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Redfish Assessment for Divisions 4RST

by

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ABSTRACT

Poor year-classes during the 1960's led to a decline in the TAC's set for the Gulf redfish stock from 30,000 t in 1976 to 16,000 t in 1980. The standardized CPUE series has shown an increase in recent years, attributable to the recruitment of the relatively successful 1970-72 year-classes to the fishery. A cohort run with terminal F = 0.075 was chosen for projections based on agreement with trends in the CPUE series and a 1980 research survey. Assuming the 1981 TAC of 20,000 t is caught and fishing at $F_{0.1}$ = 0.121 in 1982, the projected catch in 1982 was 31,000 t. A large proportion of the projected catch would be comprised of the 1970-72 year-classes (53%). Thus the present analysis is sensitive to the accurate estimation of the strength of these year-classes. In addition, the long term prospects of a yield about the 30,000 t level would be dependent on the continued strength of these year-classes and eventual replacement by future successful recruitment.

RESUME

Par suite de la faiblesse des classes d'âge dans les années 1960, les TPA fixés pour le stock de sébastes du Golfe ont dû être réduits. De 30 000 t qu'il était en 1976, le TPA a passé à 16 000 t en 1980. La série des PUE standardisées démontre qu'il y eut augmentation en ces dernières années. Cette augmentation est attribuable au fait que des classes d'âge relativement abondantes en 1970-72 ont rallié le stock exploitable. Une analyse des cohortes avec un F de dernière année de 0,075 a servi à des projections fondées sur l'accord entre les tendances de la série des PUE et un relevé par navire de recherche en 1980. Dans l'hypothèse que le TPA de 1981 de 20 000 t est capturé et que la pêche se fasse à $F_{0,1}$ = 0,121 en 1982, les prises projetées pour 1982 sont de 31 000 t. Ces prises seraient constituées, dans une forte proportion (53 %) par les classes d'âge de 1970-72. La présente analyse est donc sensible à l'estimation précise de l'abondance de ces classes d'âge. En outre, les perspectives à long terme d'un rendement d'environ 30 000 t dépendraient de leur abondance soutenue et de leur éventuel remplacement par des recrues également abondantes.

INTRODUCTION

Landings of redfish in Divisions 4RST increased dramatically in the late '60's and early '70's. A maximum catch of 130,000 t was landed in 1973 consisting mainly of the 1956 and 1958 year-classes. These two year-classes are generally thought to be extremely large relative to other year-classes in recent history of the stock. Since the large landing in 1973 the stock has continued to decline mainly due to small year-classes during the '60's. In 1976 a TAC of 30,000 t was set but in subsequent years it has been necessary to reduce the TAC to 16,000 t in 1980 mainly as a result of poor recruitment. Recruitment improved in the early '70's and the stock has shown some recovery as these year-classes entered the fishery. The 1981 TAC was set at 20,000 t.

Using traditional methods, commercial catch rates were thought to be suspect mainly as a result of regulations which restrict the composition and size of the large offshore fleet fishing in the Gulf for redfish. This assessment attempts to introduce multiple regression techniques to better use all of the catch data available.

METHODS AND RESULTS

SAMPLING DATA FROM COMMERCIAL FISHERY

Length frequencies were collected throughout the Maritimes and Newfoundland during the 1980 fishery (Table 1). No length frequencies were available from the Quebec fishery although half the landings were reported from Quebec.

Similarly, otoliths were collected from the Maritime fishery but were not available from the Quebec fishery. A total of 319 male and 404 female otoliths were read. The sample was taken by selecting otoliths from throughout the season of the fishery. Sample size was restricted mainly due to the difficulty in determining the age of long-lived slow growing species such as redfish.

TRENDS IN LANDINGS AND CATCH PER UNIT EFFORT

Historical landings were derived from ICNAF statistical bulletins and the 1979 and 1980 figures have been supplied from preliminary data from NAFO and CAFSAC respectively (Table 3).

The 1980 monthly landings for the three divisions in the Gulf of St. Lawrence for the Maritimes and Newfoundland are given in Table 2. Total landings (8573 t) from the Quebec redfish fishery were available but the landings were not available by division as for the other fleets. Catch per hour was determined using the method described by Gavaris (1980).
All vessels which reported redfish as being greater than 50% of the catch are considered as directed effort. By including all vessel categories, gear types, months, divisions and years, a greater use of the data could be obtained over the historical method of using tonnage class 4 vessels only. By including all vessel types the new catch rate represented a greater proportion of the total landings (Table 3). The 1980 estimate should be treated with some caution, however, as catch rates were not available for the Quebec redfish fleet. Catch rate data separated into Maritimes and Quebec was available in

1979 and the catch rate for the Maritime fleet was about twice that of the Quebec fleet.

NUMBERS AT AGE

Commercial length frequencies and age/length keys for male and female redfish were applied to the reported commercial catches to obtain the numbers at age by sex and the males and females were then combined. Additionally, estimated removals of small redfish ages 5-8 from the Port au Choix shrimp fishery were added to the catch matrix for 1976-80 (Table 4).

AVERAGE WEIGHT AT AGE

The average weights at age for males and females were averaged to obtain a combined weight at age (Table 5). A check was made to determine if the reported weight caught agreed with weight caught by applying the age/weight relationship to the catch at age. The two estimates were found to be in reasonably good agreement with each other.

PARTIAL RECRUITMENT

Partial recruitment was calculated assuming research survey frequencies represented the proportions at age in the population. The numbers at age (sexes combined) from 1980 Beothic Venture and A. T. Cameron cruises for ages 5-29 were averaged and ratios calculated with the numbers at age from the commercial catch. The percent caught was determined by assuming all ages over 12 years-old were fully recruited to the fishery (Table 5). No changes were made to the partial recruitment for the projection, although the Port au Choix removals were included in the estimated numbers removed.

ABUNDANCE INDICES

As in 1979, stratified-random surveys of the Gulf of St. Lawrence were carried out in 1980 by the Beothic Venture, Gadus Atlantica and A. T. Cameron (McKone et al. 1980). Catchability differences occur between the different vessels, thus, the numbers at age were summed for 5-9 years-old and 10-29 years-old. Additionally, for comparative purposes, the numbers of 5-9 year-olds and 10-29 year-olds, as estimated by cohort for 1980 at various terminal F's, were determined (Table 6).

TERMINAL FISHING MORTALITY

A number of methods were used in an effort to determine terminal fishing mortality. The new CPUE standard was considered to be representative of the fishery, although the 1980 point, being preliminary, was suspect (Table 3; Fig. 1). Correlations were attempted between age 5+ biomass from cohort and CPUE for year 1972-79. The r^2 values for various terminal F values were generally low and the predictive ability of the regressions was poor (Table 7). A plot of the points indicated little dispersion among the observations for

these years. The preliminary catch rate for 1980 was considerably outside the range of values observed from 1972-79. Predictive regressions of various weighted fishing mortalities with effort were attempted. The r^2 were all high but the predicted values of F were always considerably smaller than the estimated, for regressions predicting the 1979 and 1980 F value. Further, two-year Paleheimo Z's were attempted for ages 12-26 in 1978 and 14-28 in 1980. The catch rate was found to increase over the two-year period.

As the above techniques failed to determine an appropriate terminal F value, the following criteria were proposed. Catch rates for 1973 and 1979 were approximately equal and would reflect similar stock abundance levels, assuming catch rates to be an accurate index of stock levels. Biomass estimates (ages 5+) for 1973 and 1979 from various cohort runs were examined for a similar trend (Table 7). Of the three surveys conducted in 1980, the Beothic Venture was considered to provide the most reliable estimate of stock abundance due to its extensive coverage of the region and consistent daily fishing pattern. Therefore the cohort run which provided the best agreement with population estimates from the Beothic Venture survey was determined. Although the cohort run with a terminal F of 0.05 showed a close correspondence between the 1973 and 1979 biomass estimates of ages 5+, the estimate of population numbers in 1980 was larger than that of the Beothic Venture. Thus, considering both criteria, the cohort run with a terminal F of 0.075 in 1980 was selected as the best estimate of the status of the stock (Tables 8, 9 and 10).

RECRUITMENT ESTIMATES

Recruitment at age 5 for 1981 and 1982, calculated as the geometric mean of the 1967 to the 1975 year-classes at age 5 (Table 8) as estimated by cohort, was 129 million fish. Year-classes over this period were weak in the late sixties and in the most recent years but appeared to be better than average from 1970 to 1973.

PROJECTIONS

An estimate of $F_{0.1}$=0.121 used for the projections was calculated from yield per recruit using mean weights and partial recruitment from Table 5 (Table 11). The same partial recruitment which was calculated including Port au Choix numbers, was used in the projections. The numbers added to 5-8 year-olds in 1980 constituted less than 0.01% by weight and therefore were insignificant.

Projections were made to 1982 assuming the TAC in 1981 of 20,000 t would be caught and fishing would be at $F_{0.1}$ = 0.121 in 1982. Population numbers and catch numbers and biomass for 1980-82 are shown in Tables 12 and 13 respectively. The projected catch biomass in 1982 was 30,584 t, a substantial increase over the present TAC of 20,000 t. The 1970-72 year-classes would be mainly responsible for the increase, constituting 53% of the projected catch biomass. Thus the projections are dependent on the accurate estimation of the strength of these year-classes. According to the partial selection vector used in this analysis, only the 1970 year-class would be fully recruited in 1982. A yield about the level of 31,000 t could only be sustained in the long term if these year-classes continued in importance and were eventually replaced by equally successful year-classes. However, indications are that the prospects for good recruitment have been poor since the early seventies.

CONCLUSIONS

The standardized CPUE series indicated an improvement in the stock from 1976 to 1979. This trend continued in 1980 according to catch and effort data from Newfoundland and Maritime vessels. However since data were not available from Quebec, the magnitude of the increase in 1980 could not be confirmed. The increase in the latest years has been attributed to the recruitment of the relatively successful 1970-1972 year-classes to the fishery.

Catch projections to 1982 indicated a yield of 31,000 t fishing at $F_{0\ 1}$=0.121 and provided the TAC of 20,000 t was caught in 1981. The 1970-1972 year-classes were the main cause of the increase, making up 53% of the catch biomass. The long term prospects of a yield at about 31,000 t level for the Gulf redfish stock would be dependent on other successful year-classes recruiting to the fishery to replace the 1970-1972 year-classes.

REFERENCES

Gavaris, S. 1980. Use of a multiplicative model to estimate catch rate and effort from commercial data. Can. J. Fish. Aquat. Sci. 37: 2272-2275.

McKone, W.D., D.B. Atkinson and W.E. Legge. 1980. Gulf of St. Lawrence redfish assessment. CAFSAC Res. Doc. 80/60.

Table 1. Redfish length frequencies collected in 1980 for Division 4RST

Month	4R OT	4S OT	4S MWT	4S Other	4T OT	4RS OT	4RT OT	4RST OT	Total
Jan	1								1
Feb	4								4
Mar									
April									
May									
June					2				2
July		4				1		1	6
Aug	6	1	2				1		10
Sept	3		1	2					6
Oct									
Nov									
Dec									
Total	14	5	3	2	2	1	1	1	29

Table 2. Redfish landings for Maritimes and Newfoundland in 1980 in Division 4RST.(t)

	4R				4S				4T			
	Maritimes			Nfld.	Maritimes			Nfld.	Maritimes			
Month	OT	MWT	Other	OT	OT	MWT	Other	OT	OT	MWT	Other	Total
Jan.	58			14	6							78
Feb.	119			338	92			111				660
Mar.	30			83	21			61				195
Apr.	5		5	108				12	7			137
May				44	1		7		2			54
June	250	148	12	19	152		8		183	9		781
July	554		15	18	299		24		46			956
Aug.	336		32	9	449		64		116			1006
Sept.	351	42	3	30	381		118		62		136	1123
Oct.	197	45	4	34	516		29		29			854
Nov.	147	63		12	207	54	13		43	11		550
Dec.		59		5							3	67
Total	2047	357	71	714	2124	54	263	184	488	20	139	6461

Table 3. Trends in catch and standardized catch per unit effort and effort for Redfish in Divisions 4RST for years 1954-1980.

Year	Catch	% caught by standard of total catch	t/hr	Std. error	Effort hrs
1954	32,768				
1955	49,857				
1956	46,854				
1957	34,331				
1958	22,570				
1959	16,978	58	0.692	0.042	24,535
1960	12,218	58	0.591	0.043	20,673
1961	10,391	54	0.605	0.048	71,175
1962	6585	69	0.674	0.045	9770
1963	19,794	57	0.689	0.039	28,729
1964	29,700	47	0.893	0.047	33,259
1965	48,827	52	0.979	0.044	49,874
1966	65,215	66	1.128	0.045	57,815
1967	70,036	73	1.227	0.046	57,079
1968	90,963	79	1.109	0.038	82,023
1969	88,875	82	0.915	0.030	97,131
1970	87,588	83	0.730	0.024	119,983
1971	79,406	79	0.659	0.021	120,494
1972	80,329	90	0.607	0.022	132,338
1973	130,164	92	0.555	0.020	234,530
1974	63,458	90	0.399	0.015	159,043
1975	65,401	94	0.413	0.015	158,356
1976	37,983	88	0.401	0.018	94,721
1977	15,840	82	0.455	0.023	34,813
1978	13,591	75	0.529	0.034	25,692
1979	15,034*	72	0.566*	0.038*	26,562*
1980	15,038*	32[1]	1.167*	0.152*	12,886*

*Provisional landings, CPUE and effort.

[1]Catch and effort data from Maritimes and Newfoundland vessels only.

Table 4. Numbers at age landed (10^{-3}) for 4RST redfish from 1972-1980.

4RST REDFISH CATCH

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980
5	142	273	170	355	7359	3801	3368	2266	127
6	1272	639	698	620	1482	2119	2656	2378	290
7	784	3112	292	290	1073	824	511	2233	2781
8	944	2380	444	401	372	669	280	2899	7950
9	1887	803	510	448	188	620	800	2373	8081
10	4297	3434	216	286	44	416	708	2753	5833
11	2938	8043	403	161	146	409	491	1902	2182
12	6366	2497	463	329	125	236	372	1838	1545
13	2588	12850	2240	974	383	171	131	931	869
14	14034	7060	5381	1654	716	177	131	510	542
15	7971	76633	6364	2956	1836	79	153	326	541
16	66593	8222	28739	4572	3913	123	86	346	270
17	5102	88382	7953	25149	4025	509	247	887	312
18	7659	5583	37269	5771	15842	379	1003	1131	306
19	4299	9916	2989	41020	3380	2959	1399	2392	510
20	3697	7166	3387	4156	16519	1273	3621	1943	1632
21	2471	4548	1371	3453	1533	5259	1294	3376	939
22	2598	4333	1233	3489	2131	2519	3468	1542	2493
23	2366	4934	471	2634	1431	2314	4425	3048	1374
24	1168	1306	1168	1632	1317	1814	1027	1013	2262
25	5840	2277	825	1356	543	1160	725	869	838
26	1	7963	1815	1186	430	1027	222	905	515
27	1	1	5844	2080	408	229	222	506	304
28	1	1	1	7259	659	515	315	522	239
29	1	1	1	1	2370	196	103	102	79

Table 5. Average weight at age of males and females combined and the proportion recruited for Division 4RST redfish.

Age	Average weight gms	Proportion recruited
5	90.00	.100
6	103.00	.150
7	135.00	.180
8	169.00	.230
9	205.00	.390
10	243.00	.670
11	281.00	.900
12	322.00	1.000
13	362.00	1.000
14	394.00	1.000
15	443.00	1.000
16	482.00	1.000
17	521.00	1.000
18	559.00	1.000
19	596.00	1.000
20	631.00	1.000
21	665.00	1.000
22	698.00	1.000
23	730.00	1.000
24	759.00	1.000
25	788.00	1.000
26	815.00	1.000
27	841.00	1.000
28	866.00	1.000
29	889.00	1.000

Table 6. Total numbers (10^{-3}) from cohorts for ages 5-9 and 10-29 for various terminal F's in 1980 as compared to the total numbers from stratified-random research cruises from 1979 and 1980, for Division 4RST Redfish.

	Cohort terminal F				Research vessel		
Age	.05	.075	.10	.15	A. T. Cameron	Gadus	B. Venture
				1979			
5-9					532,916	464,563	1,417,022
10-29					345,959	152,860	290,127
Total					878,875	617,423	1,707,149
				1980			
5-9	1,147,665	1,045,938	786,956	389,259	650,243	175,983	922,460
10-29	560,163	377,579	292,942	195,086	498,718	47,552	448,129
Total					1,148,961	223,535	1,370,589

Average of 3 research vessels for 1979-80	
Ages	
5-9	693,864
10-29	297,224
Total	991,088

Table 7. Trends in catch rate and mean biomass of ages 5+ from cohort for different F values for Divs. 4RST Redfish. Regression results are listed below. 1980 was omitted from the regression calculations.

Year	CPUE	F=0.025	F=0.050	F=0.075	F=0.100
1972	0.607	850,687	621,720	545,387	507,222
1973	0.555	754,304	520,508	442,426	403,338
1974	0.399	669,869	430,926	351,233	311,373
1975	0.413	650,119	387,490	299,831	255,955
1976	0.401	707,283	390,889	285,369	232,583
1977	0.455	851,932	449,203	314,954	247,831
1978	0.529	929,986	480,768	331,023	256,149
1979	0.566	967,758	491,892	333,259	253,936
(1980	1.167	1,001,475	500,737	333,825	250,369)
	r^2	0.45	0.80	0.46	0.30
	Predicted biomass for 1980	1,502,580	1,039,744	885,502	808,417

Table 8. Population numbers (10^{-3}) from 1972-1980 for DIV. 4RST redfish from cohort with terminal F 0.075.

POPULATION NUMBERS

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980
5	35792	53060	73225	213392	454329	669241	272461	32485	17860
6	27152	32251	47751	66095	192748	404094	601939	243329	27238
7	24118	23358	28574	42543	59215	172996	363623	542131	217912
8	12598	21077	18175	25577	38219	52560	155749	328534	488416
9	18983	10501	16807	16023	22761	34228	46921	140661	294512
10	29039	15381	8738	14723	14072	20417	30381	41695	125018
11	33670	22188	10651	7701	13050	12691	18078	26816	35109
12	99519	27671	12426	9254	6815	11669	11094	15891	22455
13	69718	83993	22662	10803	8061	6048	10334	9685	12630
14	301074	60622	63777	18375	8848	6929	5309	9226	7877
15	94027	259073	48137	52589	15053	7325	6101	4680	7863
16	400042	77497	161524	37503	44773	11874	6553	5375	3924
17	66083	298627	62301	118815	29585	36790	10627	5848	4535
18	56639	54941	186138	48808	83586	22941	32805	9381	4447
19	38083	43964	44402	132973	38673	60562	20397	28729	7412
20	27795	30369	30348	37333	81299	31778	51984	17125	23720
21	17270	21633	20663	24238	29827	57849	27543	43593	13647
22	14038	13276	15248	17392	18647	25531	47342	23691	36233
23	8714	10231	7891	12624	12418	14845	20705	39538	19970
24	10938	5635	4564	6692	8917	9876	11232	14525	32876
25	41390	8786	3856	3019	4503	6816	7210	9186	12180
26	7	31896	5784	2704	1442	3558	5064	5834	7485
27	5	5	21286	3507	1319	895	2242	4371	4418
28	4	4	4	13701	1195	805	592	1818	3474
29	2	2	2	2	5492	454	239	236	1148
5+	1426699	1206042	914934	936388	1194848	1682771	1766528	1604383	1432359
6+	1390907	1152982	841709	722995	740519	1013530	1494066	1571898	1414500
7+	1363755	1120731	793958	656900	547771	609436	892127	1328569	1387261
8+	1339637	1097373	765384	614357	488556	436441	528504	786438	1169350

Table 9. Population biomass (t) from 1972-1980 for Div. 4RST redfish from cohort with terminal F 0.075.

MEAN POPULATION BIOMASS

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980
5	3059	4532	6264	18261	38585	57150	23186	2681	1524
6	2596	3129	4645	6447	18817	39501	58866	23730	2655
7	3046	2789	3651	5446	7536	22170	46681	69499	27810
8	1947	3188	2886	4080	6116	8397	25025	52595	77887
9	3509	1967	3227	3080	4421	6615	9073	27201	56636
10	6187	3128	1995	3370	3249	4671	6940	9309	28207
11	8591	4731	2792	2037	3469	3337	4766	6904	9084
12	29475	8077	3734	2783	2068	3538	3340	4572	6633
13	23553	26579	7401	3545	2708	2053	3537	3167	4194
14	112658	21818	23375	6714	3249	2622	2010	3436	2912
15	37875	91467	18871	21519	5937	3071	2539	1901	3196
16	159212	31957	63837	15325	18659	5159	2843	2269	1652
17	30050	118508	27530	49885	13009	17310	4976	2548	2072
18	27969	27662	88360	24341	39945	12099	17173	4672	2281
19	20312	21895	24296	62596	20927	33474	11153	15582	4053
20	15513	15905	17150	21101	43483	18684	30077	9667	13731
21	10098	12140	12622	14178	18369	34859	17003	26467	8326
22	8400	7225	9699	10307	11638	16077	30239	15201	23202
23	5156	5125	5311	7784	8102	9457	12726	26356	13374
24	7455	3559	2837	4194	5935	6431	7722	10108	22891
25	28712	5658	2558	1682	3161	4647	5120	6545	8805
26	5	21381	3709	1572	935	2322	3838	4151	5596
27	4	4	14479	1806	875	617	1701	3284	3409
28	3	3	3	7777	663	403	336	1262	2760
29	1	1	1	1	3512	290	153	151	936
5+	545387	442426	351233	299831	285369	314954	331023	333259	333825
6+	542327	437894	344969	281570	246784	257805	307837	330578	332301
7+	539731	434765	340324	275123	227966	218304	248971	306848	329646
8+	536685	431976	336672	269677	220431	196134	202290	237349	301836

Table 10. Fishing mortalities from 1972-1980 for Div. 4RST redfish from cohort with terminal F 0.075.

FISHING MORTALITY

Age	1972	1973	1974	1975	1976	1977	1978	1979	1980
5	0.004	0.005	0.002	0.002	0.017	0.006	0.013	0.076	0.008
6	0.051	0.021	0.015	0.010	0.008	0.006	0.005	0.010	0.011
7	0.035	0.151	0.011	0.007	0.019	0.005	0.001	0.004	0.013
8	0.082	0.126	0.026	0.017	0.010	0.013	0.002	0.009	0.017
9	0.110	0.084	0.032	0.030	0.009	0.019	0.018	0.018	0.029
10	0.169	0.267	0.026	0.021	0.003	0.022	0.025	0.072	0.050
11	0.096	0.480	0.041	0.022	0.012	0.034	0.029	0.077	0.067
12	0.070	0.100	0.040	0.038	0.019	0.021	0.036	0.130	0.075
13	0.040	0.175	0.110	0.100	0.051	0.030	0.013	0.107	0.075
14	0.050	0.131	0.093	0.099	0.089	0.027	0.026	0.060	0.075
15	0.093	0.372	0.150	0.061	0.137	0.011	0.027	0.076	0.075
16	0.192	0.118	0.207	0.137	0.096	0.011	0.014	0.070	0.075
17	0.085	0.373	0.144	0.252	0.154	0.015	0.025	0.174	0.075
18	0.153	0.113	0.236	0.133	0.222	0.018	0.033	0.136	0.075
19	0.126	0.271	0.073	0.392	0.096	0.053	0.075	0.092	0.075
20	0.151	0.285	0.125	0.124	0.240	0.043	0.076	0.127	0.075
21	0.163	0.250	0.072	0.162	0.056	0.100	0.051	0.085	0.075
22	0.216	0.420	0.089	0.237	0.128	0.110	0.080	0.071	0.075
23	0.336	0.707	0.065	0.248	0.129	0.179	0.254	0.085	0.075
24	0.119	0.279	0.313	0.296	0.169	0.215	0.101	0.076	0.075
25	0.161	0.318	0.255	0.639	0.136	0.197	0.112	0.105	0.075
26	0.173	0.304	0.400	0.618	0.376	0.362	0.047	0.178	0.075
27	0.234	0.234	0.341	0.977	0.393	0.313	0.110	0.130	0.075
28	0.344	0.344	0.344	0.814	0.867	1.116	0.819	0.359	0.075
29	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.600	0.075
12+	0.121	0.293	0.176	0.247	0.168	0.075	0.077	0.099	0.075

Table 11. Summary of yield per recruit calculated from partial recruitment and average weight at age over ages 5 to 29. Div. 4RST Redfish.

F	Y/R(KG)
.001	.0026
.050	.0849
.100	.1178
.150	.1304
.200	.1347
.250	.1356
.300	.1351
.350	.1339
.400	.1325
.450	.1310
.500	.1295
.550	.1281
.600	.1267
.650	.1253
.700	.1240
.750	.1228
.800	.1217
.850	.1206
.900	.1195
.950	.1186
1.000	.1176
1.050	.1167
1.100	.1159
1.150	.1151
1.200	.1143
1.250	.1135
1.300	.1128
1.350	.1121
1.400	.1115
1.450	.1109
1.500	.1103
1.550	.1097
1.600	.1091
1.650	.1086
1.700	.1081
1.750	.1076
1.800	.1071
1.850	.1066
1.900	.1062
1.950	.1057
2.000	.1053

F0.1 IS .1210

Table 12. Population numbers (10^{-3}) for Div. 4RST Redfish, 1980-82, assuming the TAC of 20,000t is caught in 1981 and fishing at $F_{0.1}$ = 0.121 in 1982.

POPULATION NUMBERS

Age	1980	1981	1982
5	17860	129000	129000
6	27238	16040	115703
7	217912	24370	14323
8	488416	194531	21705
9	294512	434379	172498
10	125018	258804	379803
11	35109	107577	220788
12	22455	29694	89939
13	12630	18850	24609
14	7877	10602	15622
15	7863	6612	8787
16	3924	6601	5480
17	4535	3294	5470
18	4447	3807	2730
19	7412	3733	3155
20	23720	6222	3094
21	13647	19912	5156
22	36233	11456	16502
23	19970	30416	9494
24	32876	16764	25207
25	12180	27598	13893
26	7485	10225	22871
27	4418	6283	8473
28	3474	3709	5207
29	1148	2916	3074
5+	1432359	1383395	1322583
6+	1414499	1254395	1193583
7+	1387261	1238356	1077880
8+	1169349	1213985	1063556

Table 13. Catch numbers (10^{-3}) and biomass (t) for Div. 4RST Redfish, 1980-1982, assuming the TAC of 20,000 t is caught in 1981 and fishing at $F_{0.1}$ = 0.121 in 1982. Recruitment in 1981-82 was 129 X 10^{-6}.

CATCH NUMBERS

Age	1980	1981	1982
5	127	1074	1477
6	290	200	1981
7	2781	364	294
8	7950	3704	567
9	8081	13928	7569
10	5833	14086	28164
11	2182	7788	21699
12	1545	2378	9764
13	869	1510	2672
14	542	849	1696
15	541	530	954
16	270	529	595
17	312	264	594
18	306	305	296
19	510	299	343
20	1632	498	336
21	939	1595	560
22	2493	918	1791
23	1374	2436	1031
24	2262	1343	2737
25	838	2211	1508
26	515	819	2483
27	304	503	920
28	239	297	565
29	79	234	334
5+	42814	58661	90927
6+	42687	57587	89451
7+	42397	57387	87470
8+	39616	57023	87176

CATCH BIOMASS

Age	1980	1981	1982
5	11	97	133
6	30	21	204
7	375	49	40
8	1344	626	96
9	1657	2855	1552
10	1417	3423	6844
11	613	2188	6097
12	497	766	3144
13	315	547	967
14	218	342	683
15	240	235	423
16	130	255	287
17	163	137	309
18	171	170	166
19	304	178	204
20	1030	314	212
21	624	1061	372
22	1740	640	1250
23	1003	1778	752
24	1717	1019	2077
25	660	1742	1188
26	420	667	2024
27	256	423	774
28	207	257	490
29	70	208	297
5+	15212	20000	30584
6+	15201	19903	30451
7+	15171	19883	30247
8+	14796	19834	30208

Fig. 1. Catch per unit effort (t/hr) for 4RST redfish for the years 1958-80 inclusive.