have a detrimental effect on future state of the resource.

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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	1,624	3,804	5,428	10,000
1995	177	3,037	3,214	10,000
1996	7,255	2,590	9,845	10,000
1997	2,588	2,559	5,147	10,000
1998	8,931	5,121	14,052	10,000
1999-2000 [a]	2,322	10,250	12,572	10,200 [b]
2000-2001 [a,c]	1,528	7,349	8,877	10,000 [d]

[a] Provisional

[b] Catches are for 1999. TAC adjusted from 10,000 tons and extended to March 31, 2000

[c] Provisional to Nov. 14, 2000 (based on Canadian Atlantic Quota Reports and NAFO data)

[d] TAC runs from April 1, 2000 to March 31, 2001

Table 2. Nominal catches (t) of redfish in Div. 3O by country and year since 1987 (1999-2000 are provisional, 2000 to Nov. 14)

Country	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999a	2000a
Canada (M)	24	5	18	27	4	27	21	779	4	2124	693	2850	317	
Canada (N)	159	176	9	128	24	1192	677	845	173	5131	1895	6081	2005	
France (SPM)	-	-	-	-	-	-	-	-	-	-	134	266	-	
Japan	1074	1606	1724	1406	226	125	159	-	264	417	285	355	-	
Portugal	-	22	12	83	3	1468	4794	2918	1935	1635	894	1875	5470	
Spain	26	4	-	4	-	-	-	26	22	338	1245	1925	4549	
Russia	7152	4921	4517	3811	4427	5845	6887	60	416	-	-	-	231	
Cuba	2859	2753	2138	2750	2748	2776	665	-	-	-	-	-	-	
USA	-	-	-	-	-	-	-	-	-	-	-	-	-	
Korea(S)	1726	1805	2638	833	129	1935	17	-	-	-	-	-	-	
EU	-	-	-	-	-	-	-	-	-	-	-	-	-	
OTHER [b]	14150	23500	2200	5200	900	1900	2500	800	400	200	-	700	NA	NA
Total	27170	34792	13256	14242	8461	15268	15720	5428	3214	9845	5146	14052	12572	
TAC	20000	14000	14000	14000	14000	14000	14000	10000	10000	10000	10000	10000	10200	10000

[a] Provisional

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

Table 3a. Nominal catches (t) of redfish in Div. 3O by month and year since 1987 (not including surveillance estimates).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	
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 [a]	-	-	88	119	166	46	704	783	1582	2814	1524	1481	9307	
1997 [a]	4	-	-	43	87	416	1299	943	622	963	435	49	4861	
1998 [a]	-	174	22	74	890	2485	1685	239	598	1374	1251	142	8934	
1999 [a]	1	2	53	-	188	463	337	207	847	230	18		2346	

[a] Provisional (1999 for Canada)

Table 3b. Nominal catches (t) of redfish in Div. 3O by gear since 1987 (not including surveillance estimates).

	Otter Trawls				
Year	Bottom	Midwater	Gillnets	Misc	Total
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	3085	1498	26	19	4628
1995	2221	525	26	42	2814
1996	8966	334	7	-	9307
1997	4841	10	2	-	4853
1998	8932	-	-	2	8934
1999 [a]	1053	970		320	2343

[a] Provisional (1998 for Canada only)

Table 4. Mean weight (kg) of redfish caught p
("---" indicates strata not sampled). I
Engels 145 bottom trawl. Estimates from 1996-1999 are the actual Campelen trawl data.

STRATUM	Depth (m)	Area* sq. n. mi	1991 Spring	1992 Spring	1993 Spring	1993 Summer	1994 Spring	Engel 1995 Spring	Campelen 1996 Spring	1997 Spring	1998 Spring	1999 Spring	2000 Spring
329	093-183	1721	0.3 (9)	0.0 (8)	0.0 (6)	---	11.2 (5)	0.5 (5)	0.0 (6)	1.0 (6)	0.0 (7)	0.0 (6)	0.0 (5)
332	093-183	1047	0.7 (6)	0.2 (5)	0.0 (4)	---	0.0 (4)	148.5 (4)	11.9 (4)	0.3 (3)	49.1 (4)	238.5 (4)	1.7 (4)
337	093-183	948	16.0 (5)	1.5 (4)	0.9 (2)	---	0.0 (3)	335.0 (4)	0.1 (3)	0.1 (3)	75.9 (4)	29.5 (3)	14.5 (3)
339	093-183	585	0.0 (3)	0.0 (2)	0.0 (2)	---	0.0 (2)	0.0 (2)	0.0 (2)	0.0 (2)	0.0 (2)	0.0 (2)	0.0 (2)
354	093-183	474	0.0 (3)	0.0 (2)	284.6 (2)	489.1 (3)	0.0 (2)	0.0 (3)	0.0 (2)	0.0 (2)	109.4 (2)	28.7 (2)	0.1 (2)
333	185-274	151(147)	120.8 (2)	404.0 (2)	1339.7 (2)	---	5428.5 (2)	113.5 (2)	120.4 (2)	20.2 (2)	696.3 (2)	797.6 (2)	236.2 (2)
336	185-274	121	11.6 (2)	81.2 (2)	630.9 (2)	431.2 (2)	1032.9 (2)	8543.1 (2)	161.8 (2)	7.7 (2)	5068.7 (2)	198.9 (2)	226.1 (2)
355	185-274	103	2.7 (2)	2.8 (2)	972.9 (2)	162.9 (3)	608.3 (2)	178.4 (2)	4916.3 (2)	7.5 (2)	741.6 (2)	314.7 (2)	502.8 (2)
334	275-366	92(96)	103.3 (2)	36.5 (2)	202.9 (2)	--- (3)	171.1 (2)	29.4 (2)	220.0 (2)	33.9 (2)	140.3 (2)	478.9 (2)	733.0 (2)
335	275-366	58	4.3 (3)	54.3 (3)	118.3 (2)	9874.4	1210.4 (2)	263.7 (2)	2445.8 (2)	58.7 (2)	1053.9 (2)	1460.3 (2)	138.7 (2)
356	275-366	61	26.6 (2)	113.0 (2)	462.4 (2)	5750.3 (4)	135.8 (2)	468.0 (2)	515.8 (2)	7.5 (2)	651.6 (2)	1600.5 (2)	4317.8 (2)
717	367-549	93(166)	452.4 (2)	74.3 (2)	83.2 (2)	---	395.3 (2)	91.4 (2)	191.2 (2)	534.7 (2)	143.1 (2)	670.0 (2)	310.6 (2)
719	367-549	76	33.7 (2)	12.3 (2)	150.0 (2)	4258.2 (2)	669.7 (2)	71.8 (2)	79.5 (2)	59.6 (2)	291.6 (2)	289.0 (2)	326.3 (2)
721	367-549	76	24.7 (2)	183.6 (2)	110.5 (2)	2485.7 (4)	22.0 (2)	1220.5 (2)	68.2 (2)	20.9 (2)	153.0 (2)	651.6 (2)	129.6 (2)
718	550-731	111(134)	42.2 (2)	7.5 (2)	87.7 (2)	---	156.0 (2)	7.3 (2)	27.2 (2)	15.0 (2)	35.5 (3)	16.7 (3)	174.5 (3)
720	550-731	105	11.7 (2)	57.7 (2)	9.7 (2)	50.7 (3)	15.9 (2)	14.6 (2)	129.1 (2)	21.0 (2)	14.5 (2)	103.6 (2)	17.7 (2)
722	550-731	93	118.4 (2)	12.6 (2)	33.2 (2)	75.3 (3)	126.1 (2)	6.3 (2)	25.4 (2)	12.2 (2)	137.0 (2)	19.7 (2)	261.0 (2)
Stratified Analysis:		Upper	100.7	104.2	277.6	2689.9	848.6	451.0	1210.0	189.5	1504.1	268.3	145.8
		Mean	18.8	19.6	103.1	1498.8	208.3	283.8	135.3	19.0	192.7	148.2	101.0
		Lower	-63.2	-65.0	-71.5	307.7	-431.9	116.6	-939.4	-151.5	-1118.8	28.1	56.2
SURVEY BIOMASS (metric tons)			**15278**	**15961**	**83874**	**240612**	**172264**	**234648**	**111854**	**15721**	**159313**	**122550**	**83508**

*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)

			1991 Spring	1992 Spring	1993 Spring	1993 Summer	1994 Spring	1995 Spring
Stratified Analysis:		Upper	120.0	79.3	243.4	1008.2	779.2	284.3
		Mean	18.2	15.2	93.5	597.5	164.9	186.7
		Lower	-83.6	-48.8	-56.4	126.7	-449.5	89.2
SURVEY BIOMASS (metric tons)			**8082**	**6759**	**41518**	**52338**	**74391**	**84261**

3O Spring RV Surveys

Table 5. Mean weight (kg) of redfish caught per standard tow in Division 3O during autumn Canadian research surveys from 1991-2000. ("---" indicates strata not sampled). Estimates from 1991-1994 are Campelen trawl equivalent units based on a Comparative fishing trials with an Engels 145 bottom trawl. Estimates from 1995-2000 are the actual Campelen trawl data.

						Engel	Campelen					
	Depth	Area*	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
STRATUM	(m)	sq. n. mi	Autumn	Autumn	Autumn	Autumn	Autumn	Autumn	Autumn	Autumn	Autumn	Autumn
329	093-183	1721	0.02 (7)	0.00 (3)	0.00 (5)	0.00 (6)	1.0 (5)	0.0 (5)	22.59 (5)	0.0 (5)	0.0 (5)	0.0 (5)
332	093-183	1047	0.00 (4)	13.29 (3)	2.69 (3)	15.59 (3)	31.5 (3)	0.2 (2)	7.73 (3)	2.7 (3)	0.8 (3)	0.8 (3)
337	093-183	948	30.80 (4)	64.65 (2)	7.00 (3)	5.04 (2)	55.5 (2)	0.0 (2)	17.93 (3)	34.6 (3)	1.9 (3)	13.0 (3)
339	093-183	585	0.00 (2)	0.00 (2)	0.00 (2)	0.00 (2)	0.0 (2)	0.0 (3)	0.00 (2)	0.0 (2)	---	0.2 (2)
354	093-183	474	0.00 (2)	171.5 (2)	0.00 (2)	0.00 (2)	785.3 (3)	15.6 (2)	915.00 (2)	31.5 (2)	69.0 (2)	0.0 (2)
333	185-274	151(147)	27.06 (2)	168.0 (2)	46.53 (2)	257.7 (2)	107.0 (2)	---	26.45 (2)	20.0 (2)	18.0 (2)	25.7 (2)
336	185-274	121	18.46 (2)	374.3 (2)	378.7 (2)	357.8 (2)	49.7 (2)	9.1 (2)	117.42 (2)	103.8 (2)	548.7 (2)	98.9 (2)
355	185-274	103	352.2 (2)	450.7 (2)	77.86 (2)	264.2 (2)	237.0 (2)	37.9 (2)	25.85 (2)	11.9 (2)	387.8 (2)	127.8 (2)
334	275-366	92(96)	1317.9 (2)	480.7 (2)	380.5 (3)	171.1 (2)	506.8 (2)	--- (2)	289.50 (2)	188.3 (2)	22.6 (2)	58.8 (2)
335	275-366	58	512.6 (2)	850.9 (2)	351.8 (2)	877.1 (2)	187.7 (2)	332.2 (2)	1114.4 (2)	362.1 (2)	443.2 (2)	360.3 (2)
356	275-366	61	59.40 (2)	684.6 (2)	60.08 (2)	303.8 (2)	387.6 (2)	145.5 (2)	106.10 (2)	914.5 (2)	592.9 (2)	801.7 (2)
717	367-549	93(166)	---	---	1391.3 (2)	340.4 (2)	588.8 (2)	--- (2)	2281.8 (2)	1834.0 (2)	135.7	1212.0 (2)
719	367-549	76	268.9 (2)	---	930.5 (2)	536.2 (2)	414.0 (2)	656.4 (2)	880.23 (2)	321.3 (2)	691.0 (2)	1397.9 (3)
721	367-549	76	53.71 (2)	---	100.4 (2)	16.57 (2)	1666.7 (2)	87.3 (2)	732.51 (2)	410.5 (2)	177.5 (2)	259.0 (2)
718	550-731	111(134)	---	---	169.3 (2)	442.1 (2)	409.4 (2)	---	37.13 (2)	4.4 (2)	48.0 (2)	24.8 (2)
720	550-731	105	---	---	50.02 (2)	118.7 (2)	16.5 (2)	572.6 (2)	---	162.6 (2)	21.3 (2)	58.9 (2)
722	550-731	93	7.67 (2)	---	164.0 (2)	22.71 (2)	125.8 (2)	103.9 (2)	3.96 (2)	108.6 (2)	5.3 (2)	38.3 (2)
Stratified Analysis:		Upper	306.5	147.4	105.2	109.0	971.9	86.2	1182.1	701.7	106.8	90.6
		Mean	44.9	76.3	63.6	64.5	151.9	30.5	190.3	91.5	56.4	76.2
		Lower	-216.7	5.2	22.1	20.0	-668.2	-25.1	-801.5	-518.7	6.0	61.7
SURVEY BIOMASS (metric tons)			**34618**	**56247**	**51782**	**53324**	**125579**	**22974**	**154622**	**75649**	**42100**	**62969**

*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)

Stratified Analysis:	Upper	274.2	163.4	127.9	119.8
	Mean	37.2	65.2	64.0	62.9
	Lower	199.8	-32.9	0.1	6.1
SURVEY BIOMASS (metric tons)		**15649**	**26256**	**28423**	**28387**

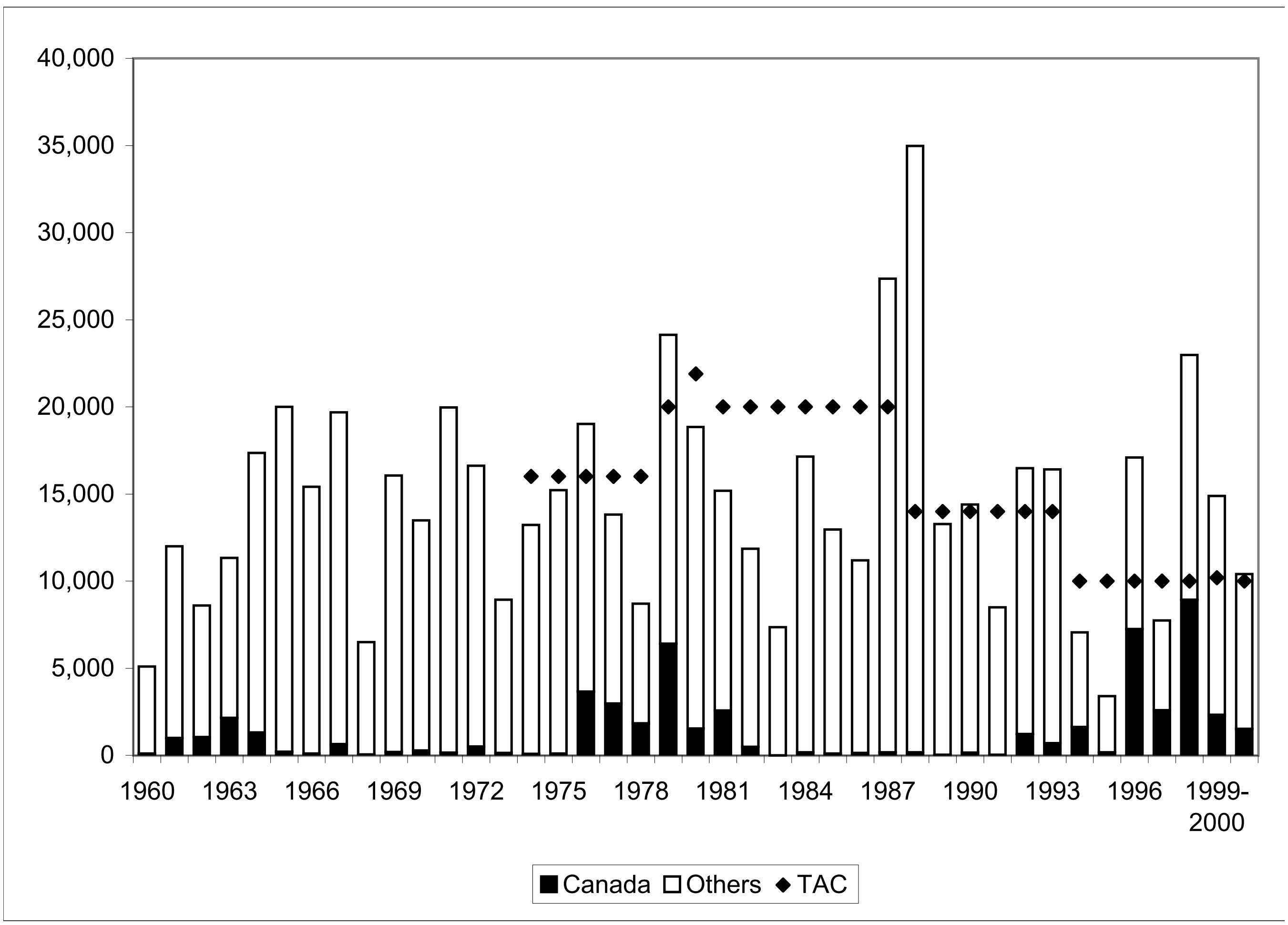

Fig. 1. Nominal catches and TACs for Division 3O redfish.

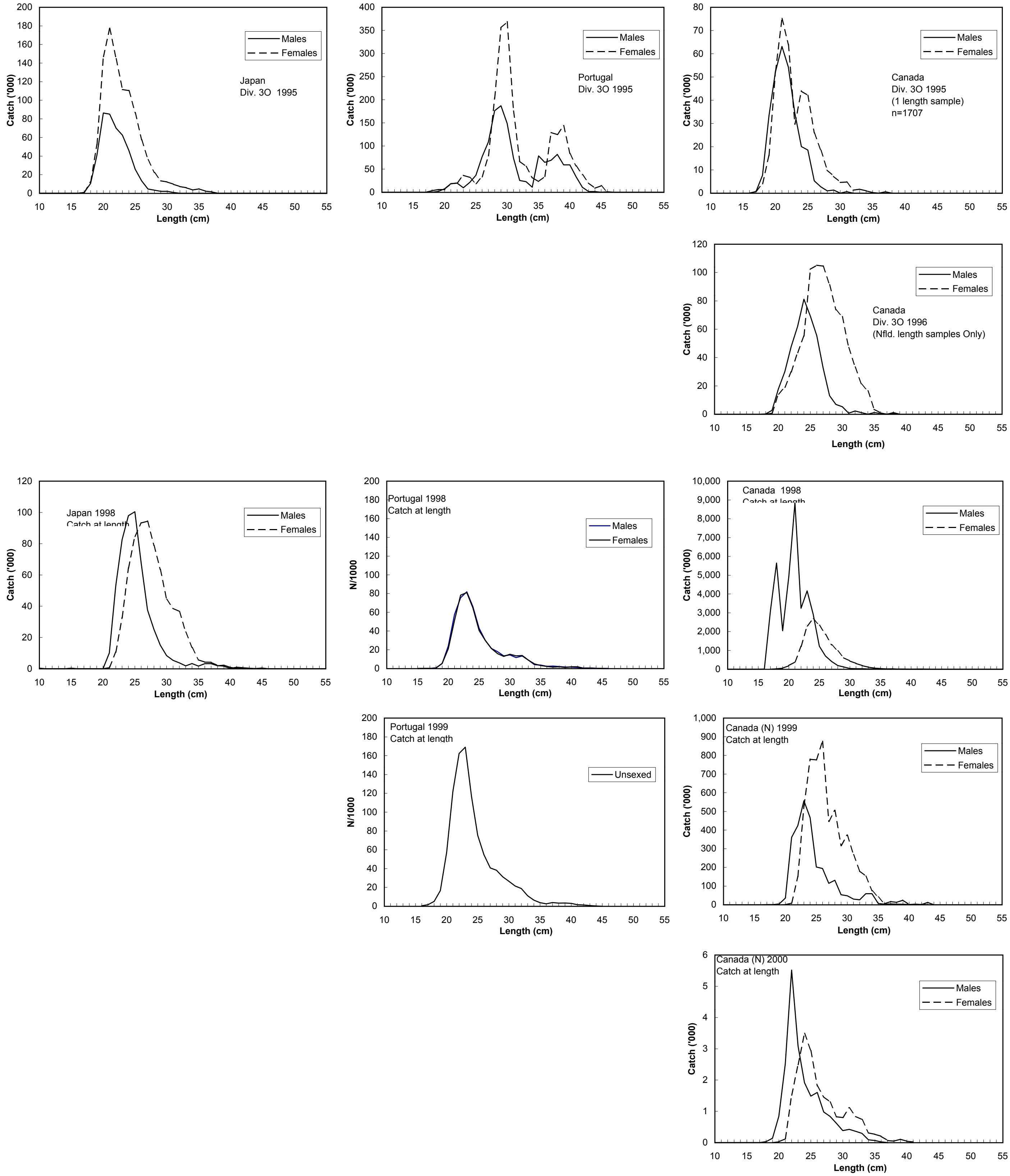

Fig. 2. Commercial catch-at-length for Div. 3O redfish estimated by available samples adjusted to landings by fleet, gear and month.

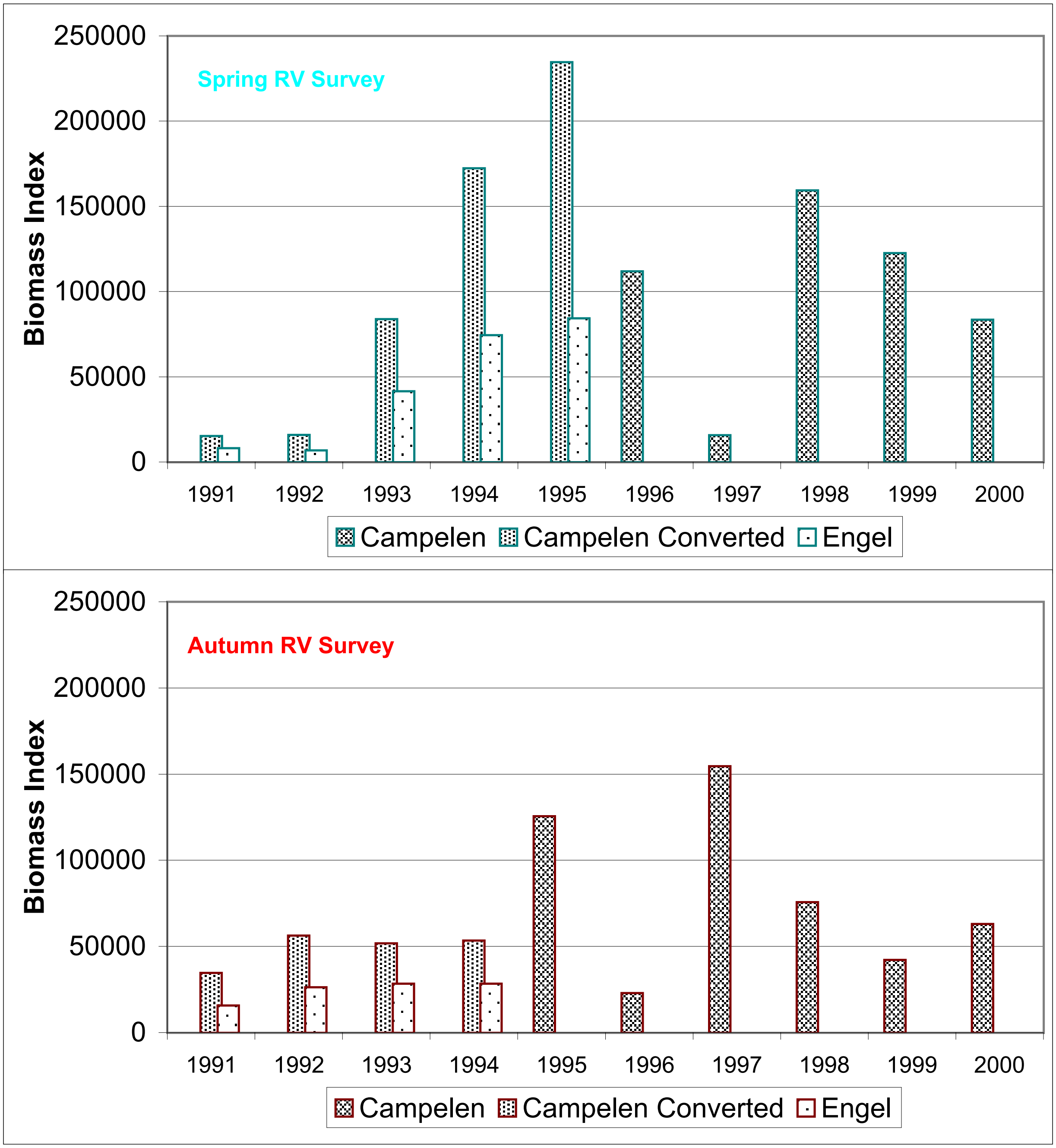

Fig. 3. Indices of survey biomass for redfish in Div. 3O for spring and autumn surveys from 1991-2000. Surveys prior to autumn 1995 utilized an Engel trawl. Estimates were converted into Campelen equivalents based on comparative fishing trials.

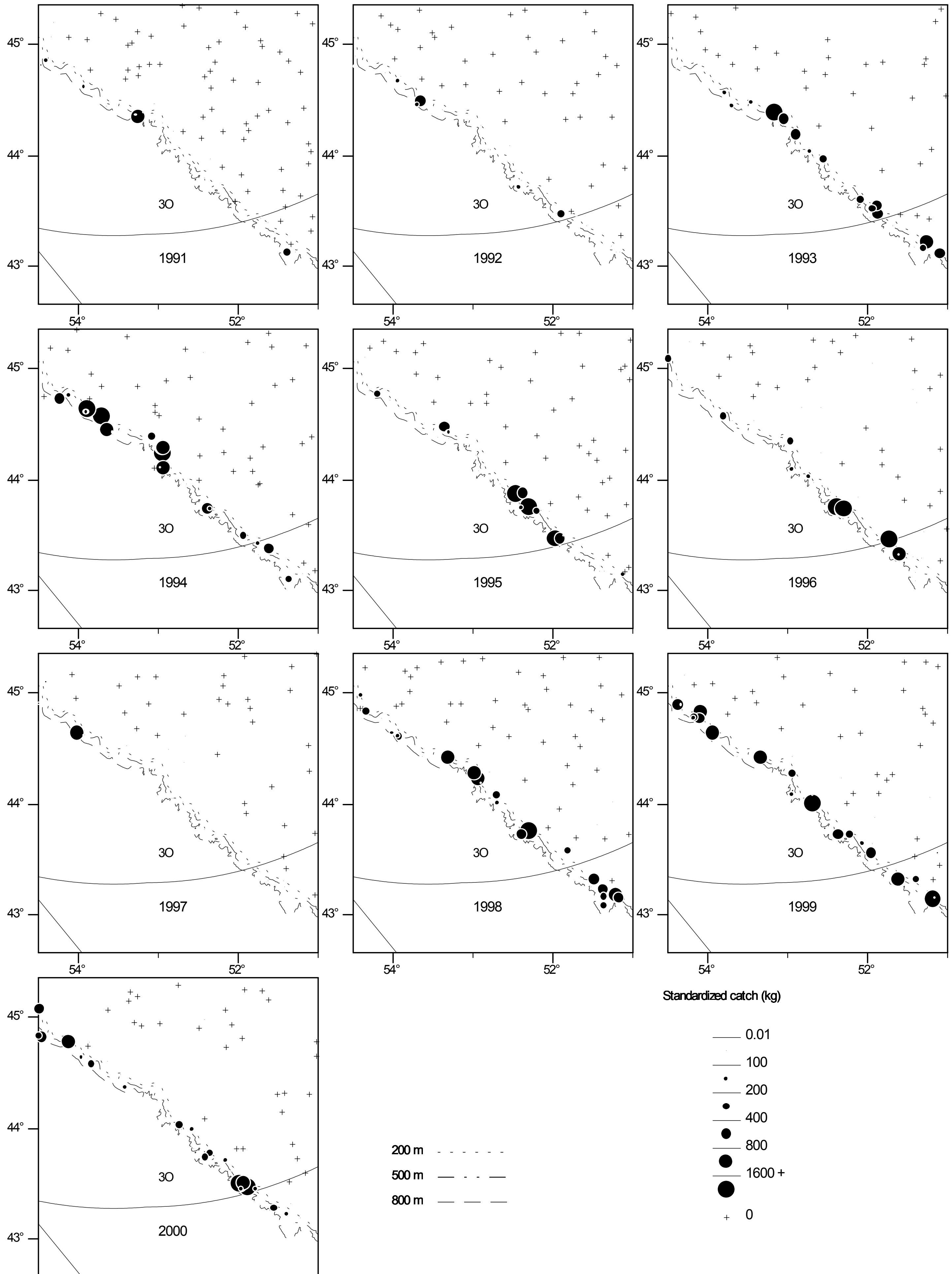

Fig. 4. Distribution of 3O Spring DFO RV Redfish catches.

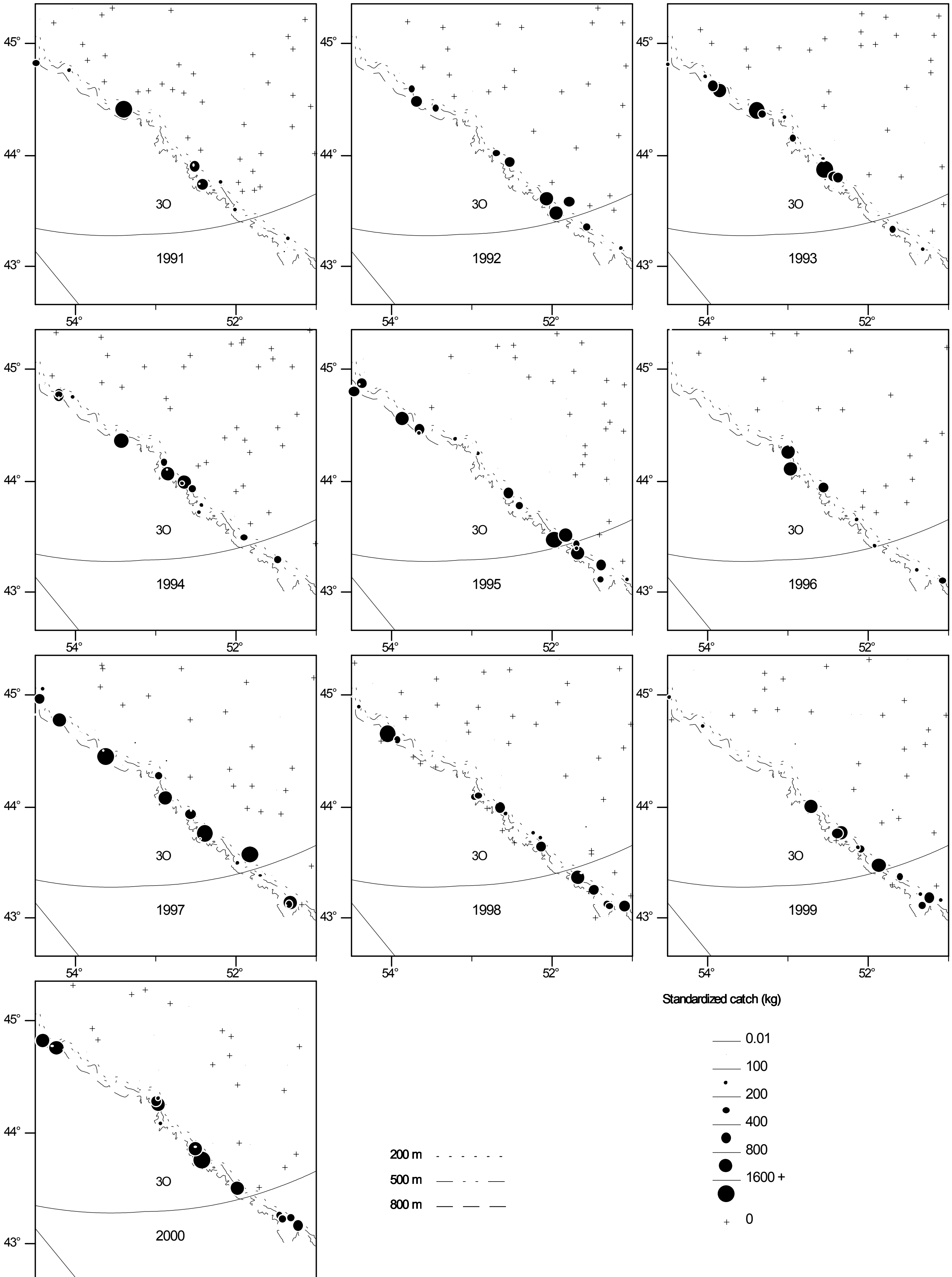

Fig. 5. Distribution of 3O Autumn DFO RV Redfish catches.

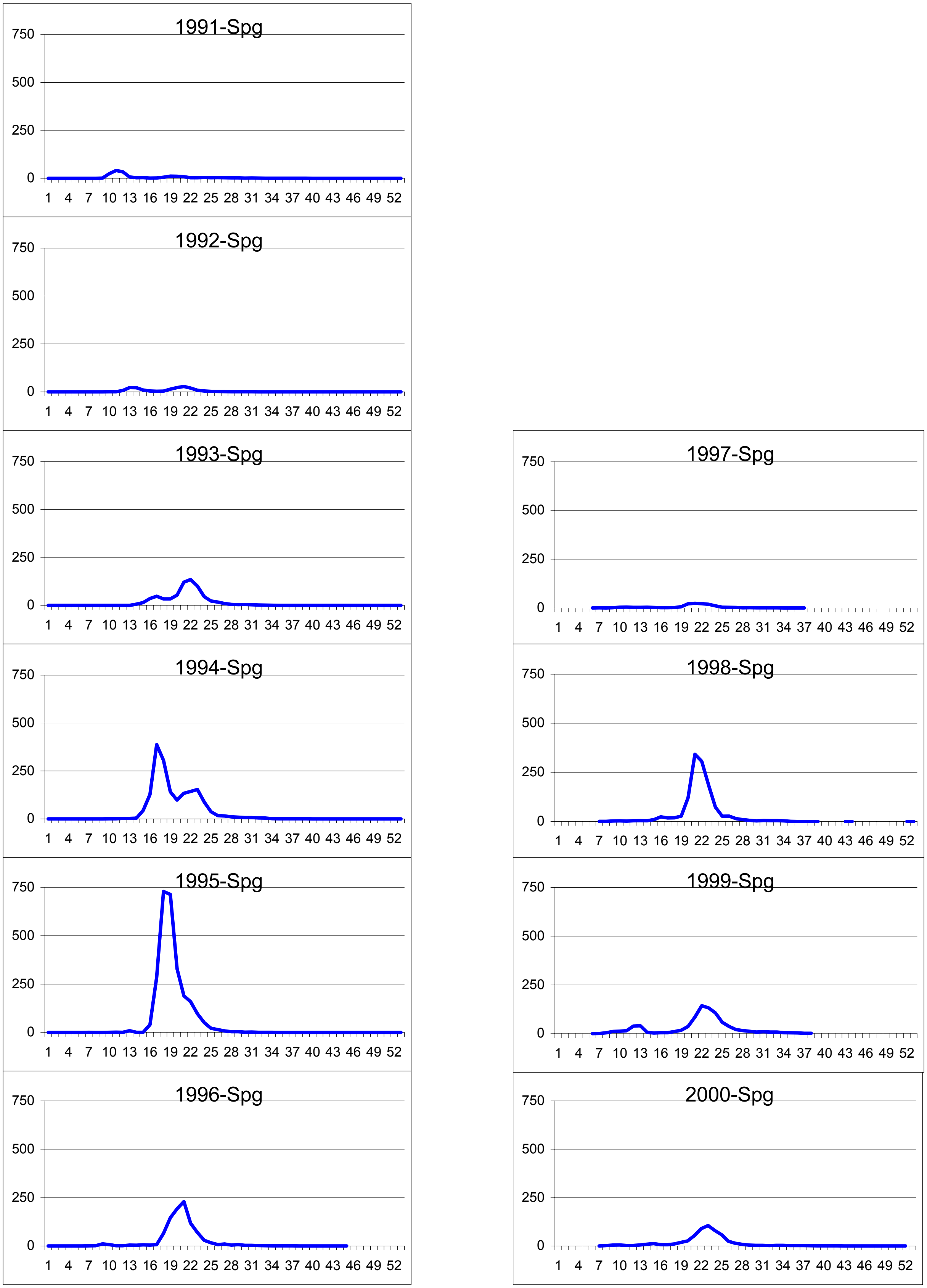

Fig. 6. Length distributions from RV surveys to Div. 3O in SPRING from 1991-2000. Plotted are mean per standard tow. The 1991-1995 data are convertions into Campelen equivalents based on a comparative fishing experiments.

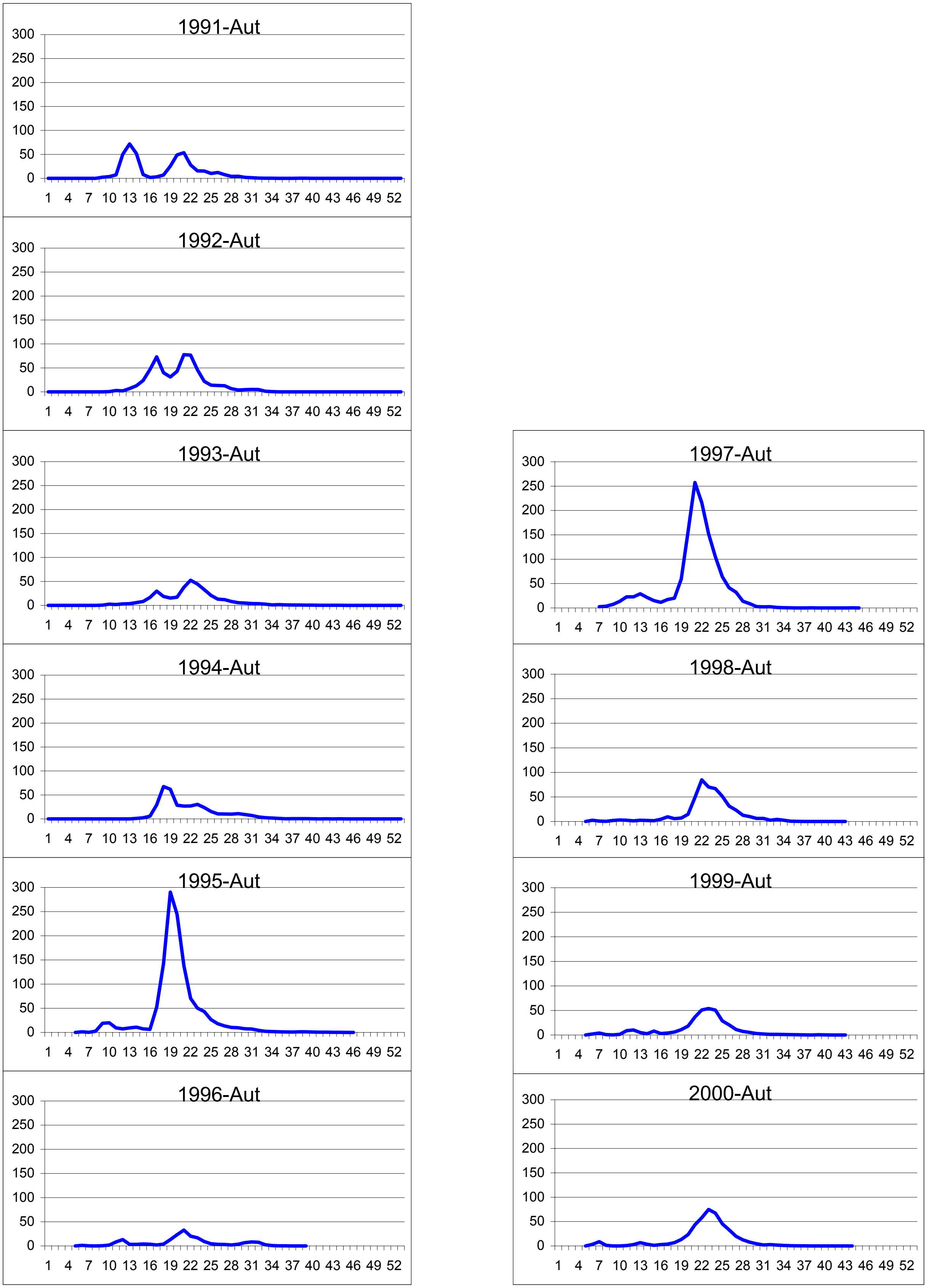

Fig. 7. Length distributions from RV surveys to Div. 3O in AUTUMN from 1991-2000. Plotted are mean per standard tow. The 1991-1994 data are convertions into Campelen equivalents based on a comparative fishing experiments.

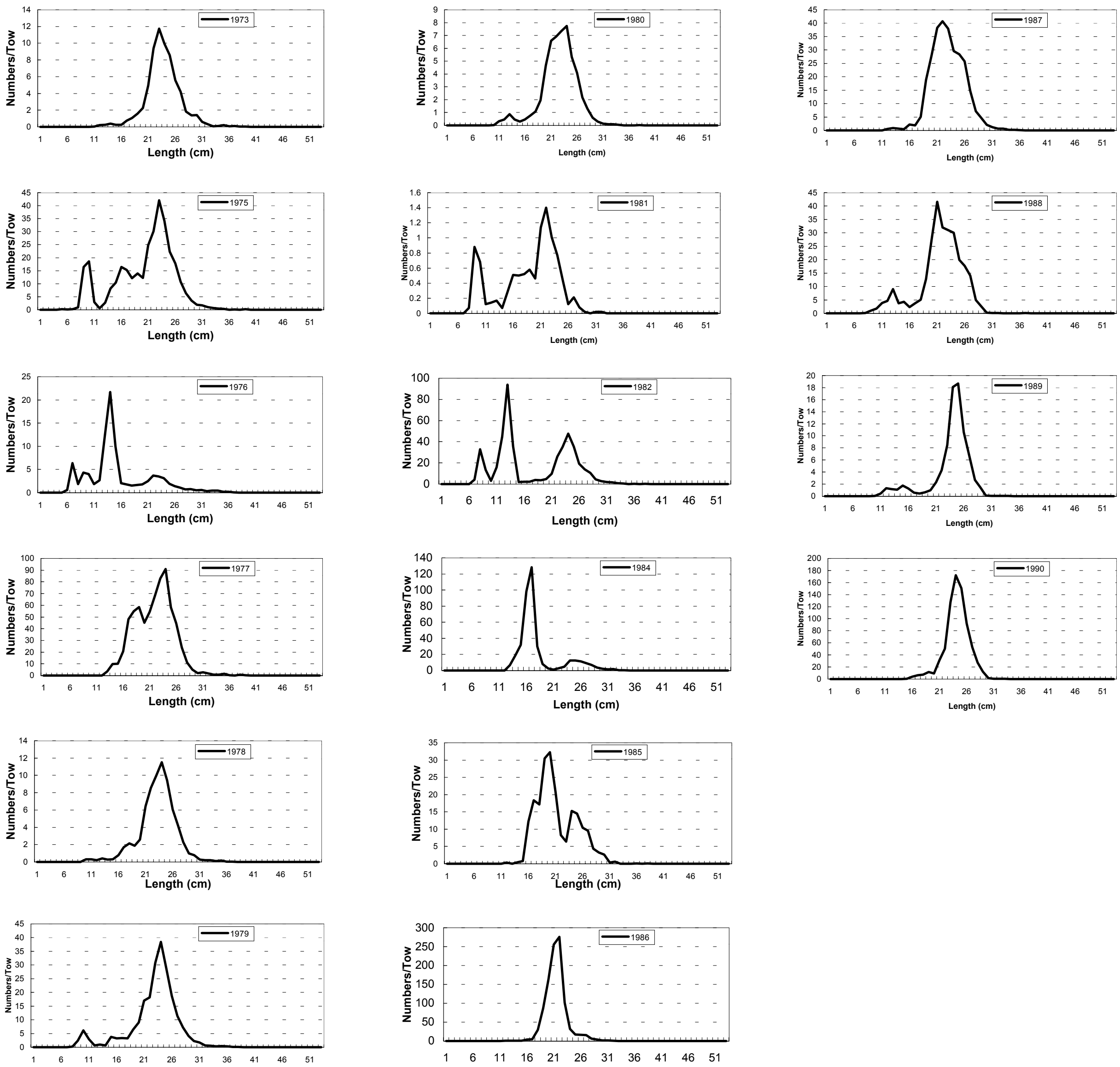

Fig. 8. Length distributions from RV surveys to Div. 3O in spring from 1973-1990. Plotted are mean per standard tow. The surveys covered depths to 200 fathoms.