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Canadian Atlantic Fisheries
Scientific Advisory Committee

CAFSAC Research Document 83/1¹

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Comité scientifique consultatif des
pêches canadiennes dans l'Atlantique

CSCPCA Document de recherche 83/50

The 1982 stock status and 1983-84 yield
projections for 4RST redbfish

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ABSTRACT

Nominal catches of 4RST redfish have decreased from 130 000 t in 1973 to 13 500 t in 1978. Provisional statistics show nominal catches of 25 719 t for 1982. The commercial catch rates were standardized to Maritimes and Quebec tonnage class 4 otter trawlers fishing in Division 4R in January. They have generally declined from 1.69 t/hour in 1967 to 0.6 t/hour in 1977 and have increased since then to reach 1.62 t/hour in 1982. Exploited biomass from Sequential Population Analysis was compared to the standardized commercial catch rate for various levels of fishing mortality in 1982. The best relationships was found at $F_c = 0.025$. However, there are indications that the fishing effort has been concentrated in a small portion of the Gulf in recent years. This may result in an upward bias of the commercial CPUE and consequently a $F_c = 0.05$ was chosen. Projections at $F_{0.1} = 0.15$ for 1983 and 1984 resulted in catches of 75,000 t and 68 000 t respectively. The projection for the 1984 harvest would be 74 000 t if the 1983 TAC of 31 000 t is taken.

RESUME

Les captures nominales de sêbaste dans les Divisions 4RST sont passées de 130 000 t en 1973 à 13 500 t en 1978. D'après les statistiques provisoires, 25 719 t ont été capturées en 1982. Les taux de captures de la pêche commerciale ont été standardisés par rapport aux chalutiers de classe de tonnage 4 des Maritimes et du Québec pêchant dans la Division 4R durant le mois de janvier. Les prises par unité d'effort ont diminué de façon plus ou moins régulière après 1967, passant de 1.69 t/heure cette année là à 0.6 t/heure en 1977. Les PUE ont augmenté de façon régulière depuis pour atteindre 1.62 t/heure en 1982. La biomasse exploitée résultant de l'Analyse Séquentielle de Populations a été comparée au taux de capture commerciale standardisé et ce à différents niveaux de mortalité par pêche pour 1982. La meilleure relation a été obtenue à $F_c = 0.025$. Toutefois, certaines observations suggèrent que récemment l'effort de pêche a été concentrée dans une petite partie du Golfe. Ceci peut avoir causé une surestimation des PUE commerciales. Un $F_c = 0.05$ a donc été choisi. Les prévisions de captures au niveau $F_{0.1} = 0.15$ en 1983 et 1984 sont de 75 000 t et 68 000 alors que si le TPA de 1983 (31,000 t) est capturé, les captures à $F_{0.1}$ seraient de 74 000 t en 1984.

INTRODUCTION

History of the Fishery

The introduction of otter trawls in the late forties on Canada's east coast has permitted the development of redfish fisheries (Martin, 1961). Exploratory fishing in 1948, 1949 and 1950 established that extensive redfish populations existed throughout the Gulf of St. Lawrence at depths greater than 200 meters (Sandeman, 1973). The fishery started in the Laurentian Channel in 1952 and was extended to the Esquiman Channel in 1953 and the Mingan Channel in 1954 (Martin, 1961). No appreciable amount of redfish were landed from the Gulf of St. Lawrence fishery until 1953 (Table 1). Nominal catches increased rapidly in 1954 and reached 50 000 t in 1955. They declined thereafter to 6 500 t in 1962 (Table 1, Figure 1).

The main participants in the Gulf redfish fishery have been from Canada (Maritimes-Québec and Newfoundland) and the United States of America. France after taking sporadic small catches between 1960 and 1966 has caught less than 1,000 t per annum from 1967 onwards. The involvement of the USA in the Gulf redfish fishery ended after 1974. Maritimes and Quebec based vessels have generally taken the largest share of the catches (Table 1). Other countries involved were Portugal, from 1972-76, and the United Kingdom.

Catches in NAFO Division 4R were the most important from 1953 to 1960. Catches from Division 4S have been more important since 1977, but the proportion caught in Division 4R has increased since 1978.

Most Gulf redfish have been harvested in July, August and September (Fig. 2). A smaller winter fishery existed from 1970-76. This fishery ceased when some of the larger non Gulf based vessels withdrew from the Gulf.

As the abundant 1956 and 1958 year-classes (Fig. 3) entered the fishery, more fishing effort was concentrated in the Gulf. Catches by vessels from Maritime provinces, Quebec and Newfoundland as well as the U.S.A., France and Portugal increased in the late 1960's (Table 1). In 1971, the Industrial Development Branch of the Fisheries Service demonstrated that midwater trawling was an extremely effective means of catching redfish (Sandeman, 1973). Catches were obtained which were 5 times higher for the same duration of tow. Consequently, many Gulf vessels were converted to midwater trawls. The imposition of quotas by ICNAF for redfish in zones outside the Gulf induced tonnage class 5 vessels from Nova Scotia and Newfoundland to enter the Gulf in 1973 (Lussiaa-Berdou, 1981). These factors resulted in 130 000 t of redfish being taken in 1973. Catches in 1974 and 1975 declined to around 65 000 t and in that year

the first TAC was set at 30 000 t for 1976. The TAC was subsequently lowered to 18 000 t (1977-1978) and 16 000 t (1979-1980). Except in 1976, catches have always been below the TAC during that period. The 20 000 t TAC was slightly exceeded in 1981 (20 549 t) while the 1982 TAC (28 000 t) was not reached (provisional data: 25 719) (Table 1).

Nominal catches

Since 1977, NAFO Division 4S has yielded the largest share of the Divisions 4RST redfish catch. This continued in 1982 with 13 562 t being reported as being caught in Division 4S. Division 4R followed with 9 657 t while 2 516 t were caught in Division 4T (Table 1). In Divisions 4R and 4S, the catches are almost evenly split between Maritimes vessels (4 024 t in 4R and 6 795 t in 4S) and Quebec vessels (3 737 t in 4R and 6 409 t in 4S). In 4T most of the catches were by Quebec based vessels (1 903 t compared with 497 for Maritimes). Most of the activity for Newfoundland vessels occurred in 4R (1 880 t) with small catches reported from 4S (358 t) and 4T (116 t).

In Division 4S, during 1982, catches increased regularly from May (590 t) to a peak in August (3 261 t), decreased slowly to 2 375 t in October and then dropped sharply to 235 t in December (Table 2). Nominal catches in Division 4T show a single mode which peaked at 767 t in July. Catches in Division 4R were less regular. They were highest in June (3 618 t) and then oscillated for the remainder of the year to 222 t in December.

The redfish fishery in Divisions 4RST is almost exclusively an otter trawl fishery (Table 3). Tonnage class 4 otter trawlers caught the largest share (19 598 t) and they were dominant in the three Divisions. Two thirds of TC3 otter trawlers redfish catches came from Division 4S. TC5 otter trawlers from Maritimes and Newfoundland re-entered the fishery for the first time since 1976 and caught 1 804 t evenly split between 4R and 4S. Shrimp trawlers caught a total of 661 t almost exclusively in Division 4S.

Catch at age

Table 4 shows the number of commercial length measurements used to calculate the numbers caught at age for males and females. Length measurements were supplied by the Newfoundland and Scotia-Fundy Regions (8 846), by the observer program of the Quebec laboratory of the Gulf Region (8 237), and by the Quebec Provincial government (9 212). Samples were available for otter

trawlers and shrimp trawlers (Table 4). Division 4S was the most sampled (where the bulk of the fishery occurred) for both otter trawlers and shrimp trawlers. However, the sampling coverage was not satisfactory for September to December. In Division 4R, sampling was adequate for otter trawler catches from February to July, but 3 864 t caught during August to December were not sampled. In Division 4T, the May-June catches only were sampled.

Monthly length frequencies were combined for each sex separately using computer software described by Gavaris and Gavaris (1983). This software allows weighting of each monthly length frequency by the appropriate catch weight to obtain composite length frequencies for a chosen time period. Length frequencies were first combined for each Division (and by gear type for Division 4S where samples for shrimp trawlers were available). A flow chart describing how the samples were combined is given in figure 4. The same combinations were made for males and females separate to obtain two yearly length frequencies and then catch at age by sex. The sexes were then combined. Other combinations were made but the one described in figure 4 gave the lowest variance for the overall catch at age (Table 6). The resulting length frequencies for males and females for Divisions 4RST are shown in figure 5. These length frequencies were aged with the age-length keys given in table 5. Weights-at-age were calculated from average length at age and the following length-weight relationships (Mckone, et al, 1980).

Male wt = 0.01659 l 2.9548

Female wt = 0.01372 l 3.021 0

The 1972 to 1980 catch at age and the 1972 to 1981 weights-at-age were taken from Gavaris and Atkinson (1982). The 1981 catch at age was adjusted for updated nominal catches. The 1972 to 1982 catch at age matrix is shown in table 7 and the average weights-at-age matrix in table 8.

STOCK SIZE INDICES

Research vessel surveys

Several stratified random surveys have been conducted to estimate the stock size of 4RST redfish since 1976 by various vessels using different gears. The results of most of these surveys are summarized in table 9. The survey results are highly variable from year to year and difficult to compare due to the different vessels and gears used. It should be noted, however, that the

results from the Beothic Venture and the Vicki and Brothers should be fairly comparable given the similarities between the two vessels and the gears they used. Unfortunately the series for these two vessels are short. Results of the 1982 survey are shown in table 10 and figure 6. They show large numbers (Table 9) of 2 to 5 years old, ages 8 to 15 show up strongly and ages 23⁺ (mostly 1956 and 1958 year-classes) are still well represented.

Commercial catch rate

Commercial catch rates from 1959 to 1982 for the directed redfish fishery (50% or more redfish catches) for vessels tonnage class 4 and larger were standardized to Maritimes and Quebec otter trawlers fishing in Division 4R during January using a multiplicative model (Gavaris, 1980). Catch and effort data for Maritimes based vessels for 1978 to 1982 were updated for potential errors in previous catch/effort data.

An unweighted regression was first calculated. The resulting regression coefficients showed that the following variables had similar power. They were thus combined to increase the explanatory power of the model:

Midwater trawlers TC5	Maritimes	Quebec]
"	"	" Newfoundland]
February]		
March]		
June]		
July]		
August]		
September]		

Examination of the residuals of several regressions using various weighting factors led to the exclusion of two observations having anomalously large negative residuals.

The regression coefficients for four regressions using different weighting factors are shown on figure 7. All regressions showed essentially the same patterns although the estimated coefficients for the last year (1982) covered a fairly wide range. The unweighted regression had a significant decline between 1980 and 1981, in contradiction to information from the fishery. It was thus decided that some weighting was justified. The regression weighted according to an Estimated Generalized least square (S. Gavaris, pers. comm.) procedure also showed a decline in 1981. Thus other weighting factors were investigated. Of the two others tried, the fourth root of catch times effort gave the smoothest pattern and the 1982 value was in the middle of the

range of the values resulting from the various regressions. The fourth root regression was thus chosen and the resulting analysis of variance is shown in table 11. The catch rates are shown in table 12 and figure 8. Catch rates increased from 1962 to 1967 (1.69 t/hr) and then declined more or less regularly until 1977 (0.6 t/hr). They have increased steadily from 1977 to reach 1.62 tons per hour in 1982. It should be noted, however, that the increase in catch rate may be somewhat overestimated due to the concentration of fishing effort (Lussiaa-Berdou, in preparation).

Sequential population analysis

Gavaris and Atkinson (1982) used a dome shaped partial recruitment for the SPA but a flat-topped one for yield-per-recruit calculations and projections "as a better reflection of long-term conditions" (p. 4). An examination of age-specific fishing mortalities from an initial SPA did not show evidence for the presence of a dome. The percent commercial catch at age divided by the percent research vessel population estimates at age was smoothed by eye and the values for ages 7 to 13 were used as partial recruitment for these ages. Partial recruitment for ages 5 and 6 were taken from Gavaris and Atkinson (1982). The partial recruitment used is showed in table 13. There is essentially no difference between that vector and the flat-topped one used in the 1982 assessment (Gavaris and Atkinson, 1982).

Fishing mortalities on the oldest age-group for SPA calculations were taken as the weighted average of the fishing mortalities on ages 23 to 26. At any F_T , iterations were made until the differences for all averages between two successive runs were smaller than 0.001. The natural mortality rate was assumed to be $M = 0.10$ for all years and all ages.

Table 14 shows the results of SPA runs at terminal fishing mortalities of $F_T = 0.025$, $F_T = 0.05$ and $F_T = .10$ comparing exploited biomass and the standardized catch rate. The correlation coefficient decreased rapidly from $r = 0.91$ at $F_T = 0.025$ to $r = 0.29$ at $F_T = 0.10$. At $F_T = .025$ the intercept is slightly negative while at $F_T = 0.05$ the intercept has a large positive value. Thus a 1982 fully recruited fishing mortality of $F_T = 0.025$ gave the best relationship between the exploited biomass and the standardized commercial catch rate. However, Lussiaa-Berdou (in preparation) shows that a large proportion of the fishing effort was concentrated in a relatively small area of the Gulf of St. Lawrence in recent years. Results from research vessel surveys indicate (D.B. Atkinson, pers. comm.) that large concentrations of redfish are generally not found in the Gulf of St. Lawrence outside of that area. Furthermore the schools of redfish located in the main fishing area are mostly of fish from the early seventies year-classes. It is thus difficult to accept the commercial catch rates at face value since the concentration of effort may have

led to catch rates higher than would have occurred were these year-classes more widely distributed. This also complicates the comparison of recent years catch rates with those of earlier years. Given the difficulties in discriminating between such low values of terminal fishing mortalities and considering the potential upward bias in catch rates, a terminal fishing mortality of $F_T = 0.05$ is likely to counterbalance the potential bias in catch rates. Results of SPA at $F_T = 0.05$ are shown in table 15 and figure 9.

YIELD PER RECRUIT

The 1982 weights at age (Table 8) and partial recruitment (Table 13) were used to calculate Thompson and Bell yield per recruit with $M = 0.1$. Maximum yield-per-recruit is 0.156 kg (Table 16) at a fishing mortality of $F_{max} = .65$ and the yield at $F_{0.1} = .16$ is 0.134 kg or 86% of the maximum Y/R. The yield per unit effort at $F_{0.1}$ is 3.41 times higher than the YPUE at F_{max} . This calculated $F_{0.1}$ value cannot be considered to be different from the $F_{0.1} = .15$ used in previous assessment.

Catch projections

Projections to 1984 (Table 17) were made using the 1982 population estimates from the SPA at $F_T = 0.05$, the 1982 average weights at age and partial recruitment. Recruitment at age 5 for 1983 and 1984 was taken as 147 million redfish, the geometric mean recruitment at age 5 for 1972 to 1982. Two options are presented: taking the 31 000 t in 1983 and fishing at $F_{0.1}$ in 1984 or fishing at $F_{0.1}$ in both 1983 and 1984. If the 1983 catch is equal to the set TAC of 31 000 t, the fishing mortality for that year would be 0.06 and the 1984 $F_{0.1}$ catch would be 73 567 t. Fishing at $F_{0.1} = 0.15$ in both years would yield catches of 75 139 t in 1983 and 68 068 t in 1984.

CONCLUSION

The results of this assessment of 4RST redfish are quite different from last year's results (Gavaris and Atkinson, 1982) for two main reasons:

- 1) This year's assessment relies more on commercial catch rates
- 2) A flat-topped partial recruitment was used.

In the 1982 assessment (Gavaris and Atkinson, 1982) the use of research vessel surveys indices and dome shaped partial recruitment resulted in what now appears to be an underestimate of the size of the early seventies year-classes.

Ever since the commercial catch rates started to increase in 1978, the tendency has been to somewhat underrate the increase in commercial catch per unit effort. The rationale was that since the year-classes contributing most to the increase in CPUE were still young and they had not reached the point where natural mortality counter balanced their growth rate, the fishery could only gain by letting them increase their biomass. In the meantime, more information on the size of the y.c. would accumulate allowing a better estimate of potential yield. However, from about 1984 onwards, the biomass of these strong year-classes will decrease even if there is no fishing. It thus appears to be an appropriate time to give somewhat more weight to commercial CPUE. The present analysis attempts to do that while still taking into account a potential upward bias of commercial catch rates.

The year-classes presently in the fishery should be able to sustain catches around 50 000 t until about 1987-1988. By that time the strong year-classes of the latter part of the seventies should begin to make significant contributions to commercial catches.

ACKNOWLEDGEMENTS

Bruce Atkinson prepared length-frequency data for catch at age calculations. Wince Legge supervised the aging of otoliths from commercial and research sampling. We would also like to thank Jim Murphy for technical assistance.

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Table 1. Nominal catches of redfish by division, country, region and year in the Gulf of St. Lawrence in metric tons.

YEAR	4R							4S							4T							4RST		
	CAN-M	CAN-Q	CAN-N	FRAN	USA	OTHERS	TOTAL	CAN-M	CAN-Q	CAN-N	FRAN	USA	OTHERS	TOTAL	CAN-M	CAN-Q	CAN-N	FRAN	USA	OTHERS	TOTAL	TOTAL	TAC	
1952																							580	
1953	4906	1075					5981	10	38					48	1087	1250						2337	8366	
1954	10207			2660			12867	1446				1602		3048	3887				12966			16853	32768	
1955	4163	3580		30777			38520	4277	932			3530		8739	1903	263		432				2598	49857	
1956	4060	4645		16990			25695	7949	2202			7749		17900	2940	233		86				3259	46854	
1957	3858	1578		12541			17977	6538	1907			4920		13365	2569	342		78				2989	34331	
1958	3324	1208		5184			9716	6226	2671			2179		11076	1744	33		1				1778	22570	
1959	4066	1333		4345			9744	4369	442			809		5620	1551	4		59				1614	16978	
1960	3095	1439	6	970	2		5512	4206	153			319		4678	1768	250		9	1			2028	12218	
1961	3444	421		62			3927	4328	16			138		4482	1883	80	19					1982	10391	
1962	1427	120		62			1609	3440	4					3444	1258	269		5				1532	6585	
1963	2385	1361		3162			6908	6990	1171			1513		9674	2443	565		204				3212	19794	
1964	3243	1370	88	5266			9967	8696	1309			6838		16843	2357	359		174				2890	29700	
1965	3301	4843	5	11966			20115	16328	2138			5051		23517	4573	540		82				5195	48827	
1966	9177	13480		10400			33057	21052	825			2256		24133	7653	262		110				8025	65215	
1967	10393	8896	388	11173		5	30855	25571	733			4408	1	30713	8100	368						8468	70036	
1968	15110	16374	729	11430			43643	34209	759	253		5007		40228	6092	916	84					7092	90963	
1969	12473	15958	838	7414			36683	32418	4084	142		4708		41352	10627	192	21					10840	88875	
1970	13395	18524	178	5322			37419	29131	9430	86		2270		40917	8416	836						9252	87588	
1971	13295	12529	33	2097			27954	37456	3502	17		2565		43540	7275	593		44				7912	79406	
1972	11267	13753	2	784	278		26084	42359	4102			327		46788	6640	815	2					7457	80329	
1973	39703	25752	772	1130	717		68074	40189	6425	437		497	46	47594	13542	855	81			18		14496	130164	
1974	20110	9909	148	329	400		30896	21435	3165	31	703	350	25684	5868	876	165						6909	63489	
1975	18770	11256	520		292		30838	21223	7108	49		119	28499	5295	633	71				65		6064	65401	
1976	10986	8485	192		300		19963	15370	973	31		20	16394	1326	266	34						1626	37983	30000
1977	4702	672	246				5620	7891	14	1				7906	2311	3						2314	15840	18000
1978	2170	809	105				3084	6334	18					6352	4155							4155	13591	18000
1979	1722	1197	717	127			3763	2408	5189	32				7629	1773	1795	74					3642	15034	16000
1980	2476	1567	709	57			4809	2444	5497	184				8125	668	1230	0					1898	14832	16000
1981	3802	2660	1207	16			7685	3618	6144	411				10173	1100	1321	270					2691	20549	20000
1982 ¹	4024	3737	1880				9641	6795	6409	358	0			13562	497	1903	116	0				2516	25719	28000

¹ provisional data

Table 2. 4RST redbfish nominal catches by division, region and month for 1982.

	4R				4S				4T				All Div.
	CAN-N	CAN-M	CAN-Q	Total	CAN-N	CAN-M	CAN-Q	Total	CAN-N	CAN-M	CAN-Q	Total	
Jan.	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb.	89	40	0	129	6	20	0	26	0	0	0	0	155
Mar.	43	11	0	54	0	8	0	8	0	0	0	0	62
Apr.	6	0	27	33	0	0	3	3	0	0	0	0	36
May	93	52	2	147	0	16	574	590	0	2	84	86	823
June	751	1771	1096	3618	88	794	237	1119	66	82	527	675	5412
July	167	1057	557	1781	0	1510	816	2326	50	120	597	767	4874
Aug.	176	139	377	692	17	1577	1667	3261	0	173	361	534	4487
Sept.	368	428	548	1344	227	1335	1074	2636	0	67	138	205	4185
Oct.	14	254	151	419	20	976	1379	2375	0	42	196	238	3032
Nov.	127	268	807	1202	0	440	543	983	0	9	0	9	2194
Dec.	46	4	172	222	0	119	116	235	0	2	0	2	459
Total	1880	4024	3737	9641	358	6795	6409	13562	116	497	1903	2516	25719

Table 3. 4RST redfish nominal catches by gear type, tonnage class and division in 1982.

Gear	Ton Class	4R			Div.	4S			Div.	4T			Div.	All div.
		N	M	Q	Total	N	M	Q	Total	N	M	Q	Total	Total
OTB	0	1			1									1
OTB	1													
OTB	2	178			178			182	182	41		3	44	404
OTB	3	301	252	41	594		1385	645	2030	75	349	185	609	3233
OTB	4	1086	3221	3691	7998	108	4449	5223	9780		143	1677	1820	19598
OTB	5	296	538		834	250	720		970					1804
ST	2							56	56			4	4	60
ST	3		13	5	18	0	241	303	544		5	34	39	601
SDN	2	7			7									7
GNS	0	11			11									11
Total		1880	4024	3737	9641	358	6795	6409	13562	116	497	1903	2516	25719

Table 4. 4RST redfish commercial sampling and nominal catches for 1982. Number of fish measured (males-females) nominal catches.

Division	4R		OTHERS	4S		4T		
	Gear	OTB		ST	OTB	ST	OTB	ST
January								
February		391-674/129			0-0/26			
March		0-0/54			0-0/8			
April		102-98/33				0-0/3		
May		581-711/139	0-0/7	0-0/1	255-478/573	320-240/17	115-85/85	0-0/1
June		1438-1220/3616		0-0/2	731-708/1061	676-298/58	391-570/667	0-0/8
July		1034-978/1770	0-0/6	0-0/5	1244-1064/2223	302-389/103	0-0/753	0-0/14
August		0-0/685	0-0/4	0-0/3	1337-1070/3032	225-382/229	0-0/524	0-0/10
September		0-0/1342		0-0/2	84-116/2499	246-376/137	0-0/196	0-0/9
October		0-0/414	0-0/1	0-0/4	415-635/2332	346-582/43	0-0/237	0-0/1
November		0-0/1201		0-0/1	234-478/973	0-0/10	0-0/9	
December		0-0/222			0-0/235		0-0/2	

Table 5a. Commercial age length key for female redbfish collected in Division 4RST during 1982.

Fork Length	Numbers at Age																				Total						
	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26		27	28	29	30		
18																											
19																											
20		1	1																								2
21	1	3	2																								6
22		3	5	2																							10
23		7	6	2																							15
24		8	11		1	1																					21
25		3	15	5	3	1																					27
26		2	13	6	6	2																					29
27			4	8	13	4																					29
28			1	5	12	10		1																			29
29			1	2	9	9	5	4																			30
30					1	8	11	4	5																		29
31					1	2	6	5	9	2	3		1	1													30
32							6	5	6	8	3	1	1	2													30
33							1	3	2	11	8	1	1	2		1											30
34								1	1	3	3	3	3	2	3	2	3	2	2	2							30
35								2			2	2	2	1													30
36									1						1	2	5	8	3	4	1	1				2	30
37														1	1	2	3	6	7	5	2	4	1				30
38												1			1	1	2	5	4	9	1	2	3	1			30
39												1					2	1	1	3	8	3	4	7			30
40																				2	2	3	5	1	8		21
41																				1	1	3	1	3	7		16
42																						1	1	9			11
43																					1			1			2
44																			1			1		2			4
45																								2			2
46																											0
47																											0
48																									3		3
49																											0
50																								1			1
Sum	1	27	59	30	46	37	29	25	24	24	19	9	10	7	6	7	17	33	22	31	19	19	13	43		557	

Table 5b. Commercial age length key for male redfish collected in Division 4RST during 1982.

Fork Length	Numbers at Age																				Total				
	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26		27	28	29	30
18	1																								1
19	1																								1
20	1																								1
21	2	5	3																						10
22		5	6																						11
23		5	11	1		1																			18
24		7	14	6	1																				28
25		2	13	6	4	1																			26
26			11	12	2	3	1	1																	30
27			2	6	16	4	2																		30
28				2	9	8	8	3																	30
29				1	4	7	6	8	3																29
30					1	3	5	7	6	2	2	1	2	1											30
31						1	2	3	5	2	1	1	2	4	2	3	1	1							28
32							1	2	3	1	1	1	2	2	4	3	6		2	1					29
33								1	2		2		2	1	4	6	8	2	1			2			31
34									1	1	3		1	1	4	3	4	6	4				1		29
35									1				1		2	1	4	1	5	5					20
36											1	1	2	2		2	4	2	5	1	1				21
37														1		1	1	2	4	2	2	1	2		16
38																	3		1	2	1			3	10
39															1	2				3	3			3	12
40																			1	2	1	1			5
41																				1	2		3		6
42																					1		1		2
43																									0
44																									0
45																								1	1
46																									0
47																									0
48																									0
Sum	5	24	60	34	37	28	25	25	19	8	5	6	5	11	11	17	21	31	14	23	18	12	4	12	455

Table 6. 4RST redfish catch at age and weights at age for 1982.

Age	Weight	Catch	Variance (catch)	Coefficient of variation
7	0.118	72	152	0.17
8	0.197	767	13880	0.15
9	0.245	3642	157818	0.11
10	0.287	4395	402348	0.14
11	0.317	9634	978268	0.10
12	0.345	9421	1221201	0.12
13	0.377	8467	1129167	0.13
14	0.387	6701	911274	0.14
15	0.420	5098	618441	0.15
16	0.483	2254	162443	0.18
17	0.478	1727	146052	0.22
18	0.529	668	41189	0.30
19	0.479	906	81962	0.32
20	0.492	995	76269	0.28
21	0.510	792	45646	0.27
22	0.527	997	47053	0.22
23	0.567	1344	57791	0.18
24	0.602	2020	63375	0.12
25	0.652	1001	32713	0.18
26	0.666	1336	35369	0.14
27	0.753	673	15565	0.19
28	0.771	539	11697	0.20
29	0.835	245	4350	0.27

TABLE 7. BEST REDFISH CATCH AT GEE LANE 1972 TO 1982

21/ 7/83

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
5	142	273	170	355	7359	3801	3338	2266	125	1	1
6	1272	639	478	620	1482	2119	2653	2378	285	4	1
7	784	3112	292	290	1073	824	511	2233	2728	308	72
8	944	2380	444	401	372	669	280	2899	7800	2586	767
9	1887	803	510	448	188	620	800	2373	7928	10810	3642
10	4297	3434	216	286	44	416	708	2753	5723	11974	4395
11	2938	8043	403	161	146	469	491	1902	2141	7276	9634
12	6366	2497	463	329	125	236	372	1838	1516	5222	9421
13	2588	12850	2240	974	383	171	131	931	853	3449	8467
14	14034	7060	5381	1654	716	177	131	510	532	2085	6701
15	7971	76633	6364	2956	1836	79	153	326	531	1219	5098
16	66593	8222	28739	4572	3913	123	86	346	265	940	2254
17	5102	88382	7953	25149	4025	509	247	887	306	328	1727
18	7659	5583	37269	5771	15842	379	1003	1131	300	401	668
19	4299	9916	2989	41020	3380	2958	1399	2392	500	973	906
20	3697	7166	3387	4156	16519	1273	3621	1943	1601	858	995
21	2471	4548	1371	3453	1533	5258	1294	3376	921	1133	792
22	2598	4333	1233	3489	2131	2519	3468	1542	2446	1192	997
23	2366	4934	471	2634	1431	2314	4425	3048	1348	2120	1344
24	1168	1306	1168	1632	1317	1814	1027	1013	2219	1235	2020
25	5840	2277	825	1356	543	1160	725	869	822	1555	1001
26	1	7963	1815	1186	430	1027	222	905	505	826	1336
27	1	1	5844	2080	408	229	222	506	298	458	673
28	1	1	1	7259	659	515	315	522	234	262	539
29	1	1	1	1	2370	196	103	102	78	136	245

TABLE 8. JEDI PEDIEN AVERAGE WEIGHTS AT AGE FOR 1972 TO 1982 21/ 7/83

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
5	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090
6	0.103	0.103	0.103	0.103	0.103	0.103	0.103	0.103	0.103	0.085	0.085
7	0.135	0.135	0.135	0.135	0.135	0.135	0.135	0.135	0.135	0.165	0.110
8	0.169	0.169	0.169	0.169	0.169	0.169	0.169	0.169	0.169	0.219	0.197
9	0.205	0.205	0.205	0.205	0.205	0.205	0.205	0.205	0.205	0.263	0.245
10	0.243	0.243	0.243	0.243	0.243	0.243	0.243	0.243	0.243	0.293	0.287
11	0.282	0.282	0.282	0.282	0.282	0.282	0.282	0.282	0.282	0.320	0.317
12	0.322	0.322	0.322	0.322	0.322	0.322	0.322	0.322	0.322	0.346	0.345
13	0.362	0.362	0.362	0.362	0.362	0.362	0.362	0.362	0.362	0.388	0.377
14	0.403	0.403	0.403	0.403	0.403	0.403	0.403	0.403	0.403	0.406	0.387
15	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.443	0.454	0.420
16	0.482	0.482	0.482	0.482	0.482	0.482	0.482	0.482	0.482	0.465	0.463
17	0.521	0.521	0.521	0.521	0.521	0.521	0.521	0.521	0.521	0.502	0.478
18	0.559	0.559	0.559	0.559	0.559	0.559	0.559	0.559	0.559	0.535	0.529
19	0.596	0.596	0.596	0.596	0.596	0.596	0.596	0.596	0.596	0.522	0.479
20	0.631	0.631	0.631	0.631	0.631	0.631	0.631	0.631	0.631	0.569	0.497
21	0.665	0.665	0.665	0.665	0.665	0.665	0.665	0.665	0.665	0.552	0.519
22	0.698	0.698	0.698	0.698	0.698	0.698	0.698	0.698	0.698	0.621	0.597
23	0.730	0.730	0.730	0.730	0.730	0.730	0.730	0.730	0.730	0.613	0.587
24	0.759	0.759	0.759	0.759	0.759	0.759	0.759	0.759	0.759	0.626	0.602
25	0.788	0.788	0.788	0.788	0.788	0.788	0.788	0.788	0.788	0.682	0.652
26	0.815	0.815	0.815	0.815	0.815	0.815	0.815	0.815	0.815	0.757	0.676
27	0.841	0.841	0.841	0.841	0.841	0.841	0.841	0.841	0.841	0.782	0.755
28	0.866	0.866	0.866	0.866	0.866	0.866	0.866	0.866	0.866	0.869	0.771
29	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.879	0.855

Table 9. 4RST redbfish summary of the results of research vessel surveys ('000 fish).

Year	Age	Length cm.*	A.T. Cameron	Gadus	B. Venture	E.P. Quebecois	Vicki and Brothers
1976	1-4	0-16				2 717 331	
	5-9	17-24				1 101 620	
	10-29	> 25				261 126	
	Total				15 044 258	4 080 077	
1977	1-4	0-16				2 984 653	
	5-9	17-24				1 129 328	
	10-29	> 25				927 662	
	Total		625 691			5 041 643	
1978	1-4	0-16	28 799	39 031	505 218	560 444	
	5-9	17-24	402 115	197 063	4 904 271	656 349	
	10-29	> 25	211 106	111 696	446 307	281 720	
	Total		642 020	347 790	5 855 796	1 498 513	
1979	1-4	0-16	15 100	21 813	222 489	130 873	
	5-9	17-24	532 916	464 563	1 417 022	1 343 782	
	10-29	> 25	345 959	152 860	290 127	862 357	
	Total		893 975	639 236	1 929 638	2 337 012	
1980	1-4			7 177			
	5-9		650 243	175 983	922 460		
	10-29		498 718	47 552	448 129		
	Total			230 712			
1982	1-4						4 857 551
	5-9						190 027
	10-29						528 216
	Total						5 575 794

* for E.P. Quebecois only

Table 10. 4RST redfish research vessel survey population estimates at age for 1982 ('000 fish).

Age	Numbers
2	427,151
3	2,547,437
4	1,882,963
5	944,457
6	16,151
7	7,393
8	30,004
9	42,022
10	47,086
11	84,303
12	45,757
13	79,972
14	35,256
15	29,170
16	8,909
17	10,994
18	4,754
19	4,855
20	8,102
21	10,582
22	12,833
23	17,156
24	42,929
25	14,302
26	28,949
27	14,027
28	9,056
29	5,709
30	11,623

Table 11. 4RST redbfish ANOVA table from standardization model.

Multiple r = 0.733

Multiple R² = 0.537

Source of variation	Degrees of freedom	Sum of squares	Mean squares	F-value
Intercept	1	27.54	27.54	
Regression	38	301	7.921	46.39
gear type-tonnage class	5	72.8	14.56	85.268
months	8	178.0	22.25	130.339
divisions	2	4.541	2.27	13.297
years	23	119.4	5.19	30.397
Residuals	1518	259.2	0.1707	
TOTAL	1557	587.7		

Table 12. 4RST redfish catch rate standardized to Maritimes and Quebec tonnage class 4 otter trawlers fishing in Division 4R during the month of January.

Year	Total catch	Proportion of total catch accounted for in standard CPUE	Catch rate		Effort
			Mean	S.E.	
1959	16,978	0.392	0.780	0.081	21,758
1960	12,218	0.390	0.774	0.079	15,792
1961	10,391	0.394	0.713	0.083	14,581
1962	6,585	0.211	0.571	0.077	11,536
1963	19,784	0.362	1.058	0.106	18,697
1964	29,700	0.162	1.208	0.134	24,581
1965	48,827	0.243	1.223	0.120	39,910
1966	65,215	0.332	1.383	0.116	47,145
1967	70,036	0.260	1.686	0.145	41,536
1968	90,963	0.395	1.621	0.126	56,128
1969	88,875	0.494	1.124	0.086	79,054
1970	87,588	0.555	0.930	0.064	94,215
1971	79,406	0.532	0.913	0.065	86,932
1972	80,329	0.742	1.093	0.079	73,473
1973	130,164	0.834	0.863	0.061	150,862
1974	63,489	0.793	0.618	0.043	102,748
1975	65,401	0.820	0.624	0.045	104,731
1976	37,983	0.705	0.702	0.052	54,129
1977	15,840	0.498	0.600	0.054	26,395
1978	13,591	0.581	0.801	0.076	16,958
1979	15,034	0.496	0.832	0.089	18,075
1980	14,832	0.689	1.229	0.124	12,067
1981	20,549	0.558	1.322	0.130	15,545
1982	25,719	0.741	1.620	0.140	15,891

Table 13. 4RST redfish partial recruitment vector used in SPA, yield-per-recruit calculations and projections.

Age	P.R.
5	0.003
6	0.003
7	0.06
8	0.17
9	0.30
10	0.45
11	0.60
12	0.75
13	0.90
14	1.00
15	1.00
16	1.00
17	1.00
18	1.00
19	1.00
20	1.00
21	1.00
22	1.00
23	1.00
24	1.00
25	1.00
26	1.00
27	1.00
28	1.00
29	1.00

Table 14. 4RST redfish SPA exploited biomass vs catch rate for $F_T = 0.025$, $F_T = 0.05$ and $F_T = 0.10$.

Year	C/E	EXB.	Pred.	EXB.	Pred.	EXB.	Pred.
1972	1.093	565	714	464	414	413	264
1973	.863	653	562	505	350	431	243
1974	.618	523	401	375	281	301	221
1975	.624	442	405	299	283	228	222
1976	.702	433	456	266	305	181	229
1977	.600	347	389	201	276	129	220
1978	.801	404	522	225	332	136	238
1979	.832	543	542	294	341	169	241
1980	1.229	701	803	369	452	203	276
1981	1.322	1,034	865	533	478	282	284
1982	1.620	1,075	1,061	543	561	277	311
r		.91		.75		.29	
B_0		- 6		109		166	
B_1		658		279		90	
F_T		.025		.05		.10	

Table 15. 4RST redfish. Results of cohort analysis at $F_t = 0.05$.

4 RST REDFISH POPULATION NUMBERS													4 RST REDFISH POPULATION BIOMASS												
	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982		1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982		
5	313532	374096	474249	572615	672157	380150	396918	131641	30985	7744	7006	5	28218	33669	42682	51535	60494	34213	35723	11848	2789	697	631		
6	145977	283561	338237	428957	517786	601193	340358	355942	115598	27918	7006	6	15036	29207	34838	44183	53332	61923	35057	36662	12047	2373	596		
7	111399	130876	255968	305385	387546	467102	541966	305442	319808	105557	25257	7	15039	17668	34554	41227	52319	63059	73165	41235	43174	17417	2980		
8	44441	100052	115461	231332	276048	349646	421868	489905	274251	286779	95219	8	7510	16909	19513	39095	46652	59090	71294	82794	46348	62805	18758		
9	63685	39314	88267	104051	208936	249425	315736	381456	440527	240733	257029	9	13055	8059	18095	21330	42832	51132	64726	78198	90308	63313	62972		
10	80611	55830	34809	79382	93723	188875	225099	284929	342898	391064	207542	10	19588	13567	8459	19290	22775	45897	54699	69238	83324	114582	59564		
11	66929	68852	47250	31291	71556	84762	170505	203605	255196	304823	342459	11	18874	19416	13325	8824	20179	23903	48082	57247	71965	97543	108560		
12	111775	57765	54650	42371	28160	64607	76307	153812	181877	228874	268894	12	35992	18600	17597	13643	9067	20804	24571	49528	58564	79190	92768		
13	123267	95083	49893	49008	38026	25361	58235	68692	137427	163127	202126	13	44623	34420	18061	17741	13765	9181	21081	24866	49749	63293	76202		
14	349900	109075	73811	43014	43418	34043	22785	52568	61269	123538	144323	14	141010	43957	29746	17335	17498	13719	9182	21185	24691	50156	55853		
15	114535	303253	91979	61668	37348	38605	30635	20492	47081	54933	109798	15	50739	134341	40747	27319	16545	17102	13571	9078	20857	24939	46115		
16	414303	96053	201500	77172	52988	32047	34856	27574	18232	42095	48545	16	199694	46298	97123	37197	25540	15447	16801	13291	8788	19574	23447		
17	82437	311532	79091	154987	65479	44223	28880	31458	24621	16245	37195	17	42949	162308	41207	80748	34115	23040	15047	16389	12827	8155	17779		
18	73903	69738	197814	64000	116316	55420	39531	25897	27620	21987	14387	18	41312	38984	110578	35778	65020	30980	22098	14476	15440	11783	7611		
19	43968	59584	57791	143538	52420	90177	49785	34815	22357	24706	19513	19	26205	35512	34444	85549	31242	53746	29672	20750	13325	12897	9347		
20	27938	35694	44482	49448	90859	44216	78781	43717	29226	19754	21430	20	17629	22523	28068	31202	57332	27900	49711	27585	18442	11240	10543		
21	18371	21763	25481	37027	40790	66500	38798	67840	37708	24922	17058	21	12216	14472	16945	24623	27125	44222	25800	45113	25076	13757	8699		
22	16923	14272	15366	21752	30219	35450	55169	33875	58173	33244	21473	22	11812	9962	10725	15183	21093	24744	38508	23644	40604	20644	11316		
23	10185	12841	8792	12731	16353	25316	29680	46620	29184	50310	28946	23	7435	9374	6418	9293	11945	18481	21666	34033	21304	30840	16413		
24	12712	6966	6926	7507	9014	13445	20706	22646	39284	25125	43506	24	9648	5287	5256	5698	6841	10205	15716	17189	29817	15728	26190		
25	45338	10391	5060	5155	5241	6903	10440	17758	19528	33435	21559	25	51486	8188	3988	4062	4130	5440	8227	13994	15388	22803	14056		
26	9	53565	7236	3794	3375	4225	5143	8757	15242	16888	28774	26	8	43656	5898	3092	2751	3444	4191	7137	12422	12784	19164		
27	10	7	40893	4821	2305	2845	2846	4442	7063	13311	14495	27	8	6	34391	4055	1938	2224	2394	3736	5940	10409	10915		
28	7	8	6	31443	2384	1697	2175	2364	3538	6107	11609	28	6	7	5	27229	2064	1470	1884	2047	3064	5307	8950		
29	9	5	6	21545	1530	1046	1669	1643	2979	5277		29	8	4	6	4	19154	1360	930	1483	1460	2618	4406		
5+	2292164	2310177	2315019	2562456	2884002	2907564	2998248	2817315	2541696	2266197	2000426	5+	810101	766395	672669	665235	665749	662725	703797	722747	727714	774828	713836		
6+	1978632	1936081	1840770	1989841	2211845	2527414	2601331	2685674	2510710	2258453	1993420	6+	781883	732726	629987	613699	605255	628511	668075	710899	724925	774131	713266		
7+	1832654	1652520	1502533	1560884	1694059	1926222	2260973	2329732	2393752	2230535	1986413	7+	766848	703520	595149	569517	551923	566589	633018	674237	712878	771758	712610		
8+	1721256	1521645	1246564	1255498	1306512	1459119	1719007	2024290	2073994	2124978	1961156	8+	751809	685851	560593	528290	499604	503530	559853	633002	669704	754342	709630		
9+	1676815	1421593	1131104	1024167	1030464	1109473	1297139	1534355	1799693	1838199	1865937	9+	744298	688943	541080	489195	452952	444440	488557	550208	623356	691537	690872		
10+	1613130	1382279	1042837	920116	821528	860048	981403	1152930	1359166	1597465	1680890	10+	731243	660883	522985	467864	410120	393307	423831	472010	533048	628224	627900		
11+	1532519	1326449	1008028	840734	727805	671174	756303	868001	1016268	1206402	1401367	11+	711654	647317	514527	448574	387345	347411	369132	402772	449724	513642	568335		
12+	1465589	1257597	960777	809443	656249	586411	585798	664996	761073	901579	1058908	12+	692780	627900	501202	439750	367167	323508	321049	345525	377558	416699	459776		
13+	1353814	1199831	906128	767072	628089	521804	509491	511184	579195	672705	790014	13+	656789	609300	483605	426107	358099	302704	296478	295997	319194	336909	367007		
14+	1230548	1104749	856235	718064	590063	496443	451256	442492	441769	509578	587887	14+	612166	574880	465544	408364	344334	293524	275397	271131	269446	273615	290805		
15+	880647	995674	782424	675049	546645	462400	428471	389924	380499	386400	443565	15+	471157	530923	435798	391031	326836	279804	266215	249946	244754	233459	234952		
16+	766113	692421	690445	613381	509297	423795	397836	369431	333419	331107	333756	16+	420418	396581	395051	363712	310291	262702	252644	240868	223897	198520	188837		

4 RST REDFISH FISHING MORTALITY

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
5	0.000	0.001	0.000	0.001	0.012	0.011	0.009	0.018	0.004	0.000	0.000
6	0.009	0.002	0.002	0.002	0.003	0.004	0.008	0.007	0.003	0.000	0.000
7	0.007	0.025	0.001	0.001	0.003	0.002	0.001	0.008	0.009	0.003	0.003
8	0.023	0.025	0.004	0.002	0.001	0.002	0.001	0.006	0.030	0.010	0.009
9	0.032	0.022	0.006	0.005	0.001	0.003	0.003	0.007	0.019	0.048	0.015
10	0.058	0.067	0.007	0.004	0.000	0.002	0.003	0.010	0.018	0.033	0.022
11	0.047	0.131	0.009	0.005	0.002	0.005	0.003	0.010	0.009	0.025	0.030
12	0.062	0.047	0.009	0.008	0.005	0.004	0.005	0.013	0.009	0.024	0.037
13	0.022	0.153	0.048	0.021	0.011	0.007	0.002	0.014	0.007	0.022	0.045
14	0.043	0.070	0.080	0.041	0.017	0.005	0.006	0.010	0.009	0.018	0.050
15	0.076	0.309	0.076	0.052	0.053	0.002	0.005	0.017	0.012	0.024	0.050
16	0.185	0.094	0.162	0.064	0.081	0.004	0.003	0.013	0.015	0.024	0.050
17	0.067	0.354	0.112	0.187	0.067	0.012	0.009	0.030	0.013	0.021	0.050
18	0.115	0.088	0.221	0.100	0.155	0.007	0.027	0.047	0.011	0.019	0.050
19	0.108	0.192	0.056	0.357	0.070	0.035	0.030	0.075	0.024	0.042	0.050
20	0.150	0.237	0.083	0.093	0.212	0.031	0.050	0.048	0.059	0.047	0.050
21	0.152	0.248	0.058	0.103	0.040	0.087	0.036	0.054	0.026	0.049	0.050
22	0.176	0.384	0.088	0.185	0.077	0.078	0.068	0.049	0.045	0.038	0.050
23	0.280	0.517	0.058	0.245	0.096	0.101	0.170	0.071	0.050	0.045	0.050
24	0.102	0.220	0.195	0.259	0.167	0.153	0.054	0.048	0.061	0.053	0.050
25	0.099	0.262	0.188	0.324	0.115	0.194	0.076	0.053	0.045	0.050	0.050
26	0.121	0.170	0.306	0.398							

Table 16. 4RST redfish Thompson and Bell yield-per-recruit analysis.

	Fishing mortality	Catch (number)	Yield (kg)	Avg. weight (kg)	Yield per unit effort
	0.1000	0.286	0.112	0.393	1.378
$F_{0.1}$	0.1644	0.366	0.134	0.367	1.000
	0.2000	0.395	0.141	0.356	0.862
	0.3000	0.452	0.150	0.332	0.612
	0.4000	0.489	0.154	0.314	0.471
	0.5000	0.515	0.155	0.301	0.380
	0.6000	0.535	0.156	0.291	0.318
F max.....	0.6501	0.544	0.156	0.286	0.293
	0.7000	0.551	0.156	0.282	0.272
	0.8000	0.565	0.155	0.275	0.238
	0.9000	0.577	0.155	0.269	0.211
	1.0000	0.587	0.154	0.263	0.189
	1.1000	0.595	0.154	0.258	0.171
	1.2000	0.603	0.153	0.254	0.156
	1.3000	0.610	0.152	0.250	0.144
	1.4000	0.617	0.152	0.246	0.133
	1.5000	0.623	0.151	0.243	0.123

Table 17a. 4RST redfish. Results of projections taking the 31,000 t TAC in 1983 and fishing at $F_{0.1}$ in 1984.

Age	Population numbers		Population biomass (mean)		Catch biomass		Fishing mortality	
	1983	1984	1983	1984	1983	1984	1983	1984
5	147,423	147,423	12,625	12,623	2	6	0.000	0.000
6	6,338	133,370	513	10,786	0	5	0.000	0.000
7	6,338	5,734	710	641	3	6	0.004	0.009
8	22,785	5,715	4,250	1,058	43	27	0.010	0.025
9	85,429	20,409	19,744	4,655	353	209	0.018	0.045
10	229,107	75,931	61,756	20,065	1,654	1,354	0.027	0.067
11	183,613	201,825	54,428	58,268	1,944	5,244	0.036	0.090
12	300,712	160,311	96,591	49,826	4,312	5,605	0.045	0.112
13	234,351	260,214	81,900	87,426	4,388	11,803	0.054	0.135
14	174,844	200,987	62,543	68,821	3,723	10,323	0.060	0.150
15	124,220	149,062	48,223	55,394	2,871	8,309	0.060	0.150
16	94,504	105,903	42,191	45,258	2,512	6,789	0.060	0.150
17	41,783	80,569	18,461	34,075	1,099	5,111	0.060	0.150
18	32,014	35,622	15,654	16,673	932	2,501	0.060	0.150
19	12,383	27,294	5,483	11,567	326	1,735	0.060	0.150
20	16,795	10,557	7,638	4,596	455	689	0.060	0.150
21	18,445	14,318	8,695	6,461	518	969	0.060	0.150
22	14,682	15,725	7,152	7,332	426	1,100	0.060	0.150
23	18,482	12,517	9,686	6,279	577	942	0.060	0.150
24	24,914	15,757	13,863	8,393	825	1,259	0.060	0.150
25	37,446	21,241	22,567	12,253	1,343	1,838	0.060	0.150
26	18,556	31,924	11,423	18,812	680	2,822	0.060	0.150
27	24,766	15,820	17,237	10,540	1,026	1,581	0.060	0.150
28	12,476	21,114	8,891	14,404	529	2,161	0.060	0.150
29	9,992	10,636	7,712	7,858	459	1,179	0.060	0.150
5 ⁺	1,892,398	1,779,978	639,936	574,064	31,000	73,567		
14 ⁺	676,302	769,046	307,419	328,716	18,301	49,308		

Table 17b. 4RST redfish. Results of projections at $F_{0.1}$ in 1983 and 1984.

Age	Population numbers		Population biomass (mean)		Catch biomass		Fishing mortality	
	1983	1984	1983	1984	1983	1984	1983	1984
5	147,423	147,423	12,623	12,623	6	6	0.000	0.000
6	6,338	133,334	513	10,783	0	5	0.000	0.000
7	6,338	5,733	709	641	6	6	0.009	0.009
8	22,785	5,684	4,218	1,052	108	27	0.025	0.025
9	85,429	20,098	19,483	4,584	877	206	0.045	0.045
10	229,107	73,898	60,542	19,528	4,087	1,318	0.067	0.067
11	183,613	193,773	53,010	55,943	4,770	5,035	0.090	0.090
12	300,712	151,841	93,464	47,193	10,515	5,309	0.112	0.112
13	234,351	243,144	78,737	81,691	10,629	11,028	0.135	0.135
14	174,844	185,271	59,869	63,440	8,980	9,516	0.150	0.150
15	124,220	136,169	46,162	50,602	6,924	7,590	0.150	0.150
16	94,504	96,742	40,387	41,344	6,058	6,202	0.150	0.150
17	41,783	73,600	17,672	31,128	2,651	4,669	0.150	0.150
18	32,014	32,541	14,985	15,231	2,248	2,285	0.150	0.150
19	12,383	24,933	5,248	10,567	787	1,585	0.150	0.150
20	16,795	9,644	7,311	4,198	1,097	630	0.150	0.150
21	18,445	13,080	8,323	5,902	1,248	885	0.150	0.150
22	14,682	14,365	6,846	6,698	1,027	1,005	0.150	0.150
23	18,482	11,434	9,272	5,736	1,391	860	0.150	0.150
24	24,914	14,394	13,271	7,667	1,991	1,150	0.150	0.150
25	37,446	19,403	21,602	11,194	3,240	1,679	0.150	0.150
26	18,556	29,163	10,935	17,185	1,640	2,578	0.150	0.150
27	24,766	14,451	16,500	9,628	2,475	1,444	0.150	0.150
28	12,476	19,288	8,511	13,158	1,277	1,974	0.150	0.150
29	9,992	9,716	7,382	7,178	1,107	1,077	0.150	0.150
5 ⁺	1,892,398	1,679,122	617,575	534,894	75,139	68,069		
14 ⁺	676,302	704,194	294,276	300,856	44,141	45,129		

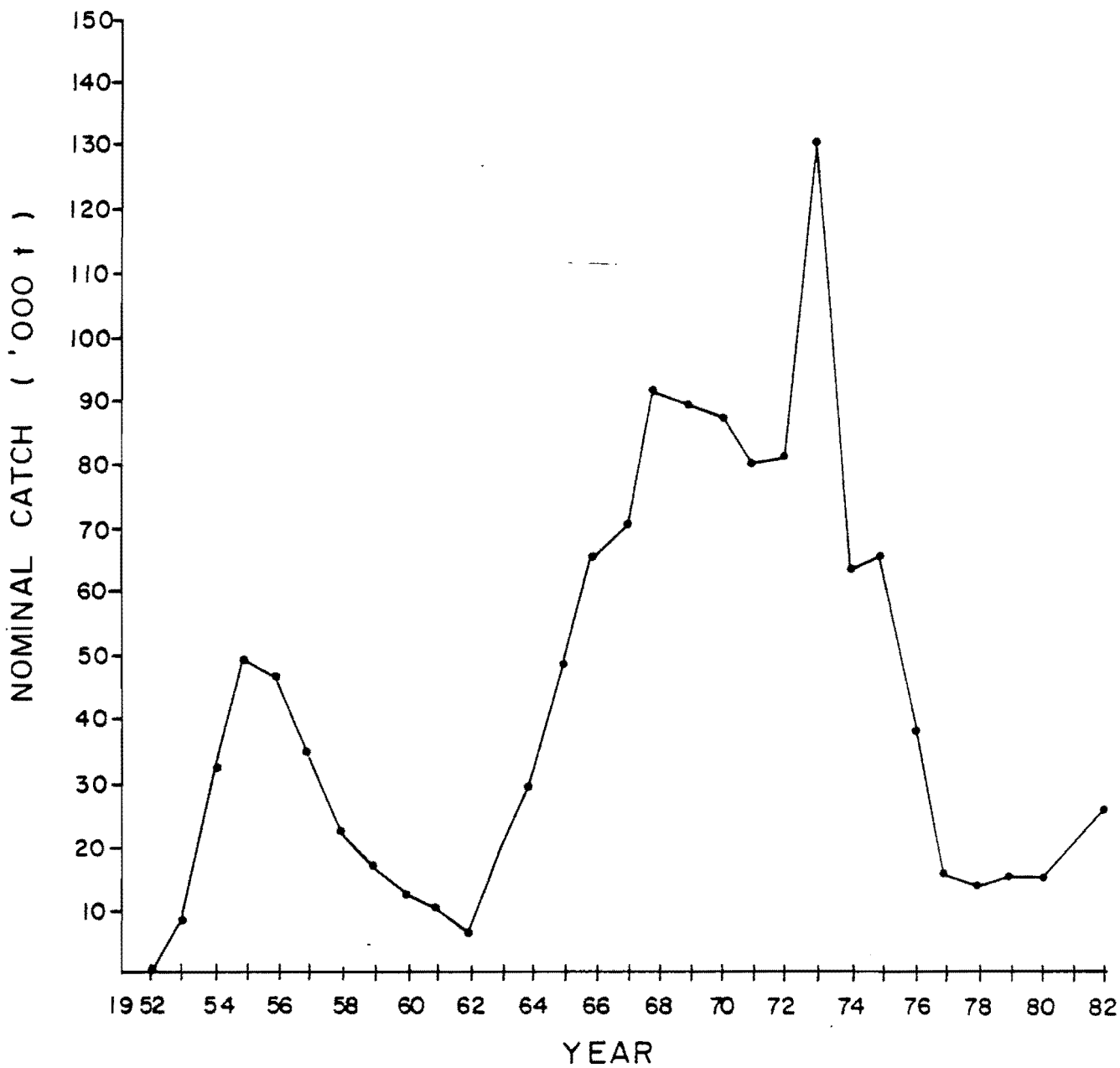


Figure 1. 4RST redfish total nominal catches for 1952-1982.

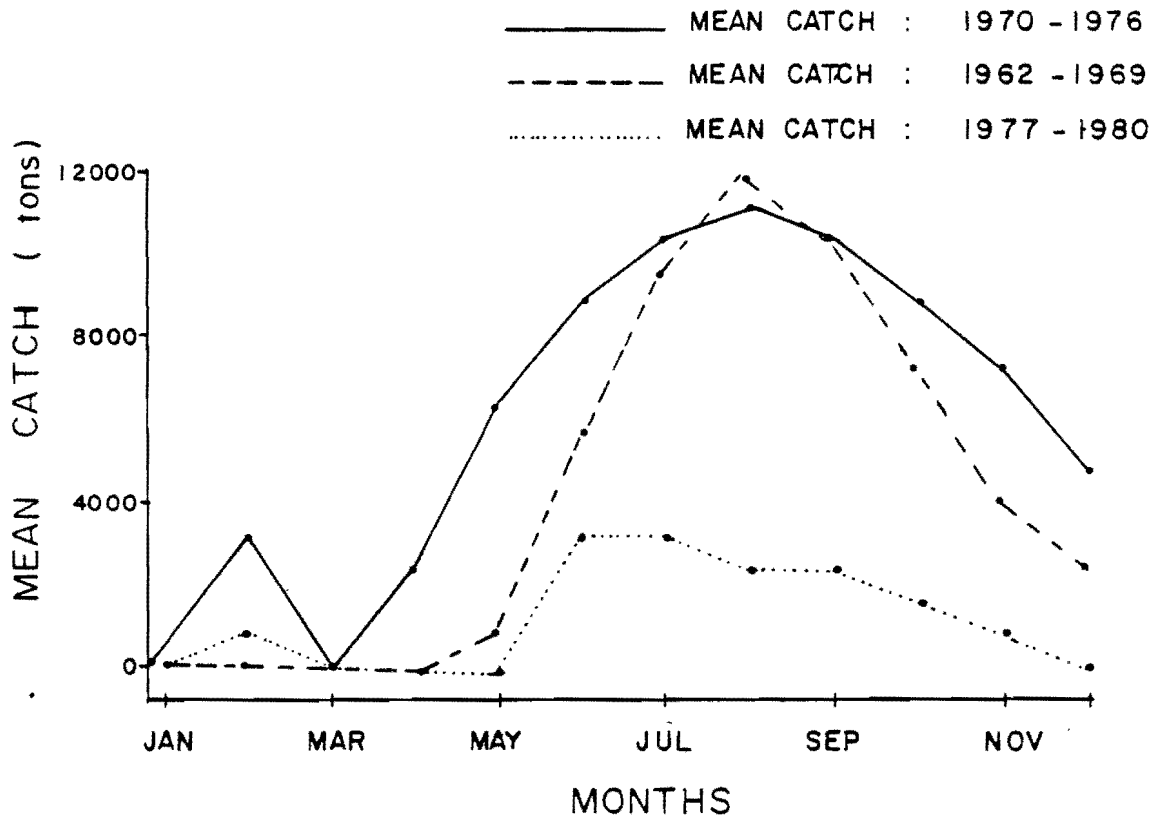


Figure 2. 4RST redfish seasonal patterns of the fishery for 3 time periods: 1962-69, 1970-76, 1977-80.

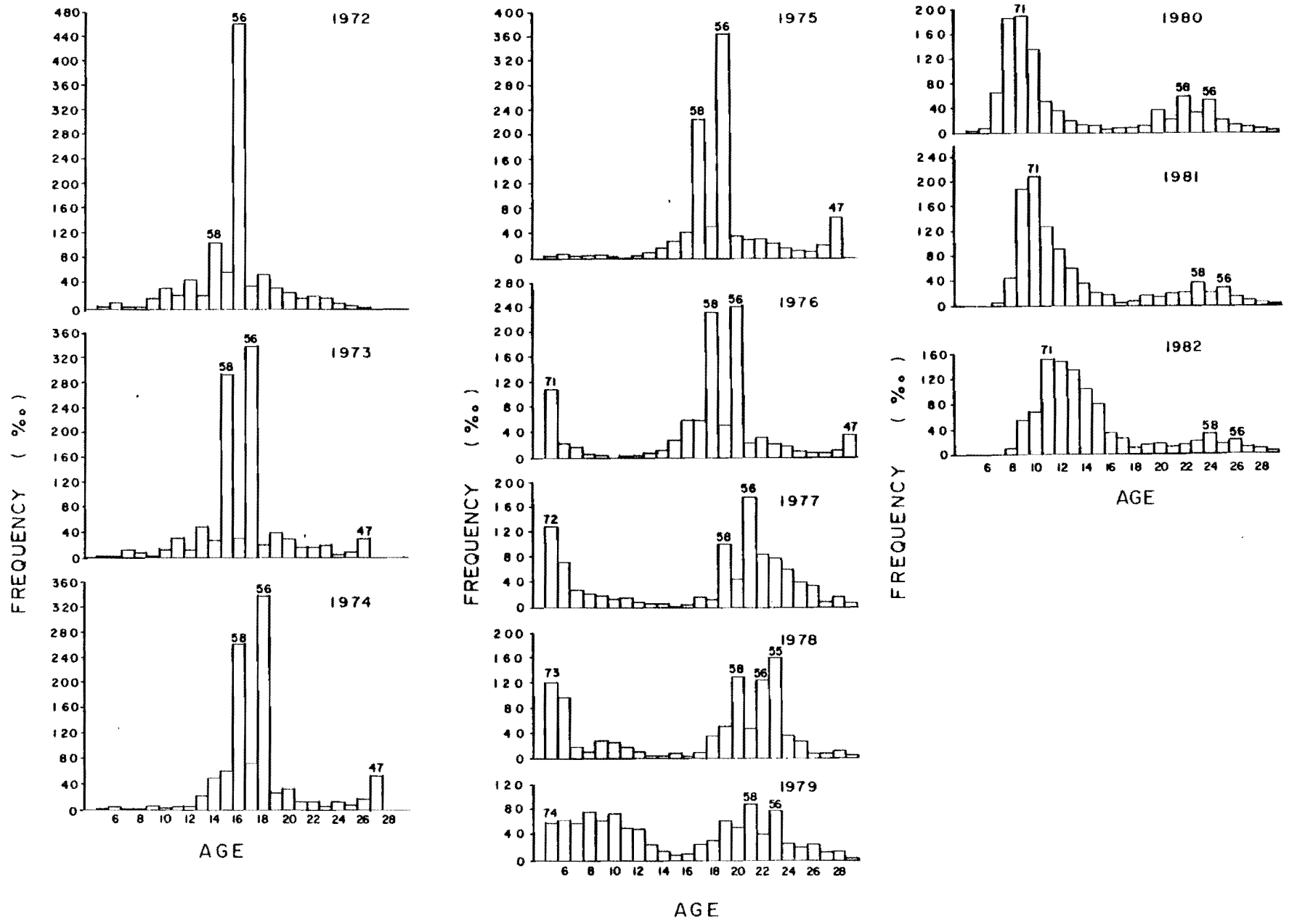


Figure 3. 4RST redfish proportion (%) caught at age for 1972-1982.

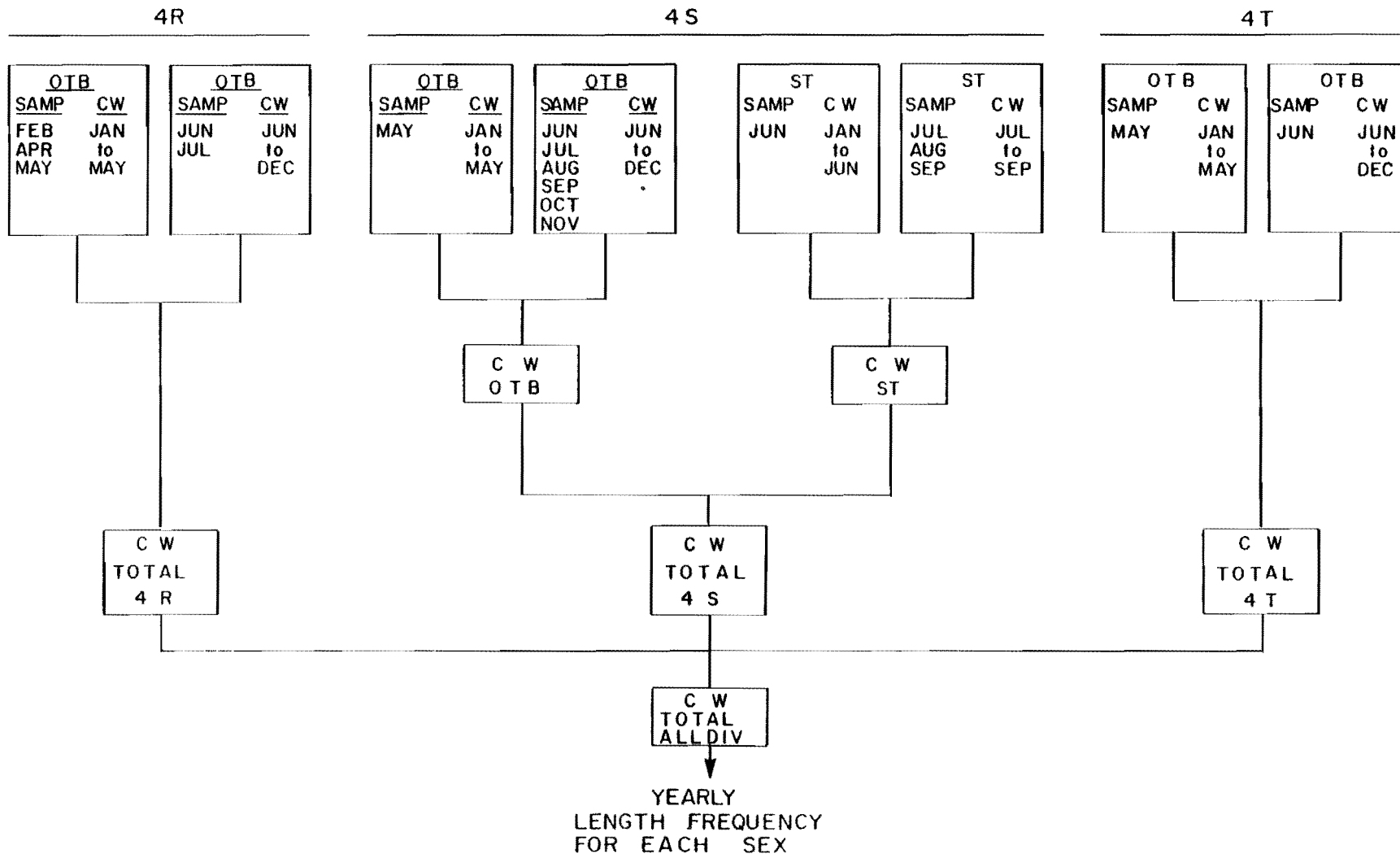


Figure 4. 4RST redfish sample combination used to calculate the 1982 catch at age for each sex. SAMP gives the months for which the length frequencies were combined and CW gives to which monthly catch weights that combined length frequency was applied.

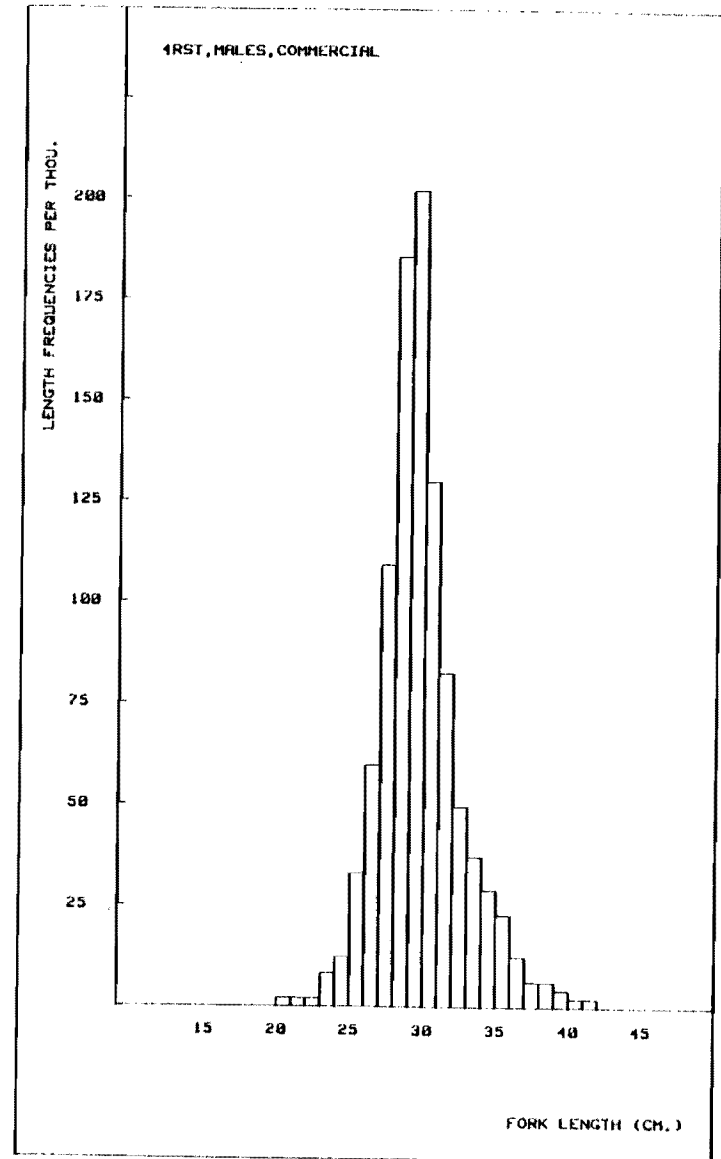
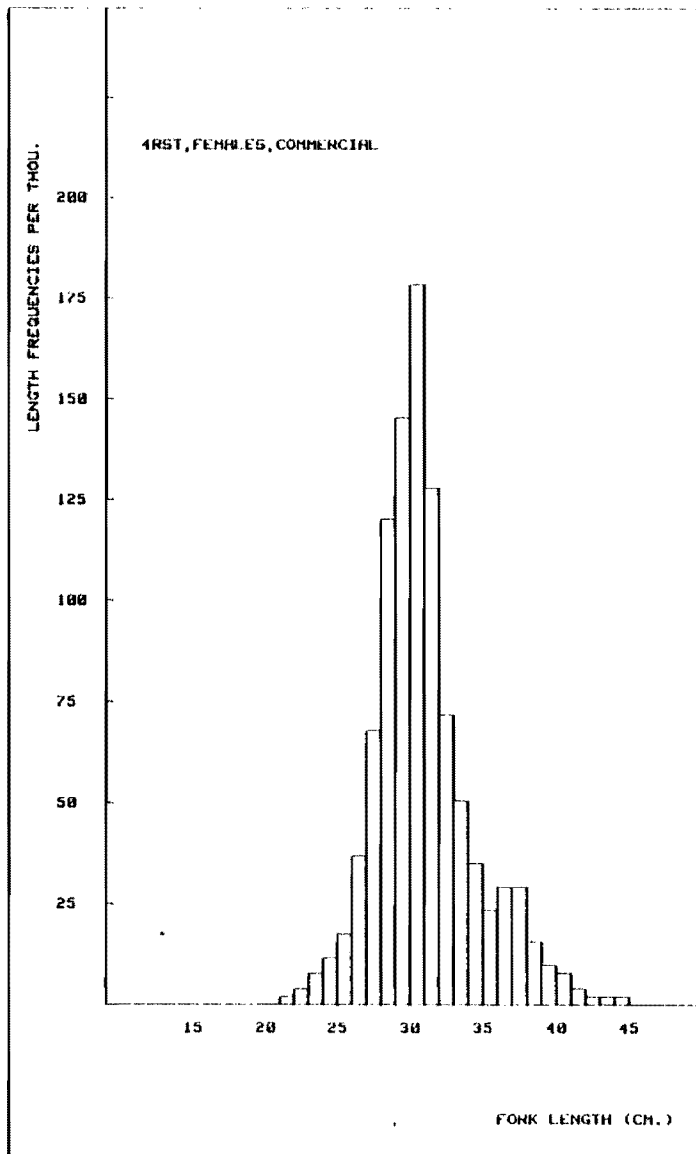


Figure 5. 4RST redfish yearly length frequencies from commercial sampling.

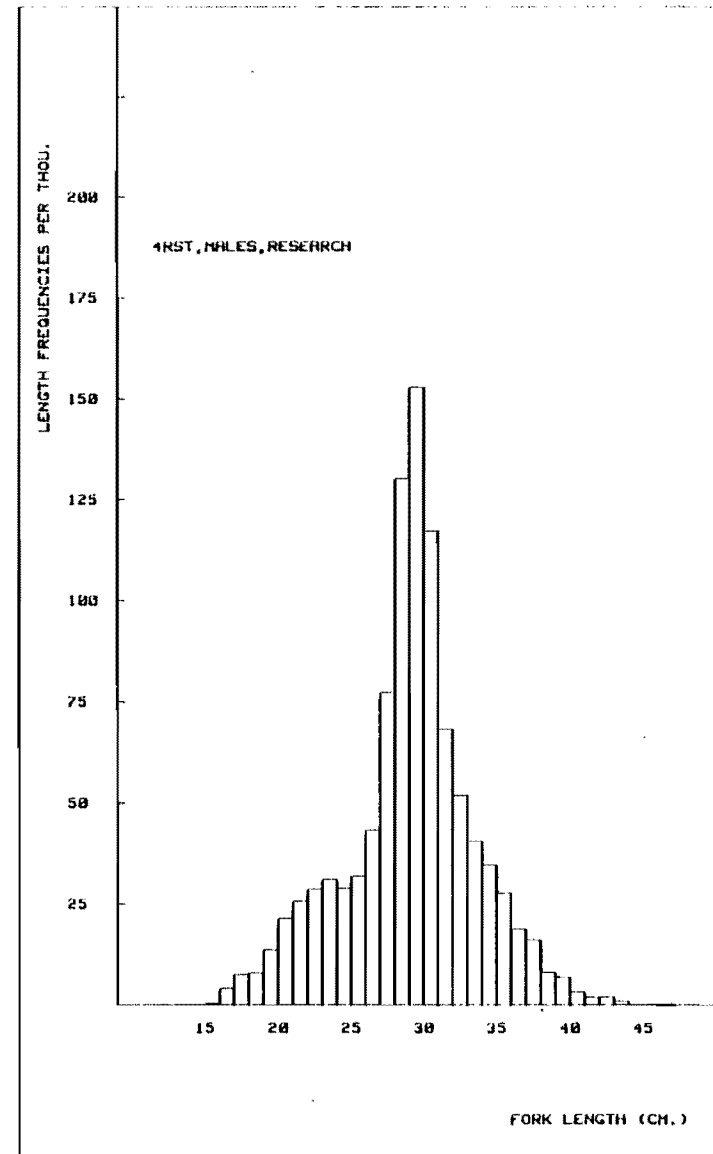
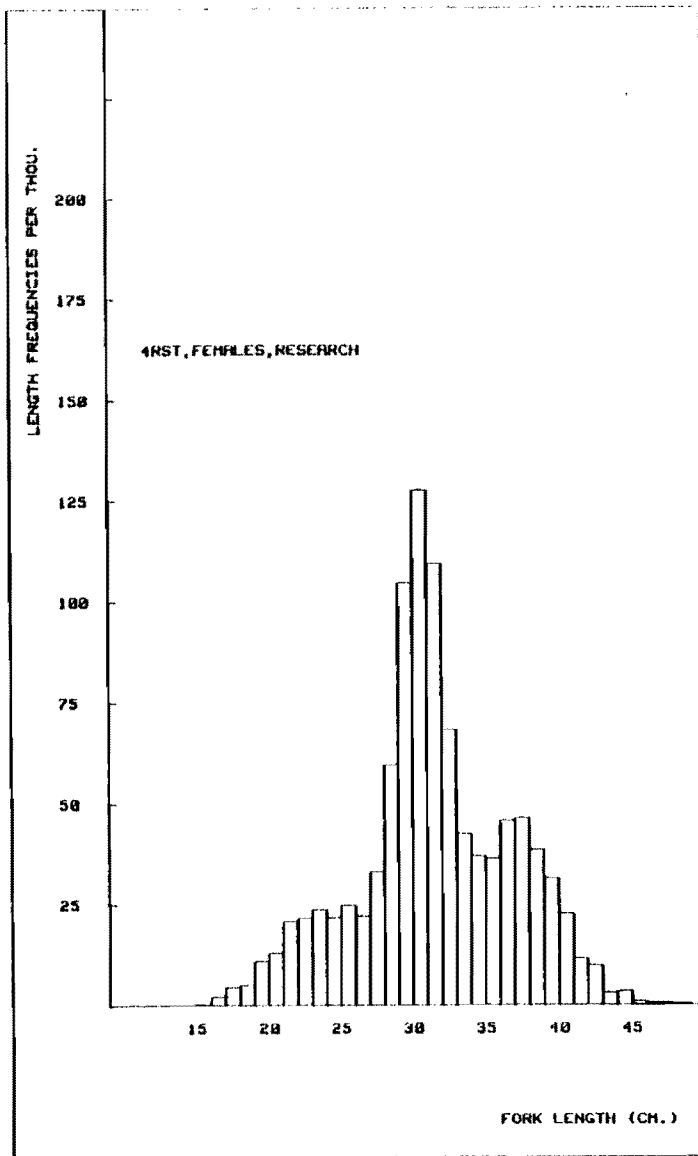


Figure 6. 4RST redfish length frequencies from 1982 research vessel survey.

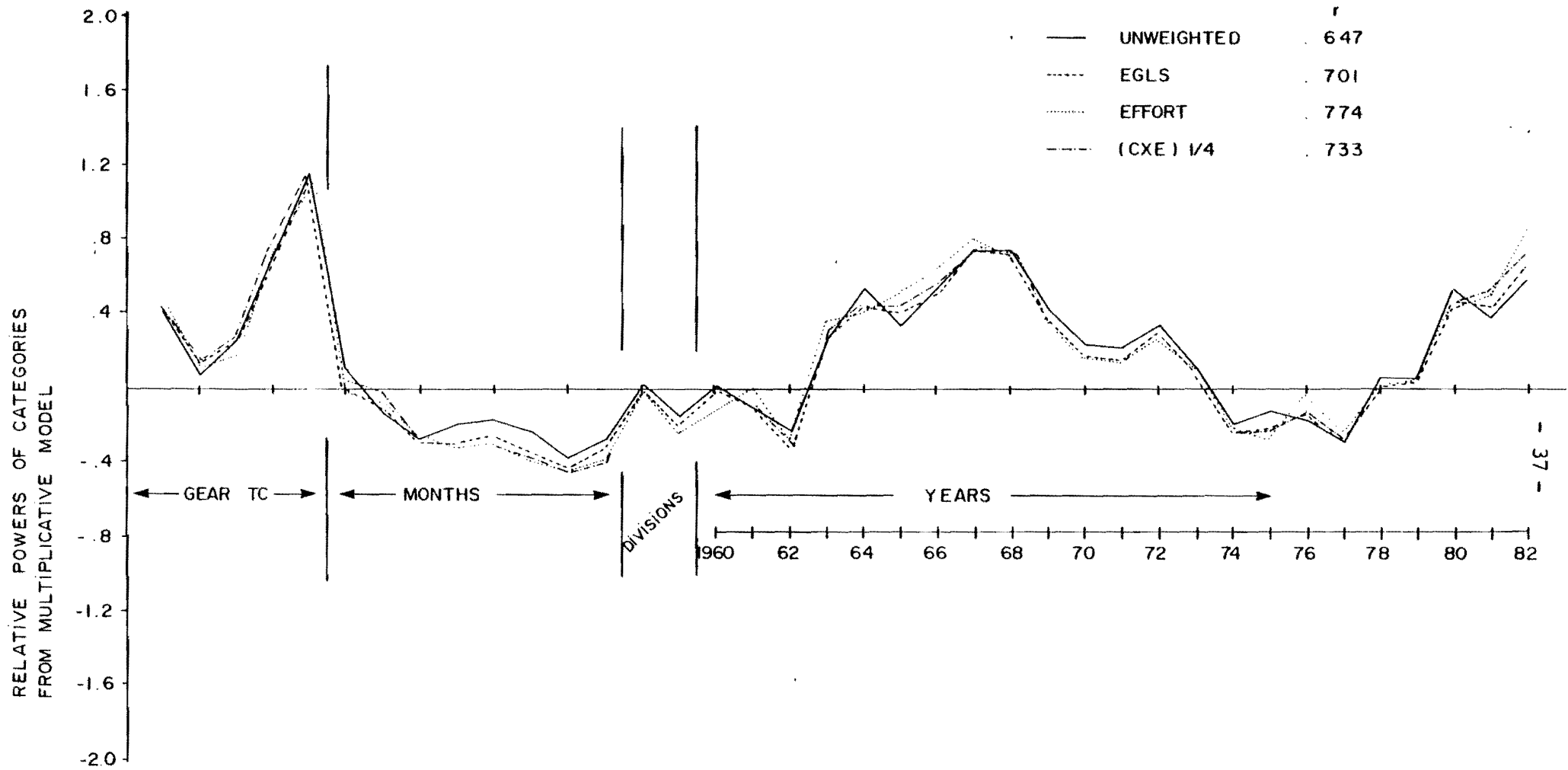


Figure 7. 4RST redfish ln powers from multiplicative model regressions using different weighting factors.

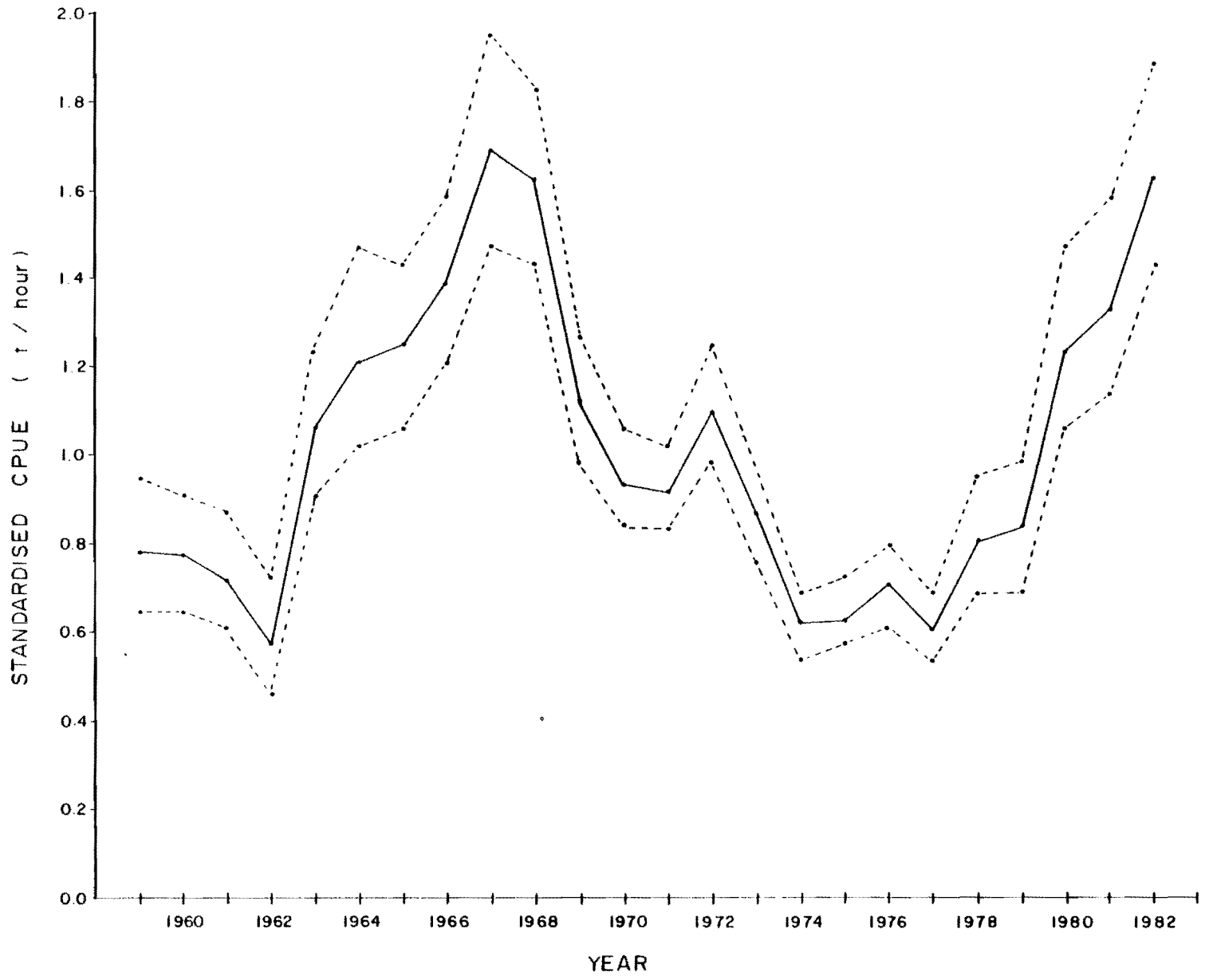


Figure 8. 4RST redfish standardized CPUE for 1959-1982 with approximate 90% confidence interval.

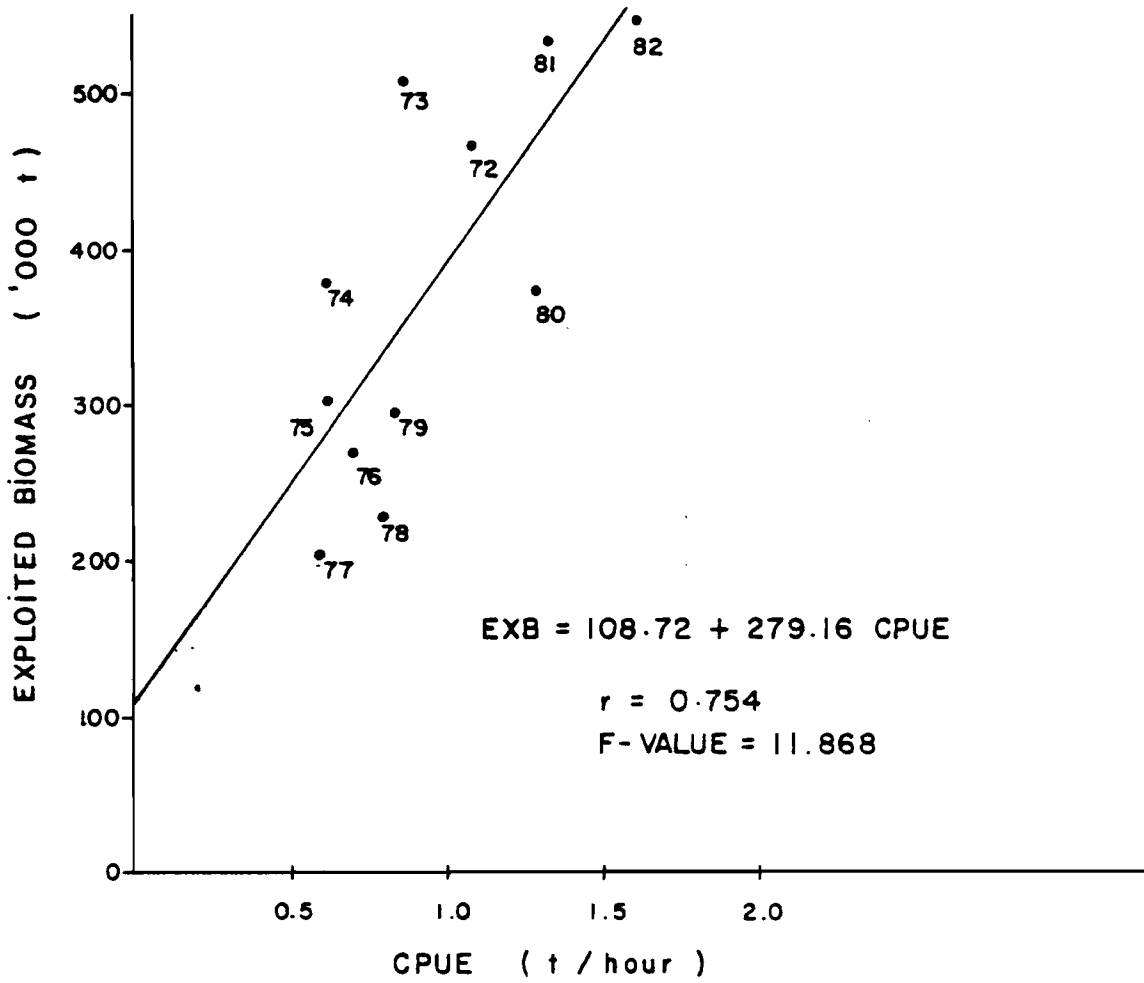


Figure 9. 4RST redfish exploited biomass versus standardized CPUE at $F_t = 0.05$.