The Redfish Stock in NAFO Division 3P

by

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ABSTRACT

The TAC of 18,000 MT was not achieved in 1980, with only 7500 MT being landed due to a reduction in fishing effort. Using a multiplicative model, a new effort standard is introduced. An analytical assessment was carried out and a series of regressions run to determine the best terminal F. The results from regressions proved inconclusive, however, a comparison of the catch ratio between 1973 and 1979-80 with the biomass ratio for the same years from cohort suggested a terminal F of 0.075. Fishing at $F_{0.1}$ of 0.15 in 1982 suggested a TAC of 18,000 MT. Again in 1980 there is good evidence of a number of relatively strong year-classes that will be available to the fishery in the near future.

RESUME

Le TPA de 18 000 t n'a pas été réalisé en 1980. Par suite d'une diminution de l'effort de pêche, seulement 7 500 t ont été débarquées. Nous avons introduit, à l'aide d'un modèle multiplicateur, de nouvelles normes d'effort. Afin de déterminer le F de dernière année, nous avons fait une évaluation analytique et effectué une série d'analyses de régression. Les régressions n'ont pas donné de résultats concluants. Cependant, une comparaison du rapport des prises entre 1973 et 1979-80 d'une part, avec le rapport de biomasse des mêmes années obtenu par analyse des cohortes, d'autre part, suggère un F de dernière année de 0,075. Pour un $F_{0.1}$ de 0,15 en 1982, le TPA suggéré est de 18 000 t. De nouveau en 1980, on a de bonnes preuves de l'existence de plusieurs classes d'âge relativement abondantes qui seront accessibles à la pêche dans un avenir prochain.

INTRODUCTION

The TAC for the 3P redfish stock was set at 25,000 MT in 1974 but poor recruitment in the mid-1960's resulted in a decline and a gradual lowering of the TAC to 11,000 MT in 1979. Assessments in 1979 and 1980 (Atkinson et al. 1979, 1980) indicated the recruitment of several relatively strong year-classes (aged 7-12) and as a result the TAC was raised to 16,000 MT during 1979 and 18,000 MT for 1980 and 1981. In 1979 and 1980 these quotas were not achieved primarily due to reduced effort.

METHODS AND RESULTS

TRENDS IN CATCH, EFFORT AND CATCH PER UNIT EFFORT

In the past, catch per hour was calculated using Canadian (Nfld.) tonnage Class 4 (OTB1) as the standard including all catches comprising >50% redfish. For this assessment, catch rates were standardized using a multiplicative model (Gavaris, 1980). The category types used were gear-tonnage class combinations, area, month and year. Only Canadian (Maritime and Nfld.) vessels were considered and Maritime tonnage Class 2 (OTB) was omitted because of the relatively few data points. Only catches consisting of >50% redfish were included and the data were weighted by effort. The historic catches, and the new standardized catch per unit effort and effort can be seen in Table 1 and Fig. 1.

Nominal catches rose from 9200 MT in 1960 to a high of 37,000 MT in 1970 but have since declined (except 1975) to 7500 MT in 1980. It should be noted that there was a 33% drop in effort (standardized) between 1978 and 1979 and a 30% drop between 1979 and 1980, a reflection of the poor market conditions that have existed during this period. In 1980 only 41% of the TAC was landed. Catch rates (standardized) peaked in 1965 at 0.946 MT/hr then declined to 0.403 MT/hr in 1979. In 1980 there was an increase perhaps reflecting some recruitment of the early 1970's year-classes.

NUMBERS AT AGE

Commercial length frequencies and age/length keys were applied to the total reported commercial catch in order to determine the numbers caught at age. Numbers of males and females were determined separately then combined. The catch matrix can be seen in Table 2.

WEIGHT AT AGE

The weights at age used were those determined previously (Atkinson et al. 1980) and are shown in Table 3.

PARTIAL RECRUITMENT

Partial recruitment was determined by comparing the numbers caught at age (sexes combined) in the commercial fishery with the numbers at age (sexes combined) determined to be present from research surveys for the years 1976 to

1980. Individuals 14 years of age and greater were considered to be fully recruited and recruitment at ages below were expressed as a percent. The percent recruited at age were averaged over the 5 years then smoothed. The resulting partial recruitment vector is shown in Table 3.

TERMINAL FISHING MORTALITY

Cohorts were run for a series of terminal F's from 0.05 to 0.15 and regressions were carried out in attempts to determine the best terminal F. Linear regressions of biomass from cohort (ages 6-29, 10-29, 14-29 and 14-25) on CPUE were run from 1973-1979 to check the coefficient of correlation, slope and intercept and to determine which would best predict the 1980 biomass given the 1980 CPUE. These are summarized in Table 4. Similarily, regressions of F from cohort (ages 6-27, 10-27, 14-27 and 14-29) on effort were run and these are summarized in Table 5.

Paloheimo Z's were calculated between 1979 and 1980, and also for 1978 to 1980 for comparision with Z's from cohort as described previously (Atkinson, et al. 1980). Both calculations resulted in very low estimates of Z (1979-80 was 0.12 and 1978-80 was 0.15) and therefore this approach was abandoned. Comparisons of research vessel cruise results and cohort results (biomass and numbers) were not carried out since previously (Atkinson et al. 1980) the regressions were consistently inconclusive.

Finally, catch rate ratios between 1973 and 1979-80 were compared with the ratio of 6+ biomass from cohort for the same years in order to determine the best terminal F.

One regression series of biomass on CPUE (age 10-29) (Table 4) indicates a shift in the prediction error from negative to positive between F's of 0.05 and and 0.075 perhaps suggesting that terminal F may lie in this range. With the series for ages 6-29 the r^2's increase toward an F of 0.15 and the predicted 1980 biomass becomes closer to that from cohort. Also, at some point between F's of 0.10 and 0.15 the intercept goes through the origin. These may lead to the suggestion that terminal F is in the range of 0.15 but because of the number of age groups not fully recruited, this is unlikely as they are probably exerting a masking effect. The other two series (ages 14-29 and 14-25) do not indicate a terminal F in the range examined.

For ages 6-27 the r^2's increase as F goes from 0.05 to 0.15 for regressions of F on effort (Table 5), however, the closeness of prediction suggests terminal F in the area of 0.075 to 0.10. Again this must be viewed with caution due to the inclusion of many incompletely recruited age groups. The age 10-27 series indicates that the intercept passes through the origin at an F between 0.05 and 0.075. Regressions of the fully recruited ages (14-27 and 14-25) do not suggest a terminal F amongst those examined.

It is felt that while the above strongly indicates a low terminal F - certainly below 0.1 and possibly less than 0.075, these data cannot pinpoint terminal F precisely, not surprising when such low values are considered. A comparison of catch rate ratios and 6+ biomass ratios from cohort for the years 1973 and 1979-80 indicated the best relationship at a terminal F of 0.075. Results of the cohort at terminal F of 0.075 can be seen in Tables 6 (a), (b) and (c).

Table 7 and Fig. 2 show the yield per recruit curve (Thompson and Bell, 1934) and projections at terminal F of 0.075 can be seen in Tables 8(a),(b),(c),(d),(e) The projections were done in three ways: 1) the TAC was input for 1981 then $F_{0.1}$ for 1982, 2) in anticipation of a continuing depressed effort, 50% of the TAC was input for 1981 then $F_{0.1}$ for 1982 and 3) $F_{0.1}$ was input for 1981 and 1982. In all cases the geometric mean of age six fish from cohort was used for recruitment. All projections suggest a TAC in the range of 18,000 MT in 1982.

Commercial length frequencies (Fig. 3) indicate a concentration on 24-34 cm groups in 3Ps in March, July and August and in 3Pn in August. In addition, in 3Ps, concentrations of females 32-42 cm in length were fished. In September there was a shift in the catches with larger males and females being landed.

Results of the annual research cruise to 3P by the A. T. Cameron in the spring of 1980 (Fig. 4) indicate the presence of relatively strong year classes (age 7-10) which are becoming available to the fishery.

REFERENCES

Atkinson, D. B., W. D. McKone, and W. E. Legge. 1979. Assessment of 3P redfish. CAFSAC Res. Doc. 79/42.

　　　　1980. 3P redfish assessment. CAFSAC Res. Doc. 80/62.

Gavaris, S. 1980. Assessment of the cod stock in Division 3M. NAFO SCR Doc. 80/II/25.

Table 1. Catch, effort and catch per unit effort (standardized) for 3P redfish 1960-80.

Year	Catch mt	CPUE mt/hr	Effort hr
1960	9225	0.650	14,192
1961	9776	0.652	14,994
1962	13,439	0.553	24,302
1963	13,747	0.713	19,281
1964	13,807	0.695	19,866
1965	18,733	0.946	19,802
1966	20,868	0.908	22,982
1967	32,991	0.844	39,089
1968	13,884	0.801	17,333
1969	32,784	0.833	39,357
1970	37,270	0.731	44,850
1971	27,500	0.613	44,861
1972	26,037	0.534	48,758
1973	18,368	0.643	28,566
1974	22,158	0.503	44,052
1975	28,445	0.504	56,438
1976	19,167	0.457	41,941
1977	17,163	0.444	38,655
1978	15,245	0.430	35,453
1979	9619	0.403	23,868
1980*	7469	0.447	16,709

*Provisional

Table 2. Catch matrix for 3P redfish 1973-80 (sexes combined).

3P   REDFISH (Numbers X 10^{-3})

Age	1973	1974	1975	1976	1977	1978	1979	1980
6	13	105	401	41	257	1339	440	189
7	11	895	694	56	491	4146	1510	964
8	16	1876	1868	263	499	7359	2703	1753
9	8	1647	883	581	790	7382	2859	2347
10	20	1528	486	386	835	5203	1606	1905
11	536	1830	1112	434	777	2358	896	1512
12	1004	1399	623	506	971	2049	1020	1204
13	3076	3602	1016	990	849	857	714	621
14	6099	3058	1123	1119	1022	1085	710	792
15	9314	3173	2206	1072	1438	1162	496	572
16	5866	7661	3613	1796	793	927	449	309
17	7300	2597	8428	1124	1298	791	603	362
18	1842	3930	6040	4154	1005	1067	548	304
19	878	1063	12060	1897	2659	852	531	311
20	1149	1326	3015	6345	1490	1883	655	315
21	589	701	2323	1463	4659	520	1021	423
22	385	1555	2080	2387	2281	1534	676	799
23	404	2821	1758	1957	2398	1040	1263	478
24	484	1410	790	1310	2031	1080	731	786
25	168	2147	1205	2269	1083	1053	1053	476
26	2	1887	995	1613	619	674	691	484
27	2	2	687	868	396	532	454	236
28	2	2	2	575	307	339	345	284
29	2	2	2	2	289	187	207	169

Table 3. Average weight at age and partial recruitment vector used in cohort runs and projections for 3P redfish (sexes combined).

Age	Mean weight (gm)	Proportion recruited
6	105.0	0.017
7	142.0	0.046
8	177.0	0.097
9	213.0	0.184
10	247.0	0.307
11	286.0	0.433
12	331.0	0.545
13	369.0	0.725
14	406.0	1.000
15	445.0	1.000
16	481.0	1.000
17	516.0	1.000
18	553.0	1.000
19	587.0	1.000
20	621.0	1.000
21	657.0	1.000
22	688.0	1.000
23	724.0	1.000
24	770.0	1.000
25	816.0	1.000
26	865.0	1.000
27	913.0	1.000
28	948.0	1.000
29	985.0	1.000

Natural Mortality is 0.10

Table 4. Summary of regressions of biomass (cohort) on CPUE (mt/hr) for 1973-79 with closeness of prediction(%) of 1980 biomass and position of intercept for 3P redfish.

Terminal F	r²	Ages 6-29 %	Slope intercept	r²	Ages 10-29 %	Slope intercept	r²	Ages 14-29 %	Slope intercept	r²	Ages 14-25 %	Slope intercept
.05	.1613	-26.9	-/+	.8403	-0.9	+/-	.7929	+41.2	+/-	.8032	+67.1	+/-
.75	.0432	-20.1	+/+	.8409	+12.2	+/-	.7970	+61.3	+/-	.8117	+91.1	+/-
.10	.5142	-13.4	+/+	.8388	+25.0	+/-	.7991	+81.0	+/-	.8159	+114.5	+/-
.15	.8265	-0.2	+/-	.8354	+50.1	+/-	.8011	+118.9	+/-	.8201	+159.6	+/-

Table 5. Summary of regressions of F (cohort) on effort (hr) for 1973-79 with closeness of prediction (%) for 1980 F and position of intercept for 3P redfish.

Terminal F	r²	Ages 6-27 %	Slope intercept	r²	Ages 10-27 %	Slope intercept	r²	Ages 14-27 %	Slope intercept	r²	Ages 14-25 %	Slope intercept
.05	.4990	+20.0	+/-	.9255	+22.6	+/-	.8182	-2.0	+/+	.7972	-2.0	+/+
.075	.5873	0.0	+/-	.9140	+21.7	+/+	.7454	-2.7	+/+	.7234	-4.0	+/+
.10	.6577	0.0	+/-	.8385	+21.3	+/+	.6311	-3.0	+/+	.6101	-5.0	+/+
.15	.7553	-3.2	+/-	.6107	+17.4	+/+	.3882	-6.7	+/+	.3750	-8.7	+/+

Table 6a. Population numbers from cohort of 3P redfish with terminal F = 0.075.

POPULATION NUMBERS (X 10^{-3})

Age	1973	1974	1975	1976	1977	1978	1979	1980
6	36446	69629	96081	145296	251442	313542	325518	155868
7	33191	32966	62903	86556	131430	227270	282431	294122
8	24280	30022	28977	56257	78266	118456	201698	254118
9	17136	21954	25380	24443	50653	70343	100183	179933
10	19424	15497	18298	22125	21564	45082	56627	87930
11	18996	17556	12569	16095	19652	18718	35842	49711
12	20970	16678	14145	10315	14150	17043	14693	31579
13	26289	18020	13760	12206	8852	11880	13472	12325
14	33020	20862	12879	11484	10103	7202	9934	11511
15	68184	24076	15968	10585	9327	8169	5485	8313
16	38155	52835	18767	12350	8558	7072	6287	4491
17	72119	28944	40520	13544	9466	6989	5517	5261
18	29831	58312	23719	28647	11186	7330	5572	4418
19	30649	25240	49025	15716	21970	9166	5618	4520
20	20711	26897	21827	32887	12416	17350	7483	4578
21	18591	17648	23076	16882	23722	9817	13907	6148
22	15417	16261	15301	18671	13883	17033	8389	11613
23	9573	13583	13235	11867	14623	10393	13953	6947
24	7673	8278	9607	10303	8876	10951	8414	11424
25	5947	6482	6149	7941	8076	6099	8881	6918
26	14	5221	3823	4417	5027	6278	4517	7034
27	14	11	2930	2513	2463	3960	5039	3430
28	8	11	8	1997	1448	1852	3077	4128
29	8	6	8	5	1260	1018	1353	2456
6+	546645	526989	528954	573103	738416	953012	1143892	1168778
7+	510199	457360	432873	427808	486974	639470	818374	1012910
8+	477008	424394	369970	341251	355544	412200	535943	718787
9+	452728	394372	340993	284994	277278	293744	334244	464669

Table 6.b. Population biomass from cohort of 3P redfish with terminal F = 0.075.

MEAN POPULATION BIOMASS (KG)

Age	1973	1974	1975	1976	1977	1978	1979	1980
6	3641	6952	9580	14516	25111	31260	32503	15565
7	4484	4392	8452	11693	17726	30421	38060	39678
8	4088	4892	4716	9453	13139	19304	33738	42650
9	3472	4275	5051	4893	10184	13470	20006	36225
10	4563	3454	4242	5153	4966	9951	13114	20436
11	5094	4516	3262	4319	5239	4755	9628	13316
12	6441	5022	4353	3166	4297	5027	4460	9750
13	8661	5648	4645	4104	2952	4014	4600	4214
14	11495	7432	4748	4210	3695	2560	3695	4287
15	26782	9484	6266	4243	3626	3198	2212	3394
16	16035	22321	7703	5216	3726	3012	2770	1982
17	33525	13542	17668	6361	4310	3227	2553	2491
18	15192	29604	10753	13914	5609	3559	2780	2241
19	16866	13790	23727	8219	11487	4870	2982	2434
20	11885	15487	11953	17423	6872	9666	4219	2608
21	11432	10805	13663	10074	13267	5968	8361	3705
22	9963	10111	9296	11396	8293	10624	5260	7329
23	6451	8312	8476	7456	9194	6783	9156	4614
24	5437	5514	6736	7041	5699	7608	5884	8070
25	4550	4110	4272	5201	5826	4299	6464	5179
26	11	3430	2701	2894	3869	4875	3416	5582
27	11	9	2222	1764	1956	3196	4171	2873
28	6	9	6	1517	1157	1507	2612	3590
29	7	4	6	4	1035	861	1165	2220
6+	210092	193113	174497	164231	173235	194013	223808	244433
7+	206451	186161	164917	149715	148124	162752	191305	228869
8+	201967	181769	156465	138022	130398	132332	153245	189191
9+	197878	176877	151749	128569	117258	113027	119507	146541

Table 6.c. Fishing mortalities of 3P redfish from cohort with terminal
F = 0.075.

FISHING MORTALITY

Age	1973	1974	1975	1976	1977	1978	1979	1980
6	0.000	0.002	0.004	0.000	0.001	0.004	0.001	0.001
7	0.000	0.029	0.012	0.001	0.004	0.019	0.006	0.003
8	0.001	0.068	0.070	0.005	0.007	0.068	0.014	0.007
9	0.000	0.082	0.037	0.025	0.017	0.117	0.030	0.014
10	0.001	0.109	0.028	0.019	0.042	0.129	0.030	0.023
11	0.030	0.116	0.098	0.029	0.042	0.142	0.027	0.032
12	0.052	0.092	0.047	0.053	0.075	0.135	0.076	0.041
13	0.131	0.236	0.081	0.089	0.106	0.079	0.057	0.054
14	0.216	0.167	0.096	0.108	0.112	0.172	0.078	0.075
15	0.155	0.149	0.157	0.113	0.177	0.162	0.100	0.075
16	0.176	0.165	0.226	0.166	0.102	0.148	0.078	0.075
17	0.113	0.099	0.247	0.091	0.156	0.127	0.122	0.075
18	0.067	0.073	0.312	0.165	0.099	0.166	0.109	0.075
19	0.031	0.045	0.299	0.136	0.136	0.103	0.105	0.075
20	0.060	0.053	0.157	0.227	0.135	0.121	0.097	0.075
21	0.034	0.043	0.112	0.096	0.231	0.057	0.080	0.075
22	0.027	0.106	0.154	0.144	0.190	0.099	0.089	0.075
23	0.045	0.246	0.150	0.190	0.189	0.111	0.100	0.075
24	0.069	0.197	0.090	0.143	0.275	0.109	0.096	0.075
25	0.030	0.428	0.231	0.357	0.152	0.200	0.133	0.075
26	0.158	0.478	0.320	0.484	0.139	0.120	0.175	0.075
27	0.166	0.210	0.283	0.451	0.185	0.152	0.100	0.075
28	0.297	0.222	0.300	0.360	0.252	0.214	0.125	0.075
29	0.297	0.478	0.320	0.485	0.275	0.214	0.175	0.075
14+	0.111	0.126	0.213	0.175	0.168	0.127	0.102	0.075

Table 7. SUMMARY OF YIELD PER RECRUIT CALCULATED FROM
          PARTIAL RECRUITMENT AND AVERAGE WEIGHT AT AGE
          OVER AGES   6 TO 29, REDFISH, DIVISION 3P.

F	Y/R(KG)
.001	.0025
.050	.0879
.100	.1277
.150	.1463
.200	.1554
.250	.1600
.300	.1623
.350	.1635
.400	.1639
.450	.1640
.500	.1639
.550	.1637
.600	.1633
.650	.1629
.700	.1624
.750	.1619
.800	.1615
.850	.1610
.900	.1605
.950	.1600
1.000	.1595
1.050	.1590
1.100	.1585
1.150	.1581
1.200	.1576
1.250	.1572

F0.1 IS .1500 AT A Y/R OF .1463
AND FMAX IS .4450 AT A Y/R OF   1641

Table 8a. Population numbers of 3P redfish from projections at terminal F (1980) = 0.075 A) TAC (18,000 MT) in 1981, $F_{0.1}$ in 1982; B) ½ TAC (9000 MT) in 1981, $F_{0.1}$ in 1982 and C) $F_{0.1}$ in 1981 and 1982.

	A POPULATION NUMBERS ($\times 10^{-3}$)				B POPULATION NUMBERS ($\times 10^{-3}$)				C POPULATION NUMBERS ($\times 10^{-3}$)		
Age	1980	1981	1982		1980	1981	1982		1980	1981	1982
6	155868	139291	139291	6	155868	139291	139291	6	155868	139291	139291
7	294122	140855	125660	7	294122	140855	125854	7	294122	140855	125715
8	254118	265216	126426	8	254118	265216	126954	8	254118	265216	126575
9	179933	228269	235926	9	179933	228269	238005	9	179933	228269	236511
10	87930	160579	199982	10	87930	160579	203338	10	87930	160579	200923
11	49711	77751	137676	11	49711	77751	141552	11	49711	77751	138758
12	31579	43543	65204	12	31579	43543	67808	12	31579	43543	65928
13	12325	27429	35805	13	12325	27429	37614	13	12325	27429	36307
14	11511	10562	21854	14	11511	10562	23335	14	11511	10562	22262
15	8313	9663	8018	15	8313	9663	8777	15	8313	9663	8226
16	4491	6978	7336	16	4491	6978	8030	16	4491	6978	7526
17	5261	3770	5298	17	5261	3770	5799	17	5261	3770	5435
18	4418	4416	2862	18	4418	4416	3133	18	4418	4416	2936
19	4520	3709	3353	19	4520	3709	3670	19	4520	3709	3439
20	4578	3794	2816	20	4578	3794	3082	20	4578	3794	2888
21	6148	3843	2881	21	6148	3843	3153	21	6148	3843	2955
22	11613	5161	2918	22	11613	5161	3194	22	11613	5161	2993
23	6947	9749	3918	23	6947	9749	4289	23	6947	9749	4019
24	11424	5832	7401	24	11424	5832	8102	24	11424	5832	7592
25	6918	9590	4427	25	6918	9590	4846	25	6918	9590	4542
26	7034	5807	7280	26	7034	5807	7970	26	7034	5807	7469
27	3430	5905	4409	27	3430	5905	4826	27	3430	5905	4523
28	4128	2879	4483	28	4128	2879	4907	28	4128	2879	4599
29	2456	3465	2186	29	2456	3465	2393	29	2456	3465	2242
6+	1168776	1178058	1157409	6+	1168776	1178058	1179923	6+	1168776	1178058	1163654
7+	1012908	1038767	1018118	7+	1012908	1038767	1040632	7+	1012908	1038767	1024363
8+	718786	897911	892458	8+	718786	897911	914778	8+	718786	897911	898648
9+	464668	632695	766032	9+	464668	632695	787825	9+	464668	632695	772073

Table 8b. Population biomass of 3P redfish from projections at terminal F (1980) = 0.075. A) TAC (18,000 MT) in 1981, $F_{0.1}$ in 1982; B) ½ TAC (9000 MT) in 1981, $F_{0.1}$ in 1982 and C) $F_{0.1}$ in 1981 and 1982.

	A			B			C		
	POPULATION BIOMASS (AVERAGE) (MT)			POPULATION BIOMASS (AVERAGE) (MT)			POPULATION BIOMASS (AVERAGE) (MT)		
Age	1980	1981	1982	1980	1981	1982	1980	1981	1982
6	15564.68	13897.66	13900.62	15564.68	13908.16	13900.62	15564.68	13900.62	13900.62
7	39677.62	18958.57	16923.10	39677.62	18997.35	16949.14	39677.62	18969.50	16930.44
8	42650.34	44300.54	21143.38	42650.34	44491.64	21231.53	42650.34	44354.35	21168.21
9	36225.42	45542.32	47178.32	36225.42	45914.97	47594.06	36225.42	45647.05	47295.25
10	20435.88	36761.90	45957.86	20435.88	37263.78	46729.11	20435.88	36902.57	46174.16
11	13315.87	20389.97	36299.18	13315.87	20782.57	37321.24	13315.87	20499.72	36584.68
12	9749.78	13090.41	19734.74	9749.78	13407.64	20522.96	9749.78	13178.88	19954.01
13	4214.27	9053.79	11924.26	4214.27	9345.63	12526.78	4214.27	9134.87	12091.26
14	4287.38	3748.12	7850.42	4287.38	3914.72	8382.46	4287.38	3794.13	7997.01
15	3393.67	3758.52	3157.11	3393.67	3925.58	3455.98	3393.67	3804.66	3238.72
16	1981.72	2933.89	3122.08	1981.72	3064.30	3417.63	1981.72	2969.91	3202.78
17	2490.41	1700.34	2418.75	2490.41	1775.92	2647.72	2490.41	1721.21	2481.27
18	2241.31	2134.69	1400.41	2241.31	2229.57	1532.97	2241.31	2160.89	1436.60
19	2434.05	1902.85	1741.37	2434.05	1987.43	1906.21	2434.05	1926.21	1786.38
20	2608.07	2059.55	1547.04	2608.07	2151.10	1693.48	2608.07	2084.83	1587.02
21	3705.55	2206.90	1674.51	3705.55	2304.99	1833.03	3705.55	2233.99	1717.80
22	7329.71	3103.60	1776.02	7329.71	3241.55	1944.15	7329.71	3141.70	1821.93
23	4614.12	6169.17	2509.91	4614.12	6443.39	2747.51	4614.12	6244.91	2574.79
24	8069.80	3924.91	5042.22	8069.80	4099.37	5519.54	8069.80	3973.09	5172.55
25	5178.73	6839.94	3196.48	5178.73	7143.97	3499.07	5178.73	6923.91	3279.10
26	5581.75	4390.75	5572.12	5581.75	4585.92	6099.60	5581.75	4444.65	5716.15
27	2872.88	4712.09	3561.53	2872.88	4921.54	3898.67	2872.88	4769.94	3653.58
28	3590.07	2385.86	3760.05	3590.07	2491.91	4116.00	3590.07	2415.15	3857.24
29	2219.30	2983.47	1905.09	2219.30	3116.08	2085.43	2219.30	3020.10	1954.33
6+	244432.38	256949.82	263296.56	244432.38	261509.09	271554.88	244432.38	258216.84	265575.87
7+	228867.70	243052.16	249395.94	228867.70	247600.93	257654.26	228867.70	244316.22	251675.25
8+	189190.08	224093.59	232472.84	189190.08	228603.58	240705.12	189190.08	225346.72	234744.81
9+	146539.74	179793.05	211329.47	146539.74	184111.93	219473.59	146539.74	180992.37	213576.60

Table 8c. Catch numbers of 3P redfish from projections at terminal F (1980) = 0.075. A) TAC (18,000 MT) in 1981, $F_{0.1}$ in 1982; B) ½ TAC (9000 MT) in 1981, $F_{0.1}$ in 1982 and C) $F_{0.1}$ in 1981 and 1982.

	A CATCH NUMBERS ($\times 10^{-3}$)			B CATCH NUMBERS ($\times 10^{-3}$)			C CATCH NUMBERS ($\times 10^{-3}$)		
Age	1980	1981	1982	1980	1981	1982	1980	1981	1982
6	189	395	338	189	192	338	189	338	338
7	964	1078	822	964	524	824	964	922	823
8	1753	4261	1738	1753	2074	1745	1753	3646	1740
9	2347	6905	6113	2347	3374	6167	2347	5915	6128
10	1905	8020	8568	1905	3940	8712	1905	6880	8609
11	1512	5418	8243	1512	2677	8476	1512	4655	8308
12	1204	3783	4874	1204	1878	5069	1204	3255	4928
13	621	3122	3514	621	1562	3692	621	2692	3563
14	792	1620	2900	792	820	3097	792	1402	2955
15	572	1482	1064	572	750	1165	572	1282	1092
16	309	1071	974	309	542	1066	309	926	999
17	362	578	703	362	293	770	362	500	721
18	304	678	380	304	343	416	304	586	390
19	311	569	445	311	288	487	311	492	456
20	315	582	374	315	295	409	315	504	383
21	423	590	382	423	298	419	423	510	392
22	799	792	387	799	401	424	799	685	397
23	478	1496	520	478	757	569	478	1294	533
24	786	895	982	786	453	1075	786	774	1008
25	476	1471	588	476	745	643	476	1273	603
26	484	891	966	484	451	1058	484	771	991
27	236	906	585	236	459	641	236	784	600
28	284	442	595	284	224	651	284	382	610
29	169	532	290	169	269	318	169	460	298
6+	17595	47576	46347	17595	23608	48228	17595	40928	46866
7+	17406	47181	46009	17406	23417	47891	17406	40590	46528
8+	16442	46103	45187	16442	22893	47067	16442	39668	45706
9+	14689	41842	43449	14689	20819	45322	14689	36022	43966

Table 8d. Catch biomass of 3P redfish from projections at terminal F (1980) = 0.075. A) TAC (18,000 MT) in 1981, $F_{0.1}$ in 1982; B) ½ TAC (9000 MT) in 1981, $F_{0.1}$ in 1982 and C) $F_{0.1}$ in 1981 and 1982.

	A CATCH BIOMASS (MT)				B CATCH BIOMASS (MT)				C CATCH BIOMASS (MT)		
Age	1980	1981	1982		1980	1981	1982		1980	1981	1982
6	20	41	35	6	20	20	35	6	20	35	35
7	137	153	117	7	137	74	117	7	137	131	117
8	310	754	308	8	310	367	309	8	310	645	308
9	500	1471	1302	9	500	719	1314	9	500	1260	1305
10	471	1981	2116	10	471	973	2152	10	471	1699	2126
11	432	1550	2358	11	432	766	2424	11	432	1331	2376
12	399	1252	1613	12	399	622	1678	12	399	1077	1631
13	229	1152	1297	13	229	576	1362	13	229	993	1315
14	322	658	1178	14	322	333	1257	14	322	569	1200
15	255	660	474	15	255	334	518	15	255	571	486
16	149	515	468	16	149	261	513	16	149	445	480
17	187	298	363	17	187	151	397	17	187	258	372
18	168	375	210	18	168	190	230	18	168	324	215
19	183	334	261	19	183	169	286	19	183	289	268
20	196	361	232	20	196	183	254	20	196	313	238
21	278	387	251	21	278	196	275	21	278	335	258
22	550	545	266	22	550	276	292	22	550	471	273
23	346	1083	376	23	346	548	412	23	346	937	386
24	605	689	756	24	605	349	828	24	605	596	776
25	388	1201	479	25	388	608	525	25	388	1039	492
26	419	771	836	26	419	390	915	26	419	667	857
27	215	827	534	27	215	419	585	27	215	715	548
28	269	419	564	28	269	212	617	28	269	362	579
29	166	524	286	29	166	265	313	29	166	453	293
6+	7193	18000	16681	6+	7193	9000	17608	6+	7193	15518	16936
7+	7173	17959	16646	7+	7173	8980	17572	7+	7173	15482	16900
8+	7036	17805	16529	8+	7036	8906	17455	8+	7036	15351	16784
9+	6726	17051	16221	9+	6726	8538	17146	9+	6726	14706	16476

Table 8e. Fishing mortalities of 3P redfish from projections at terminal F (1980) = 0.075. A) TAC (18,000 MT) in 1981, $F_{0.1}$ in 1982; B) ½ TAC (9000 MT) in 1981, $F_{0.1}$ in 1982 and C) $F_{0.1}$ in 1981 and 1982.

|	A FISHING MORTALITY			B FISHING MORTALITY			C FISHING MORTALITY		
Age	1980	1981	1982	1980	1981	1982	1980	1981	1982
6	0.001	0.003	0.003	0.001	0.001	0.003	0.001	0.003	0.003
7	0.003	0.008	0.007	0.003	0.004	0.007	0.003	0.007	0.007
8	0.007	0.017	0.015	0.007	0.008	0.015	0.007	0.015	0.015
9	0.014	0.032	0.028	0.014	0.016	0.028	0.014	0.028	0.028
10	0.023	0.054	0.046	0.023	0.026	0.046	0.023	0.046	0.046
11	0.032	0.076	0.065	0.032	0.037	0.065	0.032	0.065	0.065
12	0.041	0.096	0.082	0.041	0.046	0.082	0.041	0.082	0.082
13	0.054	0.127	0.109	0.054	0.062	0.109	0.054	0.109	0.109
14	0.075	0.176	0.150	0.075	0.085	0.150	0.075	0.150	0.150
15	0.075	0.176	0.150	0.075	0.085	0.150	0.075	0.150	0.150
16	0.075	0.176	0.150	0.075	0.085	0.150	0.075	0.150	0.150
17	0.075	0.176	0.150	0.075	0.085	0.150	0.075	0.150	0.150
18	0.075	0.176	0.150	0.075	0.085	0.150	0.075	0.150	0.150
19	0.075	0.176	0.150	0.075	0.085	0.150	0.075	0.150	0.150
20	0.075	0.176	0.150	0.075	0.085	0.150	0.075	0.150	0.150
21	0.075	0.176	0.150	0.075	0.085	0.150	0.075	0.150	0.150
22	0.075	0.176	0.150	0.075	0.085	0.150	0.075	0.150	0.150
23	0.075	0.176	0.150	0.075	0.085	0.150	0.075	0.150	0.150
24	0.075	0.176	0.150	0.075	0.085	0.150	0.075	0.150	0.150
25	0.075	0.176	0.150	0.075	0.085	0.150	0.075	0.150	0.150
26	0.075	0.176	0.150	0.075	0.085	0.150	0.075	0.150	0.150
27	0.075	0.176	0.150	0.075	0.085	0.150	0.075	0.150	0.150
28	0.075	0.176	0.150	0.075	0.085	0.150	0.075	0.150	0.150
29	0.075	0.176	0.150	0.075	0.085	0.150	0.075	0.150	0.150
6+	0.016	0.044	0.044	0.016	0.022	0.045	0.016	0.038	0.044
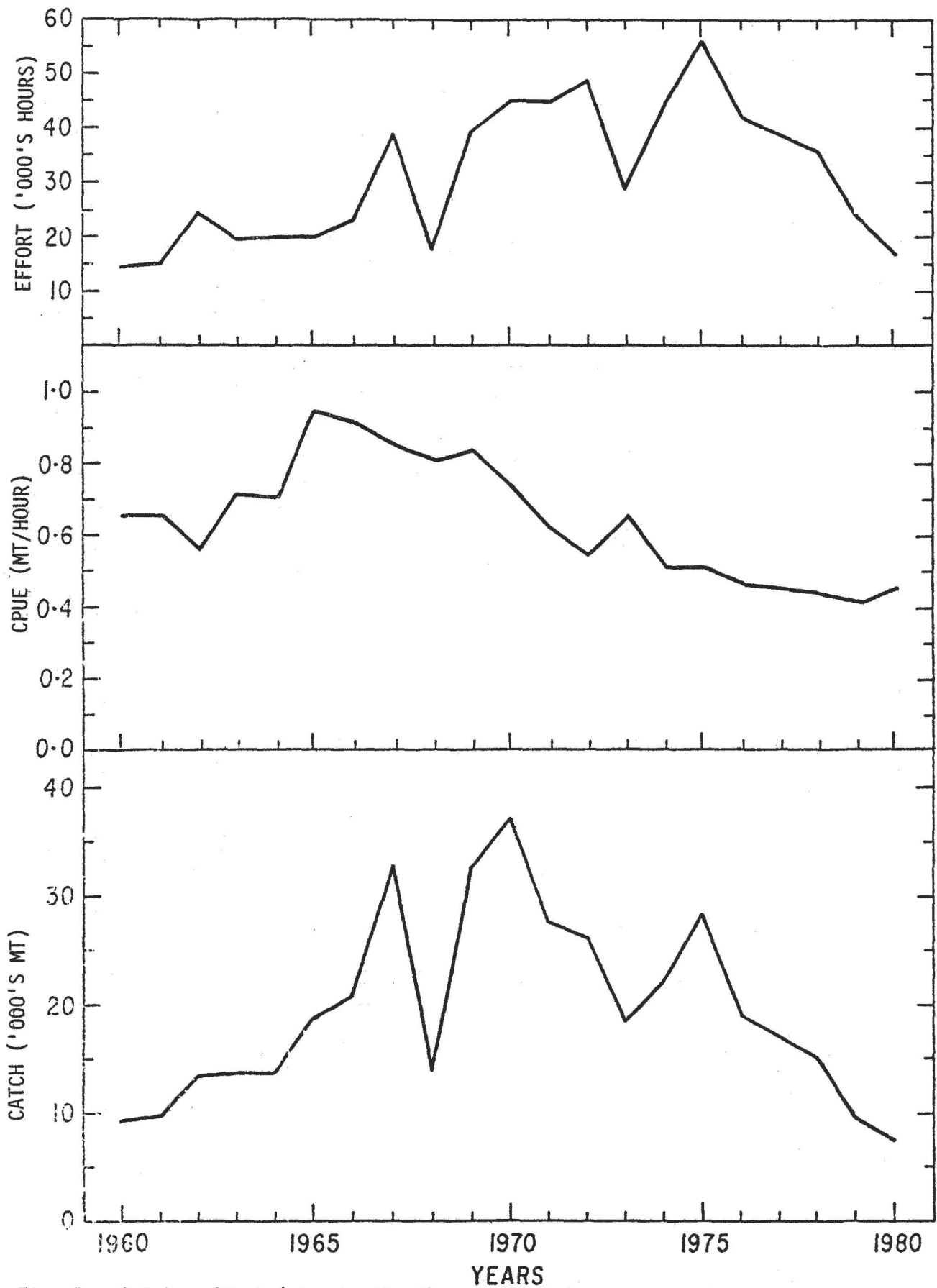
Fig. 1. Catch, effort (standardized), and CPUE (standardized) for 3P redfish.
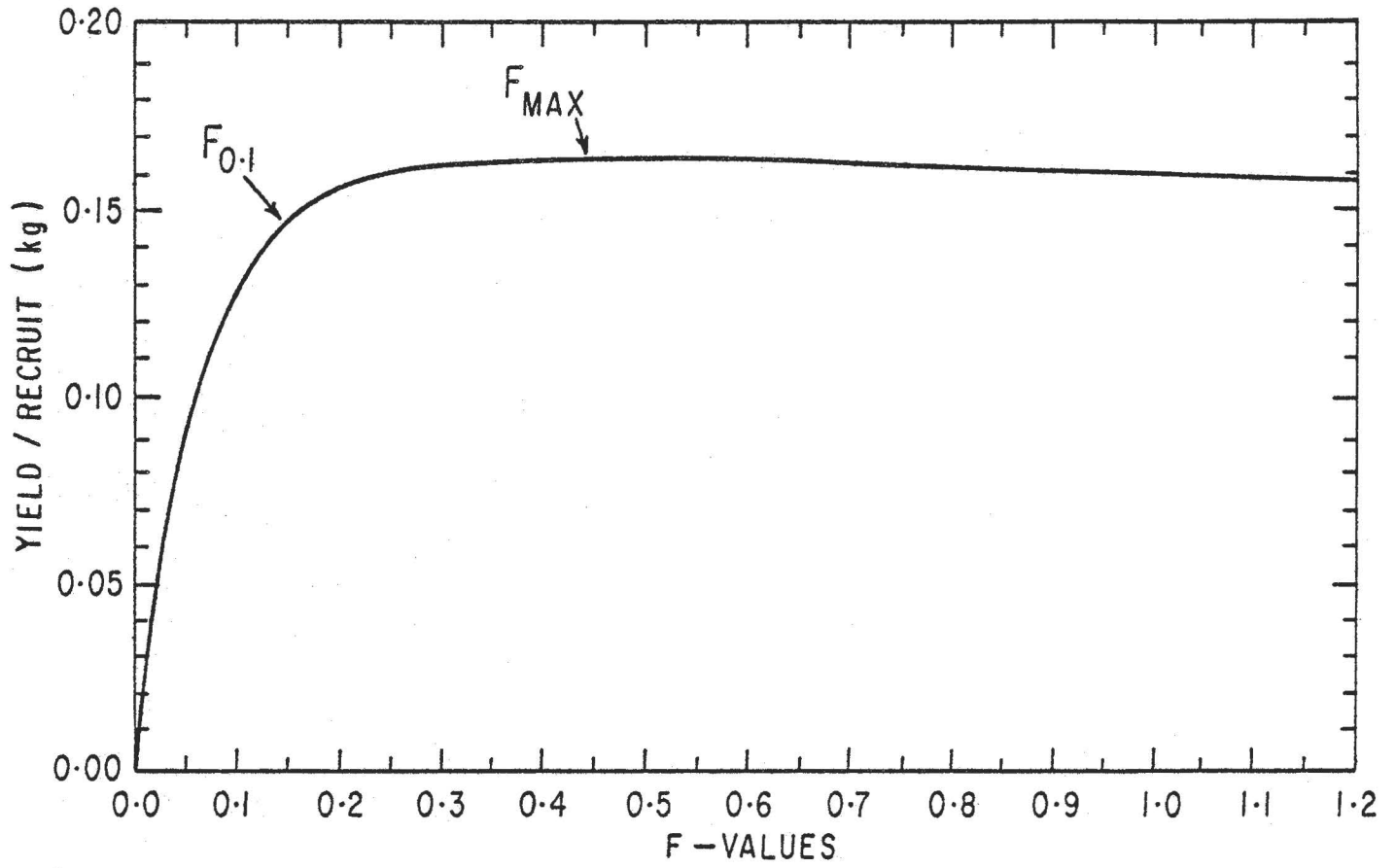
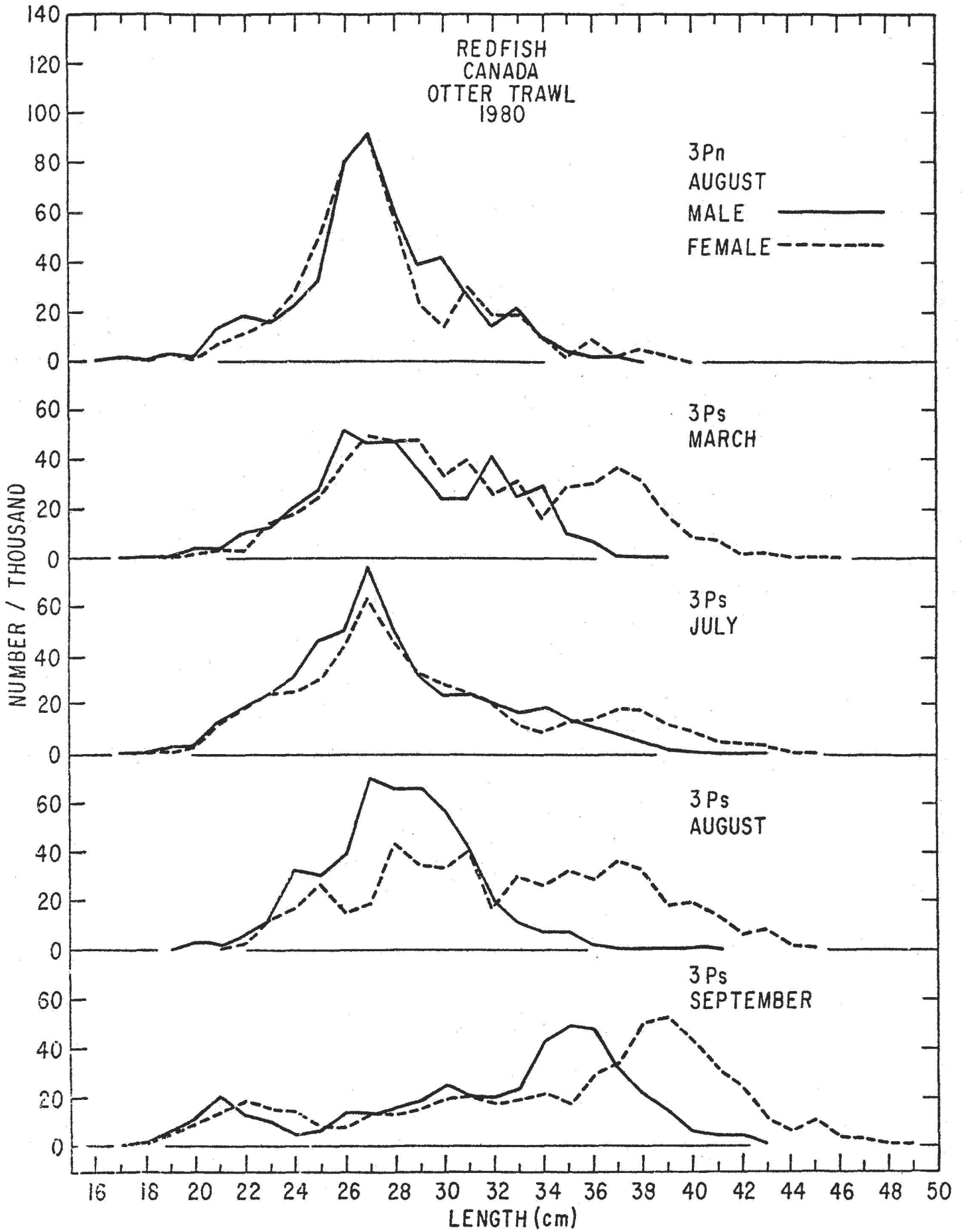Fig. 2. Yield per recruit curve showing $F_{0.1}$ and F_{MAX}, redfish, Div. 3P.

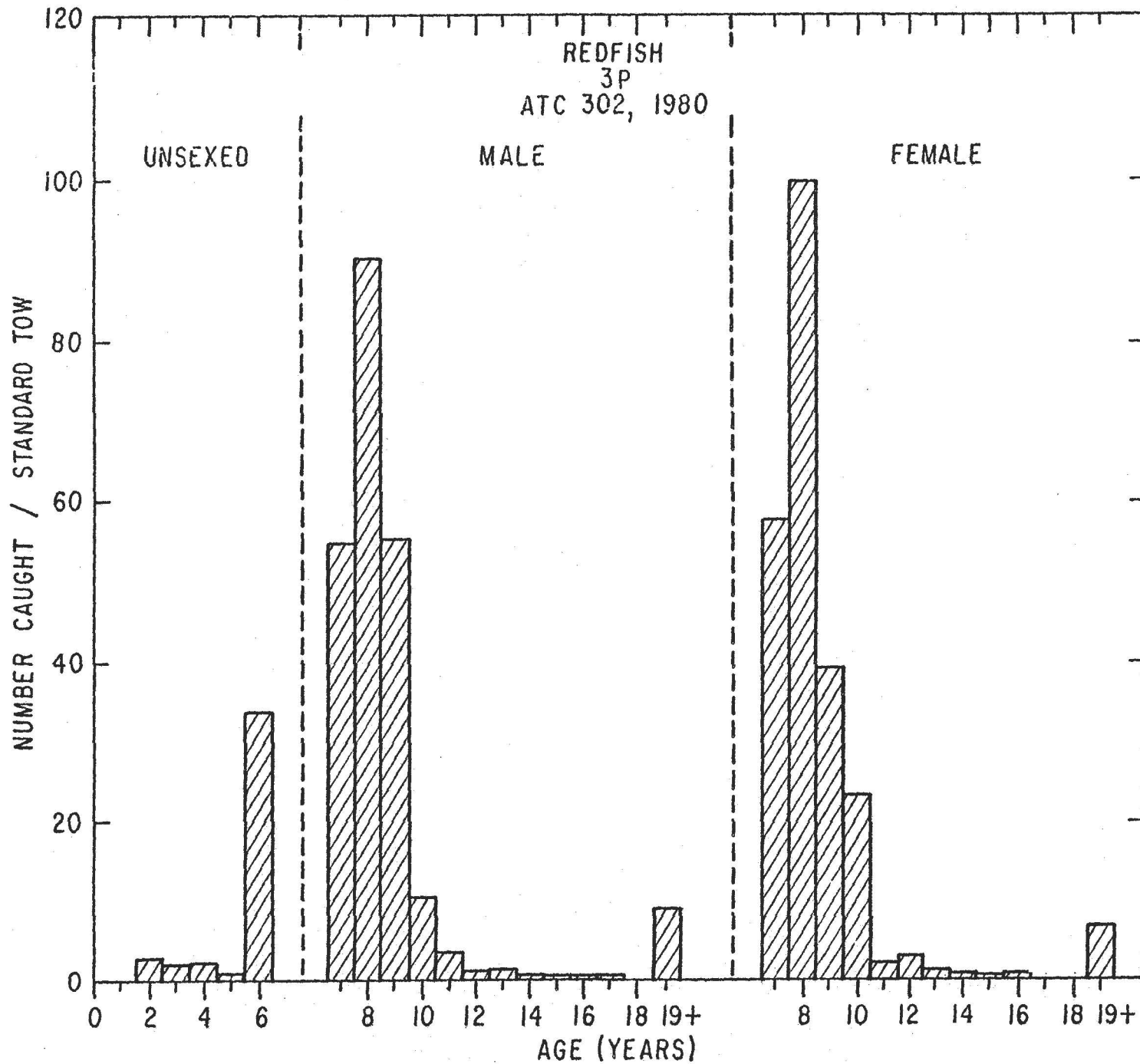Fig. 3. Commercial length frequencies for 3P redfish, 1980.

Fig. 4. Number of redfish caught at age per standard tow during 1980 research cruise to 3P.