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Unit 3 Redfish Population and Fishery Trends

by

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Abstract :

The document summarizes commercial fishery data on landings, fishing effort, catch rates and landings size compositions, and research vessel survey biomass estimates and population size compositions, for Unit 3 redfish for the period 1970 to 1993. Present biomass, as judged from the 1993 survey is not greatly different than the average over the last decade or so. The 1993 catch, although up by 100% over 1992 is largely a reflection of an increase in fishing effort probably due to lack of opportunities in other fisheries. There is no indication of any large year-classes about to enter the fished part of the stock which would cause a great change in its abundance between the present and 1995. Fishing and stock conditions in 1995 might be expected not to differ greatly from those in recent years.

Résumé

Le présent document expose sommairement les données fournies par les pêcheurs commerciaux en ce qui a trait aux débarquements, à l'effort de pêche, aux taux de prises et à la composition des débarquements selon la taille, ainsi que les estimations de biomasse et la composition de la population selon la taille qui proviennent de levés de recherche, pour ce qui concerne le sébaste de l'unité 3 de 1970 à 1993. Comme le révèle le relevé de recherche de 1993, la biomasse actuelle est comparable à la moyenne des dix dernières années environ. Les prises de 1993, quoiqu'en hausse de 100 % par rapport à 1992, reflètent en grande partie un accroissement de l'effort de pêche probablement dû à la baisse des possibilités dans d'autres pêches. Rien n'indique que de fortes classes d'âge, qui modifieraient profondément l'abondance d'ici à 1995, soient sur le point d'être recrutées dans la partie exploitée du stock. On peut s'attendre à ce qu'en 1995 la situation du stock et celle de la pêche ne diffèrent pas beaucoup de ce qu'elles étaient ces dernières années.

Introduction

New management areas were proposed for Gulf of St. Lawrence, St. Pierre Bank and Scotian Shelf redfish by CAFSAC in 1991 (CAFSAC 1992) and were implemented in the Groundfish Management Plan for 1993. The most western of these new areas, termed Unit 3, encompassed Div. 4X and the statistical unit areas 4Wdehkl (Fig. 1). These redfish had previously been managed as part of a larger Div. 4VWX management area.

The TACs for the new management areas were established on the basis of a CAFSAC proposal that the sum of the 1991 TACs for the previous areas be prorated by the historical (1981-90) catches in the new areas to derive TACs for each new Unit. This resulted in a TAC of 10,000 t being established for Unit 3 in 1993, and this TAC level was carried forward for 1994.

The stock status of Scotian Shelf redfish was monitored by CAFSAC on the basis of catch trends subsequent to the last comprehensive review conducted in 1987 (Zwanenburg and Hurley 1987). The 1987, and a series of previous annual reviews, established that there was an inadequate scientific basis for an analytical assessment and for annual adjustment of TAC advice. Advice on the appropriate catch level, which remained unchanged from 1980, was based on an exploitation rate of 15% of the trawlable biomass estimated from research vessel surveys.

Previous work conducted through CAFSAC does not provide any data summarized on the basis of the new Unit 3 management area. A provisional report on Unit 3 redfish was provided directly to the FRCC in autumn 1993, however, and provided a basis for its management recommendations for the 1994 fishery (FRCC 1993). The present document summarizes commercial fishery data on landings, fishing effort, catch rates and landings size compositions, and research vessel survey biomass estimates and population size compositions, for this new Unit. These data series are used to make inferences on potential yields and a prognosis for population and fishery trends in the coming year.

Population and Fishery Distributions

July bottom trawl surveys conducted in 1970-93 illustrate that the population is widely distributed in all deepwater areas in the management unit (defined as strata 456, 458 to 495, Halliday and Koeller (1981)) (Fig. 2). The sporadic catches along the outer edge of the shelf are probably a reflection of low sampling intensity. However, these strata have a small area and do not affect population size estimates strongly. Zwanenburg and Hurley (1987) demonstrated, also, that only a small part of the Unit 3 redfish population (2% in Div. 4X to 17% in Div. 4W) is found deeper than 200 fm, the depth limit of the July standardized surveys, thus essentially the whole population is contained within the July survey area. There is, therefore, no

apparent reason why July survey abundance estimates should not be accepted as indicative of population trends. Calculated biomass for each stratum in each year (Table 1) indicate that most of the population is distributed in the 100-200 fm zone between the coastal shelf and the offshore banks.

Commercial fishing in the period 1970-93 was consistently widespread over the statistical unit areas within the management unit (Fig. 3). The relative importance of unit areas varied over time but, 4Xo, 4Xn, 4Xm and 4Wk were commonly of importance (Fig. 4) whereas the Gulf of Maine unit areas, particularly 4Xr and 4Xs, did not usually account for an important part of the annual catch.

Commercial Catch Trends

The new management units for redfish divide Div. 4W into two parts on the basis of statistical unit areas and this creates difficulties in assigning historical catches in Div. 4W to the new management units. Only Scotia-Fundy Region and the USA utilize the Scotian Shelf unit areas for statistical collection. Power (1992) addressed this problem when deriving catches for Unit 2 redfish by assigning all Newfoundland Region catches from Div. 4W to Unit 2 and all non-Canadian and non-USA catches from 1977 to Unit 3. These third party catches, taken in the small mesh gear fishery for silver hake, squid and argentine, were not greater than 400 t in any year. However, Power left third party catches prior to 1977, which were much larger -- up to 12,000 t, unassigned. For present purposes, Unit 3 catches are taken as all catches in NAFO Statistical Bulletins for Div. 4X plus those for Scotia-Fundy Region from 4Wdehkl plus 4Wu (i.e. unknown) and USA catches from Div. 4W assigned to Unit 3 by Power (1992) (Table 2). All other catches reported from Div. 4W are included in an unassigned category. While some undetermined proportion of these are attributable to Unit 3, the total unattributed catch in recent years is insignificant and can be ignored.

In the period 1970-93, nominal catch assigned to Unit 3 redfish peaked at almost 19,000 t in 1974 and then declined gradually to a low of less than 2,600 t in 1979 (Fig. 5). A second peak occurred in 1986 at 6,700 t again followed by a decline to about 2,000 t in 1991. The provisional 1993 catch was (5,071 t), a 100% increase from that of 1992 but substantially below the TAC. Most of the increase in catch resulted from higher catches being taken in 4Xo; over half of the 1993 catch was taken from this unit area.

Research Vessel Estimates of Stock Abundance

July bottom trawl surveys provide estimates of population biomass from 1970. The A.T. Cameron was used for these surveys until 1982, at which time it was replaced by the Alfred Needler although the Lady Hammond conducted the survey in two of these latter years. Fanning (1985), on the basis of comparative fishing experiments, established that there was no difference in catchability of redfish between the Alfred Needler and the Lady Hammond, but that there very likely was between these vessels and the A.T. Cameron. The data were inadequate for determination of a conversion factor. Nonetheless, the factors estimated were quite large, 1.27 based on weight caught per tow and 1.55 based on numbers, and the problem cannot be ignored. As there were no obvious reasons for a difference in conversion factor between vessels based on weight and numbers, such as variation with length category, the two estimates are considered equally valid and an intermediate value, arbitrarily chosen as 1.33, is used here to investigate the effects of applying a conversion factor to the pre-1982 survey biomass estimates. The time series of survey biomass estimates (Fig. 6), with and without a conversion factor adjustment to A.T. Cameron data, shows a declining trend from 1970 to the early 1980s and fluctuation without trend in the 1980s-early 1990s around a level of about 70,000 t, about half that observed in the early 1970s, i.e. 120,000 t in unadjusted data, 150,000 t in adjusted data.

Commercial Estimates of Stock Abundance

The great majority of the redfish catch taken by the Scotia-Fundy fleet in 1970-93 was taken on redfish directed trips (Fig. 7). The bycatch rate, overall, in other fisheries was very low (Fig. 7). The redfish main species catch rate (tons per hour fished) did not vary greatly among the main statistical unit areas (Fig. 8) or by month (Fig. 9). Thus, it was decided not to take these factors into account when calculating annual catch rates. Historically tonnage class 4 (TC4) side otter trawlers (150-499 grt) dominated the fishery (Fig. 10). Large stern trawlers (TC5: 500+ grt) also landed significant quantities in the 1970-93 period. The smaller stern trawlers (TC2: 26-49 grt, TC3: 50-149 grt) were less important over the whole time period but equalled the TC4 side trawlers in catches in 1993 (Fig. 11).

Catch rates of the primary participants in the Unit 3 redfish fishery, i.e. TC2, 3 and 5 stern trawlers and TC4 side trawlers were examined. Catch, number of hours fished and number of days fished by each of these vessel categories in 1970-93 are given in Table 3. The TC4 side trawlers had a persistent and substantial presence in the fishery over the entire period (Fig. 12). The TC5 stern trawlers also fished in all years but at a low level, whereas the TC2 and TC3 vessels did not enter the fishery until the early 1980s. Fishing success, in terms of tons

caught per hour fished, did not differ greatly among TC2, TC3 and TC5 vessels in the 1980s and early 1990s, whereas that of TC4 vessels was about double (Figs. 12 and 13) and all vessel categories showed a gradual decline in catch per hour over that period. The fishing success of TC4 vessels showed a steady decline in the 1970s, but a substantial increase between 1979 and 1984. Catch rate tripled during that period. This was at odds with the fishing success of TC5 vessels, which did not change greatly between 1979 and 1984 and bears no relation to the population biomass trends which can be inferred from research vessel surveys.

Fishing success measured in terms of tons caught per fishing day gives a rather different perspective than catch per hour (Fig. 13). The catch per day did not change greatly for any vessel category from 1981 to 1993, but again the success of TC4 vessels was twice that of the other categories. The same decline occurred in the 1970s in catch per day of TC4 vessels as for catch per hour, but the increase over 1979-84 was two and a half times rather than three. There is a clearer indication in catch per day data of TC5 vessels that fishing success was declining in the 1970s in a fashion similar to that of TC4 vessels.

The explanation for the differences in catch per day and catch per hour trends is, of course, due to trends in the number of hours fished per day (Fig. 13). In the 1970s, hours fished per day declined for both TC5 and TC4 vessels, but particularly for the latter in the period 1977-81 when hours fished per day almost halved. It is known that there were substantial changes in the TC4 fleet in the late 1970s-early 1980s, many of the oldest vessels being decommissioned and the fishing strategies of the remaining vessel modified. The extent to which these changes affected catch rates has yet to be investigated, but it is clear that this effect was substantial. The catch rates of TC5 vessels conform in overall trends quite well with those exhibited by research vessel biomass estimates and, despite being based on scant data, may give the better measure of stock abundance trends.

Catch rates for 1993, although up from 1992 for TC2 and TC3 vessels, did not change much for TC4 and TC5 vessels and for all vessel categories 1993 fishing success was much the same as in the last several years. (The high fishing success for TC4 vessels in 1990 in terms of catch per hour is not reflected in catch per day and is viewed as anomalous.) The increase in 1993 catch is largely a reflection of an increase in fishing effort.

Size Composition of Stock

Research vessel survey estimates of population size composition in 1970-93 (Fig. 14) were most commonly unimodal at about 25 cm. Size range was typically about 20-35 cm. An

additional mode of smaller fish occurred in some years. Such a mode occurred at 16 cm in 1974 and in 1984 and, in the latter case recurred in 1985 at 17 cm. Another mode occurred in 1988 at 13 cm and can be seen at larger sizes in the following two years, and a mode at 12 cm occurred in 1991. It appears that the survey is capable of catching fish of 10 cm and above if they are present but small fish, although present, may not necessarily be caught as a result of sampling variability. The data suggest that there were very few recruitment events in the 1970s but possibly several in the mid 1980s-early 1990s. This would be consistent with overall biomass trends if the recruiting year classes were of modest size, sufficient only to maintain but not increase biomass.

Size Composition of Landings

The size composition of Scotia-Fundy Region landings, based on port samples, are superimposed on the survey population size compositions in Fig. 14. Sampling levels (Table 4) were not high in most years, thus all samples for a year were combined without weighting other than by the catch of vessels sampled. A single length-weight equation ($\log W = .000011973 + 3.09419 \log L$) was used in sample weighting for both sexes and all years. This was derived on the basis of length-weight observations for 24 years of surveys combined after examination of annual values by sex showed that year and sex effects were sufficiently small that they could be ignored for present purposes.

Historically, landed fish have typically ranged in size from 20 to 35 cm with a mode at about 25 cm. In the period 1970-92, redfish less than 20 cm occurred only rarely in port samples except in 1991, when they accounted for about 13%, but sample numbers were low in that year and the estimate is not very reliable. In 1993 and 1994 there were reports, both from industry sources and DFO field personnel, that very small redfish were being landed. In 1993, nine samples were collected and one of these had as high as 8% of fish under 20 cm but overall the level was 2-3%. To date in 1994 six samples have been collected and the percentage of fish under 20 cm ranged from 0 to 28% with an overall average of 7.5%. Almost all of these small fish were in the range 16-19 cm. The highest percentages of small fish occurred in the 1994 samples from statistical area 4Xo, north and east of Browns Bank where a high proportion of the 1993 catch was also taken. Thus, the estimated percentage of small fish in the landings would be higher if the samples were weighted by statistical area of capture. There is evidence, therefore, which supports the observations that rather higher quantities of redfish less than 20 cm are being landed currently than was the case historically. These small fish are predominantly in landings from TC 1-3 trawlers operating in statistical area 4Xo.

Commercial Gear Selectivity

The otter trawl mesh size traditionally used in the Scotian Shelf redfish fishery is about 90 mm. Neither mesh size nor minimum fish size have been subjects of regulation but the use of 90 mm mesh or larger was made mandatory in 1993 and also for 1994 through licence conditions, thus requiring conformity to what had been previous practice. The selection factor (SF = 50% retention length divided by mesh size) for redfish in diamond mesh bottom trawls is 2.5-2.9. Using 2.7 gives a 50% retention length for 90 mm mesh of 24 cm. Selection range (25-75% retention range) measurements for redfish are also variable, extending from 6.0-14.5 cm. Even at 6 cm, small quantities of redfish under 20 cm could be expected in catches when using 90 mm. Conversely, 25% of redfish of 27 cm would be expected to be escaping from the net and a few even as large as 30 cm. Thus, size selection of redfish by trawl meshes is quite poor, i.e. the selection curve is not sharp, and any increase above 90 mm in order to prevent capture of small fish would have important negative effects also on the catch rates of fish in the 20-30 cm size range, and hence on the economics of fishing.

Conclusions

After a decline in the 1970s, the Unit 3 redfish population maintained a stable level of biomass based on surveys estimates, although commercial catch rates suggest it may have declined slightly. There may have been several recruitment events in the mid 1980s-early 1990s but these year classes were apparently not large ones and did no more than maintain the size of the population. The increase in catch in 1993 was a result of increased fishing effort directed towards redfish as a result of reduced opportunities in other fisheries. The additional effort was not attracted by an increase in fishing success for redfish. Despite the increase in catch, removals in 1993 were still well below the TAC of 10,000 t set for that year.

Advice on a potential catch level for the previous management unit, Div. 4VWX, was based on the concept that catches up to 15% of the population biomass as estimated by research vessel surveys should approximate fishing at $F_{0.1}$. The Unit 3 catch to biomass ratio, smoothed using a 3 yr running mean, was consistently less than or equal to 0.15, whether or not biomass was adjusted for vessel efficiency in 1970-81 (Fig. 15). If the unassigned Div. 4W catches (Table 2) are assumed all to have been taken from Unit 3, then the ratios in the 1970s, using unadjusted biomass are greater than 0.15 and in one case greater than 0.20. This can be viewed as an upper estimate of exploitation level, because it is unlikely that the entire unassigned Div. 4W catch originated from Unit 3. These various assumptions, in any case, do not affect the ratio estimates after 1981 to any significant extent. The average exploitation from 1982 to 1993 is 7%, whereas that for the last five years is 5%. Thus, exploitation

level during the 1980s and early 1990s has been within the 15% guideline. Conversely, applying the guideline to average biomass estimates for these same two periods (65,305 t in 1982-93, 60,642 t in 1989-93) indicates catches as high as 10,000 t and 9,000 t respectively would have conformed to the guideline.

Yield per recruit calculations for Unit 3 redfish are not available but at the low exploitation rates currently prevailing yield per recruit is not sensitive to the size at first capture. Thus, large gains in potential yield from avoiding capture of small fish is unlikely as long as these fish are landed and can be utilized. If large quantities of small fish were being wasted at sea, or if the fishery came to depend very largely on small fish to the exclusion of the larger fish component traditionally fished this would be a different matter.

The present biomass, as judged from the 1993 survey is not greatly different from the average over the last decade or so, and there is no indication of any large year-classes about to enter the fished part of the stock which would cause a great change in its abundance between the present and 1995. Thus, fishing and stock conditions in 1995 might be expected not to differ greatly from those in recent years.

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Table 1. Unit 3 Redfish unadjusted biomass estimates (tons) by stratum for period 1970 to 1993 sorted by stratum total for all years.

stratum	year																							stratum totals	
	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92		93
470	0	37027	86055	96743	6795	4290	261	15599	162	469	43	19286	6244	96882	15647	738	7544	3041	9871	1392	8908	850	71969	2842	492659
460	4848	3338	427	2110	0	10037	268	46451	143891	5308	11050	1439	502	55	6383	83	933	3478	14555	1729	15094	8764	18852	4281	303879
484	3742	2686	55487	8662	7576	3734	12887	8807	1903	13452	571	1169	749	746	22910	5658	45029	1492	7292	1542	3171	6667	3588	44955	264473
459	41583	233	8389	14984	5819	400	786	19529	0	773	0	947	37525	7346	6743	4923	1249	522	29090	1781	217	584	173	3845	187441
461	4601	2079	11314	1611	188	138845	45	71	162	551	57	53	0	0	50	50	16877	130	160	211	0	0	143	50	177249
462	15516	26263	4271	1292	410	1482	7789	77	19955	93	113	493	135	46	3415	1397	10126	612	11086	5368	9201	1180	37	133	120489
476	1948	122	0	7178	8719	253	7595	2013	0	0	3617	0	0	0	3610	0	122	42616	727	917	6828	1280	487	1966	89998
481	0	93	0	0	397	491	348	0	0	87	218	0	164	8588	30954	73	0	53	8692	0	13830	59	6076	966	71098
482	0	0	1098	0	81	12517	54	0	2936	903	0	6181	472	227	850	2707	0	0	30	642	698	0	11700	32	41129
478	1933	10	38	300	12	7	87	530	0	1927	144	1558	3428	4274	9897	0	216	0	0	8588	7	1067	13	10	34044
483	46	2919	59	855	1819	3588	0	4721	960	1326	357	696	225	719	1822	615	394	567	1091	3282	2284	1481	1429	23	31278
471	2251	15246	344	1321	140	39	159	62	6368	41	0	346	44	248	376	175	438	1226	175	0	0	47	0	175	29221
485	196	78	235	3279	1760	0	704	0	146	3404	0	0	1579	2793	2590	52	9287	92	0	958	0	0	0	695	27845
472	0	0	0	1331	0	0	0	4792	0	73	0	0	19346	49	0	0	0	0	31	65	17	24	0	0	25728
491	1507	22	20	641	2571	156	163	2152	1785	181	42	2667	1170	328	657	475	100	118	110	261	1075	2573	54	1077	19905
492	0	89	25	62	128	10430	169	165	1616	27	207	134	0	221	63	30	409	644	451	45	221	202	1461	0	16801
466	70	916	19	511	19	32	37	8	6	21	264	0	1058	100	15	13	91	8421	10	1066	7	52	0	10	12744
465	29	0	0	0	0	0	0	0	0	236	0	0	0	0	0	0	0	0	0	176	165	22	0	8439	9066
490	0	45	22	59	20	172	0	297	83	0	0	15	0	0	0	0	36	0	0	0	0	0	0	0	749
456	0	0	0	240	0	36	22	0	0	14	0	0	0	0	0	26	139	12	0	0	0	0	0	0	489
477	0	0	0	0	0	0	0	91	0	0	0	122	0	107	0	0	0	21	0	0	0	0	0	81	423
474	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	246	0	0	84	0	0	0	0	330
464	0	0	0	101	0	0	0	0	0	96	0	0	0	0	0	0	0	0	0	0	0	0	0	0	197
458	0	0	36	0	0	0	90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	126
473	9	32	0	0	0	0	0	0	18	0	0	0	0	9	0	11	0	0	0	0	0	0	0	0	79
475	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	6	0	13	0	0	0	0	40
493	0	0	0	0	0	0	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36
463	0	0	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32
494	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17
480	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	8
495	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	78281	91215	167871	141281	36453	186509	31502	105364	179989	28981	16682	35106	72660	122750	105983	17027	93235	63053	83373	28117	61730	24851	115982	69580	1957575

Table 2. Nominal catches(t) of Unit 3 redfish by NAFO Division and country or Canadian Region, and Div. 4W catches not assigned to management Unit, 1970-1993. (Div. 4X data from NAFO Statistical Bulletins, Div 4W data for Canada(M) from Scotia Fundy Regional statistics files and for USA from Power (1992). Data for 1993 are provisional.)

Year	4Wdehkl			4X						Unit 3	
	Can (M)	USA	Total	Can (M)	Can (N)	USA	USSR	Other	Total	Total	4W NK
1970	1040	1191	2231	3665	7	330	384	38	4424	6655	8751
1971	1502	1681	3183	7390	0	3156	1226	4	11776	14959	12098
1972	2865	6298	9163	2494	0	5702	773	3	8972	18135	8689
1973	1870	4642	6512	1046	0	5553	485	42	7126	13638	5758
1974	7616	4794	12410	1393	0	3352	598	810	6153	18563	4018
1975	1541	2546	4087	984	0	2825	86	8	3903	7990	3968
1976	1120	682	1802	1066	0	3706	38	2	4812	6614	367
1977	1184	580	1764	930	0	2292	3	0	3225	4989	220
1978	553	124	677	648	1	2023	0	8	2680	3357	162
1979	1069	0	1069	795	4	719	0	3	1521	2590	178
1980	1433	0	1433	1441	4	885	0	21	2351	3784	97
1981	2044	0	2044	1688	1	762	0	2	2453	4497	400
1982	355	0	355	2735	1	1611	0	0	4347	4702	114
1983	937	0	937	3109	2	815	0	0	3926	4863	63
1984	1504	0	1504	3129	5	872	0	0	4006	5510	38
1985	1436	0	1436	4410	0	32	0	0	4442	5878	214
1986	1051	0	1051	5572	0	62	0	0	5634	6685	56
1987	1082	0	1082	5034	0	46	0	0	5080	6162	148
1988	671	0	671	3235	0	10	0	0	3245	3916	109
1989	1236	0	1236	1969	1	1	18	0	1989	3225	242
1990	268	0	268	1981	0	9	7	0	1997	2265	285
1991	274	0	274	1612	4	4	60	3	1683	1957	114
1992	233	0	233	2131	0	3	12	47	2193	2426	231
1993	188	0	188	4883	4883	5071	130

Note: 4W NK (unknown) for 1993 includes Div. 4X catches by Russia and other.

Table 3. Nominal catch (t), hours fished and days fished by Scotia Fundy Region Bottom Trawlers fishing Unit 3 redfish (main species redfish trips only) by vessel type/tonnage class category, 1970-93.

Year	TC4, Side Trawl			TC5, Stern Trawl			TC2, Stern Trawl			TC3, Stern Trawl		
	Catch	Hours	Days	Catch	Hours	Days	Catch	Hours	Days	Catch	Hours	Days
1970	4781	5286	464	1019	795	69	0	0	0	12	96	8
1971	7516	10216	942	1887	1346	103	15	153	11	112	82	11
1972	5453	6525	590	886	672	59	0	0	0	0	0	0
1973	2725	3632	362	130	293	25	0	0	0	0	0	0
1974	1860	3237	362	404	1005	93	0	0	0	0	0	0
1975	1939	3197	313	230	385	35	0	0	0	41	40	4
1976	1621	3205	283	237	148	26	0	0	0	19	55	11
1977	901	2183	196	297	628	79	0	0	0	27	61	7
1978	640	1244	134	328	639	72	0	0	0	0	0	0
1979	685	1418	160	349	434	57	0	0	0	0	0	0
1980	654	903	102	1170	1634	200	44	213	29	36	35	7
1981	1326	1069	161	1802	1805	192	34	133	28	125	96	13
1982	1120	922	150	870	1410	155	258	499	86	98	230	26
1983	1630	1207	203	947	1207	138	495	515	91	96	260	28
1984	2242	1360	224	214	292	40	1253	2071	280	270	433	65
1985	3416	1935	345	56	98	17	1149	1597	231	926	940	159
1986	2870	2235	381	829	1461	159	891	1907	295	1494	2103	313
1987	1928	1507	262	204	435	47	1247	2336	427	1506	2412	446
1988	1055	749	124	50	150	18	731	1441	243	747	1099	167
1989	1239	1083	150	55	91	10	1007	1335	246	528	564	127
1990	1249	515	169	26	26	4	259	609	64	107	371	44
1991	742	719	111	63	268	20	265	387	40	168	264	37
1992	1323	1365	180	186	215	21	143	703	121	176	572	56
1993	1373	1613	191	340	383	41	1584	3204	335	1302	1909	203

Table 4. Unit 3 Redfish: numbers of port samples collected from Scotia Fundy Landings by tonnage class and year, 1970-1993.

Year	Vessel Tonnage Class				Total
	TC4	TC5	TC2	TC3	
1970	5	1	0	0	6
1971	3	1	0	0	4
1972	5	0	0	0	5
1973	8	0	0	0	8
1974	4	0	0	0	4
1975	3	0	0	0	3
1976	2	1	1	0	4
1977	3	3	0	0	6
1978	3	2	0	0	5
1979	4	2	0	0	6
1980	3	4	1	0	8
1981	2	2	2	0	6
1982	3	13	1	1	18
1983	2	11	2	2	17
1984	1	1	9	2	13
1985	0	1	5	4	10
1986	1	1	2	9	13
1987	0	1	2	10	13
1988	0	1	4	4	9
1989	2	0	4	1	7
1990	2	1	1	0	4
1991	1	3	0	0	4
1992	0	1	0	3	4
1993	0	4	2	3	9

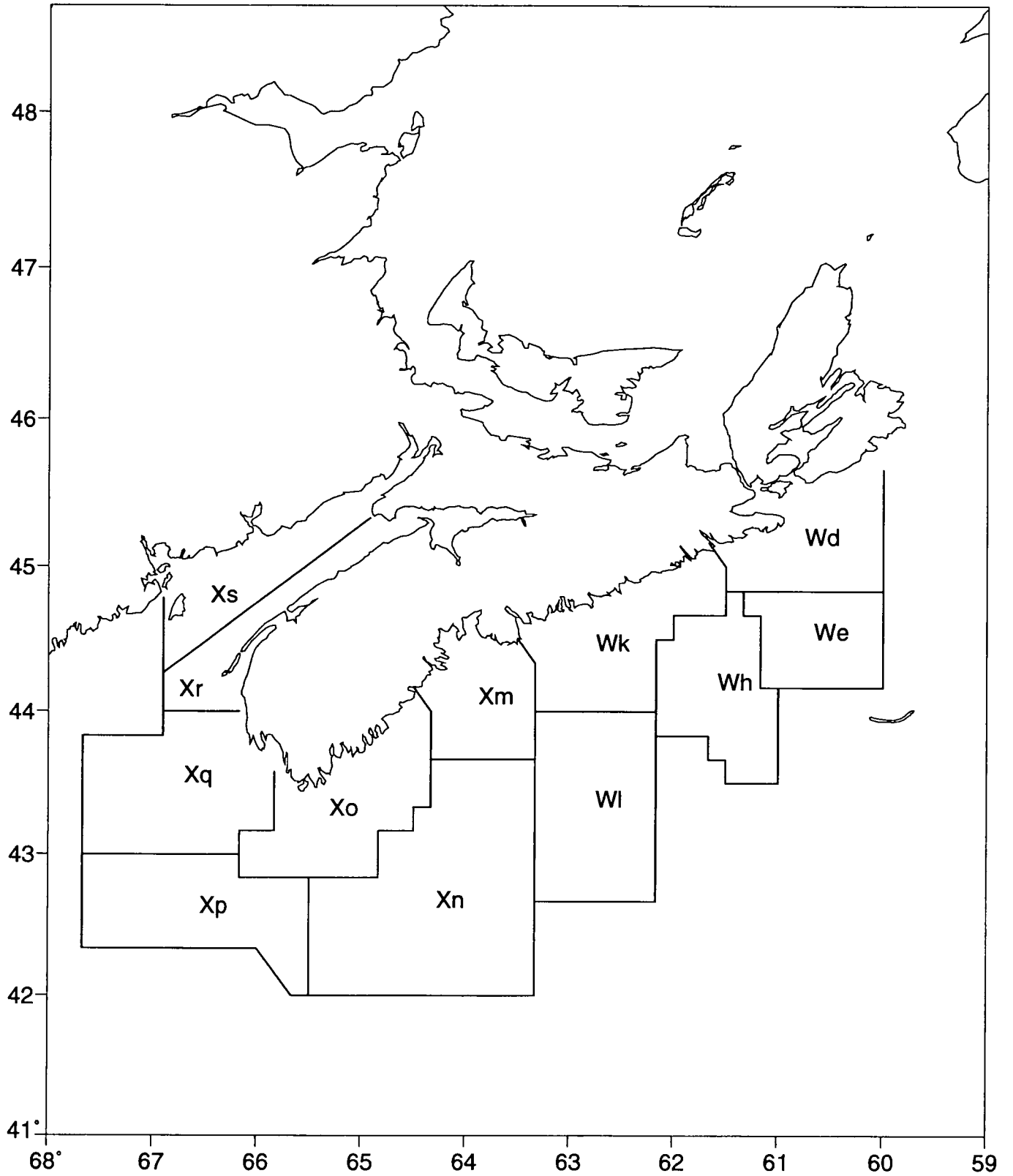


Fig 1. Unit 3 Redfish statistical unit areas.

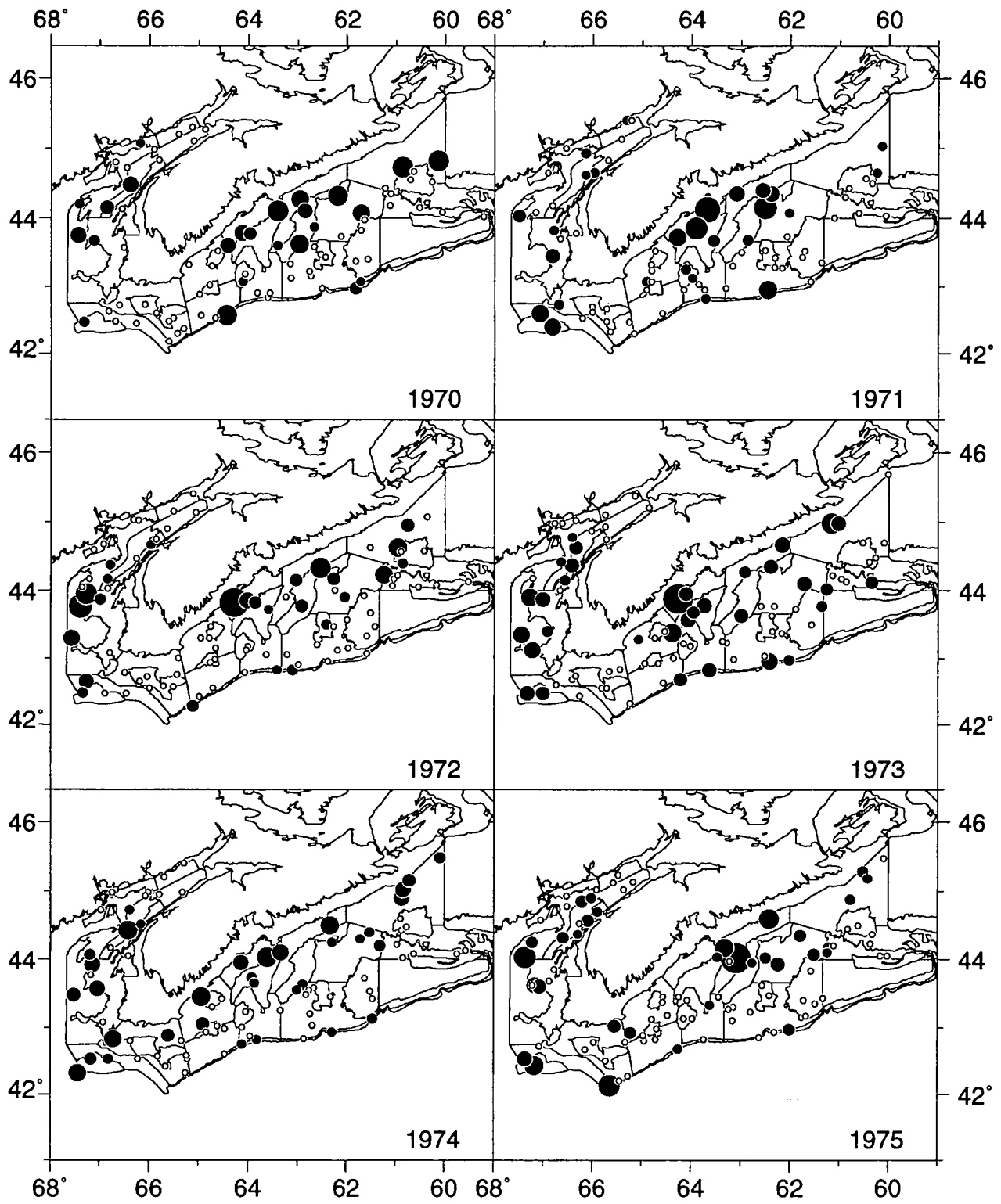
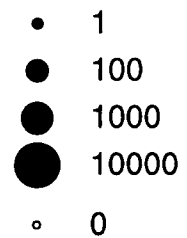


Fig 2a. Unit 3 Redfish Catch Rate 1970-1975
kg/tow from Scotia Fundy Summer Surveys



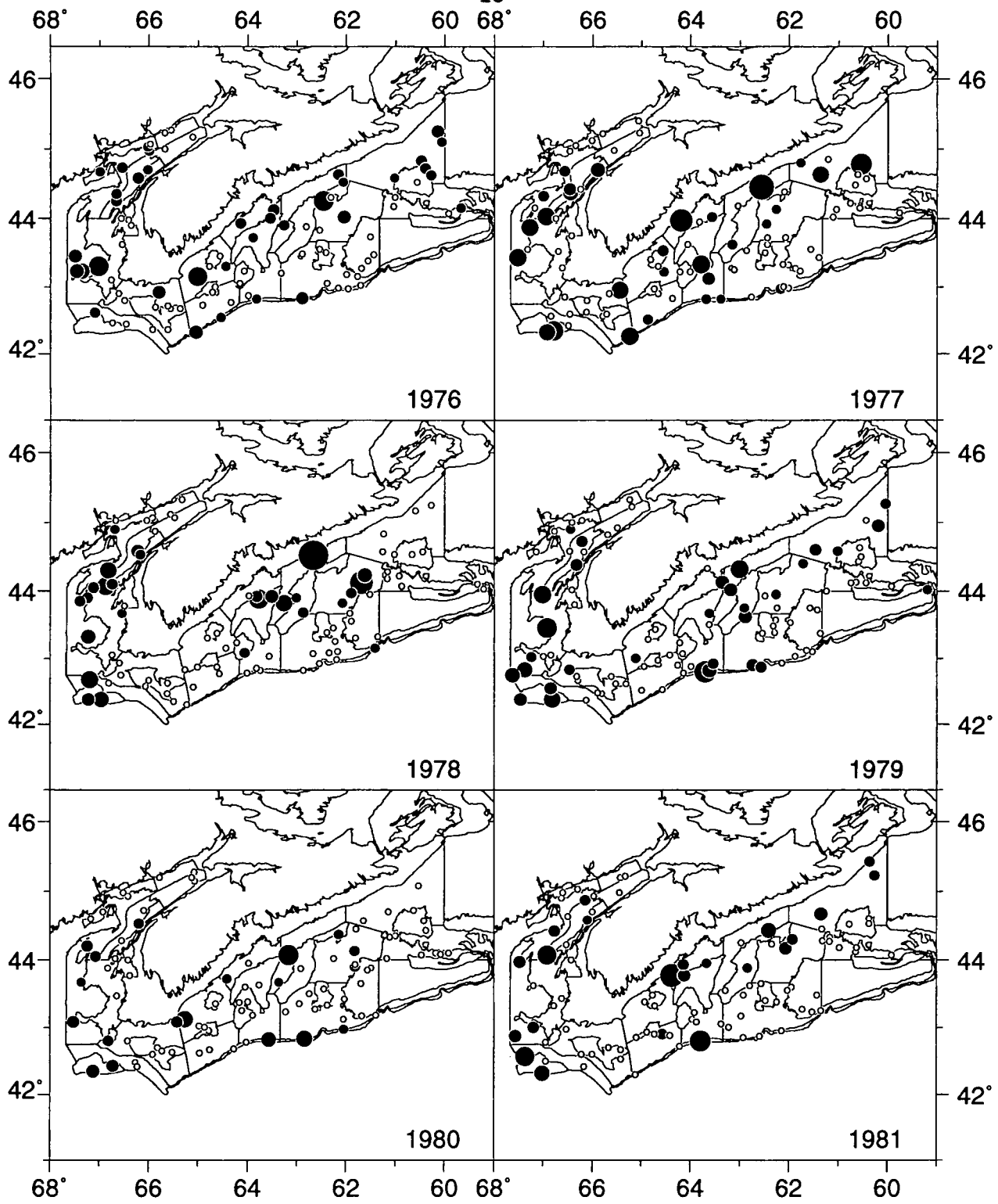
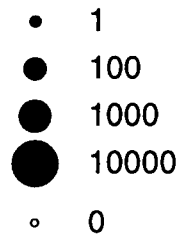


Fig 2b. Unit 3 Redfish Catch Rate 1976-1981
kg/tow from Scotia Fundy Summer Surveys



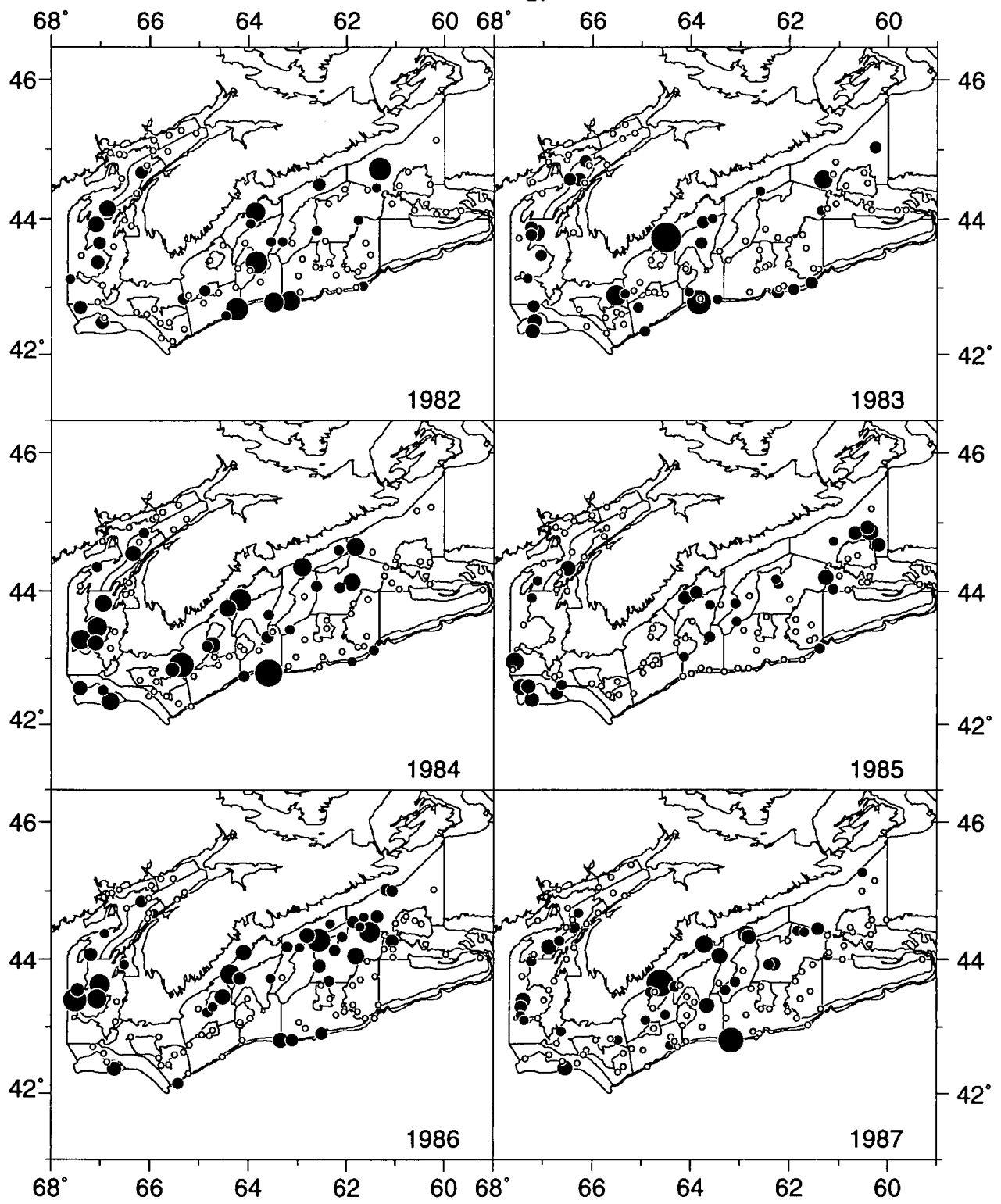
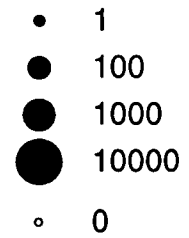


Fig 2c. Unit 3 Redfish Catch Rate 1982-1987
kg/tow from Scotia Fundy Summer Surveys



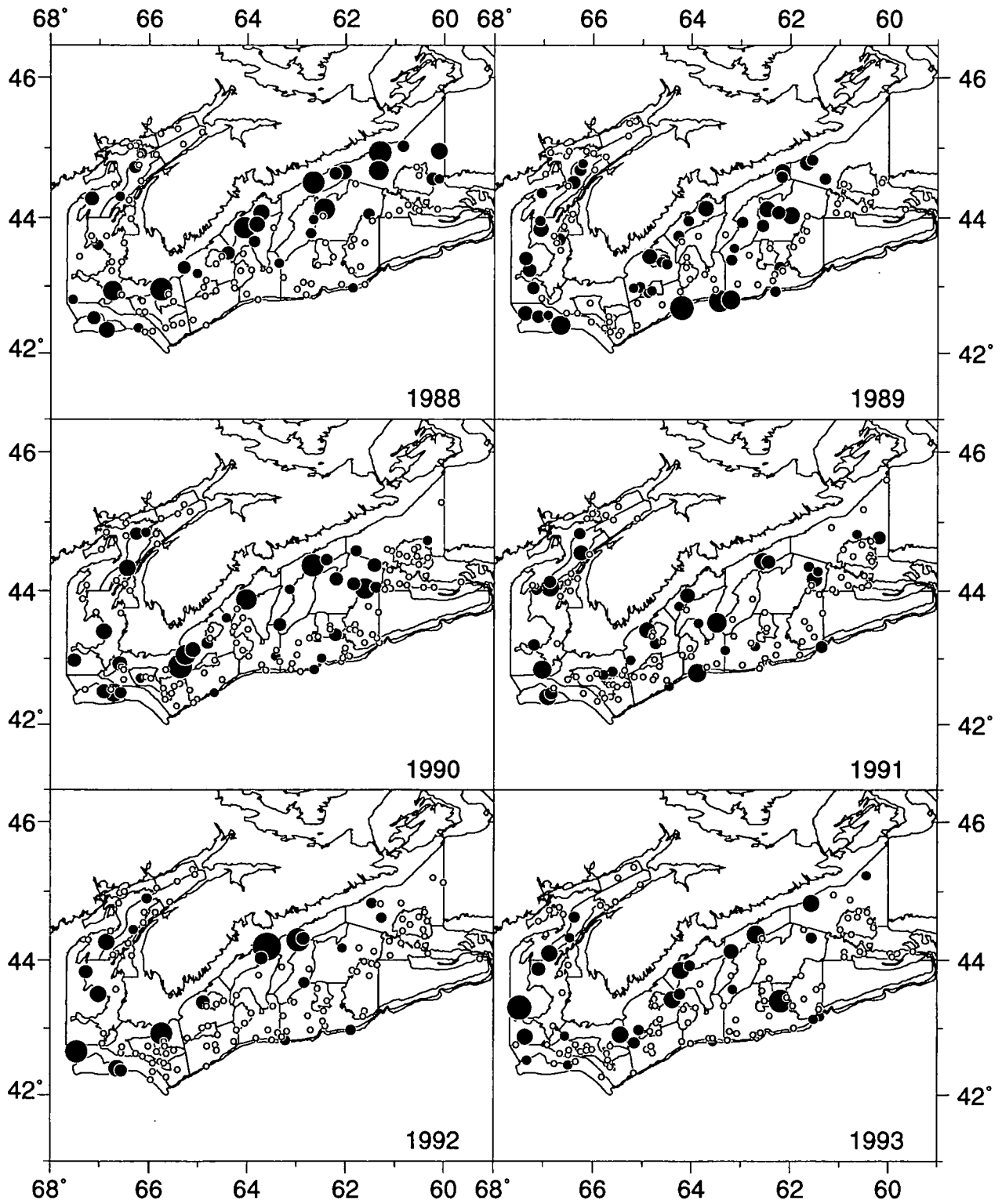
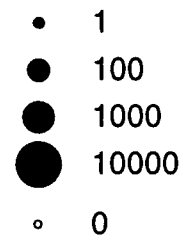


Fig 2d. Unit 3 Redfish Catch Rate 1988-1993
kg/tow from Scotia Fundy Summer Surveys



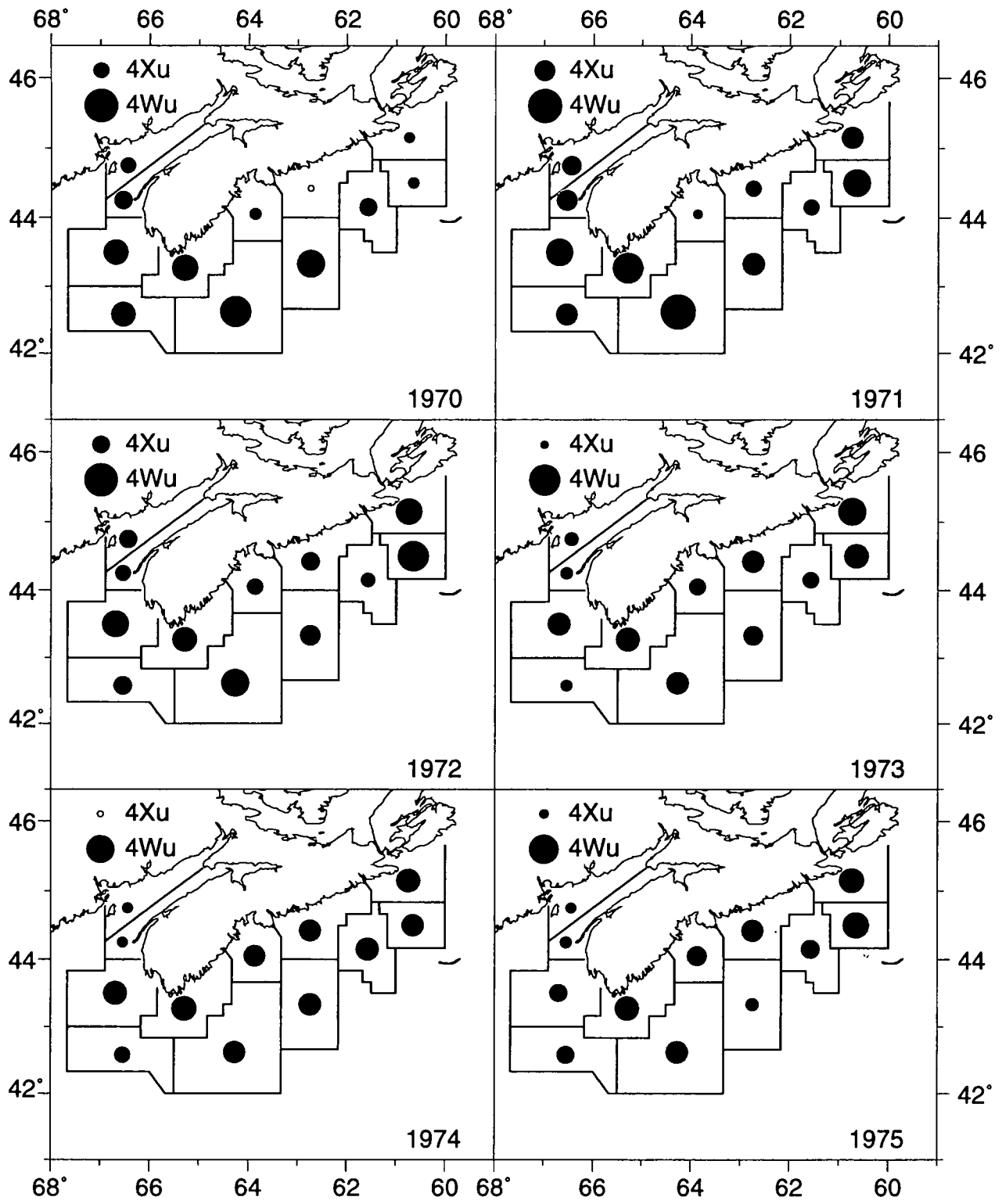


Fig 3a. Unit 3 Scotia Fundy redfish landing(t) 1970-1975 by year and statistical unit area.

- 1
- 50
- 500
- 5000
- 0

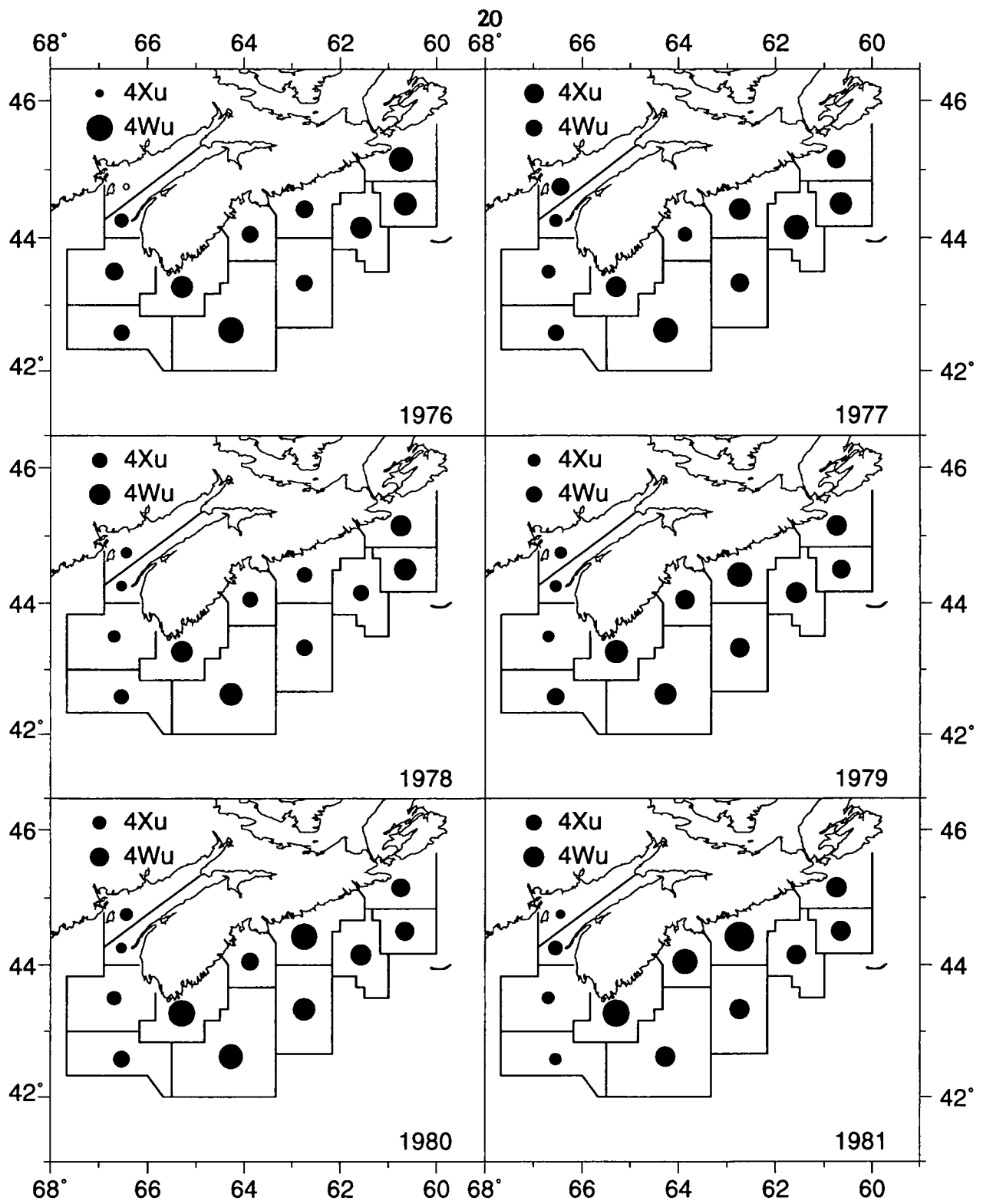


Fig 3b. Unit 3 Scotia Fundy redfish landing(t) 1976-1981 by year and statistical unit area.

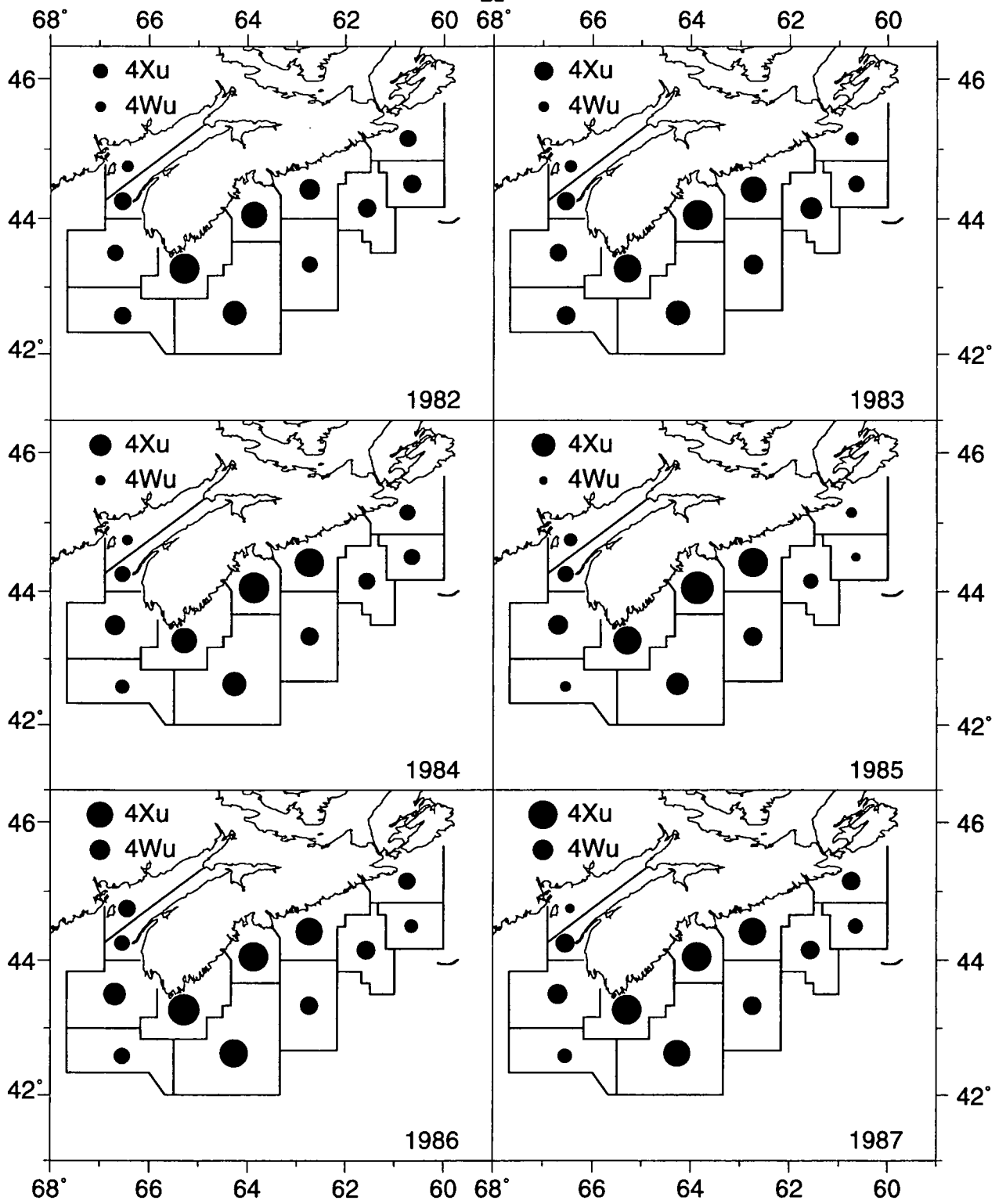
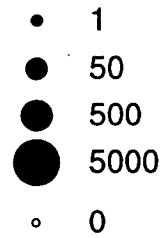


Fig 3c. Unit 3 Scotia Fundy redfish landing(t) 1982-87 by year and statistical unit area.



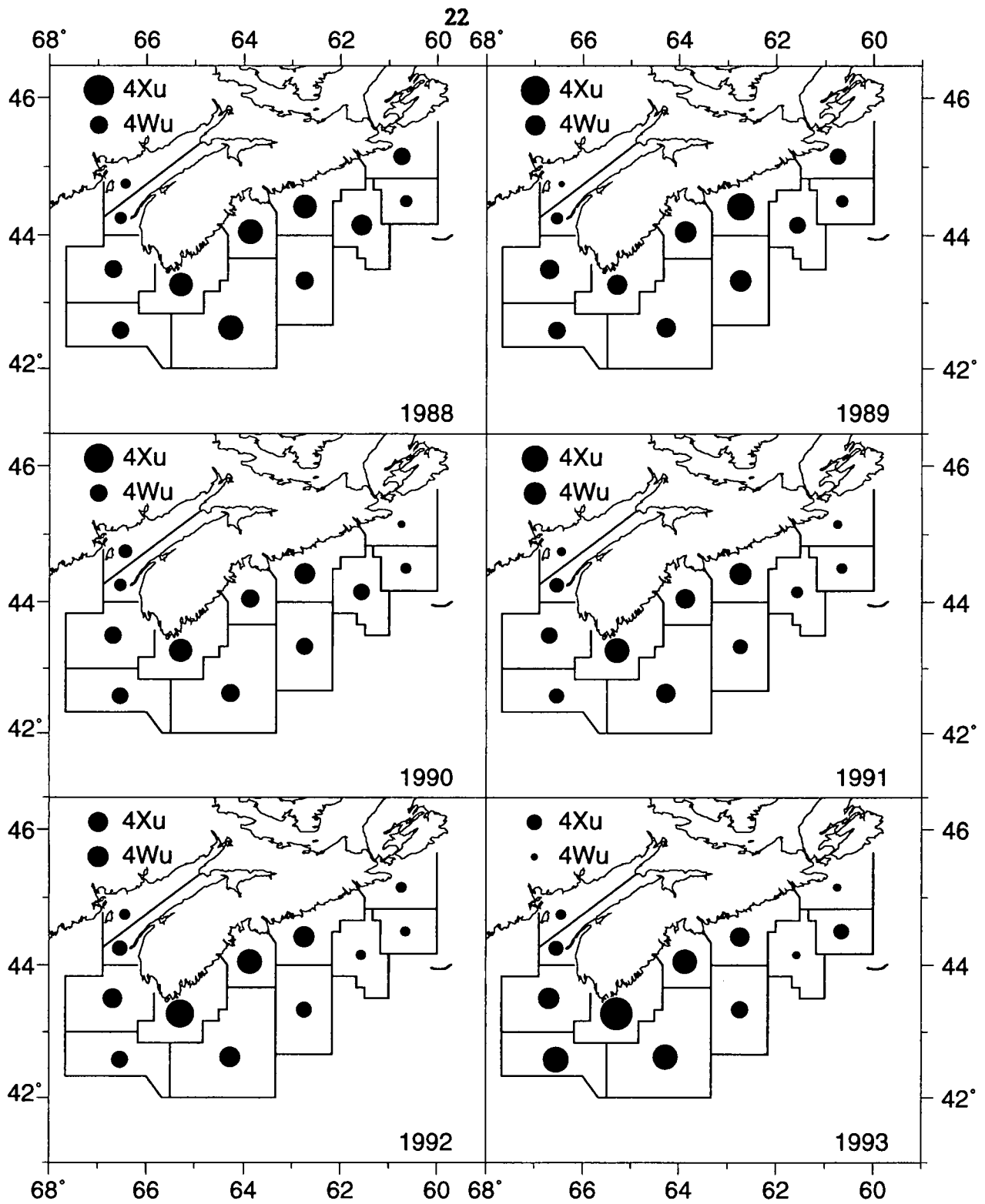
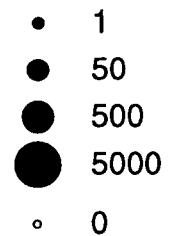


Fig 3d. Unit 3 Scotia Fundy redfish landing(t) 1988-1993 by year and statistical unit area.



Unit 3 Redfish Landings Distribution % of Total by Unit Area

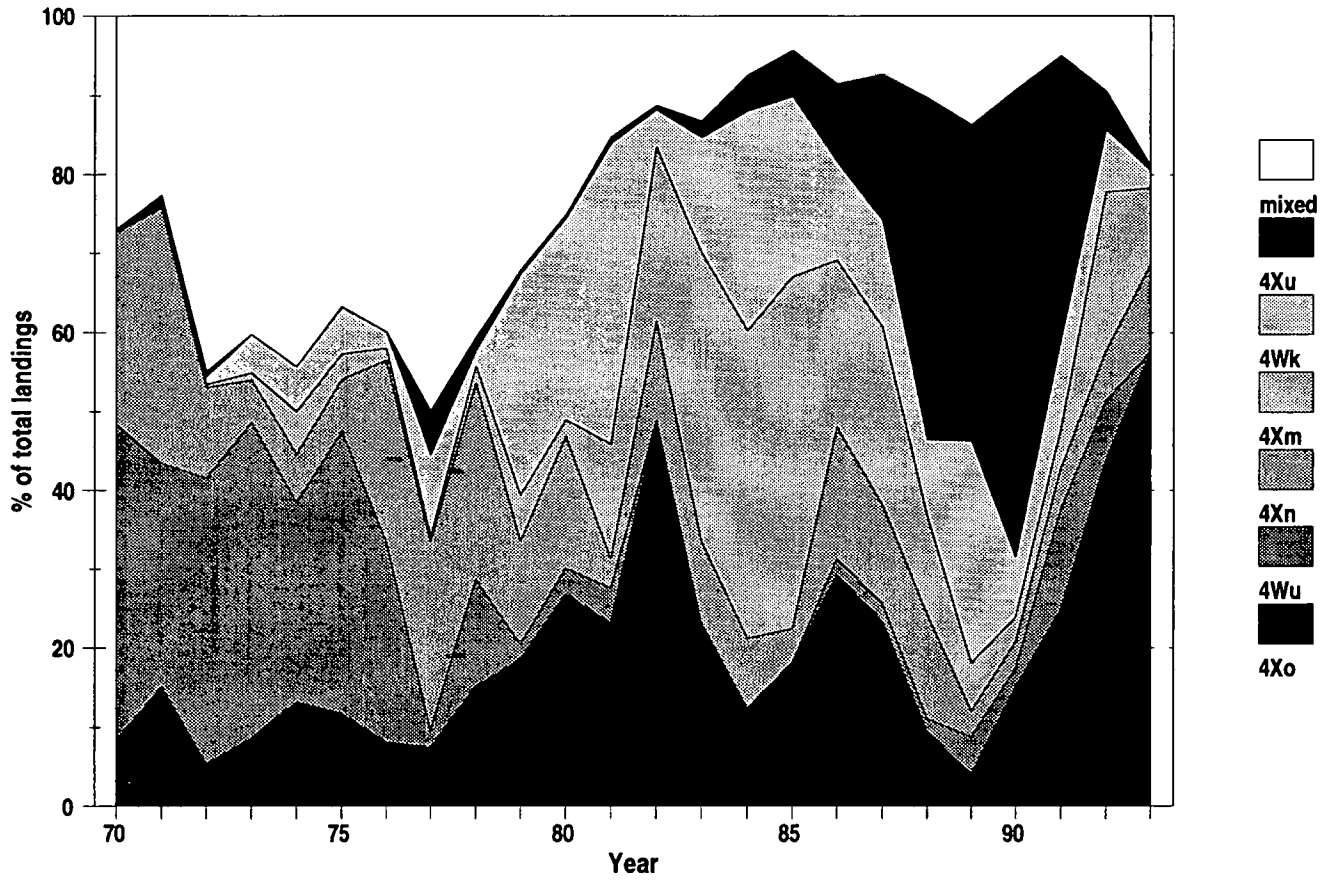


Fig 4. Percentage of Scotia Fundy Region landings by statistical unit area 1970- 1993

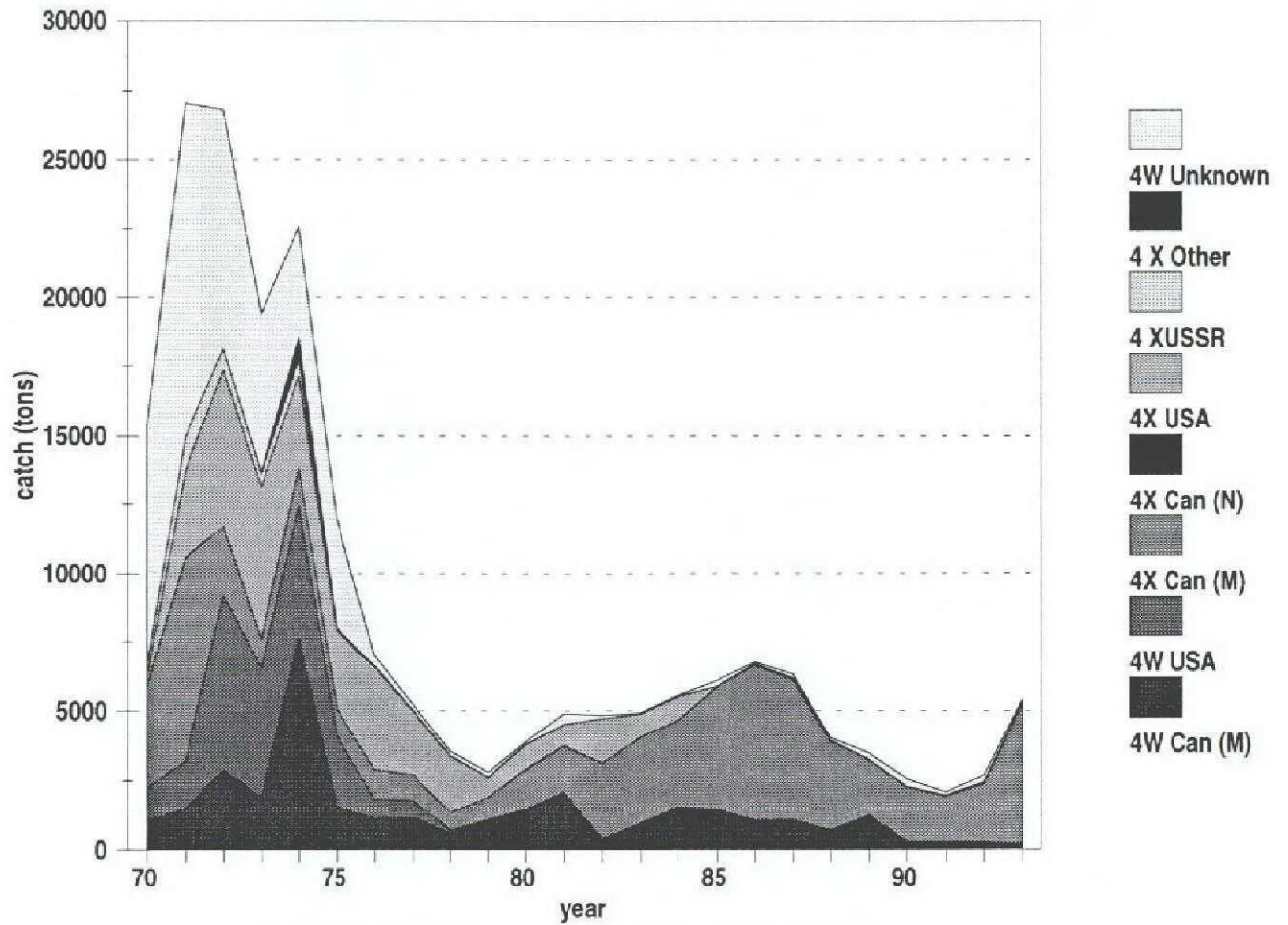


Fig 5. Nominal catches (t) of Unit 3 redfish by NAFO Division and country or Canadian Region and Div 4W unknown catches not assigned to management unit, 1970-1993.

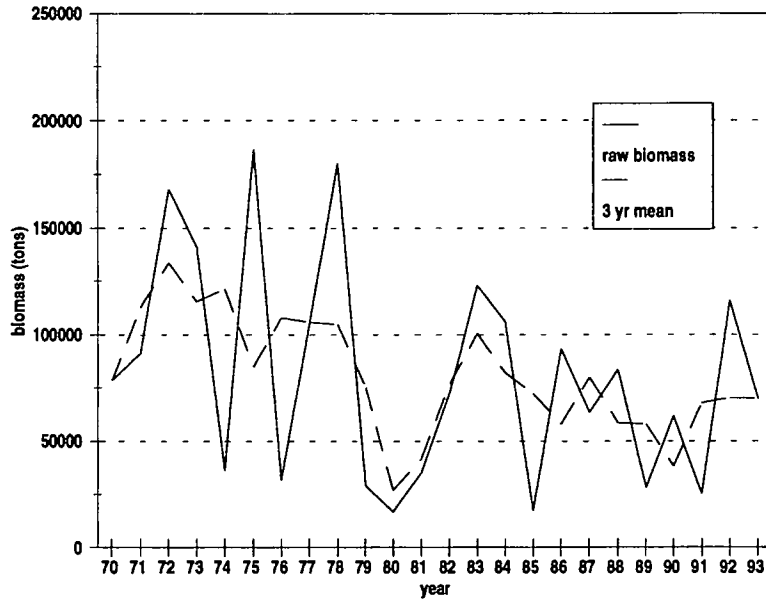


Fig 6a. Unit 3 redfish unadjusted biomass (tons) from Scotia Fundy summer survey for period 1970 to 1993.

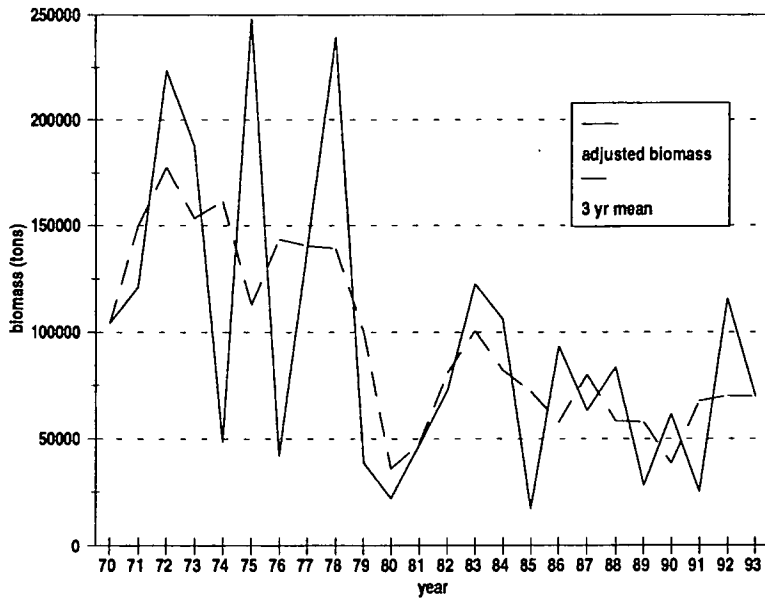


Fig 6b. Unit 3 redfish adjusted biomass (tons) from Scotia Fundy summer survey for period 1970 to 1993.

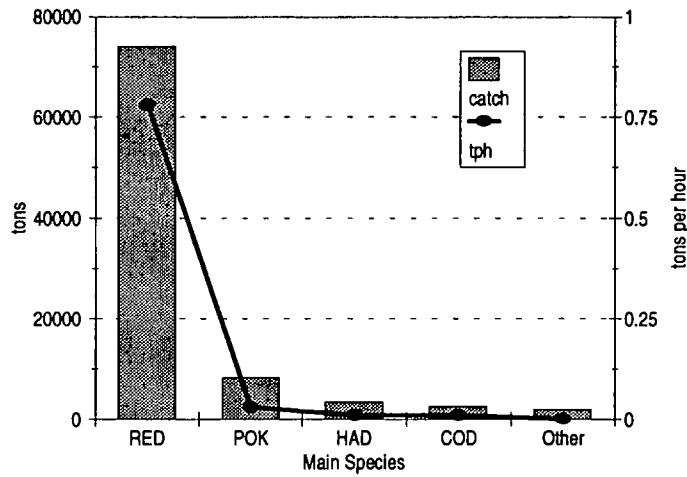


Fig 7. Scotia Fundy total landings (t) and overall catch rate (tons per hour) of Unit 3 redfish by main species caught in 1970 to 1993 period.

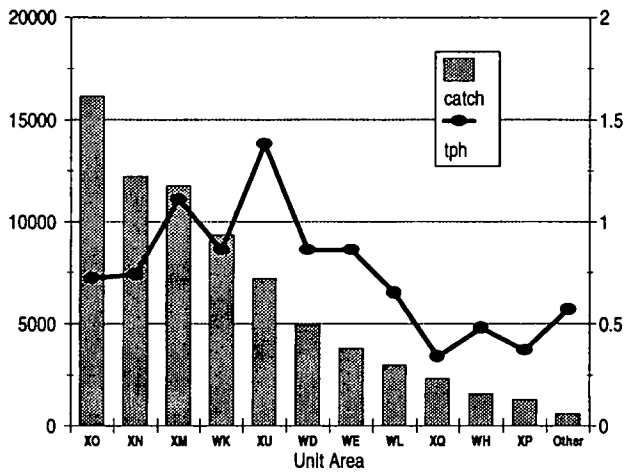


Fig 8. Scotia Fundy total landings (tons) and overall catch rate (tons per hour) of Unit 3 redfish by statistical unit area in 1970 to 1993 period where main species was redfish.

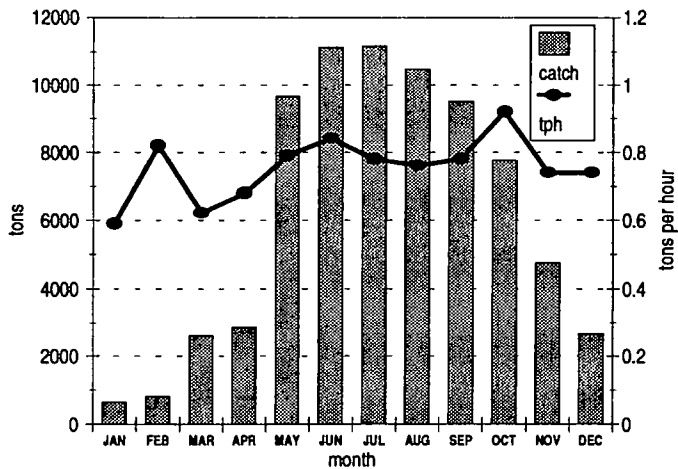


Fig 9. Scotia Fundy total landings (tons) and overall catch rate (tons per hour) of Unit 3 redfish by month for 1970 to 1993 where main species was redfish.

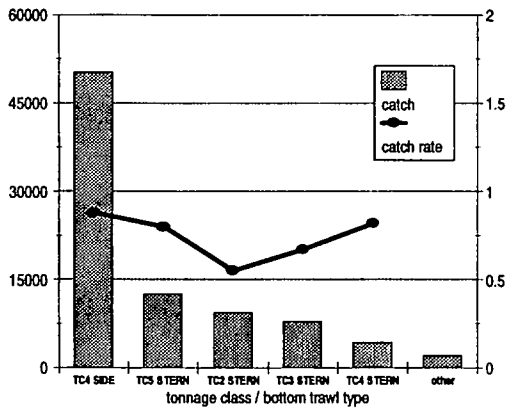


Fig 10. Scotia Fundy total landings (tons) and overall catch rate (tons per hour) of Unit 3 redfish by vessel type and tonnage class (where main species was redfish) for 1970 to 1993 period.

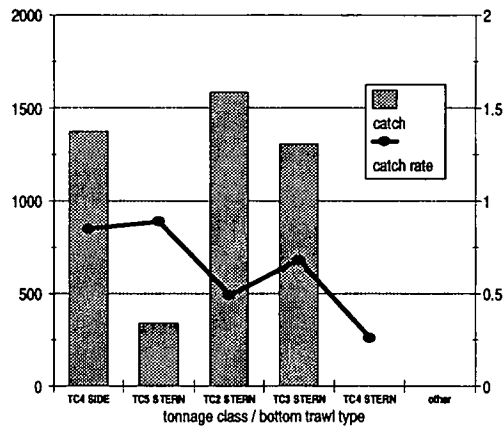


Fig 11. Scotia Fundy landings (tons) and overall catch rate (tons per hour) of Unit 3 redfish by vessel type and tonnage class (where main species caught was redfish) for 1993 only.

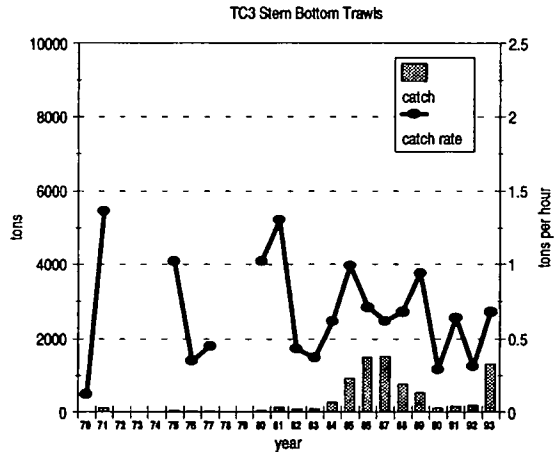
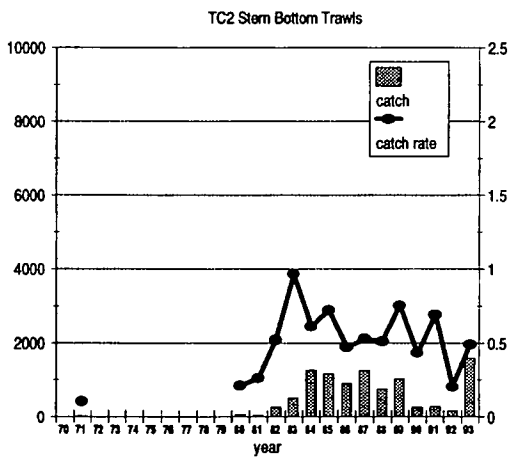
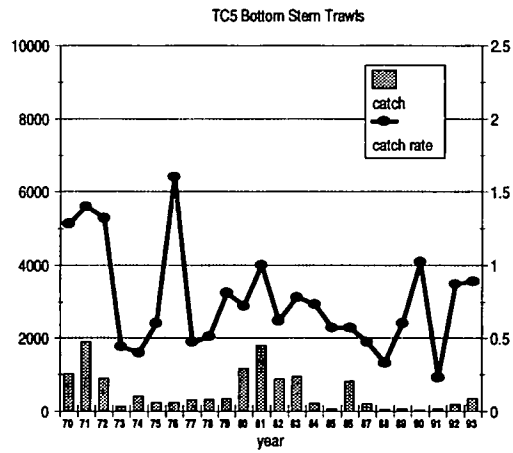
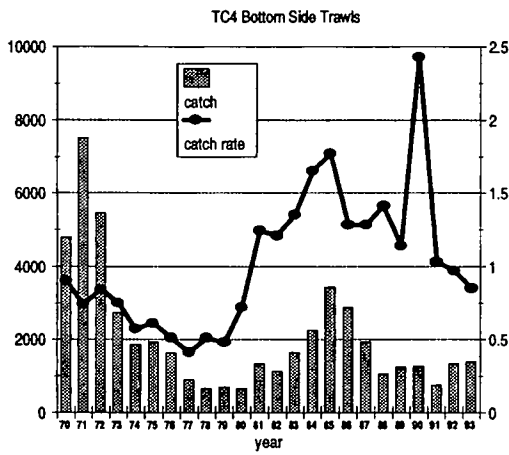


Fig 12 Scotia Fundy Region annual landings (tons) and bottom trawl catch rates(tons per hour) of Unit 3 redfish by vessel type and tonnage class category for period 1970 to 1993 where main species caught is redfish.

Unit 3 Redfish

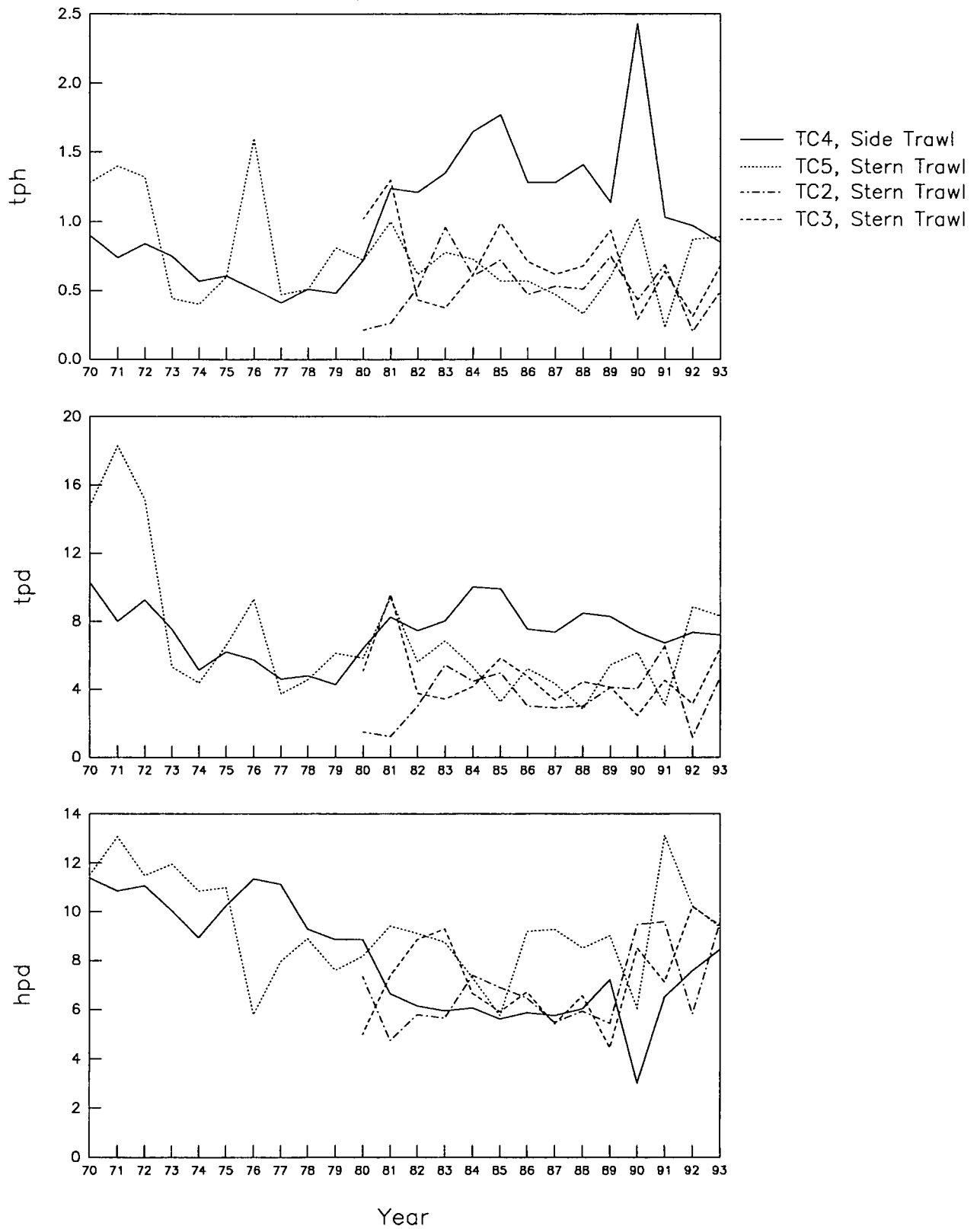


Fig. 13. Annual catch rates (tons per hour and tons per day fished) and hours fished per day of Scotia Fundy Region bottom trawlers fishing Unit 3 redfish, 1970–93, by vessel type/tonnage class category (main species redfish trips only).

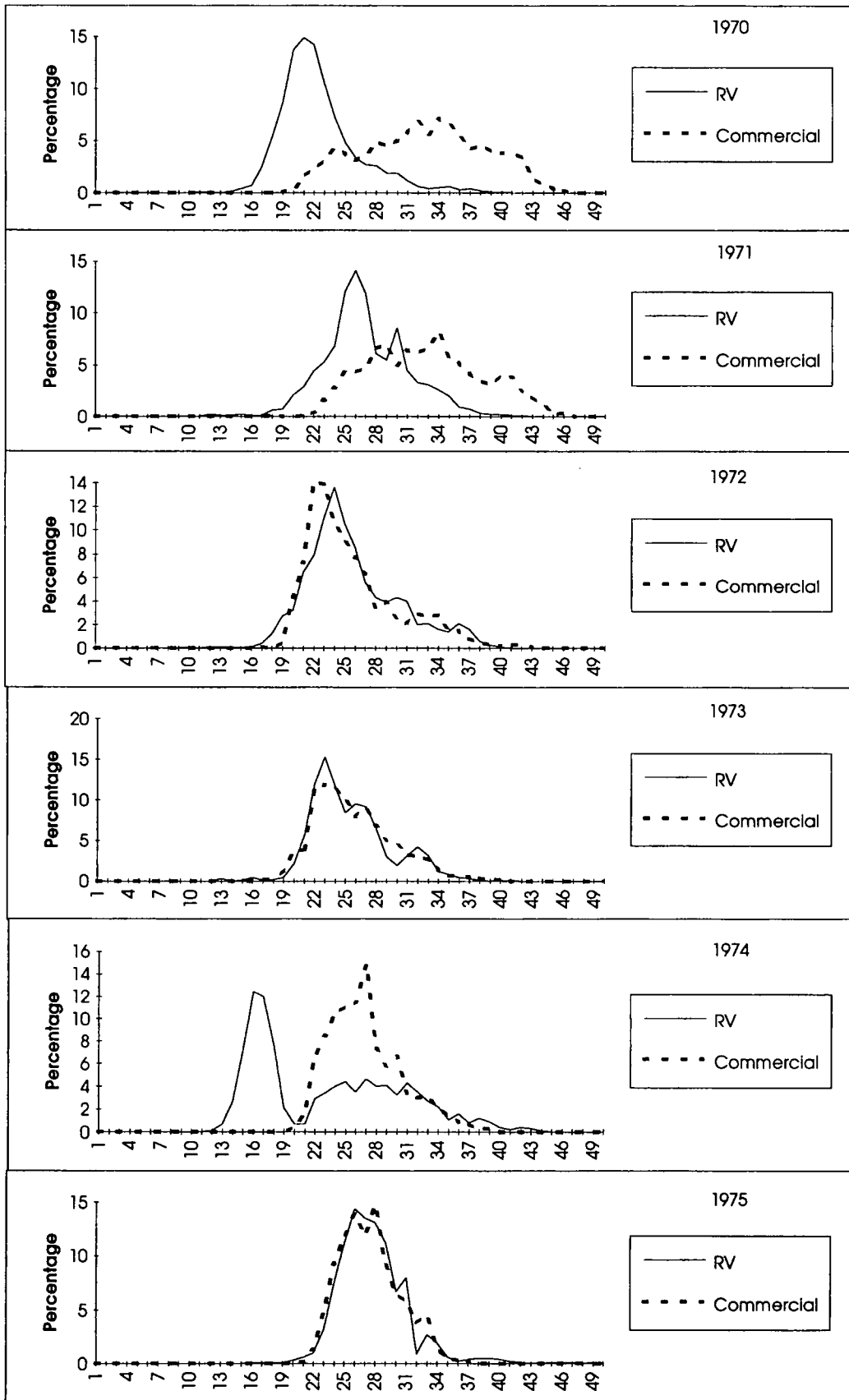


Fig. 14a: Annual percentage size compositions of unit 3 redfish from July bottom trawl surveys and of Scotia Fundy region commercial landings based on port sampling. (1970-1975)

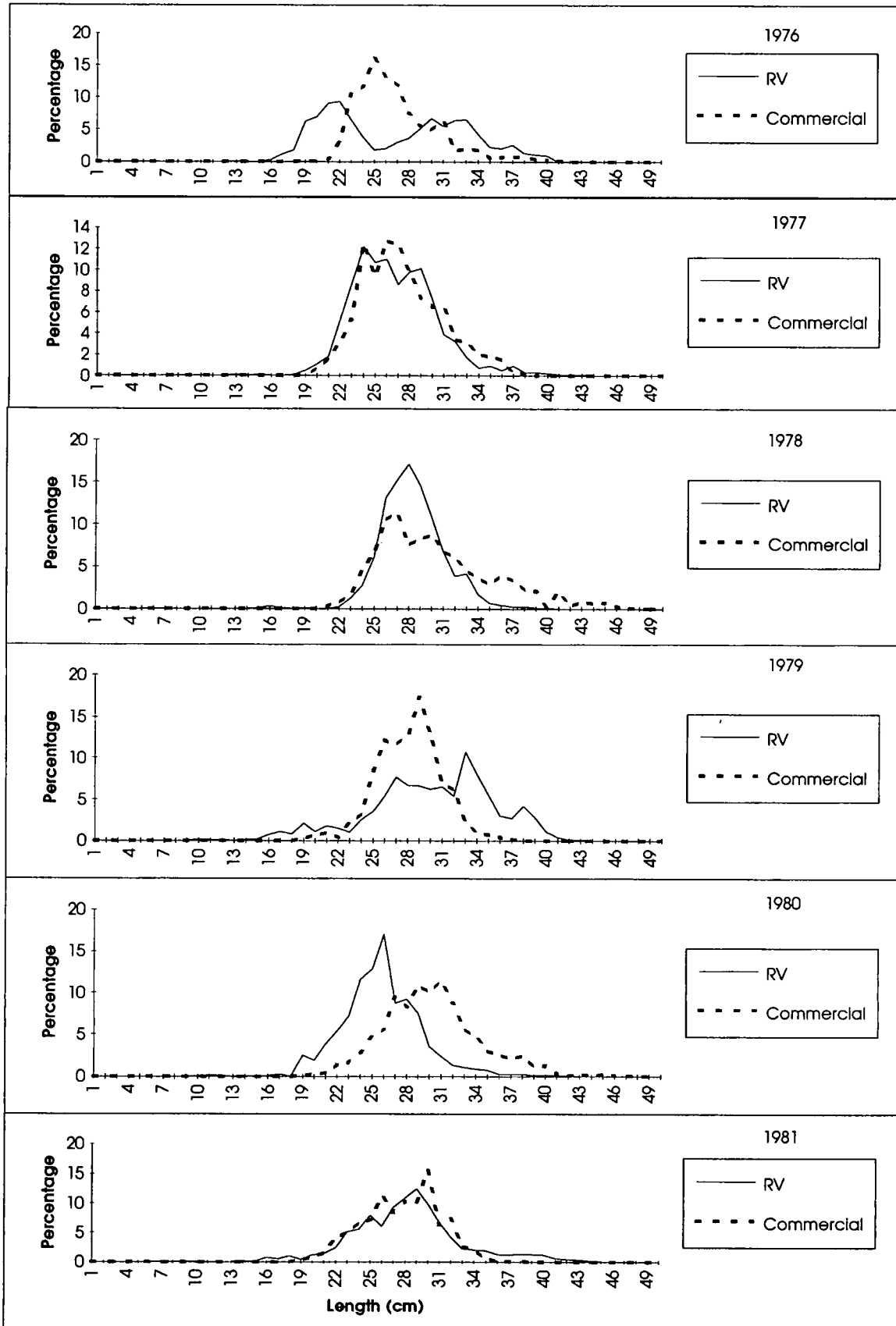


Fig. 14b: Annual percentage size compositions of unit 3 redfish from July bottom trawl surveys and of Scotia Fundy region commercial landings based on port sampling. (1976-1981)

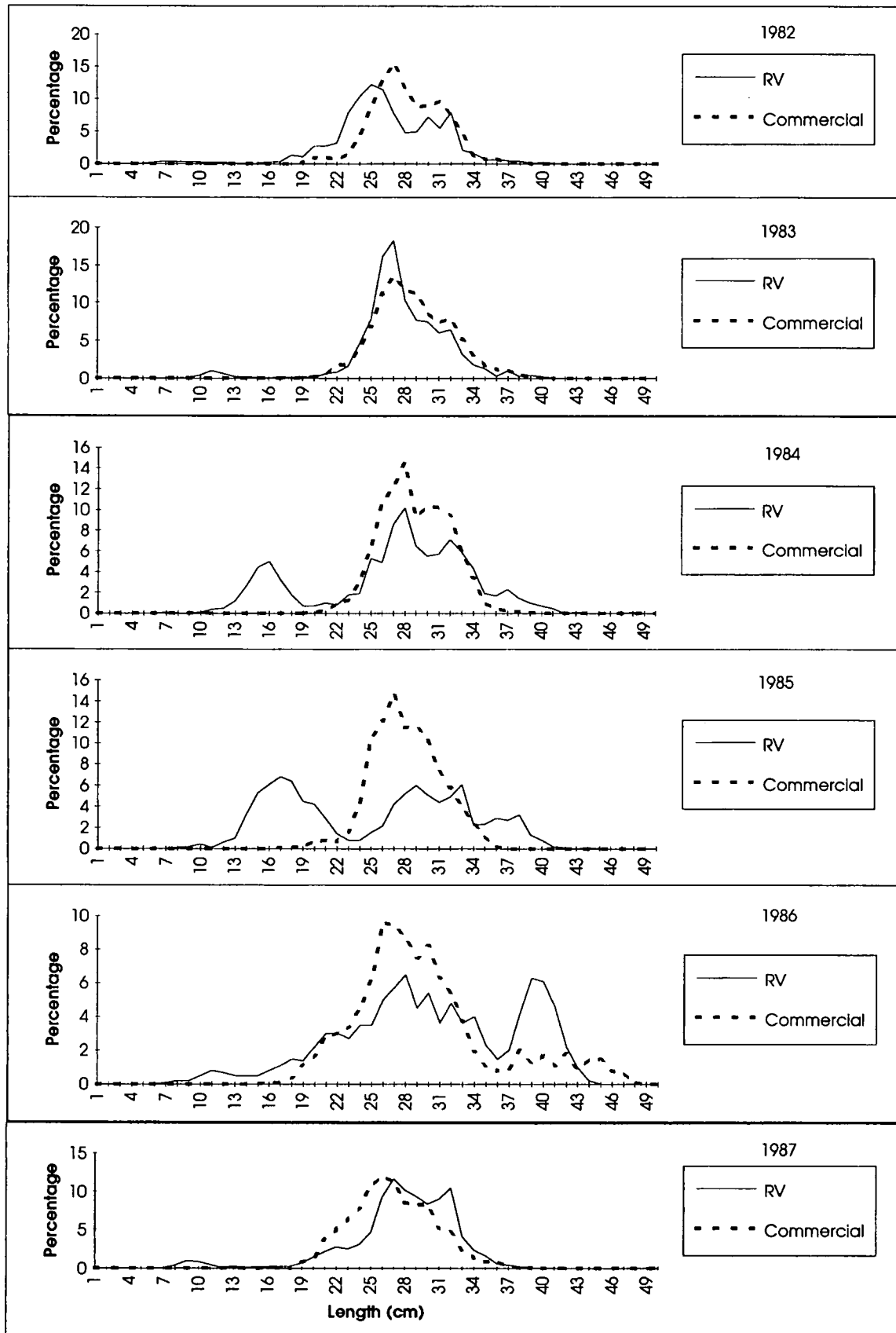


Fig. 14c: Annual percentage size compositions of unit 3 redfish from July bottom trawl surveys and of Scotia Fundy region commercial landings based on port sampling. (1982-1987)

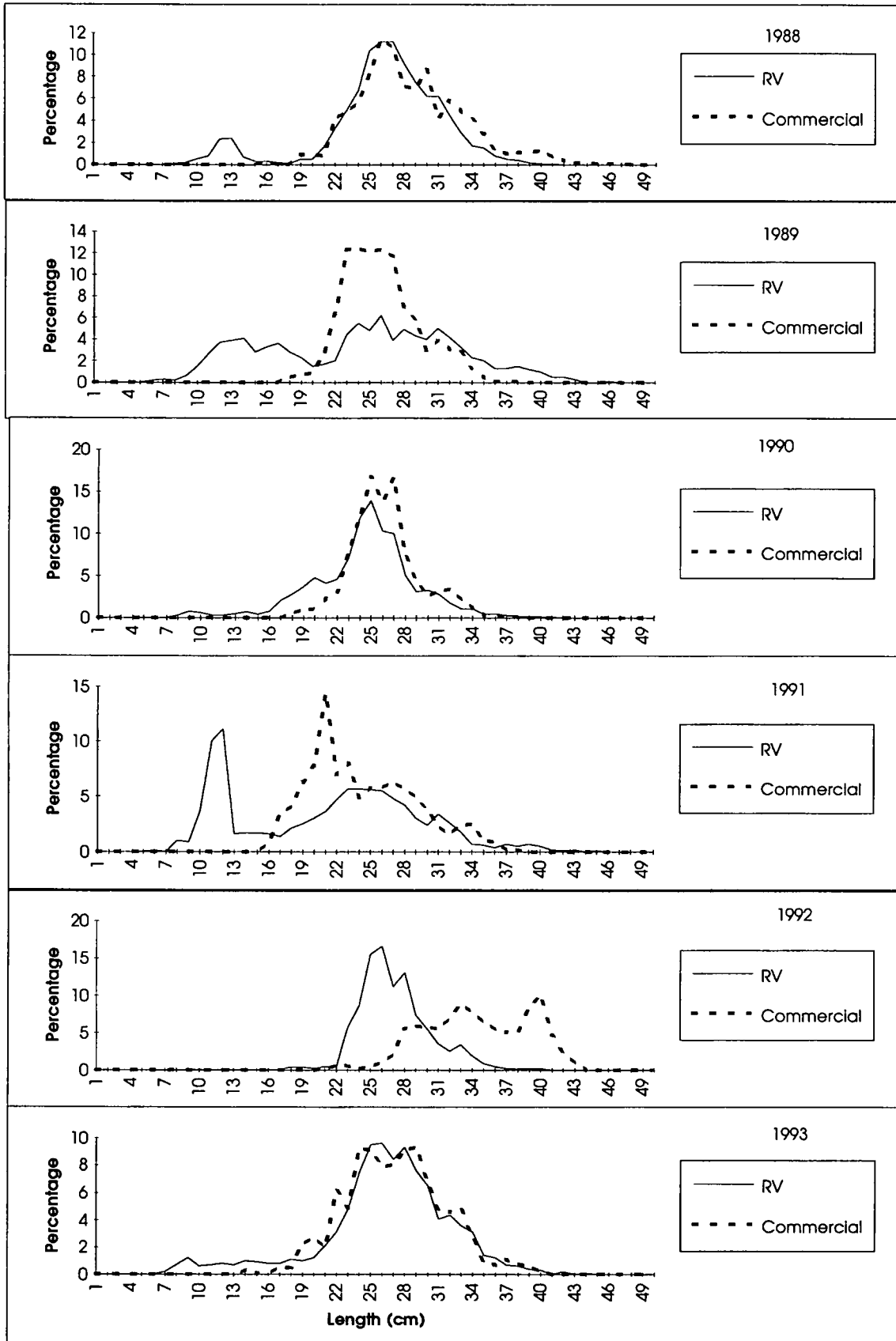


Fig. 14d: Annual percentage size compositions of unit 3 redfish from July bottom trawl surveys and of Scotia Fundy region commercial landings based on port sampling. (1988-1993)

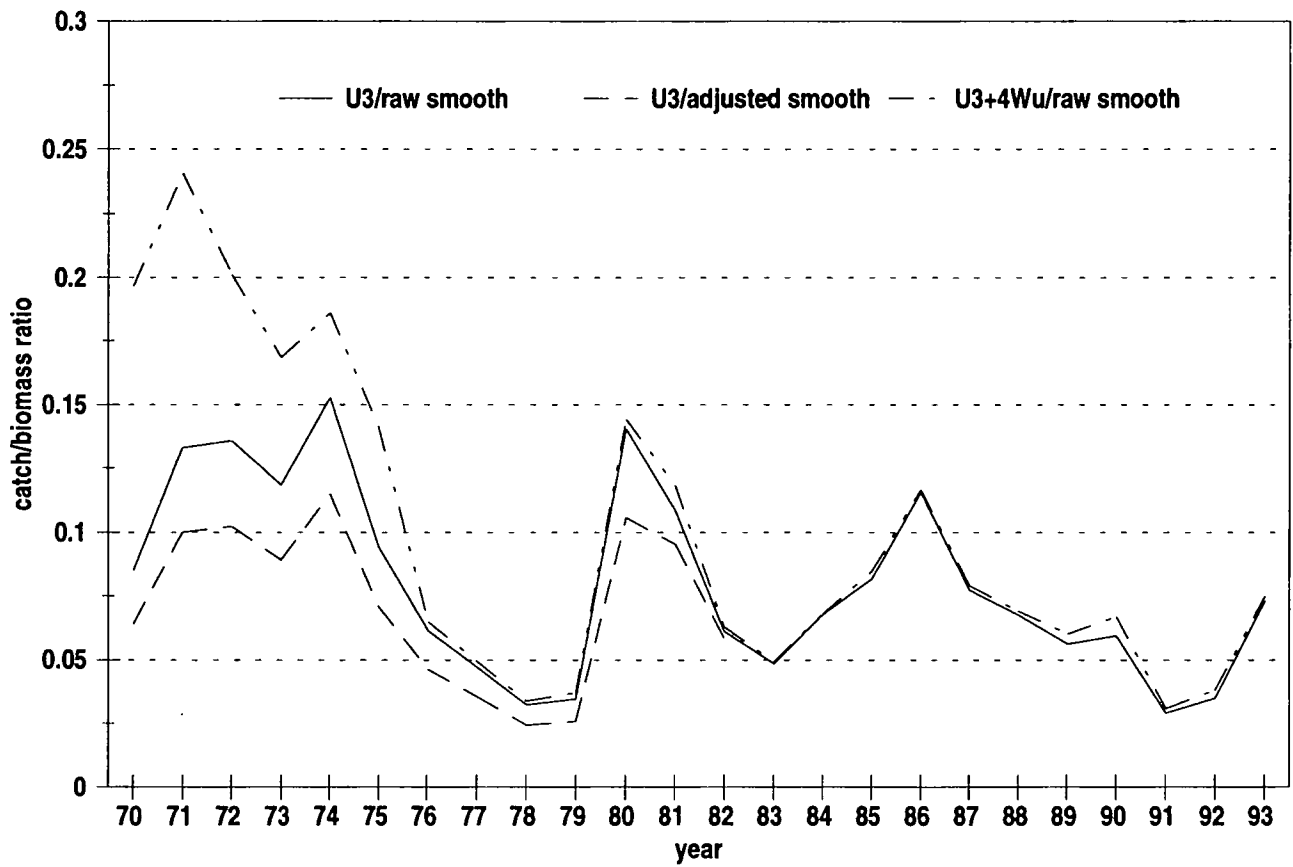


Fig 15. Nominal Catch of Unit 3 redfish and 4Wu as a proportion of Scotia Fundy research vessel raw and adjusted smoothed biomass for period 1970 to 1993.