Fisheries and Oceans Canada | Pêches et Océans Canada

Canadian Stock Assessment Secretariat
Research Document 98/138

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Secrétariat canadien pour l'évaluation des stocks
Document de recherche 98/138

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Update on the Status of Unit 3 Redfish, 1998

By R. Branton

Department of Fisheries and Oceans
Maritimes Region, Science Branch
Bedford Institute of Oceanography
1 Challenger Drive, Dartmouth
Nova Scotia, B2Y 4A2
Canada

ISSN 1480-4883
Ottawa, 1998

Canada

Abstract

This document summarizes commercial fishery and research survey data for Unit 3 (4Wdehkl and 4X) redfish to July 1998. Recent landings were somewhat higher than the average of the previous 4 years but well below the TAC. Most of the catch was taken by small otter trawlers (less than 65 ft). In 1997, fishing was distributed throughout the central and western portions of the management unit, however in 1998 (to July), most of the fishing occured to the west only. Catch rates of larger redfish was consistently good and small redfish were generally avoided. The eastern part of Unit 3 which had produced good catch rates in 1995-97 could not be fished economically in 1998. Redfish fishing with small mesh gear was constrained by management initiatives to avoid the capture of small redfish and the bycatch of other groundfish species. The small redfish protection area known as the 'Bowtie' was redefined in early 1998. The 1998 survey biomass estimate was judged to be not greatly different than average since the late 1980s. Indications of small redfish continue in the area north and east of Brown's Bank. Catches at the level of 10,000t in 1999 would be expected to not exceed the $F_{0.1}$. Reduced fishing success in the east during 1998 and concentration of effort in the west justifies extra caution in the management of this resource.

Résumé

Le présent document résume les données de la pêche commerciale et des relevés de recherche du sébaste de l'unité 3 (4Wdehkl et 4X) jusqu'en juillet 1998. Les débarquements récents sont quelque peu supérieurs à la moyenne des quatre années antérieures, mais bien en deçà du TAC. La plupart des captures ont été faites par de petits chalutiers (moins de 65 pieds). En 1997, la pêche était répartie dans le centre et l'ouest de l'unité, mais en 1998 (jusqu'en juillet), la majorité de la pêche a été concentrée dans l'ouest. Les taux de capture de sébastes de plus grande taille étaient constamment élevés et l'on évitait généralement les petits poissons. La partie est de l'unité 3 où les taux de capture étaient bons de 1995 à 1997 n'a pu être exploitée de façon rentable en 1998. La pêche du sébaste aux engins à petit maillage a été restreinte par des mesures de gestion afin d'éviter la capture des petits sébastes et la capture accidentelle d'autres espèces de poisson de fond. La zone de protection des sébastes de petite taille, surnommée la zone « Bowtie » a été redéfinie au début de 1998. L'estimation de biomasse par relevés de 1998 n'a pas été jugée différer de beaucoup de la moyenne notée depuis la fin des années 1980. On continue de déceler des indices de sébastes de petite taille au nord et à l'est du banc Brown's. Des captures de 10 000 t en 1999 ne devraient pas être supérieures à la valeur du $F_{0.1}$. La baisse du succès de la pêche notée dans l'est en 1998 et la concentration de l'effort justifient que l'on fasse preuve d'encore plus de prudence pour la gestion de cette ressource.

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 northwest 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. 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 an increasingly important part of the diet as redfish increase in size.

Management Unit 3 (Fig. 1) for redfish consists of Statistical Unit Areas 4Wdehkl and 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 1977-98. The NAFO data were reported by Division (Unit 3 contains only a portion of Div. 4W) therefore only the Div. 4X data from the two sources were compared. They agreed almost exactly, therefore the ZIF data accurately reflected the landings and were used to estimate Canadian landings for the entire management unit.

Landings by foreign vessels were available from NAFO files for 1977-93 and from Canadian Observer (Observer) files for 1988-98 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 from Div. 4X for the period 1977-87 and Observer data from the entire management unit for the period 1988-98 were combined to estimate foreign landings.

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

Emerald and LaHave Basins	4WdehkXm
Roseway Basin and Western Ridge	4Xo
Scotia Shelf slope	4WlXn
Crowell and Jordan Basins	4Xpqrs

The distribution of Canadian catches were described in the form of maps from the ZIF data using geographical coordinates, available for 1997-98 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 1994-98. Sample weights from both sources were estimated using a length-weight relationship obtained from the summer Research Vessel survey, 1970-94 combined (Branton and Halliday 1994). 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 were assumed to be gear trials and 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 where combined by fishing area.

Bycatch of other groundfish were taken from ZIF and Observer files for 1997-98. 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. The Observer catches were very low for 1997-98 (<10%) and did not agree well with ZIF. Thus, ZIF were used to estimate bycatch 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 and average hours per day were calculated for the period 1989-98.

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 1982-98 using the Alfred Needler (Branton and Black 1998). 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 1987). Given this limited effect and the extended survey coverage has only 4 of 16 years, the 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 1995-98. Some redfish size composition samples were available from these surveys, however not all tows were sampled for length. Spatial coverage of the ITQ survey differed from the RV survey: the ITQ survey did not include areas on Scotian Shelf Slope between 2-400 fathoms (stratum 498); the ITQ survey included coastal areas (stratum 499) not covered by RV survey; and in 1995 fewer strata were occupied by the ITQ survey than in 1996-98. Distribution from both surveys was similar in all years. Biomass and adundance estimates for stratum common to both surveys agreed in 1995 and 1996, but were higher in common strata for both surveys in 1997 as a result of large catches of small redfish (.17 kg average) in the Roseway Basin and Western Ridge area (stratum 476 and 481). The 1997 RV estimates were much higher than in the ITQ survey as a result one large catch (stratum 476) of small redfish. Biomass and abundance estimates were lower in the common strata for both surveys in 1998 than in 1997. The RV survey estimates were much lower than the ITQ survey estimates as a result of no sets being allocated to the RV survey in and around the small fish areas in that year. 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 (Fig. 1). 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, Branton 1996, and Branton 1997) 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 1995-98 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 increased again in 1992 and for the period 1993-96 they ranged from 4,800 to 5,300 t annually. The 1997 landings were about 6,400 t. Landings in 1997 were higher than average for the period 1993-96 but well below the 10,000 t TAC. The landings for 1998 to July (4,235 t) are somewhat more than for the same time period in 1997 (3,245 t). Most of the Unit 3 redfish landings during the period 1977-89 were from Emerald and LaHave Basins (4WXdehkm), with the Roseway Basin and Western Ridge (4Xo) accounting for most of the remainder (Table 2, Fig. 3). During the period 1992-97, landings were generally distributed among the four fishing areas of the management unit. In 1997 there were increased landings from the Scotian Shelf Slope (4WXln)(Fig 4.) while in 1998 (to July) almost all of the landings were from the Crowell and Jordan Basins (4Xpqrs)(Fig 5.). In 1997, the highest landings were in the May to July period as was the case in 1993-96 (Table 3-5). In 1998 (to July), landings were highest in May (1,397 t).

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. 6). In 1998 (to July), almost all of the landings were by small otter trawlers. The redfish allocation to small otter trawlers was included in the Individual Transferable Quota (ITQ) management program for this fleet component starting in 1996 (Annand and Hansen 1997). In 1997, 96% of the inshore (<65 ft) quota allocation was caught while the mid-shore (65-100 ft) utilization was about 9% and the off-shore (>100 ft) utilization was 68%. Almost all of the off-shore allocation was caught by small otter trawlers under the Temporary Vessel Replacement Plan (TVRP) (Table 7), thus the discrepancy between quota and landings reports by vessel class.

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 7). At industry's request, this area was closed to fishing with small mesh gear (<130 mm) on May 19, 1995 and a 22 cm minimum fish size was included in Conservation and Harvesting Plans (CHP) for 1996-98. Following FRCC recommendations, the boundaries of the 'Bowtie' small redfish protection area were redefined in early 1998. Percentages by number of redfish landings from the management unit as a whole under this size were:

	93	94	95	96	97	98 (to July)
% < 22 cm	4	15	15	10	6	7

The proportions of small redfish (<22cm) were highest in commercial catches from Roseway Basin and Western Ridge in 1994-96 (Fig 8). Small redfish in catches from that area declined after 1996. The proportions of small redfish from Crowell and Jordan Basins were high only in 1997, the same time as when the proportions of large redfish (>35cm) from that area were low (Fig. 9). The proportions of large redfish have been consistently high in the catches from the Scotian Shelf slope (Fig. 10). Catches from Emerald and LaHave Basins have contained commercial sized redfish (20-35 cm) only, throughout the period (Fig. 11).

Bycatch of other groundfish species in the directed redfish fishery (< 130 mm sq. mesh cod end) 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 other areas were closed to redfish fishing to avoid bycatches of other species. These closures include:

Area	Period
4W	Jan 01-Jun 30
Haddock Nursery	All year
Brown's Bank	Jan 01-Jun 30
Bay of Fundy N. of 43°30'	All year
All areas < 50 fathoms	All year

'Test Fishing' and mandatory observer coverage were required before the start of fishing for redfish in NAFO Divisions 4VW in 1996-98. Fleet sectors were controlled separately. Vessels fishing under offshore license conditions (including TVRP vessels) were permitted to test the area open beginning January 1, while the area was closed to the <65' mobile gear fleet (ITQ) from January 1 to June 30 (based on license conditions). 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 was about 12% for 1997 and about 15% for 1998 (to July)(Table. 11-12). The bycatch consisted mostly of pollock. Highest rates of all species combined were in Crowell and Jordan Basins. 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. Observer data for 1998, although very limited, show much higher bycatch rate for pollock in Crowell and Jordan basins than do commercial statistics. There were no observer data from Crowell and Jordan basins for 1997.

Resource Status

Fishing effort of small otter trawlers and large otter trawlers were examined (Table 14-15). 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). The increase in catches after 1992, resulted from an increase in fishing effort by small otter trawlers <65', reflecting decreased fishing opportunities for more valuable species, and not an increase in redfish abundance. Fishing success of small otter trawlers did decline in 1998 to the eastward (Lahave and Emerald basins) and along the shelf edge and did increase slightly to the westward in Crowell and Jordan basins (Fig. 12). The substantial increase in the proportion of catch to the westward resulted mainly from the concentration of fishing effort there, encouraged by the relatively greater fishing success compared to the more eastern areas.

Survey estimates of population (< 200 fm), are highly variable between years but show no trend over time from the late 1980s (Branton and Black 1998). The 1997 abundance estimate is much higher than earlier values and is 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 low abundance in 1998 is very likely a result of not having any of the RV survey sets allocated to the small fish areas in that year. The industry survey in 4X provides biomass estimates similar to the RV survey for that area, but the estimates are less variable. The industry survey indicates abundance in 1998 (unlike the RV survey) was similar to the previous three years (Fig 13). USA surveys of the Gulf of Maine and George's Bank, which include Crowell and Jordan basins, have shown an increase in resource abundance in 1996-97 (Mayo 1998).

The size composition of surveys catches 1993-98 differs for each of the fishing areas. There are however small redfish (<22 cm) in all fishing areas and they appear to have been avoided by the commercial fishery. The smallest redfish (modal length 20-22 cm) on average for the period 1993-98 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 does cover more Unit 3 redfish habitat 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) and found in the Roseway Basin and Western Ridge fishing area.

Redfish smaller than commercial size do not contribute greatly to this biomass estimate, so survey biomass can be taken as an indicator for the size classes fished commercially. However, survey biomass underestimates the actual biomass on which the commercial fishery is based, as not all of the commercial sized fish are available to the survey gear, and some are outside the survey area (deeper than 200 fm).

Recent catches compared to survey biomass estimates indicate an exploitation rate of 7 to 9 percent, but this is an over estimate of the actual exploitation rate in the fishery because survey biomass is an underestimate of the actual biomass.

Discussion

Captains of small otter trawler are concerned over the concentration of fishing effort in Crowell and Jordan basins in 1998, but indicated that catch rates of market sized redfish were good and that the bycatch rates of spiny dogfish in that area were much lower than in previous years. They are particularly concerned over the lower catch rates encountered in the eastern part of the management unit (Emerald and LaHave basins) and on the shelf slope, in 1998. The shelf slope area, which produced commercial quantities of large redfish in 1997, was closed in early 1998 due to the high incidence of undersized fish in the haddock fishery, on the shelf slope. The greatest concern was expressed for the eastern area. Areas, which produced good catch rates in 1995-97 could not be fished economically in 1998. This when combined with the cost of a mandatory observer when fishing in 4W resulted in little or no fishing in those areas (100% observer coverage is not a requirement in 4X). Some captains claim that the total bycatch limit for 4X should be 20%, as most of the fish caught as bycatch are of market size. They claim also that small mesh fishing could be safely extended northward from 43° 30' to 43° 40'. Most captains and plant operators have responded favourably to the 'Bowtie' closed area revisions.

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 improve fishing success. The ratio of catch tonnages (4-5,000 t) to recent (5 yr 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

The reduced commercial fishing success in eastern areas during 1998 is inconsistent with the results of research vessel surveys. The factors underlying this inconsistency are presently not understood and require further study in cooperation with industry.

Research vessel surveys indicate stability in the population biomass with improved recruitment particularly in and around Roseway Basin and Western Ridge. This recruitment, although promising, has not yet resulted in a detectable increase in population biomass, but combined with the current low exploitation rates, should result in fishing and stock conditions in 1999 being very much the same as in recent years. However the reduced commercial success in the east and the concentration of effort in the west justify extra caution in the management of this resource. Catches of 10,000 t in 1999 would be consistent with an exploitation of 15% of survey biomass. Since survey biomass in this area is an underestimate of actual biomass, the harvest rate is less than 15% and probably does not exceed $F_{0.1}$.

Acknowledgments

The author acknowledges with thanks the valuable assistance of Gerry Black, who prepared the map of closed areas and RV survey distribution maps and of Peter Comeau, who provided ITQ survey distribution maps and assisted with their interpretation.

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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	6.30	0.05	6.35	10.0
98	4.24	0.01	4.25	10.0 (to July)

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

Year	dehkm	ln	o	pqrs	u	Unit3	
77	1118	598	162	117	120	2114	
78	544	386	210	37	24	1201	
79	1067	360	353	75	8	1864	
80	1212	783	797	70	12	2874	
81	2480	279	905	34	34	3731	
82	1005	420	1508	139	18	3090	
83	2314	519	935	193	83	4044	
84	3156	473	565	167	210	4570	
85	3961	329	1061	152	342	5844	
86	2416	1197	1978	363	668	6623	
87	2412	849	1451	213	1143	6067	
88	1096	594	376	118	1718	3903	
89	1230	320	137	172	1343	3203	
90	290	128	348	122	1374	2261	
91	363	135	547	82	785	1912	
92	715	191	1114	203	145	2367	
93	629	614	2917	886	29	5075	
94	391	972	2712	1054	39	5169	
95	1441	466	1384	1525	22	4838	
96	1867	319	1411	1115	23	4735	
97	1646	1422	1177	1997	53	6295	
98	208	434	295	3296	2	4235	(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 1993 to 1996.

AREA	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
dehkm	13	15	7	71	205	134	39	113	107	192	61	83	1039
ln	0	6	3	10	112	129	154	87	18	15	7	6	548
o	1	0	3	61	231	390	673	394	150	109	25	3	2041
pqrs	2	6	30	241	225	257	91	33	57	40	7	25	1014
u				0		0	2	0	2	0	2	0	6
	15	27	43	383	773	911	959	628	334	356	101	117	4647
SA5	0		0	0	2	2	0	0	2	0		1	8
	0		0	0	2	2	0	0	2	0		1	8

Table 4. 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	225	88	423	236	24	59	27	1619
ln		0		258	569	231	97	25	47	31	67	39	1365
o				0	17	59	905	86	11	4	22	60	1164
pqrs		0	69	404	369	131	38	33	197	451	91	59	1841
	54	52	142	665	1311	646	1129	567	491	511	239	184	5989
SA5									0	10	12		22

Table 5. Landed tons by statistical unit area grouping and month for mobile gear fishing redfish in Unit 3 during 1998 (to Sept 14, 1998).

AREA	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
dehkm	19	21	13	23	83	26	14	20	5				225
ln	8	5	61	176	95	34	13		10				402
o	2	3	2	2	44		190	65					308
pqrs	7	29	462	192	1175	840	410	456	55				3626
	36	58	538	393	1397	901	627	542	69				4561
SA5		0		1	12	87	5	1					106
		0		1	12	87	5	1					106

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' TC2+3	>65' TC4+5	Other	Combined	
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	0.17	4.84	
96	4.15	0.28	0.34	4.77	
97	5.88	0.11	0.31	6.30	
98	3.88	0.07	0.28	4.24	(to July)

Table 7. Quota allocations and percent used by vessel type for Unit 3 redfish during 1997 and 1998 (to Oct 8, 1998).

Year	Vessel	Quota	Catch	%used
1997	<65'	3707	3544	96
	65-100'	2851	269	9
	>100'	3442	2349	68
	total	10000	6262	63
1998	<65'	3707	3108	84
(July)	65-100'	2734	129	5
	>100'	3559	1995	56
	total	10000	5232	52

Table 8. Number of port samples of redfish landings in Unit 3 by vessel/gear class and by statistical area, and by Div., 1993-98. Inventory for 1998 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	6	8	3	17	3	31	34
	OTB 4+	1	2				3	3
****								
sum		7	10	3	17	3	34	37
1998	OTB 0-3	2	6	1	16	1	24	25
	OTB 4+				1		1	1
****								
sum		2	6	1	17	1	25	26

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., 1993-98. Inventory for 1998 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	37	4	0	0	40	3	40
	OTB 4+	1	5	0	0	0	6	6
*****								
sum		38	9	0	0	40	9	46
1998	OTB 0-3	8	3	1	4	10	6	15
*****								
sum		8	3	1	4	10	6	15

Table 10. Tons of sampled catch used to construct catch at length, by source, statistical area, and year for period 1993-98. Tons of sampled catch for 1998 is incomplete.

Port Samples						Observer Samples				
year	dehkm	ln	o	pqrs	total	dehkm	ln	o	pqrs	total
1993	.4	6.3	72.0	20.7	99.4	16.1	33.2	243.9	.0	293.2
1994	85.3	67.7	279.4	33.3	465.7	15.2	89.7	218.9	28.5	352.3
1995	189.8	43.9	132.0	79.0	444.8	132.0	32.8	16.7	97.5	279.0
1996	364.1	.5	57.1	35.8	457.5	1045.7	27.6	35.7	.5	1109.5
1997	90.8	127.5	2.5	294.5	515.4	522.4	36.4	.0	.0	558.8
1998	25.7	43.3	10.8	220.5	300.3	97.6	45.6	12.2	58.3	213.8

Table 11. Percent bycatch of other groundfish species by the Unit 3 redfish fishery by unit area and species for 1997.

SPECIES	dehkm	ln	o	pqrs	total
Pollock	3.8	3.7	1.6	11.0	5.9
Cod	.6	.3	2.5	5.3	2.4
Haddock	.9	.2	1.1	3.9	1.6
White hak	.2	1.4	.1	2.6	1.2
Flatfish	.3	.2	.4	.5	.3
Cusk	.0	.8	.0	.3	.3
Catfish	.1	.1	.3	.1	.1
sum	5.9	6.7	6.0	23.7	11.8

Table 12. Percent bycatch of other groundfish species by the Unit 3 redfish fishery by unit area and species for 1998 (to July).

SPECIES	dehkm	ln	o	pqrs	total
Pollock	3.1	2.9	1.9	10.3	8.7
Cod	1.0	.3	2.5	3.1	2.7
Haddock	.7	.3	1.1	1.6	1.5
White hak	.0	3.8	.0	1.0	1.2
Cusk	.0	1.2	.1	.6	.6
Flatfish	.2	1.0	.4	.5	.5
Halibut	.2	1.9	.0	.0	.2
sum	5.2	11.4	6.0	17.1	15.4

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= 97

	catch (tons)					bycatch (% of redfish)				
species	dehkm	ln	o	pqrs	Unit3	dehkm	ln	o	pqrs	Unit3
Redfish	630.90	42.51	1.29		674.70	100.00	100.00	100.00		100.00
Pollock	37.53	9.09	.00		46.62	5.95	21.38	.31		6.91
Dogfish	35.88	.01			35.89	5.69	.03			5.32
Monkfish	.69	5.48	.00		6.18	.11	12.90	.15		.92
Haddock	3.74	.00	.23		3.97	.59	.00	17.88		.59
Cod	3.73	.00	.03		3.76	.59	.00	2.63		.56
Silver Hake	2.09	.64	.00		2.73	.33	1.51	.08		.40
Herring	2.10	.01			2.10	.33	.01			.31
Halibut	.65	.22			.87	.10	.52			.13
Basking Shark		.75			.75		1.76			.11
White Hake	.57	.18			.75	.09	.43			.11
Red Hake	.13	.62			.74	.02	1.45			.11
Short-fin Squid	.56	.01			.57	.09	.03			.08

year= 98

species	dehkm	ln	o	pqrs	Unit3	dehkm	ln	o	pqrs	Unit3
Redfish	99.09	45.61	12.23	59.26	216.18	100.00	100.00	100.00	100.00	100.00
Pollock	4.48	1.21	.01	16.18	21.88	4.52	2.66	.09	27.30	10.12
Haddock	4.30		.15	1.57	6.02	4.34		1.21	2.65	2.79
Smooth skate	.00	.01	.07	3.05	3.13	.00	.02	.53	5.15	1.45
Cod	1.16	.03	.17	1.52	2.88	1.17	.06	1.39	2.56	1.33
Monkfish	.19	2.46		.10	2.75	.20	5.39		.17	1.27
Dogfish	.87			1.69	2.55	.87			2.85	1.18
White Hake	.01	.61		.94	1.56	.01	1.34		1.58	.72
Herring	.08		.00	.92	1.00	.08		.01	1.55	.46
Halibut	.29	.51		.04	.83	.29	1.11		.06	.38
Silver Hake	.42	.11			.53	.42	.24			.24

Table 14. Unit 3 redfish fishing effort in hours and days by small otter trawlers during the period 1989 to 1998.

year	hrs	days	hrs/day	
1989	1833	313	6	
1990	879	108	8	
1991	736	98	8	
1992	1421	149	10	
1993	5095	541	9	
1994	9759	895	11	
1995	12656	1176	11	
1996	9983	1121	9	
1997	16228	1445	11	
1998	12614	997	13	(to July)
avg	7120	684	9	

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

year	hrs	days	hrs/day	
1989	1310	157	8	
1990	684	165	4	
1991	1410	158	9	
1992	1686	189	9	
1993	1984	215	9	
1994	1861	184	10	
1995	1622	195	8	
1996	732	88	8	
1997	282	26	11	
1998	168	12	14	(to July)
avg	1174	139	9	

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
1998	24.7	45.9
avg	67.6	78.9

Table 17. Trawl units, stratified total weight of redfish per tow (kg), total numbers of redfish per tow, and average weigth (kg) for summer 4X Mobile Industry (ITQ) and DFO groundfish research (RV) surveys in Div 4x, 1995-98. For A) all strata surveyed by the industry, B) strata in 4Xo, C) stratra in 4Xpqrs, and D) strata sampled in both surveys in all years. (Strata 483 was not sampled by industry survey, 499 was not sampled by research survey, 471, 482, and 484 were not sampled by ITQ survey in 1995, 478 was not sampled by ITQ survey 1995 and 1998, and numbers were not recorded for some sets in ITQ survey for 1997.)

A) All Industry Survey strata (460, 461, 470-482, 484-495, 499)

a) All industry survey strata (460, 461, 470-482, 484-495, 499)

Yr	ITQ Units	TotWgt	TotNo	AvgWgt	RV Units	TotWgt	TotNo	AvgWgt
1995	1490179	20.36	88.73	.23	1739064	25.19	91.09	.28
1996	1989052	23.92	130.34	.18	1739064	28.69	122.76	.23
1997	1989052	33.21	175.02	.19	1739064	68.80	324.82	.21
1998	1953206	29.45	130.85	.23	1739064	12.93	64.07	.20

b) 4X strata (470-491, 495)

Yr	ITQ Units	TotWgt	TotNo	AvgWgt	RV Units	TotWgt	TotNo	AvgWgt
1995	1142400	27.77	121.00	.23	1572463	28.22	101.01	.28
1996	1527380	32.58	177.81	.18	1572463	19.27	98.52	.20
1997	1527380	45.35	239.10	.19	1572463	72.65	354.81	.20
1998	1507635	40.21	178.72	.22	1572463	15.21	71.19	.21

c) 4Xo strata (474-481)

Yr	ITQ Units	TotWgt	TotNo	AvgWgt	RV Units	TotWgt	TotNo	AvgWgt
1995	366507	97.27	427.35	.23	366507	103.34	346.77	.30
1996	366507	90.21	563.77	.16	366507	49.50	224.73	.22
1997	366507	164.10	889.76	.18	366507	224.05	1268.44	.18
1998	366507	93.09	498.44	.19	366507	14.67	67.21	.22

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

Yr	ITQ Units	TotWgt	TotNo	AvgWgt	RV Units	TotWgt	TotNo	AvgWgt
1995	465231	3.66	17.15	.21	745386	1.39	3.61	.38
1996	745386	18.98	74.55	.25	745386	4.95	22.91	.22
1997	745386	9.75	43.23	.23	745386	36.75	97.15	.38
1998	745386	21.52	46.72	.46	745386	1.69	5.74	.29

e) Strata common to both surveys in all year (470, 472-477, 480, 485-495)

Yr	ITQ Units	TotWgt	TotNo	AvgWgt	RV Units	TotWgt	TotNo	AvgWgt
1995	1142400	37.13	161.78	.23	1142400	37.87	137.18	.28
1996	1142400	36.67	217.27	.17	1142400	25.07	128.60	.19
1997	1142400	56.71	302.42	.19	1142400	95.86	479.37	.20
1998	1142400	46.05	231.27	.20	1142400	19.21	95.42	.20

Table 18. Number of tows, average depth of fishing, average total weight of redfish per tow (kg), average total numbers of redfish per tow, and average weigth (kg) of individual redfish by stratum from the 4X Mobile Gear Industry Survey (I) compared with the standard DFO groundfish research survey (R) during the period 1995-98.

Str	Units	Yr	Tows	Depth	Totwgt	Totno	AvgWgt	Tows	Depth	Totwgt	Totno	AvgWgt
460	113893	1995						3	81	.41	2.39	.17
		1996	2	87	.53	1.59	.33	3	90	170.54	511.06	.33
		1997	1	67	.00	.00		3	84	32.23	2.61	12.33
		1998						3	88	1.43	7.72	.19
461	97792	1995						2	124	.34	1.52	.23
		1996						2	120	2.05	5.60	.37
		1997						2	118	22.46	81.00	.28
		1998	1	68	.00	.00		2	116	.45	2.99	.15
470	77962	1995	4	93	54.11	174.51	.31	2	85	41.59	162.03	.26
		1996	5	92	30.48	111.33	.27	2	86	106.24	667.23	.16
		1997	5	94	23.92	81.49	.29	2	71	40.35	197.12	.20
		1998	9	92	153.71	676.92	.23	2	86	198.42	1023.19	.19
471	85080	1995						2	119	1.39	4.50	.31
		1996	3	107	2.82	6.00	.47	1	121	.15	4.05	.04
		1997	4	108	1.06	6.08	.17	2	126	5.35	13.27	.40
		1998	2	110	1.09	4.36	.25	2	125	.00	.00	
472	105842	1995	3	64	.00	.00		4	77	13.49	139.60	.10
		1996	12	71	.26	.35	.75	3	58	.00	.00	
		1997	12	71	.00	.00		4	85	4.84	15.98	.30
		1998	13	76	1.59	21.70	.07	4	69	.83	7.02	.12
473	22456	1995	2	48	.00	.00		2	50	.00	.00	
		1996	2	48	.00	.00		2	48	.03	.97	.04
		1997	2	49	.00	.00		2	48	.16	2.09	.08
		1998	2	49	.00	.00		2	47	.31	1.50	.20
474	13643	1995	1	48	.00	.00		2	38	.36	2.08	.17
		1996	1	49	.00	.00		2	45	.25	1.37	.18
		1997	2	47	.00	.00		2	45	30.52	155.32	.20
		1998	4	49	.27	.54	.50	2	41	.15	2.92	.05
475	13220	1995	2	50	.00	.00		2	49	.37	2.98	.13
		1996	1	49	.00	.00		2	48	.06	6.38	.01
		1997	2	51	.00	.00		2	47	1.50	38.56	.04
		1998	1	49	1.09	1.09	1.00	2	45	.19	5.01	.04
476	125248	1995	15	79	108.08	485.48	.22	4	75	18.87	86.70	.22
		1996	17	78	136.81	1052.76	.13	4	78	141.96	633.30	.22
		1997	15	79	159.66	937.48	.17	4	73	605.98	3476.40	.17
		1998	15	80	203.45	1175.82	.17	4	77	42.89	195.84	.22
477	104401	1995	6	63	1.44	17.32	.08	5	62	.06	1.87	.03
		1996	11	64	.29	1.15	.25	5	61	1.11	26.04	.04
		1997	11	65	.00	.00		5	66	.08	2.02	.04
		1998	11	63	.20	.20	1.00	5	64	.04	.56	.06
478	19745	1995						3	148	1.28	10.66	.12
		1996	1	123	1.06	2.12	.50	3	129	1.08	9.70	.11
		1997	1	121	.00	.00		2	148	7.49	46.03	.16
		1998						2	198	3.90	36.43	.11
480	55506	1995	9	43	.00	.00		8	46	.04	.49	.07
		1996	8	43	.42	.97	.43	8	46	.00	.11	.03
		1997	7	41	.16	.16	1.00	8	43	.00	.00	
		1998	6	43	.18	.18	1.00	8	42	.00	.00	
481	158890	1995	17	71	156.53	603.06	.26	7	80	223.43	730.94	.31
		1996	19	77	117.78	470.23	.25	9	75	2.25	18.48	.12
		1997	20	74	295.13	1313.33	.22	9	67	36.40	169.00	.22
		1998	19	76	74.20	222.67	.33	9	67	.00	.00	
482	88301	1995						3	134	.15	.99	.15
		1996	5	119	46.73	178.27	.26	3	131	4.21	10.10	.42
		1997	6	119	42.45	162.03	.26	3	125	.00	.00	
		1998	7	112	70.73	.00		3	128	.00	.00	
484	191855	1995						3	117	1.63	3.05	.53
		1996	11	118	23.68	36.87	.64	3	115	6.39	33.31	.19
		1997	11	119	7.17	25.49	.28	3	120	19.10	36.44	.52
		1998	11	124	21.83	43.79	.50	3	113	1.33	2.66	.50
485	134061	1995	16	77	13.27	60.28	.22	3	73	.47	1.51	.31
		1996	17	78	43.02	172.69	.25	3	76	7.29	50.49	.14
		1997	17	74	3.32	22.76	.15	3	87	170.00	462.16	.37
		1998	18	79	9.57	32.18	.30	3	75	.14	2.33	.06
490	50930	1995	8	48	1.87	16.01	.12	5	45	.14	2.53	.06
		1996	9	46	.77	6.03	.13	4	39	.07	1.32	.05
		1997	10	43	.00	.00		4	44	.00	.00	
		1998	10	44	.13	.13	1.00	4	43	.00	.00	
491	58217	1995	5	69	17.16	51.61	.33	3	85	10.79	26.71	.40
		1996	5	73	53.12	145.17	.37	3	89	14.78	44.28	.33
		1997	5	71	42.77	125.56	.34	3	75	10.06	32.49	.31

		1998	6	68	122.17	328.80	.37	3	82	14.98	52.56	.28
492	92029	1995	8	62	1.87	7.62	.24	2	89	.11	1.47	.08
		1996	8	58	1.56	8.86	.18	3	95	2.64	3.60	.73
		1997	9	62	9.66	28.98	.33	3	71	3.81	17.13	.22
		1998	10	59	12.15	32.06	.38	3	76	1.26	4.33	.29
493	45167	1995	4	35	1.24	3.42	.36	3	44	.00	.00	
		1996	5	41	.56	.56	1.00	2	45	.19	1.04	.19
		1997	5	42	.00	.00		3	36	.00	.00	
		1998	5	44	.26	.26	1.00	3	37	.00	.00	
494	35337	1995	5	36	.00	.00		2	26	.00	.00	
		1996	4	31	.00	.00		2	36	.00	.00	
		1997	3	33	.00	.00		2	26	.00	.00	
		1998	4	33	.00	.00		2	37	.00	.00	
495	49489	1995	7	40	.36	.53	.67	2	39	.00	.00	
		1996	7	41	.00	.00		2	50	.00	.00	
		1997	7	42	.00	.00		2	43	.00	.00	
		1998	7	41	.00	.00		2	46	.00	.00	
499	347779	1995	23	32	.26	1.02	.26					
		1996	16	32	.35	.69	.50					
		1997	20	34	.11	.11	1.00					
		1998	28	37	.12	.27	.43					

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

year	biomass	landings	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
97	67.3	6.4	9.4
93-97 avg	63.9	5.3	8.3
86-97 avg	64.7	4.5	8.2

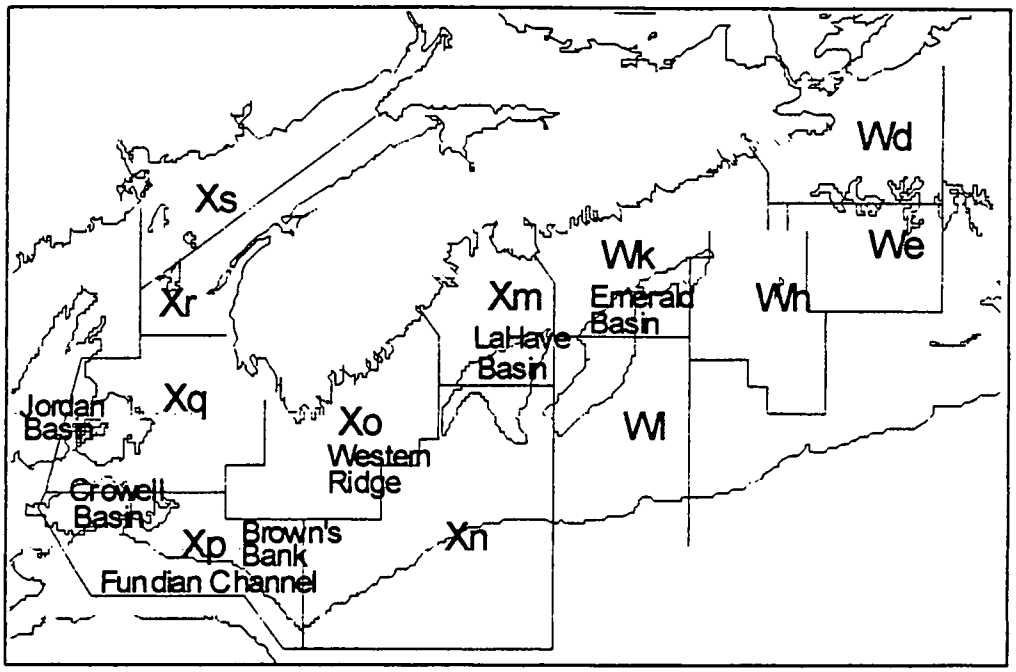

Figure 1. Unit 3 Management area for redfish.

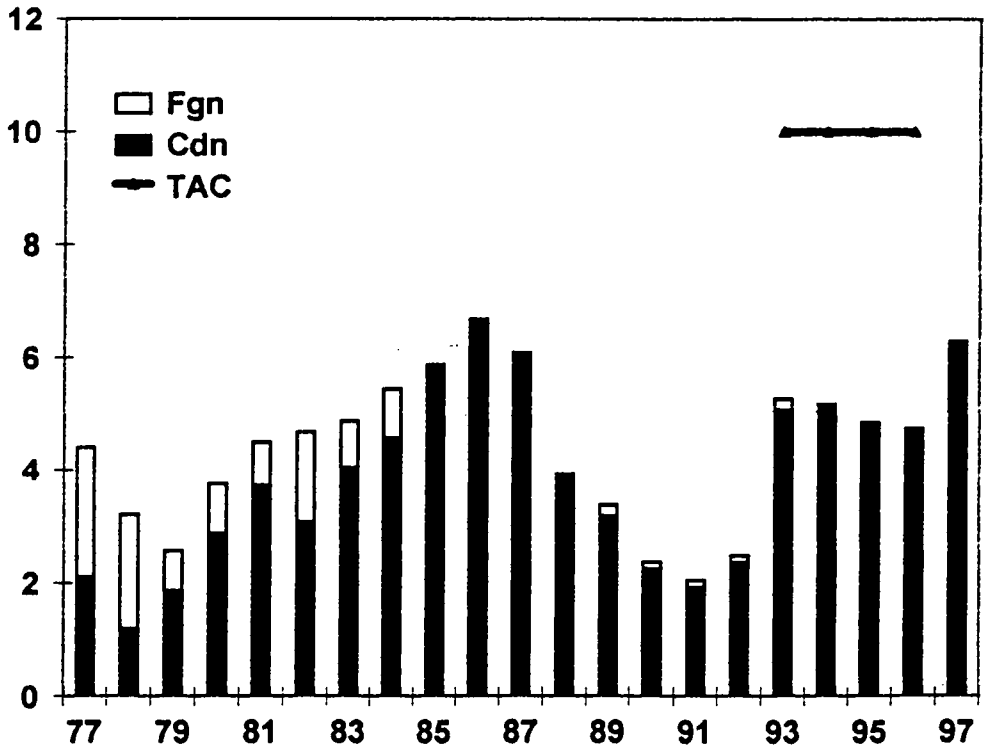

Figure 2. Canadian and Foreign Landings and TAC in thousands of tons for Unit 3 redfish during the period 1977 to 1998.

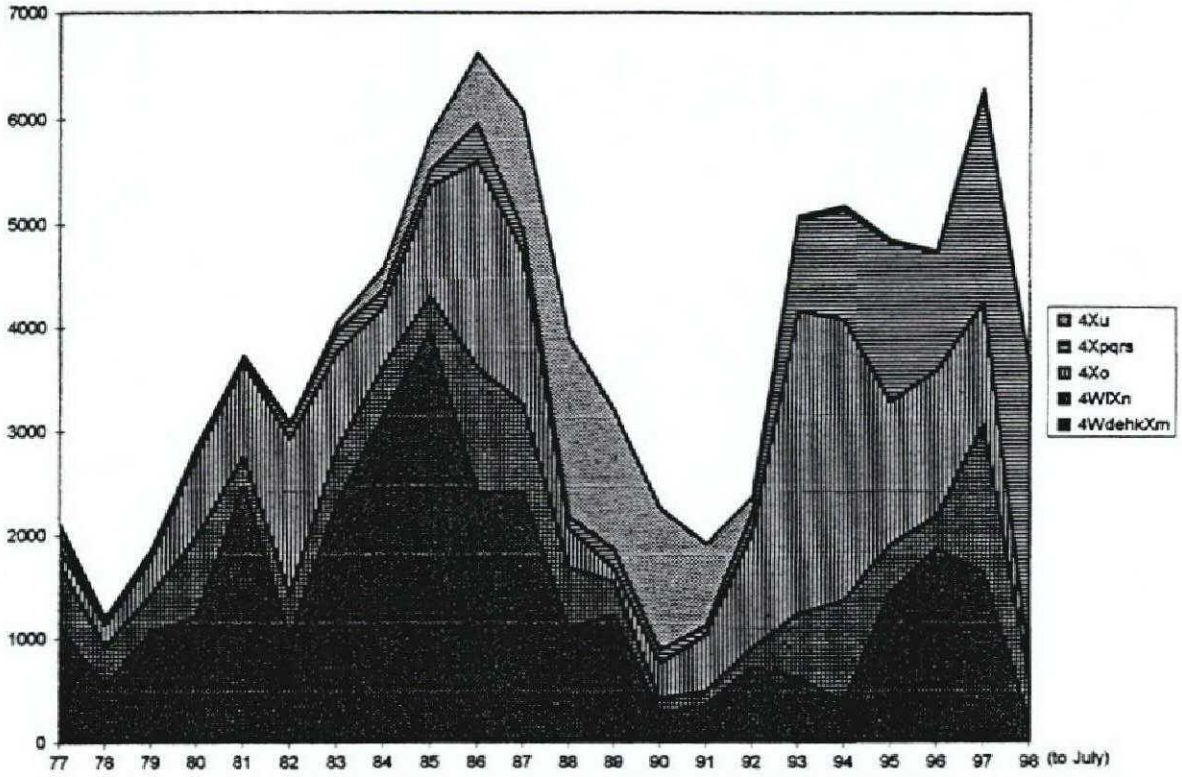

Figure 3. Unit 3 redfish Canadian landings (tons) by year and statistical area for 1977-97 (to July).

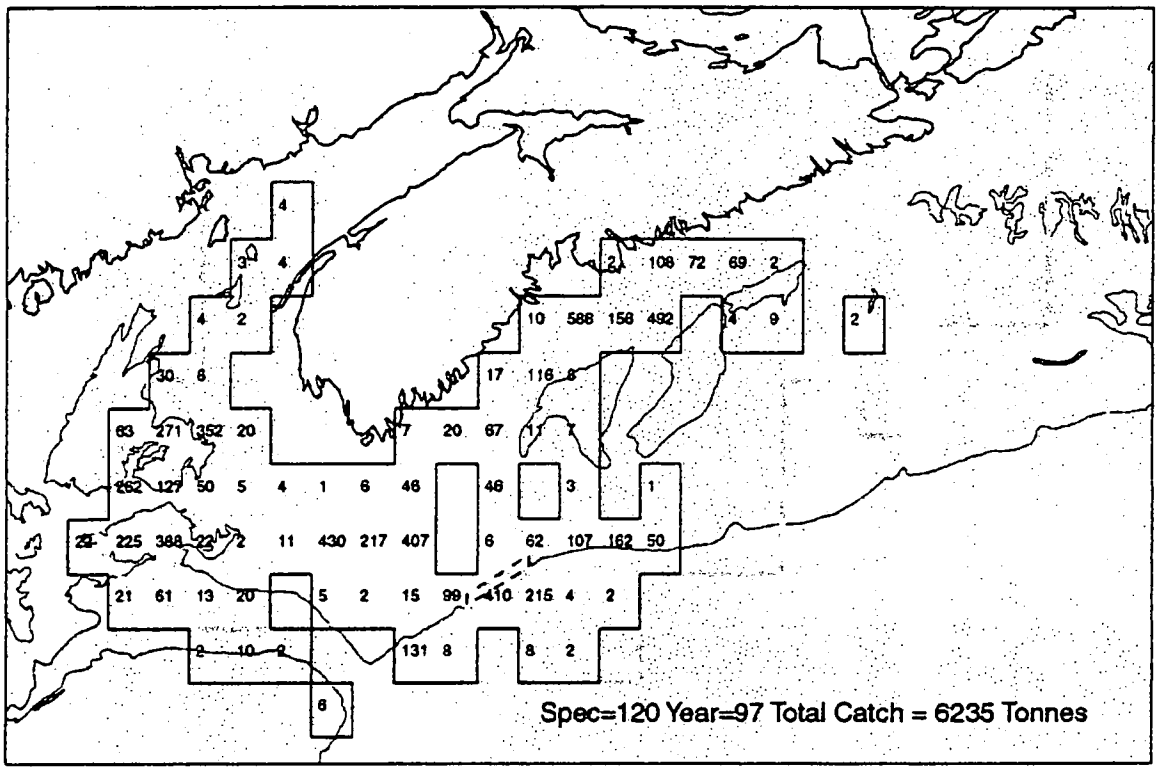

Figure 4. Distribution of Unit 3 redfish catch (from logbooks) by the Canadian fleet in 1997.

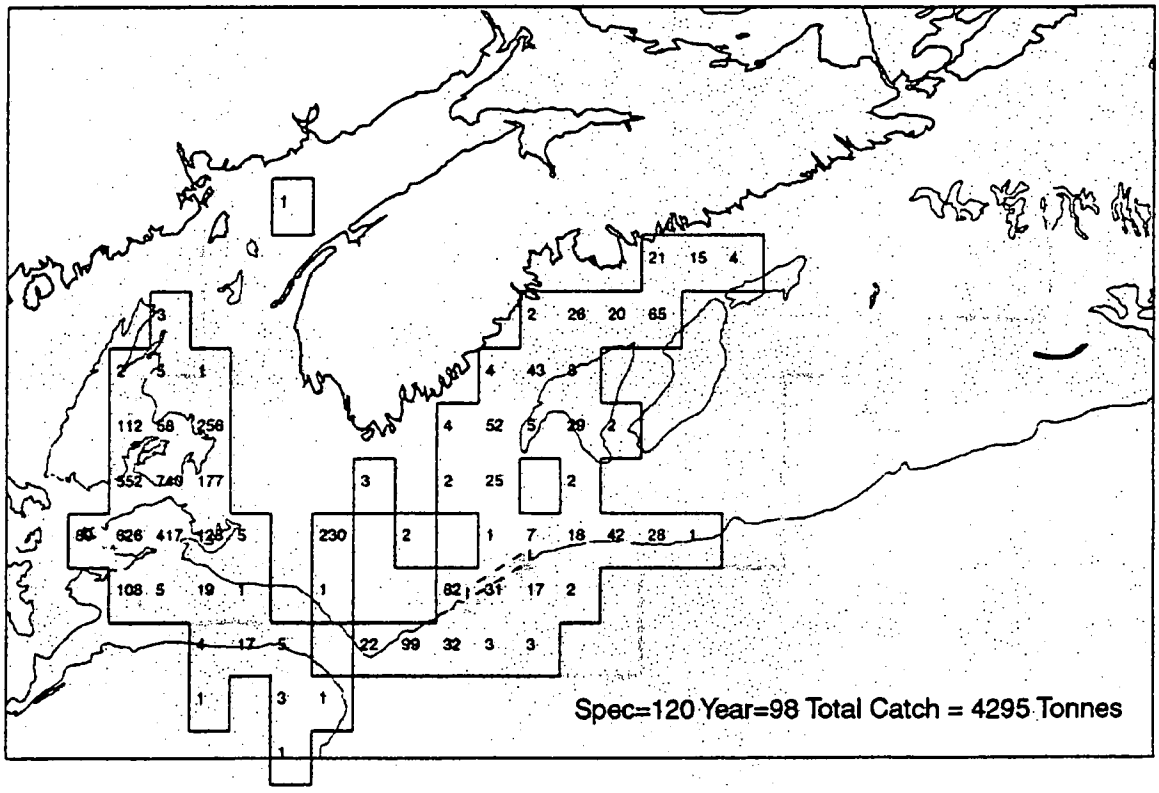

Figure 5 Distribution of Unit 3 redfish catch (from logbooks) by the Canadian fleet in 1998 (to July)

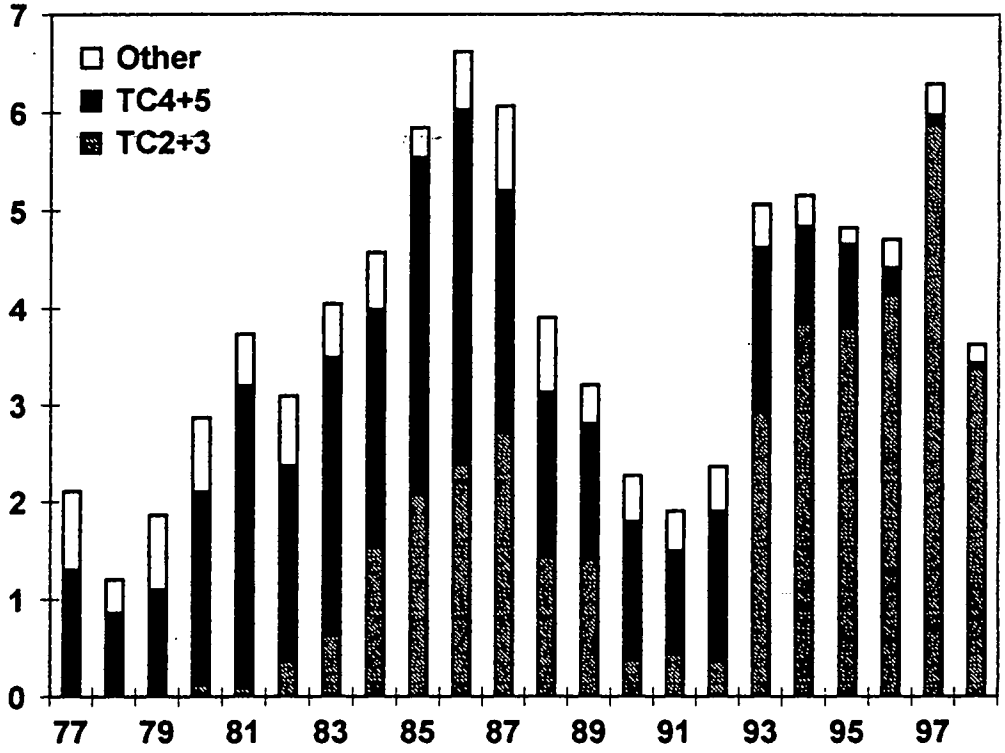

Figure 6. Unit 3 redfish catch by year and vessel type (main species redfish trips only) and other catches in thousands of tons during the period 1977-98 (to July).

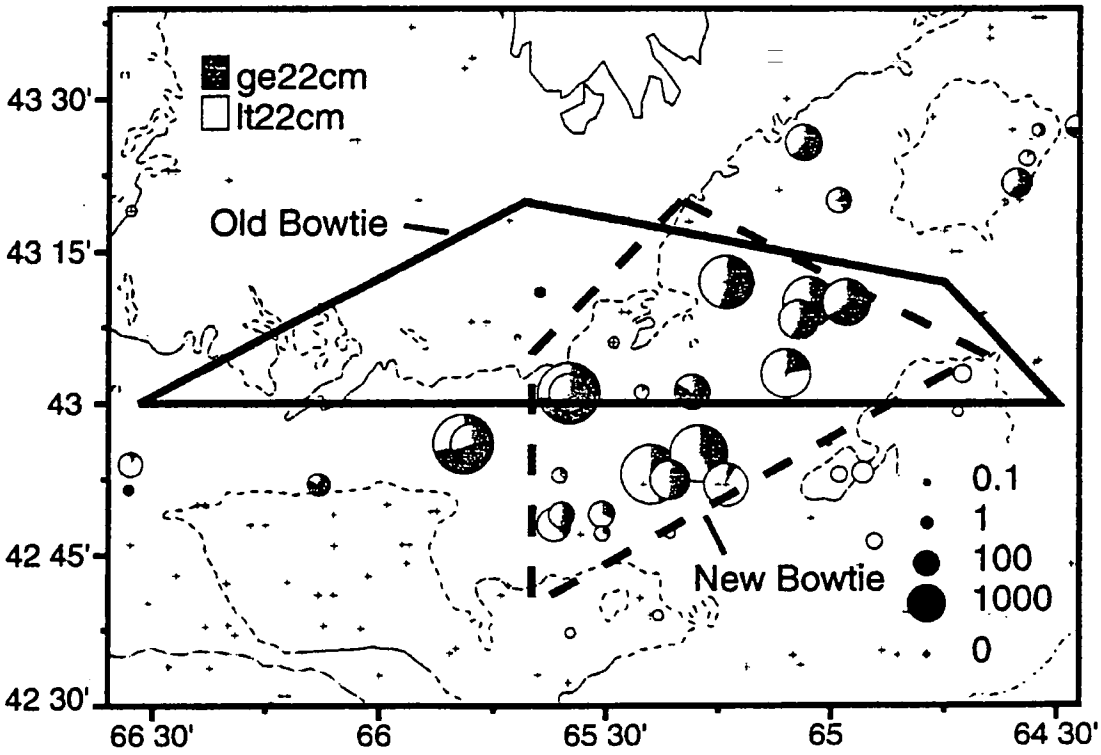

Figure 7. Unit 3 small fish closures changes made during 1998.

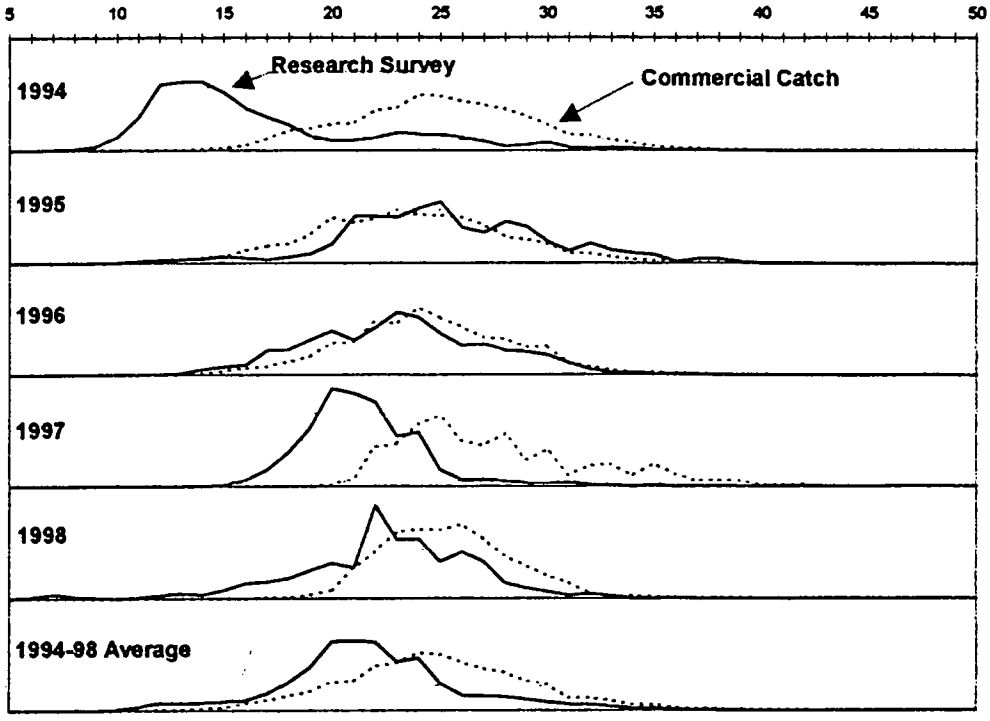

Figure 8. Redfish research survey (solid) and commercial catch (dashed) size composition (%) from Roseway Basin and Western Ridge (4Xo) for the period 1994-98.

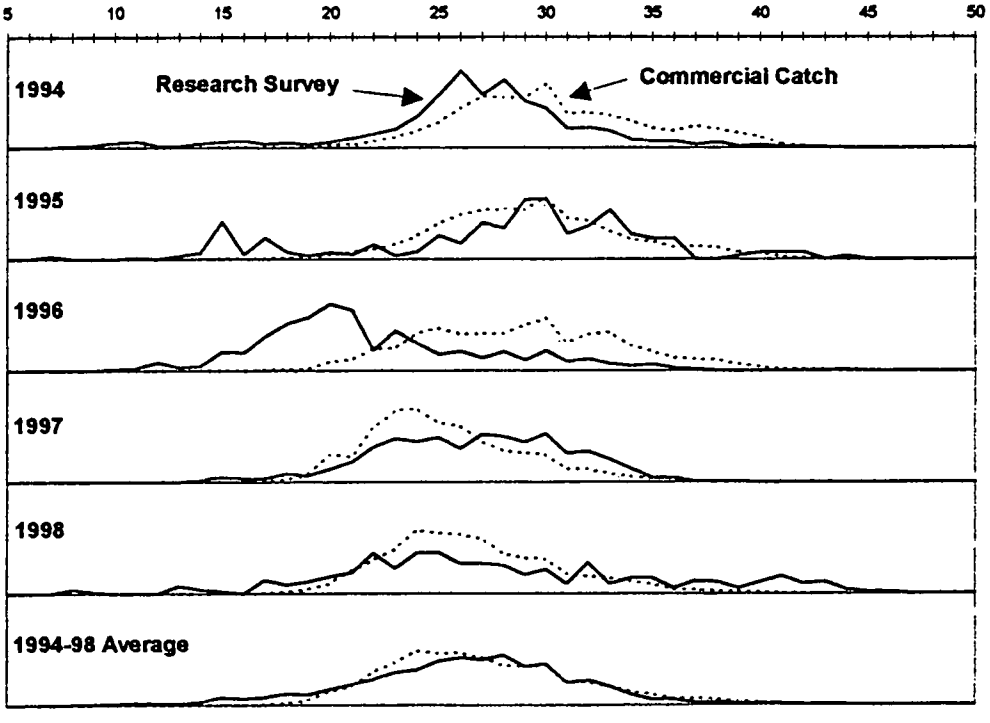

Figure 9. Redfish research survey (solid) and commercial catch (dashed) size composition (%) Crowell and Jordan Basins (4Xpqrs) for the period 1994-98.

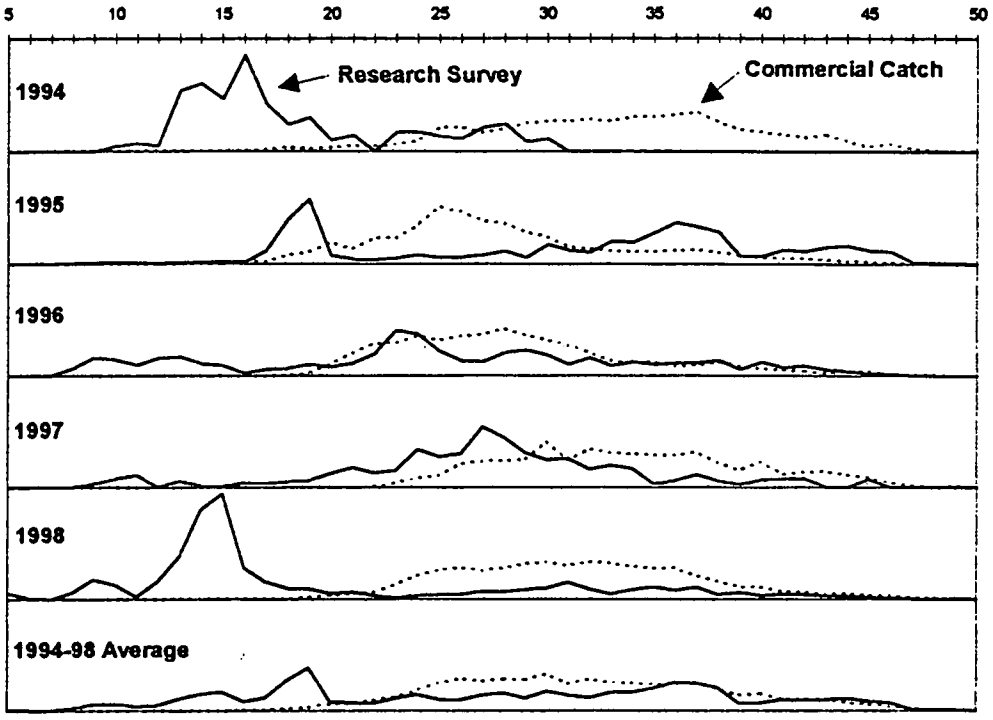

Figure 10. Redfish research survey (solid) and commercial catch (dashed) size composition (%) from Scotian Shelf Slope (4WlXn) for the period 1994-98.

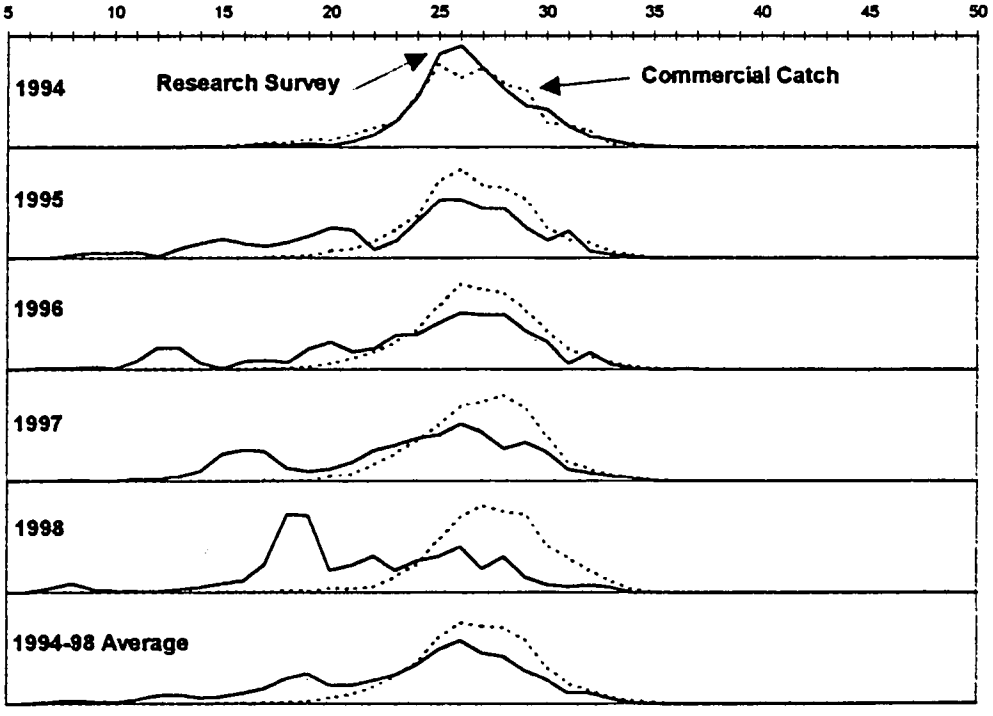

Figure 11. Redfish research survey (solid) and commercial catch (dashed) size composition (%) from Emerald and La Have Basins (4WdehkXm) for the period 1994-98.

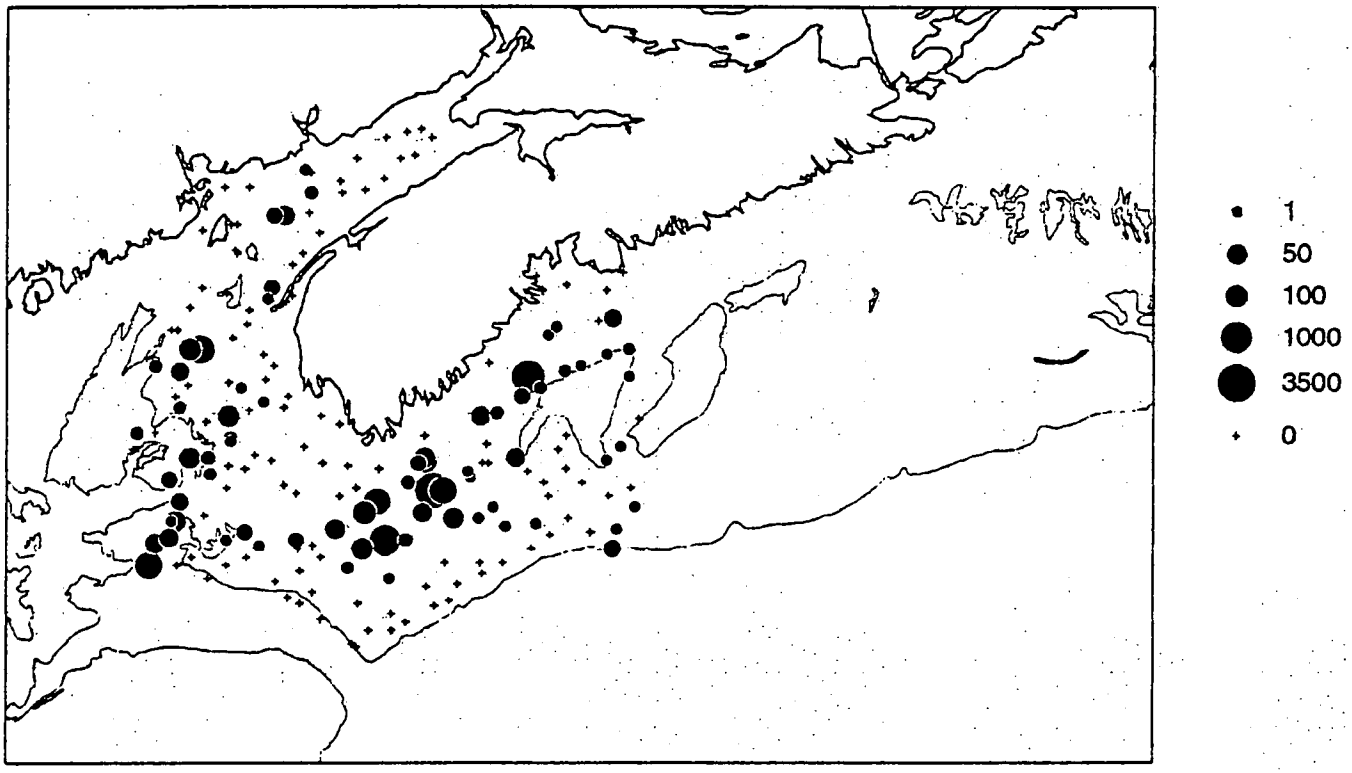

Figure 12. The distribution of redfish in Div 4X (kg/tow*) from ITQ surverys, 1998.
* not adjusted for distance towed

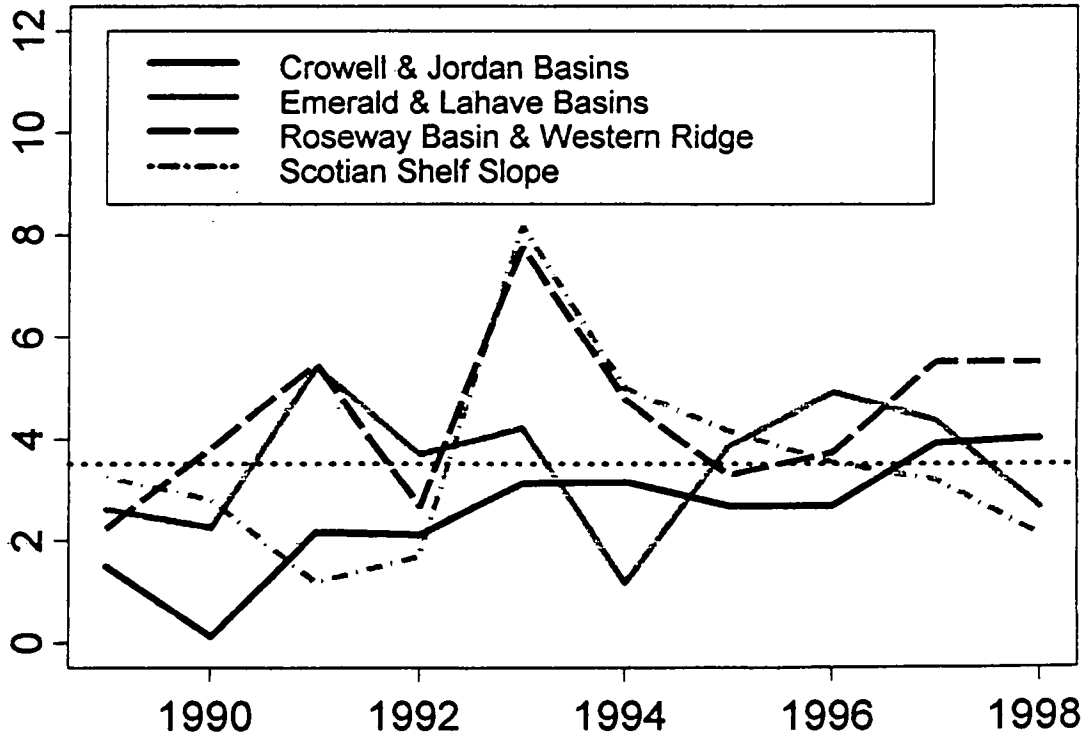

Figure 13. Small otter trawler catch rates by fishing area (tonnes per days fished)

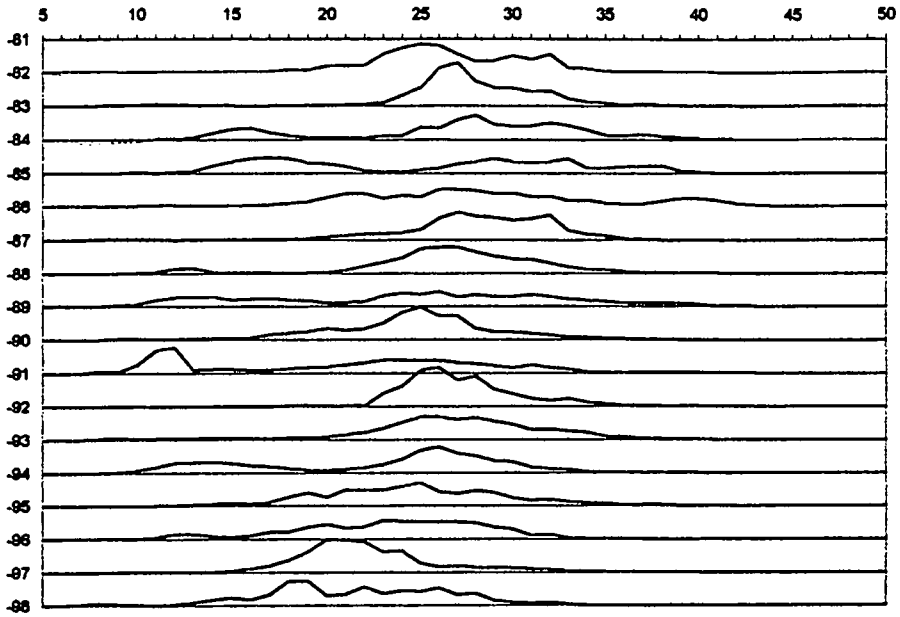

Figure 14 Size composition of survey catches for Unit 3 redfish from Scotia Fundy Summer Research Vessel Survey for the period 1982 to 1998.

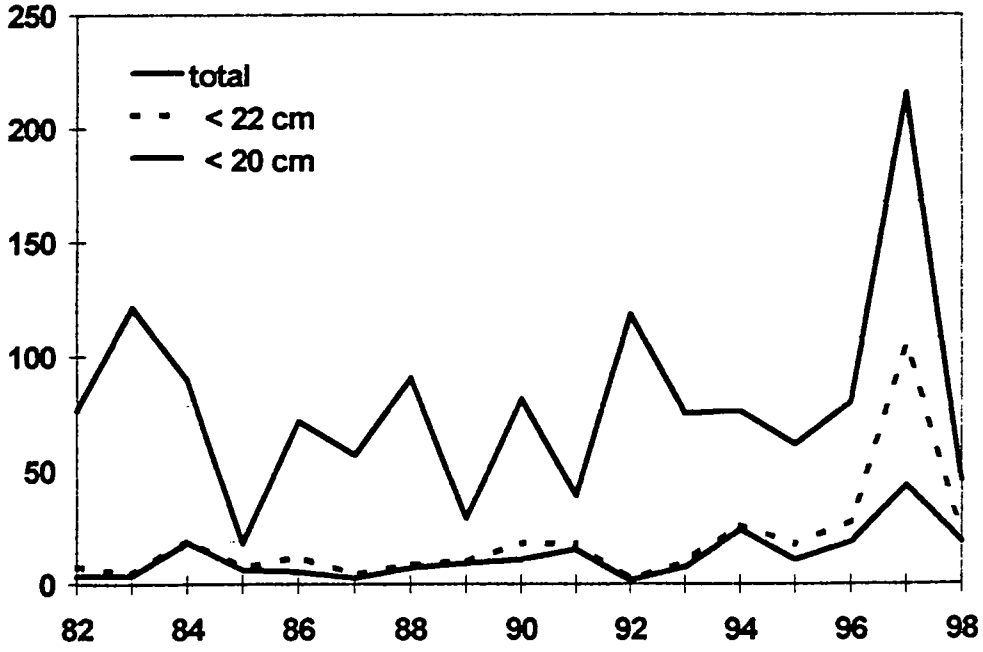

Figure 15. Abundance of unit 3 redfish by size category from summer surveys for the period 1982 to 1998.