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Update on the Status of Unit 3 Redfish: 1997

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Abstract

The document summarizes commercial fishery and research survey data for Unit 3 (4Wdehkl and 4X) redfish from August 1996 to July 1997. Total landings for 1996 were slightly less than for the previous two years, and well below the TAC. The 1997 landings (to July) were somewhat more than for the same time period in 1996. Almost all of the catch was taken by small otter trawlers (less than 65 feet) fishing in the basins and at the shelf edge. Redfish fishing operations using small mesh gear during the period were constrained by management initiatives to avoid the capture of small redfish and bycatch of other groundfish species as well as conflicts with fixed gear. Present biomass as judged from the 1997 survey is not greatly different than average since the late 1980s however there continues to be increased numbers of small redfish particularly in the area north and east of Brown's Bank. However, it is not clear as to what extent this recruitment will increase exploitable biomass and hence improve fishing success, therefore when combined with the low exploitation rates, which currently prevail, should result in fishing and stock conditions in 1998 being very much the same as in recent years.

Résumé

Le document résume les données de la pêche commerciale et des relevés de recherche pour le sébaste de l'unité 3 (4Wdehkl et 4X) d'août 1996 à juillet 1997. Les débarquements totaux de 1996 ont été légèrement inférieurs à ceux des deux années antérieures et bien en deçà du TAC. Les débarquements de 1997 (jusqu'en juillet) ont été quelque peu supérieurs à ceux notés pour la même période en 1996. Pratiquement toutes les prises ont été réalisées par de petits chalutiers (moins de 65 pieds) pêchant dans les bassins et à la bordure du plateau. La pêche du sébaste aux engins de petit maillage était limitée par des mesures de gestion visant à éviter la capture des petits poissons et les prises accidentelles d'autres espèces de poisson de fond, de même que les interférences avec les engins fixes. La biomasse actuelle, telle qu'indiquée par le relevé de 1997, ne diffère pas de beaucoup de la moyenne obtenue depuis la fin des années 1980, mais l'on note une augmentation maintenue du nombre de petits poissons notamment dans la zone au nord et à l'est du banc Brown's. On ne sait cependant pas dans quelle mesure ce recrutement accroîtra la biomasse exploitable et, par conséquent, le succès de la pêche et, si l'on tient compte des faibles taux d'exploitation actuels, les résultats de la pêche et l'état du stock en 1998 devraient être très semblables à ceux obtenus au cours des dernières années.

Introduction

Redfish, also known as ocean perch occur on both sides of the Atlantic Ocean. They are normally found along the slopes of fishing banks and deep channels usually at 100 - 700 m, in water of 3 to 8 ° C. In the north west Atlantic, redfish range from Baffin Island in the north to New Jersey in the south. The predominant species on the Scotian Shelf are *Sebastes fasciatus* (acadian redfish), occurring in the deep basins and at the edge of the continental shelf, and *S. mentella* (beaked redfish) occurring in the deeper waters off the continental shelf. Differences between these two species are not readily apparent, therefore commercial and research catch are not routinely separated by species.

Redfish are ovoviviparous as fertilization is internal, and the young are born live. Mating occurs in the fall and females carry the developing young until release from April to July of the following year. Redfish in general are slow growing and long lived, with ages of >30 years and sizes of >50 cm (weight of about 2.5 kg) having been observed. The young grow to about 8 cm in their first year of life and then take 8-10 years to reach a commercial size of 25 cm (weight of about 300 gm). *S. fasciatus* reaches a smaller size than *S. mentella*. Growth is usually faster in southern areas than in northern areas, and females grow faster than males. The average length at which 50% of redfish on the continental slope of 4WX (Ni and Sandeman 1984) are mature is about 24 to 26 cm for females and 16 to 17 cm for males, while in the Gulf of Maine (Mayo *et al.* 1990) it is about 22 cm for females and 19 to 22 cm for males.

Redfish are semipelagic; feeding is thought to take place at night, when redfish rise off the bottom. Food consists primarily of pelagic crustaceans such as amphipods, copepods, and euphausiids, fish become increasingly important as redfish increase in size.

Management Unit 3 (Fig. 1) for redfish consists of Statistical Unit Areas 4Wdehkl & 4X. The fishery is primarily conducted using bottom otter trawls (OTB) with small mesh cod ends (90-100 mm). Assessment and management strategies used for this, and other Canadian redfish stocks, have been the same as for other groundfish; the $F_{0.1}$ reference level has been assumed to approximate an exploitation rate of about 12%.

Materials and Methods

Commercial Data

Landings by domestic vessels were taken from North Atlantic Fishing Organization (NAFO) files for 1977-94 and from Department of Fisheries and Oceans (DFO) Zonal Interchange Format (ZIF) files for 1977-97. The NAFO data were reported only by Division (Unit 3 contains only a portion of Div. 4W). These data were compared to the Div. 4X for 1977-94 catch values and found to agree almost exactly. Thus, the ZIF data accurately reflected the landings and were used to estimate Canadian landings.

Landings by foreign vessels were available from NAFO files for 1977-93 and from Canadian Observer (Observer) files for 1988-97 when there was 100% coverage of foreign vessels. The NAFO data were compared to Div. 4X landings for 1988-93 and found to agree fairly well. Therefore NAFO data for Div. 4X 1977-87 and Observer data for 1988-97 were combined to estimate foreign landings.

ZIF and Observer data were also summarized by fishing area as defined by Statistical Unit Areas, namely:

Emerald and LaHave Basins	4WdehkXm
Roseway Basin and Western Ridge	4Xo

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Scotia Shelf slope	4WIXn
Crowell and Jordan Basins	4Xpqrs

The distribution of Canadian catches were described from ZIF data using geographical coordinates, available for 1994-97 and aggregated into 20 minute squares.

The size composition of Canadian landings was estimated from port samples obtained by the National Sampling Program (NSP) and from sea samples obtained from the Observer Program for 1993-97. Sample weights from both sources were estimated using a length-weight relationship obtained from the summer Research Vessel survey, 1970-94 combined. The equation was:

$$W = .0142 L^{3.09}$$

Port length frequency samples were adjusted to landed weight. Length frequency samples collected at sea on trips where more than one cod end was used (i.e. gear trials) were excluded from the analysis. The remaining sea samples were adjusted to individual tow weight, then combined and adjusted to landed weight for each fishing area. Port and sea samples were combined by fishing area.

Bycatches of other groundfish were taken from ZIF and Observer files for 1996-97. From the ZIF files, only those trips where redfish was the main species landed were used and from observer files, only those tows where redfish was the species sought as determined by the observer before the tow were used. Catch weights of other groundfish from both sources were summarized by fishing area and vessel class and then divided by the redfish catch weight. Most of the Observer catch was from Div. 4W and results from the two sources agreed fairly well for the Emerald and LaHave Basins. Other areas did not agree well. Thus, ZIF were used to estimate bycatches of other groundfish species.

Fishing effort analysis was based on ZIF records; selection of trips was limited to those in which redfish was main species landed; effort hours and days fished were summed by year for the period 1989-97.

Research Data

Estimates of population biomass, abundance, distribution and size structure were from the stratified-random Scotia Fundy summer research vessel (RV) survey (strata 456, 458-495). The surveys have been conducted on the Scotian Shelf (<200 fm) from 1982-97 using the Alfred Needler (Branton and Black 1997). Starting in 1995, this survey was enhanced to include redfish species identification techniques and extended to include the Scotian Shelf Slope (2-400 fm, strata 496-498) in order to cover redfish habitat at the shelf edge previously not covered by the survey. These deep strata have a small area and do not affect population size estimates strongly (Zwanenburg and Hurely 1978). Given this limited effect and the extended survey coverage has only 3 of 16 year, biomass and abundance estimates were derived from the Scotian Shelf only. Distribution and size composition estimates however were derived from the Scotian Shelf and the western Scotian Shelf Slope (stratum 498).

An industry survey, conducted in July by the ITQ fleet (ITQ survey) in Div. 4X, using a fixed station design, also provided estimates of the population distribution and abundance for 1995-97 and size composition for 1996-97. Spatial coverage of the ITQ survey differed from the RV survey: the ITQ survey did not include areas on the Scotian Shelf Slope between 2-400 fathoms (stratum 498); the ITQ survey included coastal areas (stratum 499) not covered by the RV survey; and in 1995 fewer strata were occupied by the ITQ survey than in 1996-97. Distribution from both surveys agreed well in all years as did biomass and abundance for those stratum common to both surveys in 1995-96.

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Biomass and abundance were higher in the common strata for both surveys in 1997 than in 1995-96 as a result of large catches of small redfish (.17 kg average) in the Roseway Basin and Western Ridge area (stratum 476 and 481). Furthermore biomass and abundance in 1997 were much higher in the RV survey than in the ITQ survey as a result of one large catch (stratum 476). Analysis of results from the ITQ survey are provisional.

Results

Description of the Fishery

The Unit 3 management area for redfish was first implemented in the 1993 Groundfish Management Plan. Redfish in this area were previously managed as part of a larger 4VWX management area. The 10,000 t Total Allowable Catch (TAC), introduced in 1993 was based on 1991 TACs for the previous management unit prorated by historical (1981-90) catches in the Statistical Unit Areas which comprise Unit 3. The first scientific description of Unit 3 redfish was a report to the Fisheries Resource Conservation Council (FRCC) in autumn 1993 which was used as a basis for a recommendation for the 1994 TAC also of 10,000 t (FRCC 1993). The 1994-96 stock status reports (Branton and Halliday 1994, Branton 1995, and Branton 1996) all concluded that fishing and stock conditions in coming years were not expected to differ greatly from those in recent years. As a result, the TACs for 1995-97 were all set at 10,000 t.

Annual redfish landings from Unit 3 gradually increased from the late 1970s, peaking at almost 7,000 t in 1986, followed by a decline to about 2,000 t in 1991 (Table 1, Fig. 2). Landings for the period 1993-95 ranged from 4,700 to 5,300 t with 1996 being about 4,800 t, all well below the 10,000 t TAC. Emerald and LaHave Basins accounted for most of the Unit 3 redfish landings during the period 1977-89 (Table 2, Fig. 3). The majority of the remaining landings were from the Roseway Basin and Western Ridge and from the Crowell and Jordan Basins to the west (Fig. 4-6). In 1997 (to July) a major part of the Unit 3 redfish landings have been from the Scotian Shelf Slope (Fig. 7). Monthly landings during the period 1992-95 on average were highest in June (839 t), while in 1996 landings peaked in July (968 t) (Table 3-4). The peak month for 1997 (to July) was May (1,283 t) and total landings to July (3,254 t) are somewhat more than for the same time period in 1996 (2,700 t) (Table 5).

Large otter trawlers (>65 ft, TC 4+5) accounted for most of the Unit 3 redfish landings during the period 1977-92. More recently most of the landings have been by small otter trawlers (<65 ft, TC 2+3) (Table 6, Fig. 8). In 1997 (to July), almost all of the landings were by small otter trawlers. In 1996 the redfish allocation to small otter trawlers was included in the Individual Transferable Quota (ITQ) management program for this fleet component (Annand and Hansen 1997). On average 82% of the inshore (<65 ft) quota allocation has been caught while the while mid-shore (65-100 ft) utilization declined from 34 to 10%. The off-shore (>100 ft) utilization has increased from 16 to 44% through use of small otter trawlers under the Temporary Vessel Replacement Plan (TVRP) (Table 7). Thus a discrepancy has occurred between the quota and landings reports by vessel class. Large otter trawler owners claim that they are increasingly unable to operate due to conflicts with fixed gear and to high bycatch levels as well as high proportions of small redfish in the catches.

Unit 3 redfish landings have traditionally had a high proportion of fish in the 20-25 cm range and port samples for the period 1984-93 indicate that landings of smaller redfish were rare. Increased catches of fish less than 20 cm in 1994-95 occurred in an area north and east of Brown's Bank known as the 'Bowtie' (Figure 9). At industry's request, this area was closed to fishing with small mesh gear (<130 mm) on May 19, 1995 and a

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22 cm minimum fish size was included in Conservation and Harvesting Plans (CHP) for 1996-97. Percentages by number of redfish landings (Tables 8-10) under this size were:

	93	94	95	96	97 (to July)
% < 22 cm	3.5	14.8	15.1	10.3	6.9

The proportions of small redfish (<22cm) were highest in catches from Roseway Basin and Western Ridge in 1994-96 and from Crowell and Jordan Basins in 1997 (to July) (Fig. 10-11). Proportions of small redfish in catches from Roseway Basin and Western Ridge were much lower in 1997 than in previous years. The proportions of large redfish (>35cm) were highest in catches from the Scotian Shelf slope and virtually absent from catches from Emerald and LaHave Basins in all years (Fig. 12-13).

Small otter trawler captains and plant operators in Southwest Nova Scotia have been pleased with the catches of large redfish at the shelf edge, but concerned about the increasing numbers of smaller redfish elsewhere. There were reports of very small redfish being landed after the July opening of Brown's Bank to small mesh gear in the area immediately south of the 'Bowtie' in both 1996 and 97. Industry processing records confirm that biological sampling does not fully reflect the landings of small redfish from that area during this period (697 and 384 t for 1996 and 1997). Industry also note a lack of DFO enforcement of the 22 cm small fish protocol in Div. 4X but claim some self-regulation of the catching of fish less than 20 cm. Most operators advocate that these small redfish should be avoided through modification of the closed area boundaries and/or a system of test fishing. Small otter trawler captains also indicated that they had not fished in the Crowell Basin during 1997 (to July) due to high catches of dogfish there. There has historically been more large redfish in Crowell Basin than in Jordan Basin and thus the higher proportions of small redfish coming from Crowell and Jordan Basins combined in 1997 (to July) than in the past.

Bycatch of other groundfish species in the directed redfish fishery has also been cited as a problem in recent years. In addition to limits of 2% each of cod and haddock (as a percentage of redfish catch) in 4VW and 10% of all other groundfish species in 4X, DFO Operations also implemented a number of mobile gear closures (Figure 9) in Unit 3:

Fleet	Species	Area	Portion	1995	1996	1997
ITQ	redfish	4W	all	Jan 01-Jun 30	Jan 01-Jun 30	Jan 01-Jun 30
		4X	all	Jul 05-Sep 21	-	-
			130 mm sq. only	Sep 21-Dec 31	-	-
all	all groundfish	4W	Haddock Nursery	all year	all year	all year
		4X	Brown's Bank	Feb 01-Jun 15	Feb 01-Jun 15	Feb 01-Jun 15
			Bay of Fundy E. of Margaretsville	Jan 01-Apr 30	Jan 01-Apr 30	Jan 01-Apr 30
	redfish	4X	Brown's Bank	Jan 01-Jun 30	Jan 01-Jun 30	Jan 01-Jun 30
			Bay of Fundy N. of 43°30'	all year	all year	-
			Bay of Fundy N. of 43°40'	-	-	all year
			< 50 fathoms	-	all year	all year

'Test Fishing' was required before the start of fishing for redfish in NAFO Divisions 4VW in 1996-97. Fleet sectors were controlled separately. Vessels fishing under offshore license conditions (including TVRP vessels) were permitted to test the

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area open beginning January 1, while the <65' mobile gear fleet (ITQ) license conditions closed the area from January 1 to June 30. Test fisheries, particularly in Area 1 portion of Div. 4W resulted in sporadic closures throughout the period due to a combination of high bycatch and incidence of small fish especially pollock.

The percent bycatch of all other groundfish species combined, in the Unit 3 redfish fishery in 1996-97 (to July) was about 12%, and consisted mostly of pollock (11%) (Table 11-13). Highest rates of all species combined were in Crowell and Jordan Basins (25%). Neither industry nor management consider the situation there to be a problem because most of the bycatch consisted of legal sized fish and was counted towards the vessels' quota of these species. Large otter trawler also had bycatch problems in the Emerald and LaHave Basins (25%) and the Roseway Basin and Western Ridge (14%), all higher than the legal limit for Div. 4X (10%) during 1997. Bycatch in the Scotian Shelf Slope area has been much lower in 1997 (7%) than in 1996 (11%).

Resource Status

Fishing effort of small otter trawlers and large otter trawlers were examined (Table 14-15), but many changes in the fishery (e.g. many new entrants, small fish closures, bycatch closures, ITQ management and the TVRP) would make the resulting catch rates impossible to interpret in the context of redfish abundance (Branton and Halliday 1994, Branton 1995).

Survey estimates of population biomass (< 200 fm), are highly variable between years and show no trend over time from the late 1980s (Table 16). The 1997 abundance estimate is much higher than earlier values but that is, at least in part, a reflection of higher availability of small redfish to surveys in the Roseway Basin and Western Ridge fishing area in that year (Table 17-18).

The size composition of survey catches 1993-97 differs for each fishing area (Fig 10-12). There are however small redfish (<22 cm) in all fishing areas and appear to have been avoided by the commercial fishery. The smallest redfish (modal length 20-22 cm) on average for the period 1993-97 were in the Roseway Basin and Western Ridge fishing area where avoiding small redfish has been most difficult. The RV size composition on the Scotia Shelf Slope shows evidence of the larger commercial fish (>30 cm) only after 1994 when the survey was extended beyond 200 fm, suggesting that the newly extended survey has succeeded in covering more redfish habitat in Unit 3 than in the past.

The size composition of survey catches (Unit 3 overall, <200 fm) provides some evidence of small redfish (< 22 cm) entering the population (Fig. 14). In 1993-97 there are indications of more small redfish than in the past, a large proportion of which, since 1995 have been 20-22 cm long (Fig. 15), in the Roseway Basin and Western Ridge fishing area (Fig. 16).

Discussion

The increase in catches during recent years, compared to 1992, resulted from an increase in fishing effort by small otter trawlers, reflecting decreased fishing opportunities for more valuable species, and not an increase in redfish abundance. The various closures and subsequent test fishing has resulted in reduced landings, particularly from the Roseway Basin and Western Ridge. Some fishing was directed towards small redfish because of their accessibility but these areas are generally being avoided.

RV surveys indicate stability in the population biomass with increased catches of small redfish (20-22 cm) north and east of Brown's Bank. It is not yet clear to what extent the small redfish being observed will increase exploitable biomass and hence

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improve fishing success. The ratio of catch tonnages (4-5,000 t) to recent (5 year average) survey biomass (60-66,000 t) gives an estimated exploitation rate of about 6 percent for the period 1986-96 and 8 percent for the period 1993-96 (Table 19). A catch at the current 10,000 t TAC would result in an exploitation rate of about 15%.

Conclusion

As survey biomass estimates are considered underestimates of actual exploitable biomass a catch of 10,000 tons is not likely to exceed that corresponding to $F_{0.1}$ in 1998. Fishing and stock conditions in coming years are not expected to differ greatly from those in recent years

Acknowledgments

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Table 1. Unit 3 redfish Canadian and foreign landings and TAC by year in Thousands of Tons.

Year	Cdn	Fgn	Total	TAC
77	2.11	2.29	4.40	
78	1.20	2.02	3.22	
79	1.86	0.72	2.58	
80	2.87	0.89	3.76	
81	3.73	0.76	4.49	
82	3.09	1.58	4.67	
83	4.04	0.82	4.86	
84	4.57	0.87	5.44	
85	5.84	0.03	5.87	
86	6.62	0.06	6.68	
87	6.07	0.02	6.09	
88	3.90	0.04	3.94	
89	3.20	0.19	3.39	
90	2.26	0.12	2.38	
91	1.92	0.13	2.05	
92	2.37	0.12	2.49	
93	5.08	0.19	5.27	10.0
94	5.17	0.01	5.18	10.0
95	4.83	0.02	4.85	10.0
96	4.72	0.03	4.75	10.0
97	3.43	0.05	3.48	10.0 (to July)

Table 2. Unit 3 redfish Canadian landings (tons) by year and statistical area.

YEAR	4WdehkXm	4WlXn	4Xo	4Xpgrs	Unit 3
77	1118	598	162	117	1994
78	544	386	210	37	1177
79	1067	360	353	75	1856
80	1212	783	797	70	2862
81	2480	279	905	34	3697
82	1005	420	1508	139	3072
83	2314	519	935	193	3961
84	3156	473	565	167	4360
85	3961	329	1061	152	5502
86	2416	1197	1978	363	5955
87	2412	849	1451	213	4924
88	1096	594	376	118	2184
89	1230	320	137	172	1860
90	290	128	348	122	887
91	363	135	547	82	1127
92	715	191	1114	203	2222
93	629	614	2917	886	5046
94	391	972	2712	1054	5130
95	1441	466	1384	1525	4816
96	1867	319	1411	1115	4712
97	763	1119	483	1061	3426 (to July)

Table 3. Annual average landed tons by statistical unit area grouping and month for mobile gear fishing redfish in Unit 3 for the period 1992 to 1995.

AREA	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
dehkm	0	0	10	29	153	70	42	107	100	157	59	21	748
ln	3	4	4	11	100	124	128	77	18	10	9	7	495
o	2	1	3	67	199	417	579	390	168	95	28	3	1953
pgrs	3	3	27	208	201	229	62	10	32	15	2	0	791
sum	7	8	44	315	653	839	811	586	317	277	98	31	3987

Table 4. Landed tons by statistical unit area grouping and month for mobile gear fishing redfish in Unit 3 during 1996.

AREA	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
dehkm	50	59	5	174	293	260	39	212	108	264	89	264	1818
ln	1	8	1	0	79	30	107	39	2	25	0	4	296
o		0	0	18	141	220	697	142	33	81	3	1	1338
pqrs	2	12	11	138	145	117	125	93	104	111	21	95	974
sum	53	79	19	330	658	627	968	487	247	482	113	364	4427

Table 5. Landed tons by statistical unit area grouping and month for mobile gear fishing redfish in Unit 3 during 1997.

AREA	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
dehkm	54	51	73	3	355	220	0						756
ln		0		258	541	222	35						1056
o				0	17	56	384						458
pqrs		0	69	404	369	130	11						983
sum	54	52	142	665	1283	628	430						3254

Table 6. Unit 3 Canadian redfish catch (thousands of tons) by year and vessel type (main species redfish trips only) and all other catches.

Yr	<65'	>65'	Other	Combined
77	0.02	1.28	0.81	2.11
78	0.00	0.87	0.33	1.20
79	0.01	1.09	0.77	1.86
80	0.12	1.99	0.77	2.87
81	0.09	3.10	0.53	3.73
82	0.36	2.01	0.71	3.09
83	0.63	2.86	0.55	4.04
84	1.53	2.46	0.58	4.57
85	2.07	3.47	0.30	5.84
86	2.38	3.65	0.59	6.62
87	2.71	2.49	0.86	6.07
88	1.43	1.69	0.78	3.90
89	1.41	1.40	0.39	3.20
90	0.37	1.43	0.47	2.26
91	0.44	1.06	0.41	1.92
92	0.36	1.55	0.46	2.37
93	2.92	1.71	0.44	5.08
94	3.84	1.01	0.31	5.17
95	3.80	0.87	0.16	4.83
96	4.15	0.28	0.29	4.72
97	3.19	0.06	0.18	3.43 (to July)

Table 7. Quota allocations and percent used by vessel type for Unit 3 redfish during 1994 to 1997 (to July).

Year	Vessel	Quota	Catch	%used
1994	<65'	3707	3569	96
	65-100'	2673	919	34
	>100'	3620	573	16
	total	10000	5061	51
1995	<65'	3707	2685	72
	65-100'	3023	929	31
	>100'	3270	1189	36
	total	10000	4803	48
1996	<65'	3707	2844	77
	65-100'	2771	288	10
	>100'	3522	1556	44
	total	10000	4688	46
1997 (July)	<65'	3707	2556	69
	65-100'	2677	54	2
	>100'	3616	1188	33
	total	10000	3798	37

Table 8. Number of port samples of redfish landings in Unit 3 by vessel/gear class and by statistical area, and by Div., 1993-97. Inventory for 1997 is incomplete.

year	class	dehkm	ln	o	pqrs	4W	4X	Unit 3
1993	OTB 0-3		1	3	1		5	5
	OTB 4+	1	1	1		2	1	3

sum		1	2	4	1	2	6	8
1994	OTB 0-3		1	12	5		18	18
	OTB 4+	3	2	2		2	5	7

sum		3	3	14	5	2	23	25
1995	LONGLINE	1	1				2	2
	OTB 0-3	13	3	6	9		31	31
	OTB 4+	2	2	2		2	4	6

sum		16	6	8	9	2	37	39
1996	LONGLINE	1					1	1
	OTB 0-3	18		5	7	7	23	30
	OTB 4+	1	1				2	2

sum		20	1	5	7	7	26	33
1997	OTB 0-3	5	5	3	7	3	17	20
	OTB 4+	1	2				3	3

sum		6	7	3	7	3	20	23

Table 9. Number of observer sampled redfish fishing trips used in catch at length from Unit 3 by vessel/gear class and by statistical area, and by Div., 1993-97. Inventory for 1997 is incomplete.

year	class	dehkm	ln	o	pqrs	4W	4X	Unit 3
1993	OTB 0-3	1		1		1	1	2
	OTB 4+		4	3		1	6	7

sum		1	4	4		2	7	9
1994	OTB 0-3			14	3		16	16
	OTB 4+	1	7	4		5	7	10

sum		1	7	18	3	5	23	26
1995	OTB 0-3	9		2	11	4	15	19
	OTB 4+	2	7	1	2	3	10	10

sum		11	7	3	13	7	25	29
1996	OTB 0-3	41	2	1		36	7	41
	OTB 4+	10	7	1	1	6	11	14

sum		51	9	2	1	42	18	55
1997	OTB 0-3	31	4			34	3	34
	OTB 4+	1	3				4	4

sum		32	7			34	7	38

Table 10. Tons of sampled catch used to construct catch at length, by source, statistical area, and year for period 1993-97.

Port Samples year	Observer Samples				
	dehkm	ln	o	pqrs	total
1993	.4	6.3	72.0	20.7	99.4
1994	85.3	67.7	279.4	33.3	465.7
1995	189.8	43.9	132.0	79.0	444.8
1996	364.1	.5	57.1	35.8	457.5
1997	73.1	93.1	2.5	135.2	303.9

Table 11. Percent bycatch of other groundfish species by the Unit 3 redfish fishery by: unit area and vessel type; species and vessel type; and unit area and species for 1996.

All Species = 12.6 %

area	<65'	>65'	total
dehkm	10.1	10.0	10.1
ln	10.9	13.1	11.0
o	7.0	14.2	7.4
pgrs	28.2	34.7	28.7

species	<65'	>65'
pollock	6	12.1
cod	2.5	3.3
white hake	1.5	1.5
haddock	1.4	0.8
flatfish	0.4	0.2
silver hake	0.2	
cusk	0.2	0.1
catfish	0.1	
sum	12.2	18.0

species	dehkm	ln	o	pgrs	total
pollock	7.6	4.6	2.8	12.6	6.4
cod	1.3	3.0	2.6	5.6	2.5
white hake	0.3	0.8	0.2	5.8	1.5
haddock	0.5	1.1	1.0	3.4	1.4
flatfish	0.2	0.8	0.5	0.6	0.4
silver hake				0.1	0.2
cusk	0.1	0.1		0.5	0.2
catfish		0.5	0.2	0.1	0.1
sum	10	10.9	7.3	28.7	12.6

Table 12. Percent bycatch of other groundfish species by the Unit 3 redfish fishery by: unit area and vessel type; species and vessel type; and unit area and species for 1997 (to July).

All Species = 11.8 %

area	<65'	>65'	total
dehkm	7.1	25.1	7.2
ln	7.0	2.6	6.8
o	6.5	13.7	6.5
pgrs	22.2	37.7	22.6

species	<65'	>65'
pollock	6.8	10.1
cod	2.2	5.9
white hake	0.9	1.1
haddock	0.8	
cusk	0.3	0.2
flatfish	0.3	0.1
catfish	0.1	
halibut	0.1	0.2
sum	11.6	17.5

species	dehkm	ln	o	pgrs	total
pollock	5	3.7	1.7	12.9	6.8
cod	0.5	0.2	2.4	5.8	2.2
white hake	0.2	1.5	0.1	1.4	0.9
haddock	0.9	0.1	1.1	1.7	0.8
cusk	0.1	0.9		0.1	0.3
flatfish	0.3	0.1	0.6	0.5	0.3
catfish	0.1	0.1	0.5	0.1	0.1
halibut	0.1	0.3		0.1	0.1
sum	7.2	6.9	6.4	22.6	11.7

Table 13. Bycatch of other species (>500 kg total catch) during redfish directed tows as recorded by observers program during 1996 and 1997 (to July)

year	species	catch(tons)					bycatch(% of redfish)				
		dehkm	ln	o	pgrs	total	dehkm	ln	o	pgrs	total
1996	redfish	1089.38	28.69	38.75	0.50	1157.39					
	pollock	73.13	16.38	1.40	0.10	91.04	6.7	57.1	3.6	20.0	7.9
	dogfish	61.73	2.56	0.08	0.05	64.42	5.7	8.9	0.2	10.0	5.6
	silver hake	10.48	0.21	0.08		10.77	1.0	0.7	0.2		0.9
	cod	7.88	0.15	0.90		8.93	0.7	0.5	2.3		0.8
	haddock	6.92	0.04	0.48		7.44	0.6	0.1	1.2		0.6
	herring	4.67	0.04	0.28		4.98	0.4	0.1	0.7		0.4
	monkfish	0.91	1.80			2.72	0.1	6.3			0.2
	thorny skate	1.99	0.44	0.08		2.5	0.2	1.5	0.2		0.2
	white hake	1.53	0.90	0.01		2.46	0.1	3.1			0.2
	halibut	1.16	0.09	0.01		1.25	0.1	0.3			0.1
	witch flounder	0.79	0.04	0.01		0.84	0.1	0.1			0.1
1997	redfish	413.43	40.7			454.13					
	pollock	23.11	8.29			31.4	5.6	20.4			6.9
	spiny dogfish	23.69				23.69	5.7	0.0			5.2
	monkfish	0.26	5.47			5.72	0.1	13.4			1.3
	silver hake	1.39	0.60			1.99	0.3	1.5			0.4
	cod	1.91				1.91	0.5				0.4
	haddock	1.22				1.22	0.3				0.3
	basking shark		0.75			0.75		1.8			0.2
	red hake	0.12	0.62			0.73	0.0	1.5			0.2
	halibut	0.47	0.17			0.64	0.1	0.4			0.1

Table 14. Unit 3 redfish fishing effort in hours and days by small otter trawlers during the period 1989 to 1997.

YEAR	HRS	DAYS
1989	1833	313
1990	879	108
1991	736	98
1992	1421	149
1993	5095	541
1994	9759	895
1995	12656	1176
1996	9964	1118
1997	8507	775 (to July)
avg	5650	575

Table 15. Unit 3 redfish fishing effort in hours and days by large otter trawlers during the period 1989 to 1997.

YEAR	HRS	DAYS
1989	1310	157
1990	684	165
1991	1410	158
1992	1686	189
1993	1984	215
1994	1861	184
1995	1622	195
1996	732	88
1997	207	18 (to July)
avg	1277	152

Table 16. Survey biomass (thousands of tons) and abundance (numbers per standard tow) estimates for unit 3 redfish from Scotia Fundy Summer Research Survey.

YEAR	BIOMASS	NUMBERS
1982	72.7	76.5
1983	122.8	121.3
1984	106.0	89.7
1985	17.0	18.0
1986	93.2	71.7
1987	63.1	57.5
1988	83.4	91.1
1989	27.7	29.0
1990	61.9	81.6
1991	24.9	38.4
1992	116.0	118.8
1993	69.6	75.5
1994	50.4	76.3
1995	45.6	61.1
1996	50.1	79.7
1997	120.6	209.2
avg	70.3	81.0

Table 17. Stratified weight (kg.) and number per tow for summer RV and ITQ surveys in Div 4x, 1995-97. A) for all strata sampled, B) for strata in 4Xo, C) for strata in 4Xpqrs, and D) for those strata sampled in both surveys in all years. (Strata 471, 478, 482, and 484 not sampled in 1995. Numbers not recorded for all sets in ITQ survey in 1997. Stratum 499 not sampled in RV surveys, and 483 not sampled in ITQ surveys.)

A) All strata

S	Totwgt			Totno			AvgWgt		
	1995	1996	1997	1995	1996	1997	1995	1996	1997
R	28.22	19.27	72.65	101.01	98.52	354.81	.28	.20	.20
I	22.90	26.87	38.76	99.78	146.47		.23	.18	.19

B) 4XO (strata 474-476, 480, 481)

S	Totwgt			Totno			AvgWgt		
	1995	1996	1997	1995	1996	1997	1995	1996	1997
R	103.34	49.50	224.05	346.77	224.73	1268.44	.30	.22	.18
I	97.27	90.21	167.78	427.35	563.77	912.64	.23	.16	.18

C) 4Xpqrs (strata 482, 484-495)

S	Totwgt			Totno			AvgWgt		
	1995	1996	1997	1995	1996	1997	1995	1996	1997
R	2.12	4.71	35.22	4.48	21.82	93.20	.47	.22	.38
I	3.66	18.98	11.48	17.15	74.55		.21	.25	

D) Strata in common

S	Totwgt			Totno			AvgWgt		
	1995	1996	1997	1995	1996	1997	1995	1996	1997
R	34.47	38.25	90.09	124.96	163.28	436.15	.28	.23	.21
I	37.13	36.67	58.95	161.78	217.27		.23	.17	

Table 18. Comparison of RV and ITQ surveys by stratum for all strata in 4X.

STR	S	No. of Tows			Average Depth			Kg. per Tow			No. per Tow			Average Wgt. per Fish		
		1995	1996	1997	1995	1996	1997	1995	1996	1997	1995	1996	1997	1995	1996	1997
470	R	2	2	2	85	86	71	41.59	106.24	40.35	162.03	667.23	197.12	.26	.16	.20
	I	4	5	5	93	92	94	54.11	30.48	23.92	174.51	111.33	81.49	.31	.27	.29
471	R	2	1	2	119	121	126	1.39	.15	5.35	4.50	4.05	13.27	.31	.04	.40
	I		3	4		107	108		2.82	1.06		6.00	6.08		.47	.17
472	R	4	3	4	77	58	85	13.49	.00	4.84	139.60	.00	15.98	.10		.30
	I	3	12	12	64	71	71	.00	.26	.00	.00	.35	.00		.75	
473	R	2	2	2	50	48	48	.00	.03	.16	.00	.97	2.09		.04	.08
	I	2	2	2	48	48	49	.00	.00	.00	.00	.00	.00			
474	R	2	2	2	38	45	45	.36	.25	30.52	2.08	1.37	155.32	.17	.18	.20
	I	1	1	2	48	49	47	.00	.00	.00	.00	.00	.00			
475	R	2	2	2	49	48	47	.37	.06	1.50	2.98	6.38	38.56	.13	.01	.04
	I	2	1	2	50	49	51	.00	.00	.00	.00	.00	.00			
476	R	4	4	4	75	78	73	18.87	141.96	605.98	86.70	633.30	3476.40	.22	.22	.17
	I	15	17	14	79	78	81	108.08	136.81	171.06	485.48	1052.76	1004.44	.22	.13	.17
477	R	5	5	5	62	61	66	.06	1.11	.08	1.87	26.04	2.02	.03	.04	.04
	I	6	11	11	63	64	65	1.44	.29	.00	17.32	1.15	.00	.08	.25	
478	R	3	3	2	148	129	148	1.28	1.08	7.49	10.66	9.70	46.03	.12	.11	.16
	I		1	1		123	121		1.06	.00		2.12	.00		.50	
480	R	8	8	8	46	46	43	.04	.00	.00	.49	.11	.00	.07	.03	
	I	9	8	7	43	43	41	.00	.42	.16	.00	.97	.16		.43	1.00
481	R	7	9	9	80	75	67	223.43	2.25	36.40	730.94	18.48	169.00	.31	.12	.22
	I	17	19	20	71	77	74	156.53	117.78	295.13	603.06	470.23	1313.33	.28	.25	.22
482	R	3	3	3	134	131	125	.15	4.21	.00	.99	10.10	.00	.15	.42	
	I		5	6		119	119		46.73	42.45		178.27	162.03		.26	.26
483	R	2	2	2	180	178	174	14.18	.78	9.98	18.71	3.91	27.86	.76	.20	.36
484	R	3	3	3	117	115	120	1.63	6.39	19.10	3.05	33.31	36.44	.53	.19	.52
	I		11	11		118	119		23.68	7.68		36.87	40.06		.71	.30
485	R	3	3	3	73	76	87	.47	7.29	170.00	1.51	50.49	462.16	.31	.14	.37
	I	16	17	17	77	78	74	13.27	43.02	11.25	60.28	172.69	40.47	.22	.25	.49
490	R	5	4	4	45	39	44	.14	.07	.00	2.53	1.32	.00	.06	.05	
	I	8	9	10	48	46	43	1.87	.77	1.79	16.01	6.03		.12	.13	
491	R	3	3	3	85	89	75	10.79	14.78	10.06	26.71	44.28	32.49	.40	.33	.31
	I	5	5	5	69	73	71	17.16	53.12	48.02	51.61	145.17	209.27	.42	.37	.38
492	R	2	3	3	89	95	71	.11	2.64	3.81	1.47	3.60	17.13	.08	.73	.22
	I	8	8	9	62	58	62	1.87	1.56	12.57	7.62	8.86	65.20	.24	.18	.43
493	R	3	2	3	44	45	36	.00	.19	.00	.00	1.04	.00		.19	
	I	4	5	5	35	41	42	1.24	.56	.00	3.42	.56	.00	.36	1.00	
494	R	2	2	2	26	36	26	.00	.00	.00	.00	.00	.00			
	I	5	4	3	36	31	33	.00	.00	.00	.00	.00	.00			
495	R	2	2	2	39	50	43	.00	.00	.00	.00	.00	.00			
	I	7	7	7	40	41	42	.36	.00	.20	.53	.00		.67		
499	I	23	16	20	32	32	34	.26	.35	.11	1.02	.69	.11	.26	.50	1.00

Table 19. Harvest rate (5yr avg survey biomass/commercial landings * 100%) of Unit 3 redfish for the period 1982 to 1996.

YEAR	BIOMASS (5yr AVG)	LANDING S	HARVEST RATE (%)
86	82.3	6.7	8.1
87	80.4	6.1	7.6
88	72.5	3.9	5.4
89	56.9	3.4	6.0
90	65.9	2.4	3.6
91	52.2	2.1	3.9
92	62.8	2.5	4.0
93	60.0	5.3	8.8
94	64.6	5.2	8.0
95	61.3	4.9	7.9
96	66.3	4.8	7.2
93-96 avg	63.1	5.0	8.0
86-96 avg	65.9	4.3	6.4

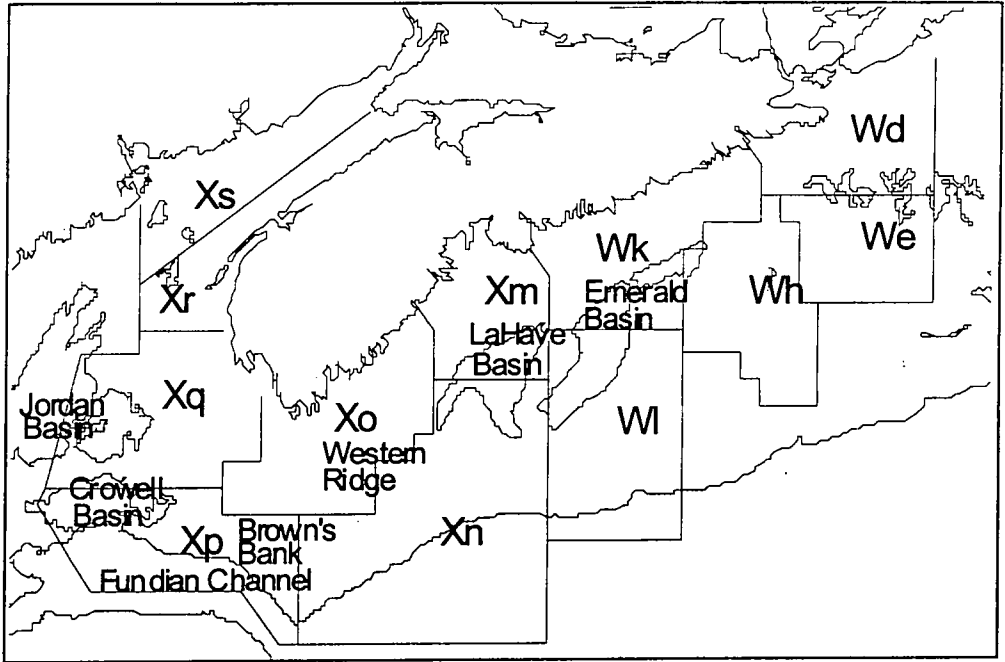


Figure 1. Unit 3 Management area for redfish.

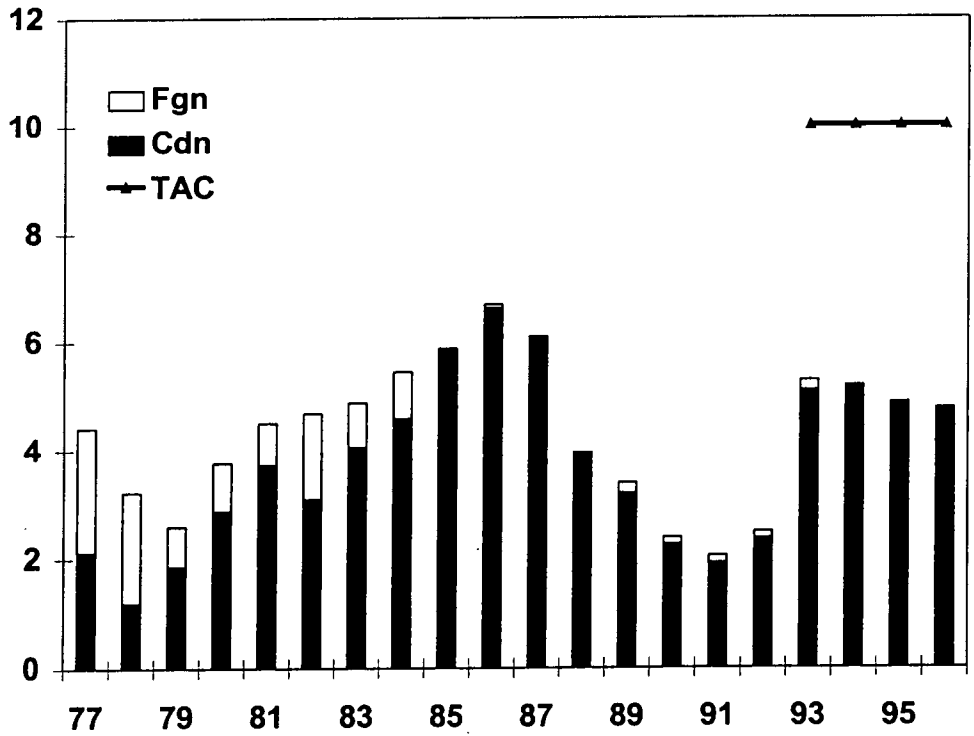


Figure 2. Canadian and Foreign Landings and TAC in thousands of tons for Unit 3 redfish during the period 1977 to 1996.

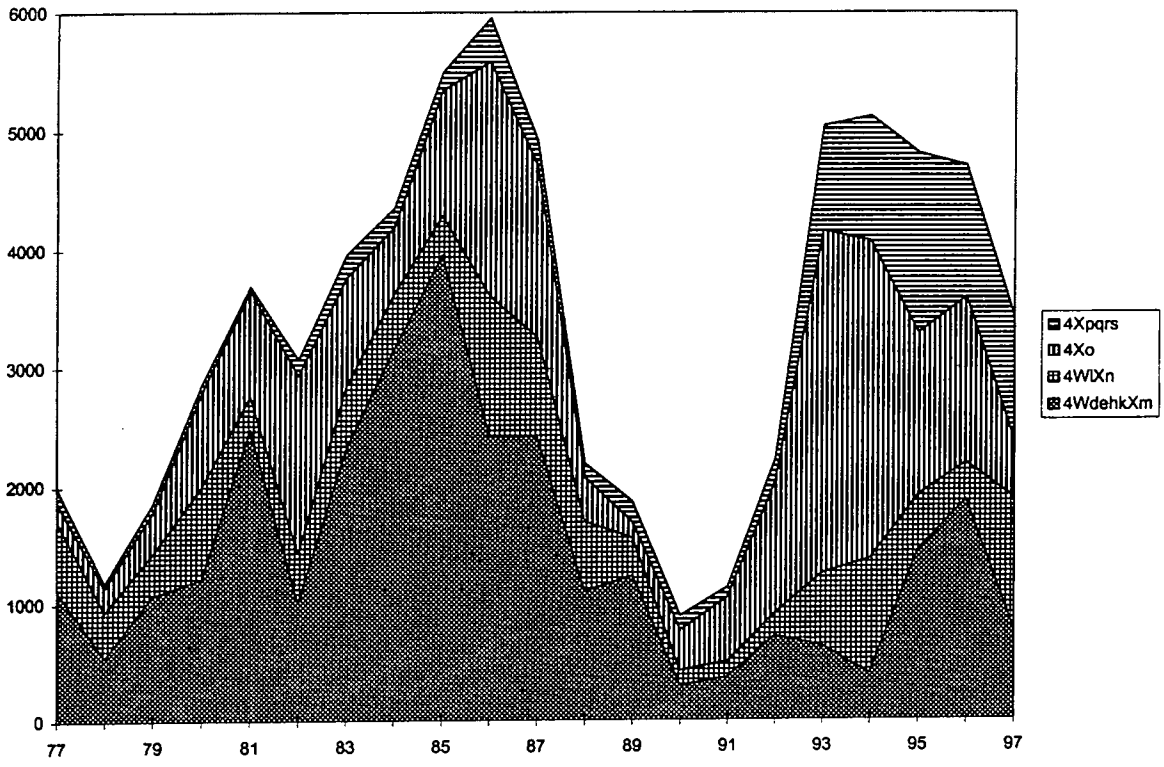


Figure 3. Unit 3 redfish Canadian landings (tons) by year and statistical area for 1977-97 (to July).

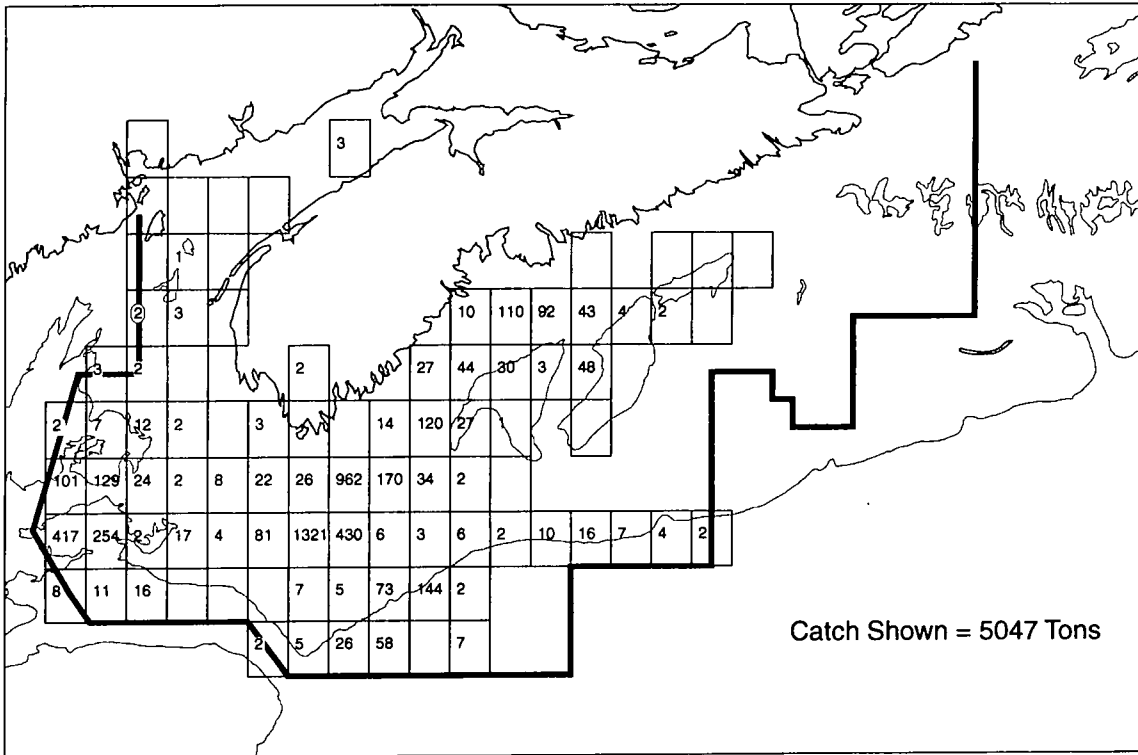


Figure 4. Distribution of Unit 3 redfish catch (from logbooks) by the Canadian fleet in 1994.

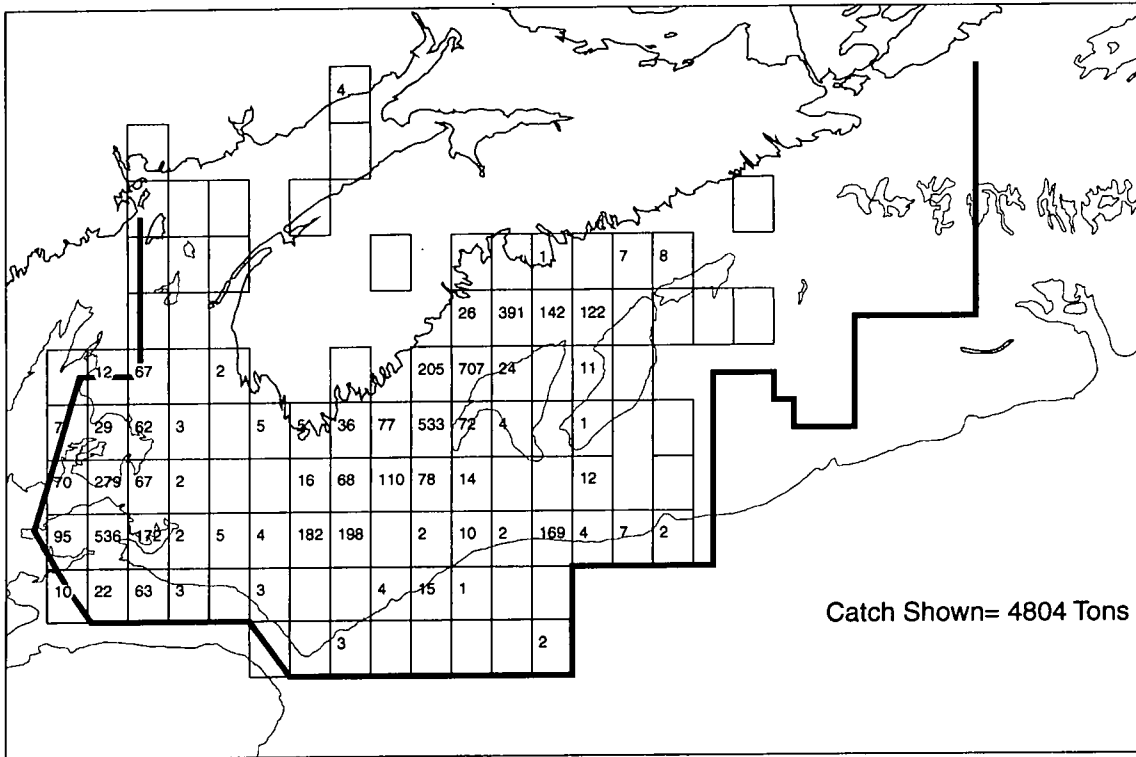
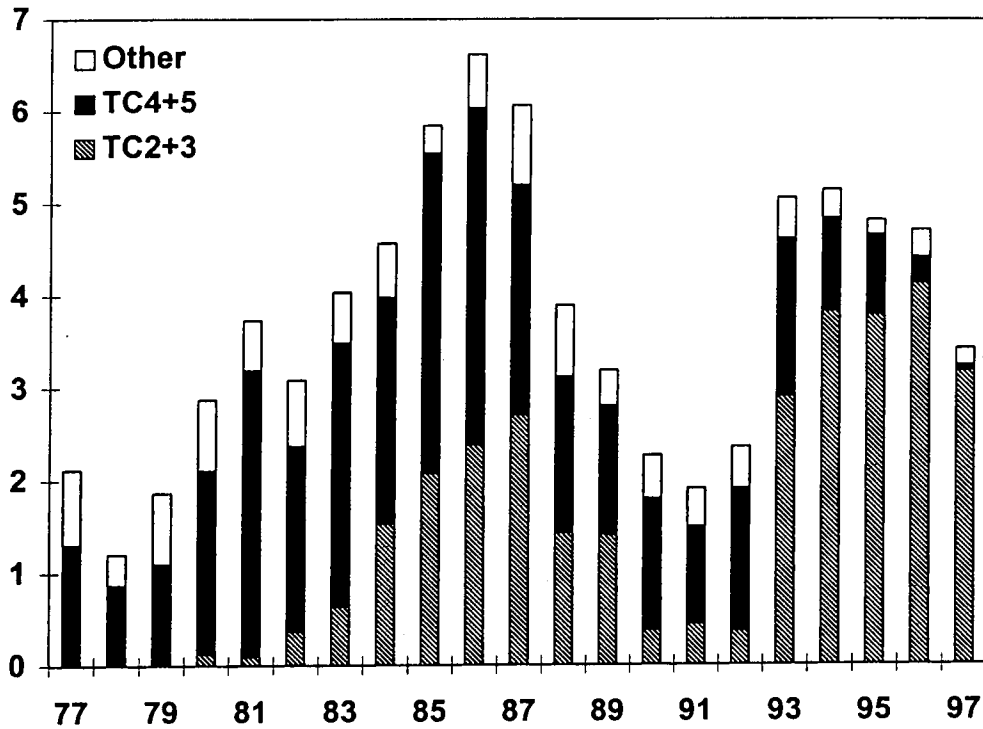


Figure 5. Distribution of Unit 3 redfish catch (from logbooks) by the Canadian fleet in 1995.



Unit 3

Figure 8. Unit 3 redfish catch by year and vessel type (main species redfish trips only) and other catches in thousands of tons during the period 1977 to 1996.

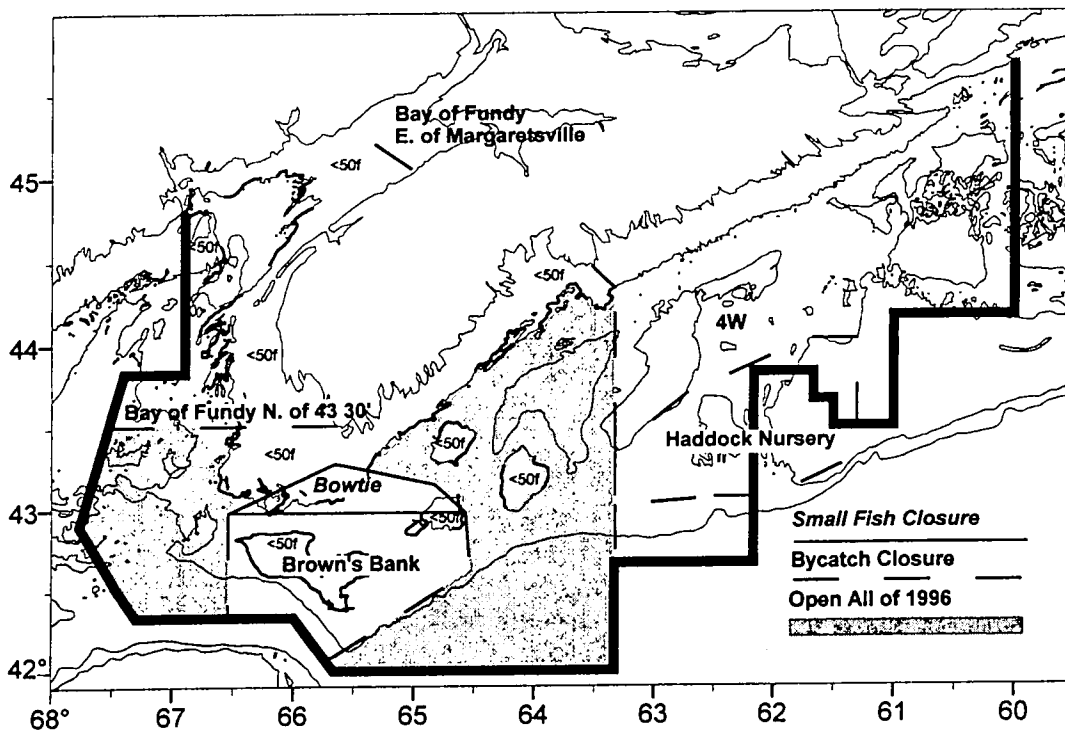


Figure 9. Unit 3 small fish and bycatch closures for 1996.

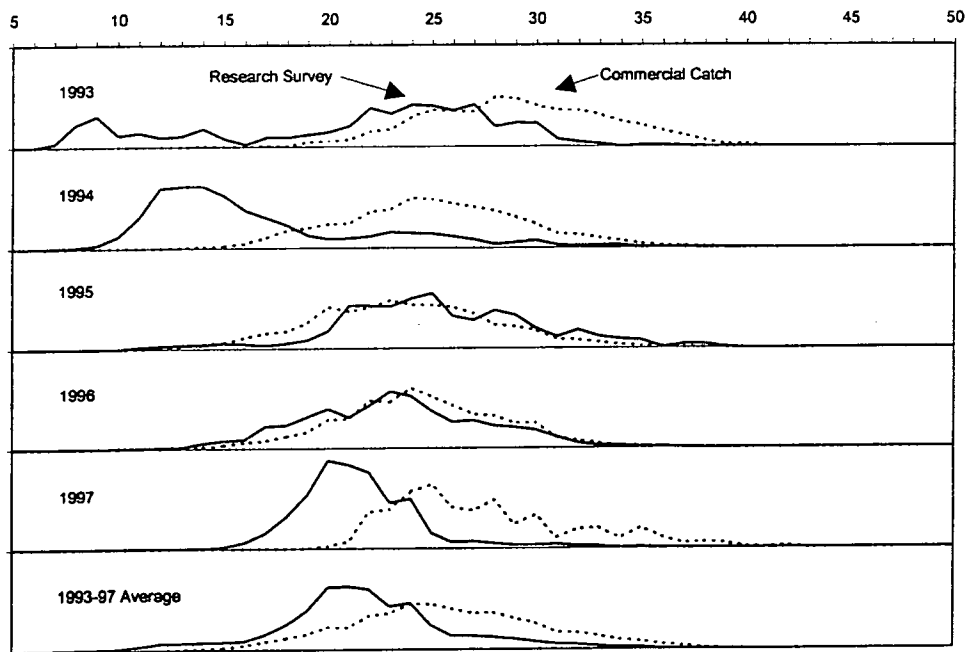


Figure 10. Redfish research survey (solid) and commercial catch (dashed) size composition (%) from Roseway Basin and Western Ridge for the period 1993-97.

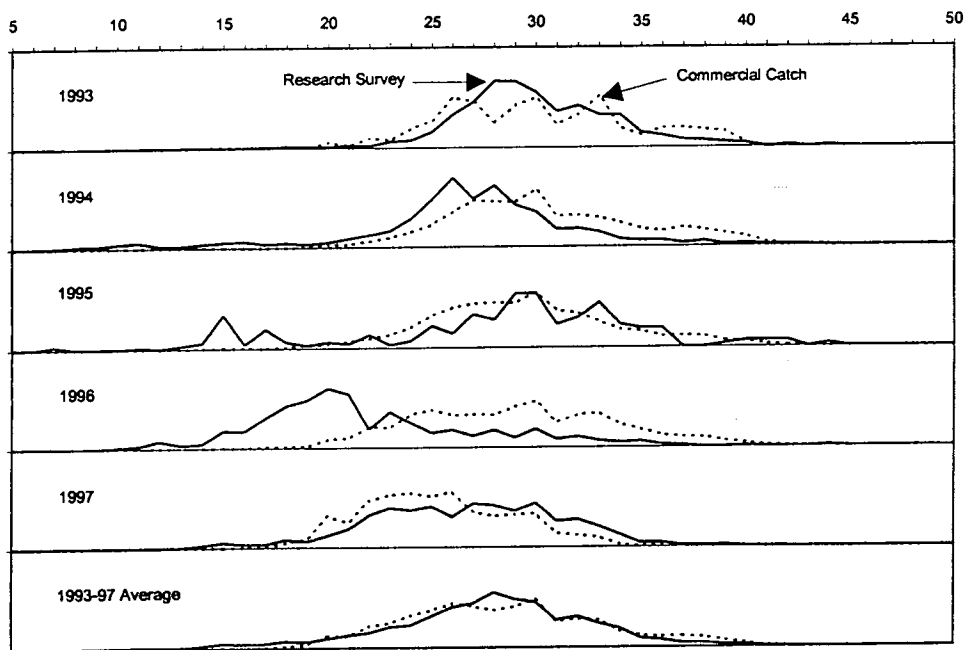


Figure 11. Redfish research survey (solid) and commercial catch (dashed) size composition (%) Crowell and Jordan Basins for the period 1993-97.

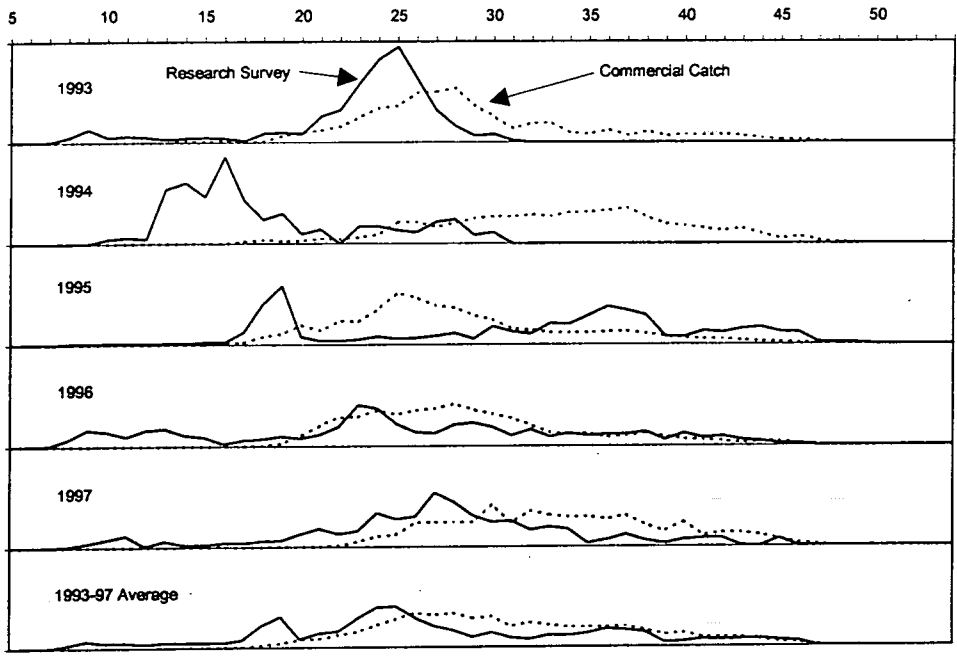


Figure 12. Redfish research survey (solid) and commercial catch (dashed) size composition (%) from Scotian Shelf Slope for the period 1993-97.

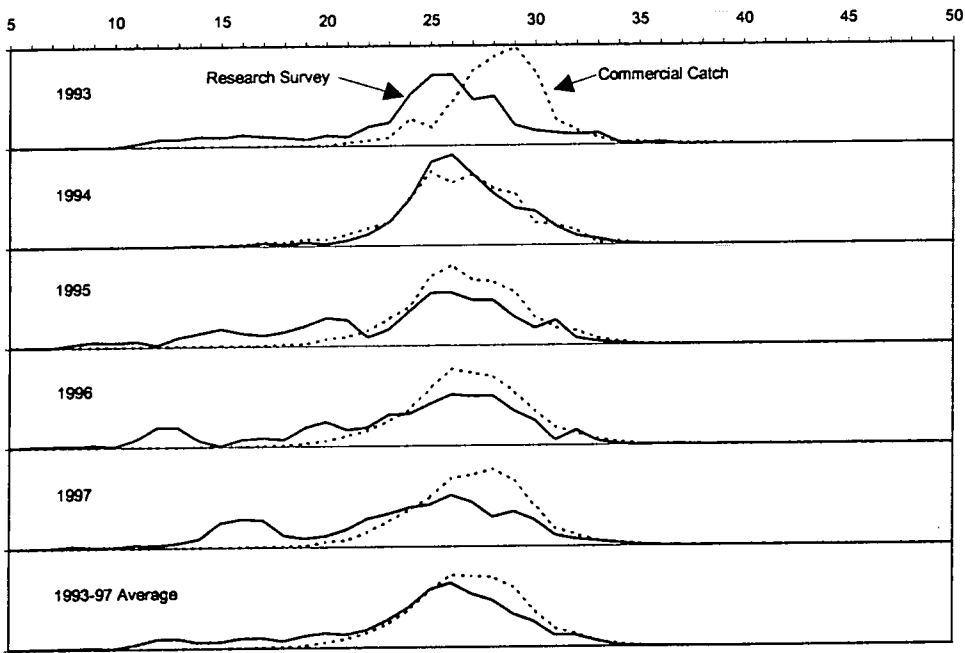


Figure 13. Redfish research survey (solid) and commercial catch (dashed) size composition (%) from Emerald and La Have Basins for the period 1993-97.

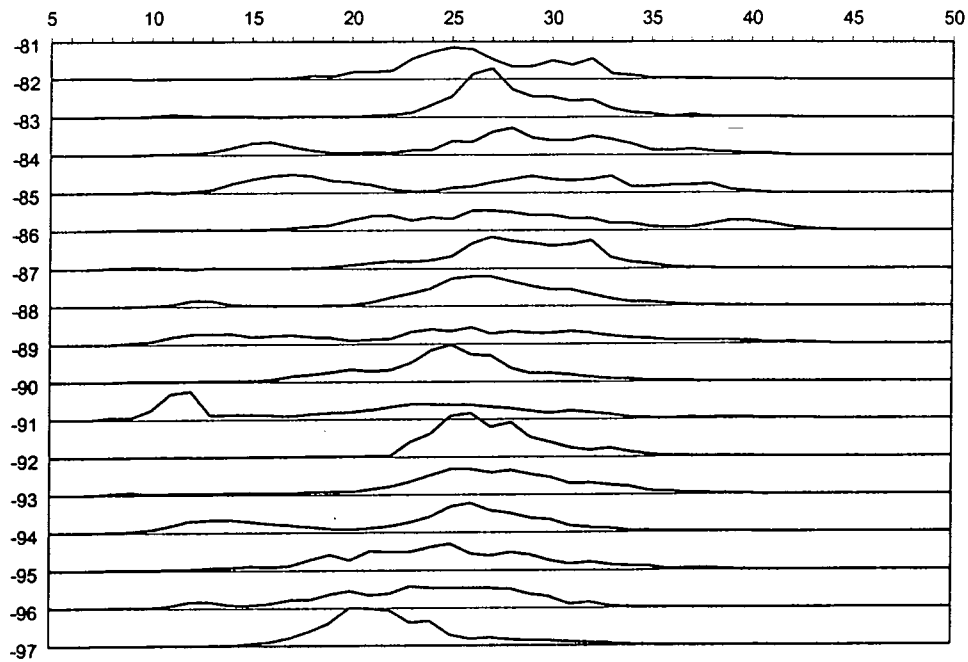


Figure 14. Size composition of survey catches for Unit 3 redfish from Scotia Fundy Summer Research Vessel Survey for the period 1982 to 1997.

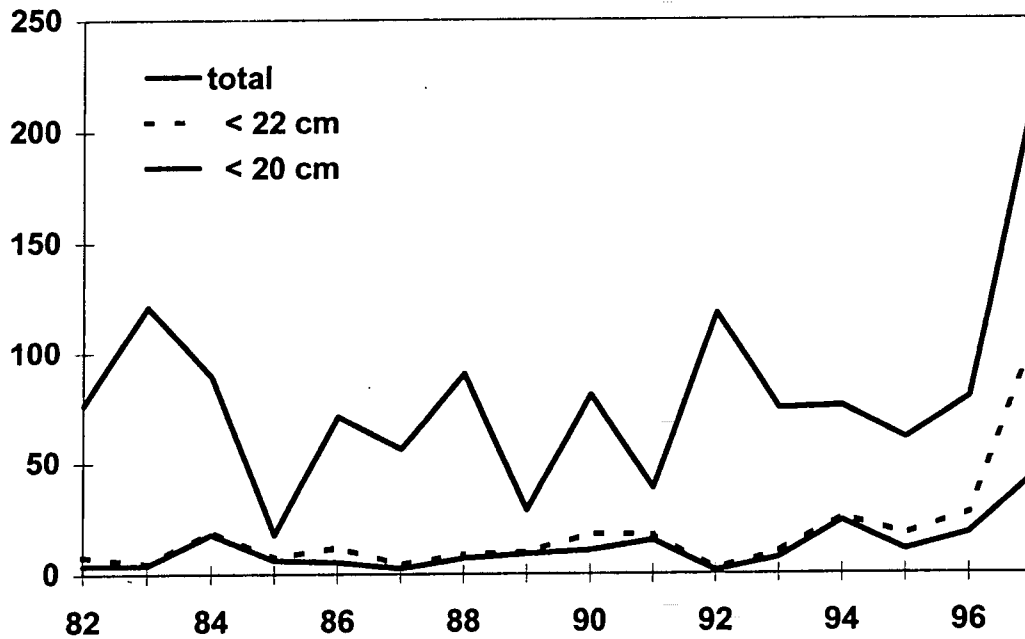


Figure 15. Abundance of unit 3 redfish by size category from summer surveys for the period 1982 to 1997.

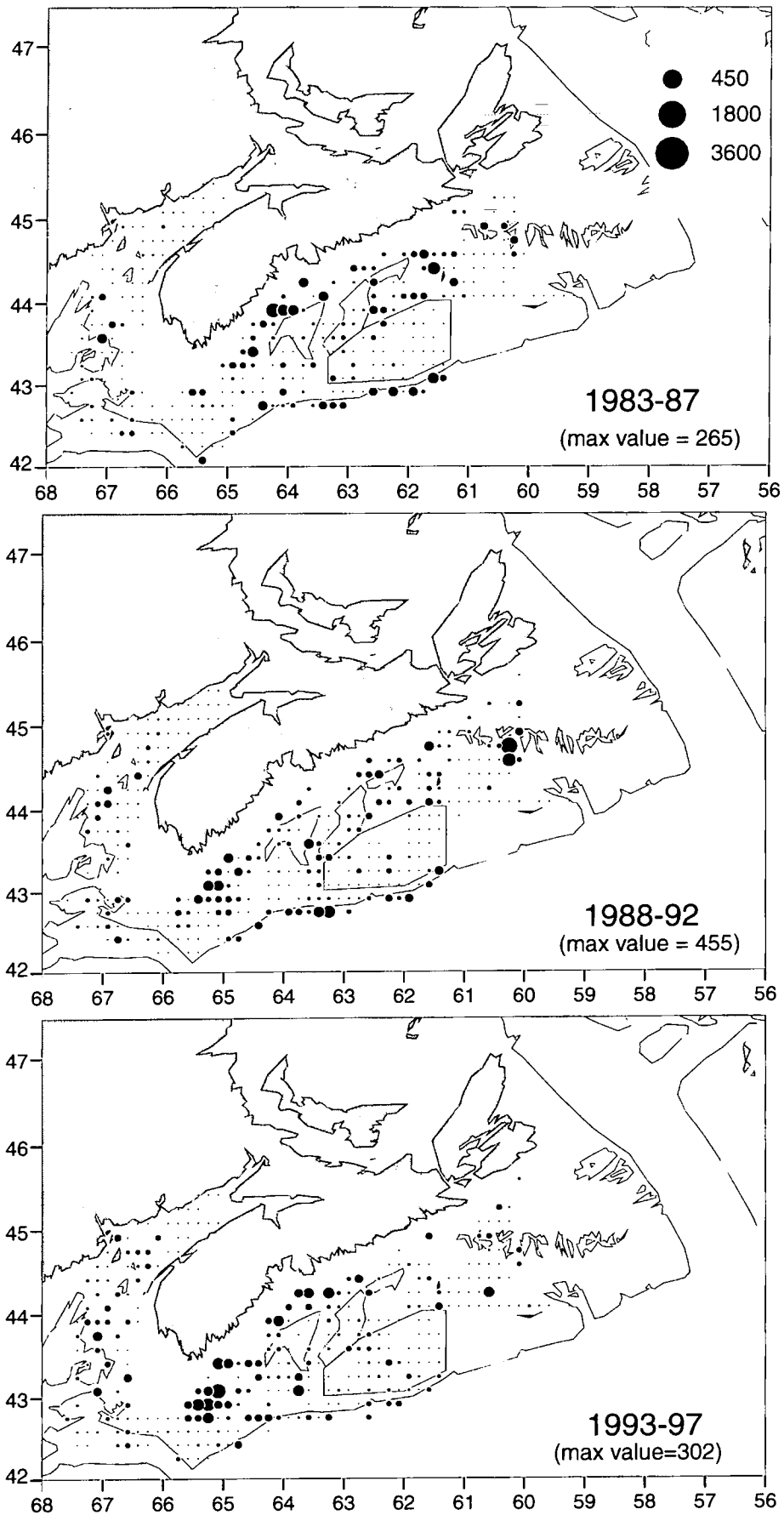


Fig 16. The distribution of small redfish (< 22 cm, number/tow) in Unit 3 (+ straub 498) from RV surveys, 1983-87 (top), 1988-92 (middle) and 1993-97(bottom).

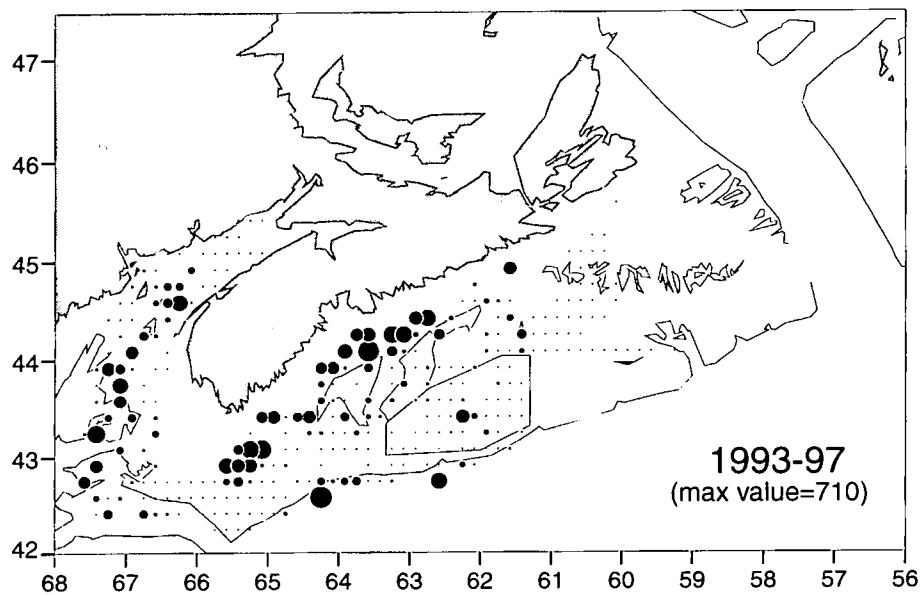
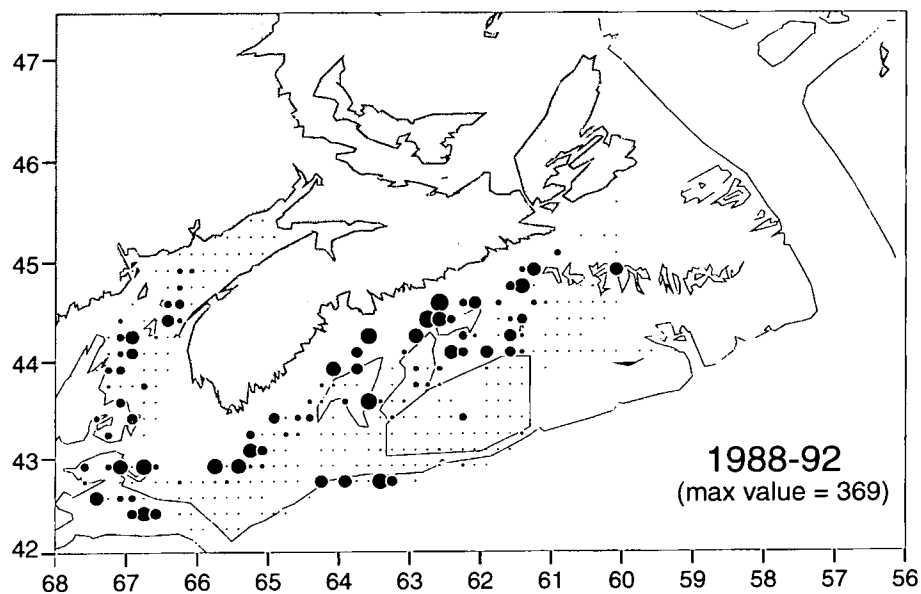
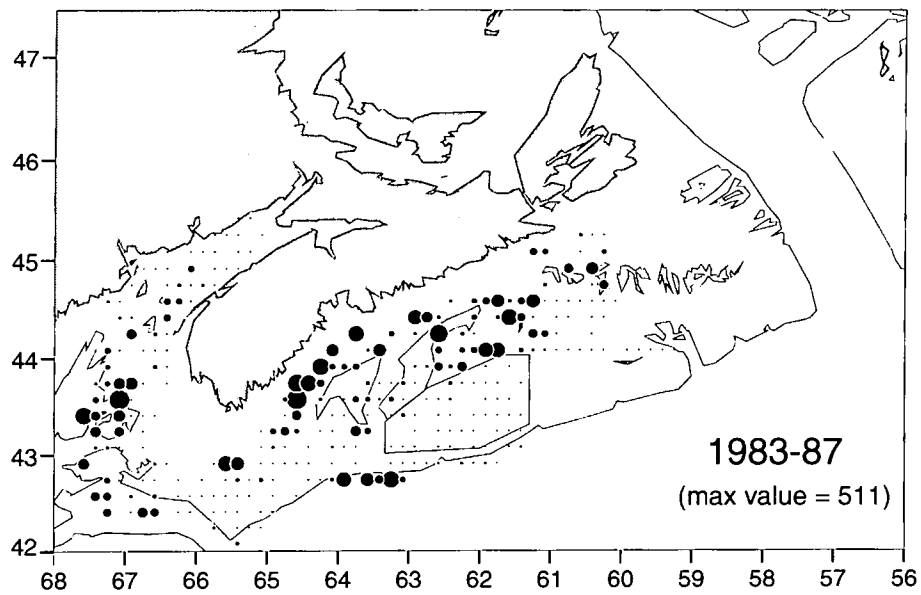


Fig 17. The distribution of large redfish (≥ 22 cm, number/tow) in Unit 3 (+ straum 498) from RV surveys, 1983-87 (top), 1988-92 (middle) and 1993-97(bottom).

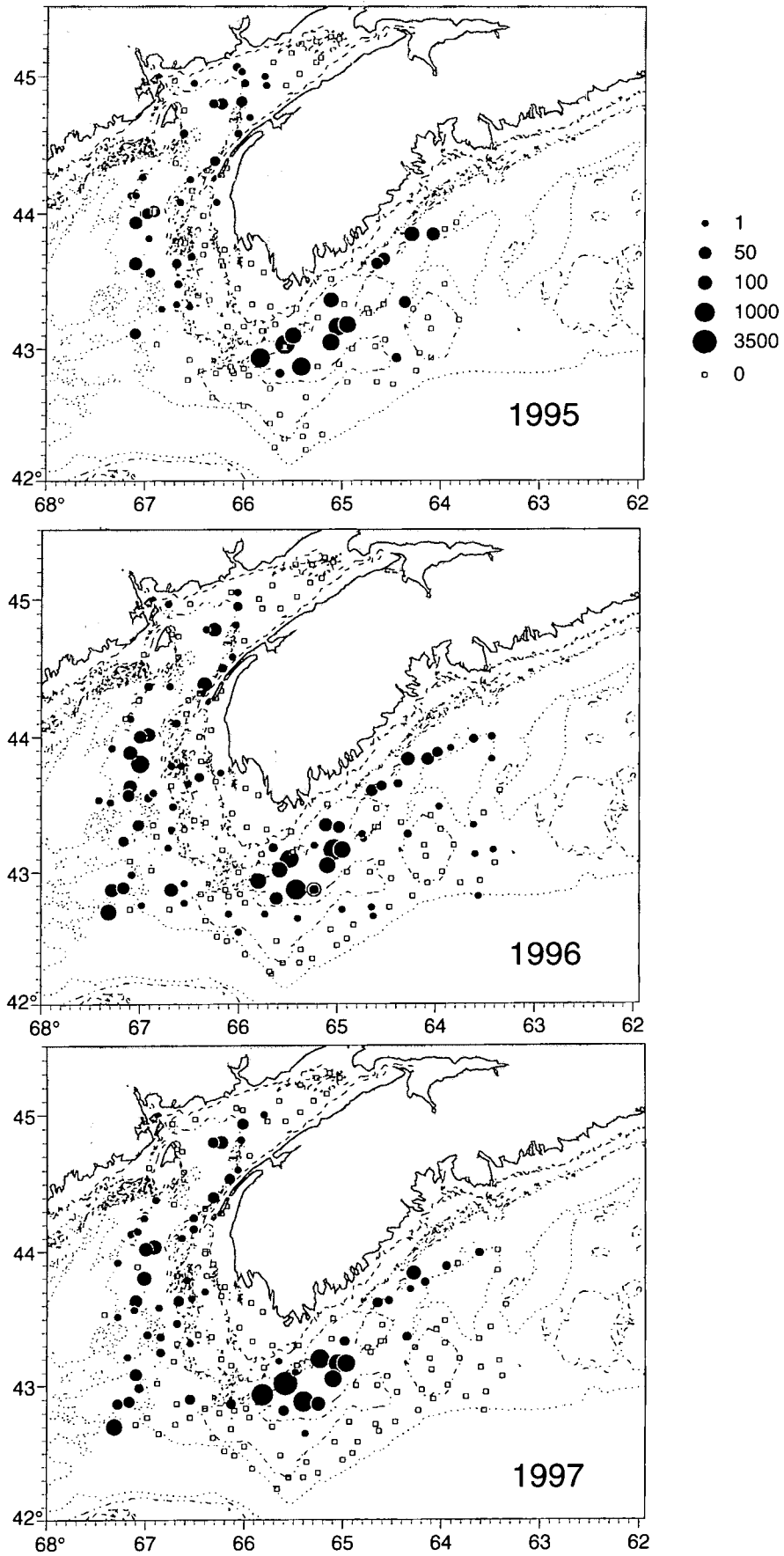


Figure 18. The distribution of redfish in Div. 4X (kg per tow) from ITQ surveys, 1995-97.