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Assessment of 3P Redfish

by

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INTRODUCTION

In recent years the 3P redfish stock has shown a decline as a result of poor recruitment of the mid-1960's year-classes which have not entered the fishery in expected strength. The Total Allowable Catch was first set at 25,000 MT in 1974 but has since been reduced to 11,000 MT in 1979. In response to the request of CAFSAC to review information on 3P redfish, this document provides additional observations on the status of this stock.

METHODS

TRENDS IN CATCH AND CATCH PER UNIT EFFORT

Catch per hour was determined from Canadian tonnage class 4 by using all data in which redfish comprised more than 50% of the catch.

Nominal catches have declined from a high of 37,000 MT in 1970 to less than 20,000 MT in 1977 and 1978 (Fig.1). Similarly, catch rates have steadily declined for this stock from a high of 0.91 MT per hour in 1965. In recent years, the catch rate remained stable at 0.5 MT per hour in 1974-76 but decreased to 0.42 in 1977 and to 0.38 in 1978.

Trends in effort fluctuate but increased to a high of 56,000 hours fished in 1975 and subsequently have declined to about 40,000 hours from 1976-78.

NUMBERS AT AGE

Commercial sampling frequencies and otolith collections of male and female mentella redfish were applied to the reported commercial catches to determine numbers caught at age. The calculated numbers of males and females were combined and a cohort was run using the 1973-78 data.

AVERAGE WEIGHT AT AGE

The average weight at age was calculated from the average length at age for each sex using the following:

$$\text{Male}_{wt} = 0.01659 \; l_t^{2.9548}$$

$$\text{Female}_{wt} = 0.01372 \; l_t^{3.0210}$$

The resultant male and female vectors of weight at age were averaged to give a combined weight at age (Table 1).

PARTIAL RECRUITMENT

Partial recruitment was recalculated to take into account the apparent recruitment of several strong year-classes in 1978 (7, 8, 9 and 10 year-olds) which in previous years were not evident in the commercial fishery.

The numbers per tow for male and female redfish from ages 6-18 from a research cruise in the spring of 1978 were expressed as a percent of the total numbers caught at age. Similarly, numbers at age (6-18) for male and female redfish from commercial sampling were expressed as a percent of the total numbers caught. Ratios of the % commercial to % research were calculated for both sexes and averaged over 3 ages. The partial recruitment vector was calculated by averaging these ratios of males and females at age and determining the % recruited assuming all ages older than 13 years are fully recruited (Table 1).

TERMINAL FISHING MORTALITY

Fishing mortality in 1978 was estimated by regression of weighted fishing mortality for 13 +ages from a series of cohort runs with directed fishing effort and by regression of 13+biomass from a series of cohort runs with commercial catch per unit effort (Fig. 3 & 4). In both cases natural mortality was assumed to be 0.10 and a range of F_T= 0.05 to 0.35 was used. The best fit from regression in the former case was F_T= 0.10 with r^2= 0.82 while in the latter case the best fit was F_T = 0.15 r^2= 0.79. Because the regression of fishing mortality on effort is based on a few points and the possibility that there may be errors due to effort being estimated from CPUE the regression of biomass on CPUE was thought to be a better estimate of terminal fishing mortality. Thus a cohort run with F_T= 0.15 in 1978 was used to project the estimated catch in 1980 (Tables 3-6).

Fishing mortality ($F_{0.1}$ = 0.145) for catch projections was estimated by averaging the values from yield per recruit for male and female (Table 2).

RECRUITMENT VALUES

Recruitment of males and females combined was estimated to be 135 million at age 6 for years beyond 1978 by calculating the geometric mean of 6 year-olds from cohort for the years 1973 to 1978 inclusive.

CATCH PROJECTIONS

Catch projections were done for 1980 using the population size at

the beginning of 1978 from the cohort run. With the apparent influx of a number of year-classes one projection was carried out assuming a terminal $F_{0.1}$ = .145 for all years including 1979 (Table 7-10). In the second projection it was assumed that the TAC of 11,000 MT was caught in 1979 and for successive years $F_{0.1}$ = 0.145 was used (Table 11-14).

ABUNDANCE INDICES

Commercial length frequencies indicate that the fishery in most months is concentrated on 20-26 cm length groups for both sexes but in some months namely February, March and August redfish from 32-40 cm for both sexes predominate in the catch (Fig. 5). These results do not appear to be the result of the depth but possibly the area fished.

The number caught per standard tow from the 1978 research survey indicate that the stock is mainly comprised of young fish which are barely large enough for the commercial fishery (i.e. 10 years-old) (Fig. 6). Ages 7 to 10 from research are in the 18-25 cm size range and are evident in large numbers in the commercial fishery.

Length frequencies from research cruises for certain strata fished consistently from 1974-1978 indicate that several relatively good length groups will be available to the fishery in the Hermitage Channel Area and north of Burgeo Bank (Fig. 7a, 7b, 7c). These length groups have been evident for a number of years in the northern part of 3P. In the southern area, length frequencies indicate the availability of length groups of young fish ranging from 18-26 cm for both sexes (Fig. 7d, 7e). There isn't, however, any indication that these fish have been available to research sampling in earlier years as the length groups apparently are the same from year to year. One explanation would be that the smaller length groups are from Div. 3Ø and do not migrate into 3P until they are larger.

DISCUSSION

The development of the Div. 3P fishery during 1965-70 was supported by the influx of several strong year-classes (1953-1958) producing a recruitment level substantially greater than that which prevailed during the late 50's and early 60's. The commercial catch rate peaked in 1965 at 0.91 MT per hour but thereafter has declined steadily to a low of 0.38 MT per hour in 1978. The observed decrease in CPUE and analysis of research frequencies suggest that the 1953-1958 year-classes are now substantially reduced and the abundance of subsequent year-classes entering the fishery has been lower than expected. Hence, the yield from this stock has been decreasing in recent years. Cohort analysis suggests a TAC in 1979 of 16,000 MT and 17,500 MT in 1980 fishing at $F_{0.1}$. Using the previously established 1979 TAC of 11,000 MT, a TAC of 18,000 MT at $F_{0.1}$ is suggested for 1980. The general production model (Fig. 2) agrees favorably with this,

suggesting an MSY of 19,630 MT and a yield at 2/3 F_{msy} of 17,450 MT.

Current research and commercial frequencies indicate that several relatively strong year-classes (ages 7-12) will be entering the fishery over the next few years. Thus the fishery might be expected to show some recovery during this period. Some caution must be taken however, as the strengths of these incoming year-classes are not fully known as yet and the catch rate continued to decline in 1978. Further, it is possible that fish taken on the southern part of St. Pierre Bank may migrate between 3P and 3Ø in an, as of yet, undertermined pattern.

Table 1. Partial recruitment and average weight at age for males and females combined of 3P redfish.

AGE	PARTIAL RECRUITMENT	AVE. WEIGHT
6	0.06	0.103
7	0.12	0.135
8	0.25	0.169
9	0.47	0.205
10	0.62	0.243
11	0.84	0.281
12	0.73	0.322
13	1.00	0.362
14	1.00	0.403
15	1.00	0.443
16	1.00	0.459
17	1.00	0.498
18	1.00	0.559
19	1.00	0.596
20	1.00	0.631
21	1.00	0.665
22	1.00	0.698
23	1.00	0.730
24	1.00	0.759
25	1.00	0.788
26	1.00	0.815
27	1.00	0.841
28	1.00	0.866
29	1.00	0.889

Table 2. Yield per recruit for male and female redfish from 3P calculated by the method of Thompson and Bell (1934).

MALE

YIELD PER RECRUIT

	FISHING MORTALITY	CATCH (NUMBER)	YIELD (KG)	AVG. WEIGHT (KG)	YIELD PER UNIT EFFORT
	.030	.14134	.056	.396	1.000
	.060	.24001	.090	.374	.802
	.090	.31144	.110	.354	.658
	.120	.36501	.123	.337	.550
F0.1---	.147	.40311	.130	.323	.475
	.150	.40658	.131	.322	.469
	.180	.43983	.136	.309	.405
	.210	.46715	.139	.298	.355
	.240	.49012	.141	.288	.315
	.270	.50980	.142	.279	.282
	.300	.52694	.143	.271	.255
	.330	.54206	.143	.264	.232
FMAX---	.358	.55471	.143	.258	.214
	.360	.55555	.143	.257	.213
	.390	.56771	.143	.252	.197
	.420	.57875	.143	.247	.182
	.450	.58885	.142	.242	.170
	.480	.59814	.142	.237	.159
	.510	.60672	.142	.233	.149
	.540	.61470	.141	.230	.140
	.570	.62213	.141	.226	.133
	.600	.62909	.140	.223	.126

FEMALE

YIELD PER RECRUIT

	FISHING MORTALITY	CATCH (NUMBER)	YIELD (KG)	AVG. WEIGHT (KG)	YIELD PER UNIT EFFORT
	.030	.13381	.069	.518	1.000
	.060	.22755	.111	.487	.800
	.090	.29553	.136	.460	.654
	.120	.34655	.151	.436	.545
F0.1---	.142	.37642	.158	.420	.481
	.150	.38615	.160	.415	.463
	.180	.41781	.166	.397	.399
	.210	.44382	.169	.381	.348
	.240	.46568	.171	.367	.308
	.270	.48443	.172	.355	.275
	.300	.50076	.172	.344	.248
FMAX---	.315	.50844	.172	.339	.234
	.330	.51520	.172	.334	.226
	.360	.52810	.172	.325	.207
	.390	.53975	.171	.317	.190
	.420	.55035	.171	.310	.176
	.450	.56007	.170	.304	.164
	.480	.56904	.170	.298	.153
	.510	.57735	.169	.292	.143
	.540	.58510	.168	.287	.135
	.570	.59234	.167	.283	.127
	.600	.59915	.167	.278	.120

Table 3. Known catches of males and females for 3P Redfish

Age	1973	74	75	76	77	1978
6	13	105	401	41	257	339
7	11	895	694	56	491	4146
8	16	1876	1848	263	499	7359
9	8	1647	883	581	790	7382
10	20	1528	486	386	835	5203
11	536	1830	1112	434	777	2358
12	1004	1399	623	506	971	2049
13	3076	3602	1016	990	849	857
14	6099	3058	1123	1119	1022	1085
15	9314	3173	2206	1072	1438	1162
16	5866	7661	3613	1796	793	927
17	7300	2597	8428	1124	1298	791
18	1842	3930	6040	4154	1005	1067
19	878	1063	12060	1897	2659	852
20	1149	1326	3015	6345	1490	1883
21	589	701	2323	1463	4659	520
22	385	1555	2080	2387	2281	1534
23	404	2821	1758	1957	2398	1040
24	484	1410	790	1310	2031	1080
25	168	2147	1205	2269	1083	1053
26	2	1887	995	1613	619	674
27	2	2	687	868	396	532
28	2	2	2	575	307	389
29	2	2	2	2	289	187

Table 4. Population numbers 3P redfish males and females combined, terminal F=0.15, new partial recruitment from cohort.

POPULATION NUMBERS 2/ 6/7

	1973	1974	1975	1976	1977	1978
6	40059	94150	154862	257158	270142	157033
7	39287	36234	85091	139743	232647	244190
8	15339	35538	31935	76333	126392	210041
9	18740	13864	30372	27119	68819	113889
10	20390	16949	10978	26641	23985	61519
11	18852	18431	13882	9471	23739	20909
12	19274	16548	14936	11503	8157	20741
13	27458	16484	13643	12922	9927	6457
14	28493	21919	11489	11378	10751	8175
15	62971	19980	16925	9328	9231	8755
16	28428	48119	15060	13216	7420	6985
17	63093	20143	36252	10190	10250	5960
18	25616	50145	15756	24785	8151	8040
19	26011	21426	41634	8511	18475	6420
20	23736	22700	18376	26201	5896	14168
21	16613	20385	19279	13759	17672	3918
22	15496	14472	17778	15235	11058	11558
23	10731	13655	11616	14108	11514	7236
24	8317	9326	9672	8838	10904	8137
25	7316	7065	7097	8000	6751	7934
26	87	6460	4351	5276	5081	5078
27	23	23	4050	2990	3239	4008
28	19	19	19	3011	1880	2554
29	15	15	15	15	2178	1409
	516304	524050	585067	735731	904259	945734

Table 5. Population biomass for 3P redfish, new partial recruitment, terminal F=0.15, males and females combined from cohort.

POPULATION BIOMASS 2/ 6/79

	73	74	75	76	77	78
6	2964	6967	11460	19030	19991	11620
7	4047	3732	8764	14394	23963	25152
8	2071	4798	4311	10305	17063	28355
9	3167	2343	5133	4583	11630	19247
10	4180	3474	2251	5461	4917	12611
11	4581	4479	3373	2302	5769	5081
12	5416	4650	4197	3232	2292	5828
13	8842	5308	4393	4161	3197	2079
14	10314	7935	4159	4119	3892	2959
15	25377	8052	6821	3759	3720	3528
16	12594	21317	6672	5855	3287	3094
17	28960	9246	16640	4677	4705	2736
18	12757	24972	7846	12343	4059	4004
19	14540	11977	23274	4758	10328	3589
20	14147	13529	10952	15616	3514	8456
21	10483	12863	12165	8682	11151	2472
22	10305	9624	11822	10131	7354	7686
23	7491	9531	8108	9847	8037	5470
24	6072	6808	7061	6452	7960	5940
25	5553	5363	5387	6072	5124	6022
26	22	5090	3428	4157	4004	4002
27	19	19	3391	3437	2640	3267
28	16	16	16	2532	1581	2148
29	13	13	13	13	1886	1220
	193927	182105	171546	164917	172061	176567

Table 6. Fishing mortality; new partial recruitment for 3 P redfish from cohort.

FISHING MORTALITY 2/ 6/79

	1973	1974	1975	1976	1977	1978
6	0.000	0.001	0.003	0.000	0.001	0.009
7	0.000	0.026	0.009	0.000	0.002	0.018
8	0.001	0.057	0.063	0.004	0.004	0.037
9	0.000	0.133	0.031	0.023	0.012	0.070
10	0.001	0.100	0.048	0.015	0.037	0.093
11	0.030	0.110	0.088	0.049	0.035	0.126
12	0.056	0.093	0.045	0.047	0.134	0.109
13	0.125	0.261	0.082	0.084	0.094	0.150
14	0.255	0.159	0.108	0.109	0.105	0.150
15	0.169	0.183	0.147	0.129	0.179	0.150
16	0.245	0.183	0.291	0.154	0.119	0.150
17	0.130	0.146	0.280	0.123	0.143	0.150
18	0.079	0.086	0.516	0.194	0.139	0.150
19	0.036	0.054	0.363	0.267	0.164	0.150
20	0.052	0.063	0.189	0.294	0.309	0.150
21	0.038	0.037	0.135	0.119	0.325	0.150
22	0.026	0.120	0.131	0.180	0.244	0.150
23	0.040	0.245	0.173	0.158	0.247	0.150
24	0.063	0.173	0.090	0.169	0.218	0.150
25	0.024	0.385	0.197	0.354	0.185	0.150
26	0.080	0.367	0.275	0.388	0.137	0.150
27	0.097	0.097	0.196	0.364	0.138	0.150
28	0.119	0.119	0.119	0.224	0.188	0.150
29	0.150	0.150	0.150	0.150	0.150	0.150

Table 7. Population numbers (10^{-3}) from catch projection for 3P redfish. Fishing at $F_{0.1}$ in 1979.

	1978	1979	1980
6	157033	135000	135000
7	244190	140816	121095
8	210041	217011	125218
9	113889	183058	189369
10	61519	96036	154726
11	20909	50721	79426
12	20741	16680	40632
13	6457	16821	13576
14	8175	5029	13166
15	8755	6367	3936
16	6985	6818	4983
17	5960	5440	5337
18	8040	4642	4258
19	6420	6262	3633
20	14188	5000	4901
21	3918	11050	3913
22	11558	3051	8649
23	7836	9001	2388
24	8137	6103	7045
25	7934	6337	4777
26	5078	6179	4960
27	4008	3955	4836
28	2554	3121	3095
29	1409	1989	2443
	945734	946486	941362

Table 8. Biomass (mt) from catch projections for 3P redfish. Fishing at $F_{0.1}$ in 1979.

	1978	1979	1980
6	16174.40	13905.00	13905.00
7	32965.65	19010.20	16347.82
8	35496.93	36674.81	21161.84
9	23347.24	37526.88	38820.61
10	14949.12	23336.77	37598.31
11	5875.43	14252.70	22318.67
12	6678.60	5370.81	13083.38
13	2337.43	6089.11	4914.65
14	3294.52	2026.56	5305.77
15	3878.46	2820.44	1743.64
16	3206.11	3129.63	2287.30
17	2968.08	2709.10	2657.71
18	4494.36	2594.69	2380.16
19	3826.32	3731.93	2165.30
20	8952.63	3154.97	3092.53
21	2605.47	7348.02	2602.47
22	8067.48	2129.83	6036.73
23	5720.28	6570.99	1743.46
24	6175.98	4631.93	5347.46
25	6251.99	4993.59	3763.95
26	4138.57	5035.89	4042.43
27	3370.73	3325.91	4067.36
28	2211.76	2703.11	2680.59
29	1252.60	1768.24	2171.93
	209240.17	214841.10	220239.04

Table 9. Catch numbers (10^{-3}) from catch projection for 3P redfish. Fishing at $F_{0.1}$ in 1979.

	1978	1979	1980
6	1339	1113	1113
7	4146	2312	1988
8	7359	7354	4244
9	7382	11483	11879
10	5203	7863	12669
11	2358	5541	8676
12	2049	1596	3887
13	957	2163	1746
14	1085	647	1693
15	1162	819	506
16	927	877	641
17	791	700	686
18	1067	597	548
19	852	805	467
20	1883	643	630
21	520	1421	503
22	1534	392	1112
23	1040	1158	307
24	1080	785	906
25	1053	815	614
26	674	795	638
27	532	509	622
28	339	401	398
29	197	256	314
	45419	51043	56788

Table 10. Catch Biomass (mt) from catch projections 3P Redfish, fishing at $F_{0.1}$ in 1979.

	1978	1979	1980
6	138	115	115
7	560	312	268
8	1244	1243	717
9	1513	2354	2435
10	1264	1911	3079
11	663	1557	2438
12	660	514	1252
13	310	783	632
14	437	261	682
15	515	363	224
16	425	402	294
17	394	348	342
18	596	334	306
19	508	480	278
20	1188	406	398
21	346	945	335
22	1071	274	776
23	759	845	224
24	820	596	688
25	830	642	484
26	549	648	520
27	447	428	523
28	294	348	345
29	166	227	279
	15697	16334	17634

Table 11. Population numbers (10^{-3}) from catch projection for 3P Redfish. Assumed TAC = 11,000 MT caught in 1979.

	1978	1979	1980
6	157033	135000	135000
7	244190	140816	121452
8	210041	217011	125958
9	113889	183058	191709
10	61519	96036	158340
11	20909	50721	81882
12	20741	16680	42344
13	6457	16821	14072
14	8175	5029	13829
15	8755	6367	4134
16	6985	6818	5234
17	5960	5440	5606
18	8040	4642	4472
19	6420	6262	3816
20	14188	5000	5148
21	3918	11050	4111
22	11558	3051	9084
23	7836	9001	2509
24	8137	6103	7400
25	7934	6337	5017
26	5078	6179	5210
27	4008	3955	5080
29	2554	3121	3251
29	1409	1989	2566
	945734	946486	957224

Table 12. Population biomass (mt) from catch projection for 3P redfish. Assumed TAC = 11,000 MT caught in 1979.

	1978	1979	1980
6	16174.40	13905.00	13905.00
7	32965.65	19010.20	16396.08
8	35496.93	36674.81	21286.97
9	23347.24	37526.88	39300.37
10	14949.12	23336.77	38476.60
11	5875.43	14252.70	23008.98
12	6678.60	5370.81	13634.62
13	2337.43	6089.11	5094.12
14	3294.52	2026.56	5572.95
15	3878.46	2820.44	1831.44
16	3206.11	3129.63	2402.48
17	2968.08	2709.10	2791.54
18	4494.36	2594.69	2500.02
19	3826.32	3731.93	2274.34
20	8952.63	3154.97	3248.26
21	2605.47	7348.02	2733.52
22	8067.48	2129.83	6340.72
23	5720.28	6570.99	1831.25
24	6175.98	4631.93	5616.74
25	6251.99	4993.59	3953.50
26	4138.57	5035.89	4245.99
27	3370.73	3325.91	4272.18
28	2211.76	2703.11	2815.57
29	1252.60	1768.24	2281.30
	208240.17	214841.10	225814.55

Table 13. Catch numbers (10^{-3}) from catch projections for 3P redfish. Assumed TAC = 11,000 MT caught in 1979.

	1978	1979	1980
6	1339	737	1113
7	4146	1533	1994
8	7359	4892	4269
9	7382	7678	12026
10	5203	5276	12965
11	2358	3737	8945
12	2049	1073	4051
13	857	1464	1810
14	1085	438	1778
15	1162	554	532
16	927	594	673
17	791	474	721
18	1067	404	575
19	852	545	491
20	1883	435	662
21	520	962	529
22	1534	266	1168
23	1040	784	323
24	1080	531	952
25	1053	552	645
26	674	538	670
27	532	344	653
28	339	272	418
29	187	173	330
	45419	34257	58291

Table 14. Catch biomass (mt) from catch projections for 3P redfish. Assumed TAC = 11,000 MT caught in 1979.

	1978	1979	1980
6	138	76	115
7	560	207	269
8	1244	827	721
9	1513	1574	2465
10	1264	1282	3150
11	663	1050	2513
12	660	346	1304
13	310	530	655
14	437	176	717
15	515	246	236
16	425	272	309
17	394	236	359
18	596	226	322
19	508	325	292
20	1188	275	418
21	346	640	352
22	1071	185	815
23	759	572	236
24	820	403	722
25	830	435	508
26	549	438	546
27	447	290	549
28	294	235	362
29	166	154	293
	15697	11000	18230

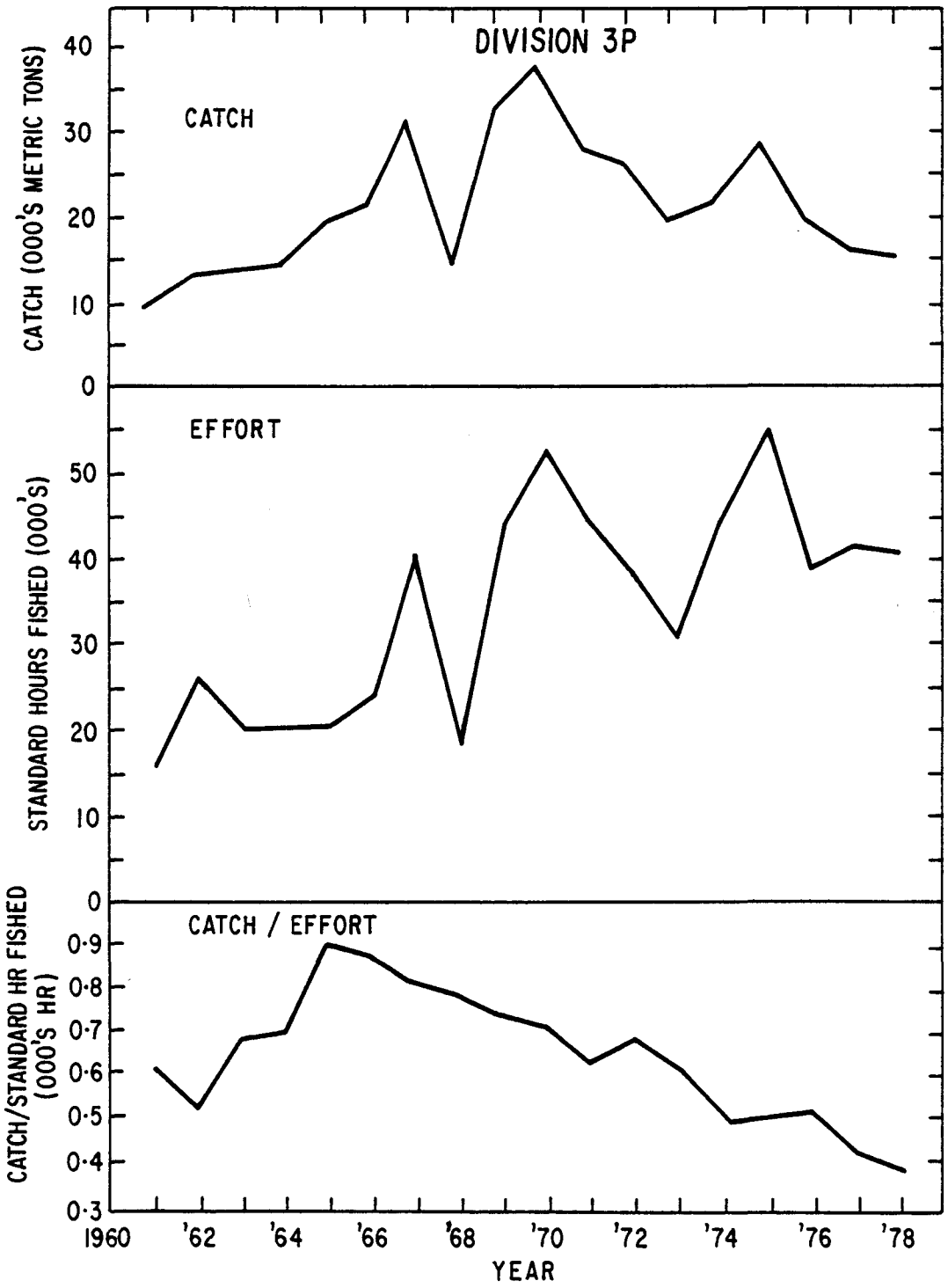

Figure 1. Catch, Effort (Standard). and Catch Per Unit Effort (Standard) from 1961 to 1978 for Redfish in 3 P.
(Standard is Can. (Nfld.) tonnage class 4).

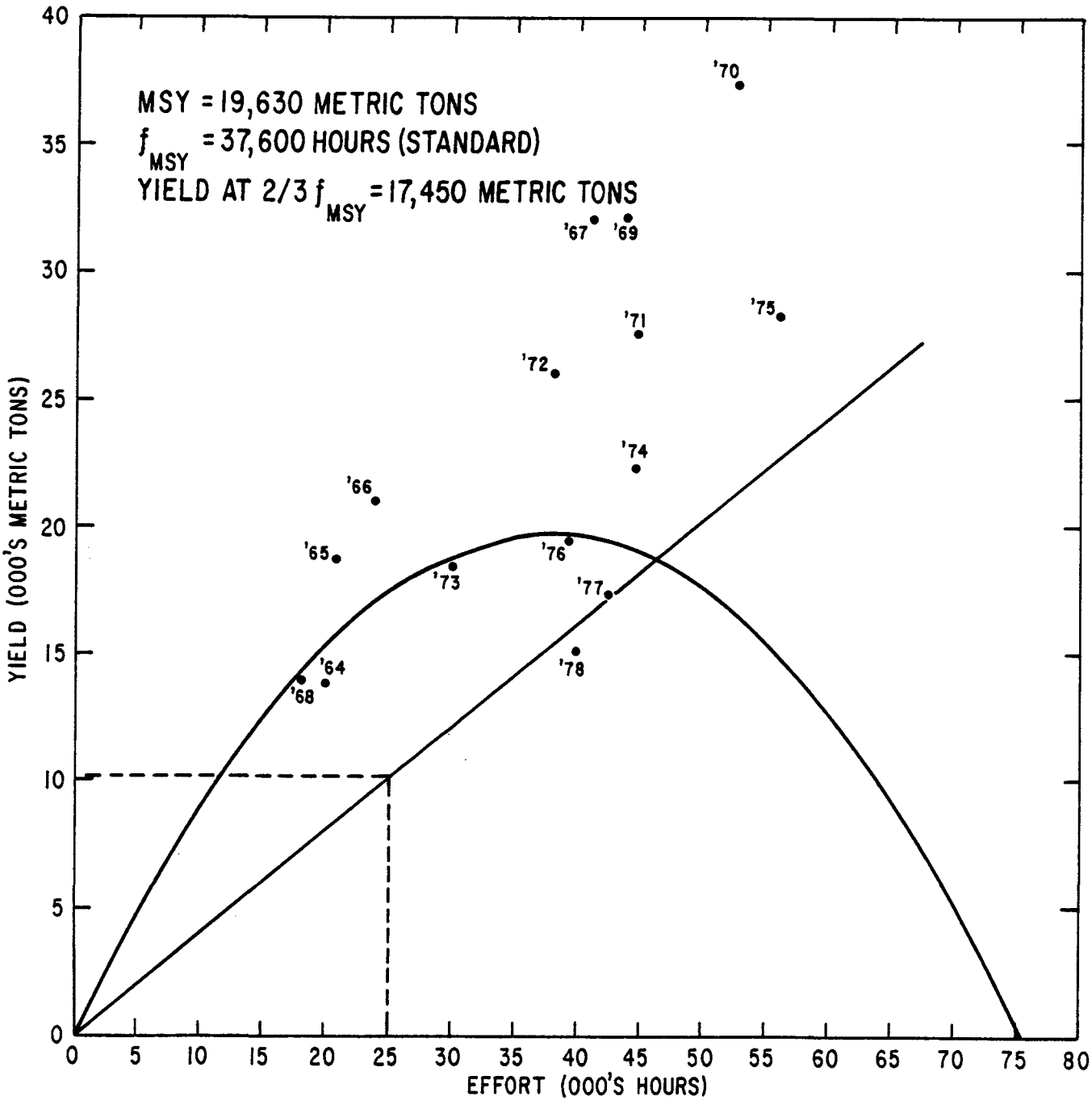

Fig. 2. General production parabola (10 yr. running average) for 3P Redfish from Regression: C.P.U.E.=1.0448-0.0139(EffortX10^{-3}) r^2=0.8202 (Standard Used is Can.(Nfld.) Tonnage Class 4 Qt.)

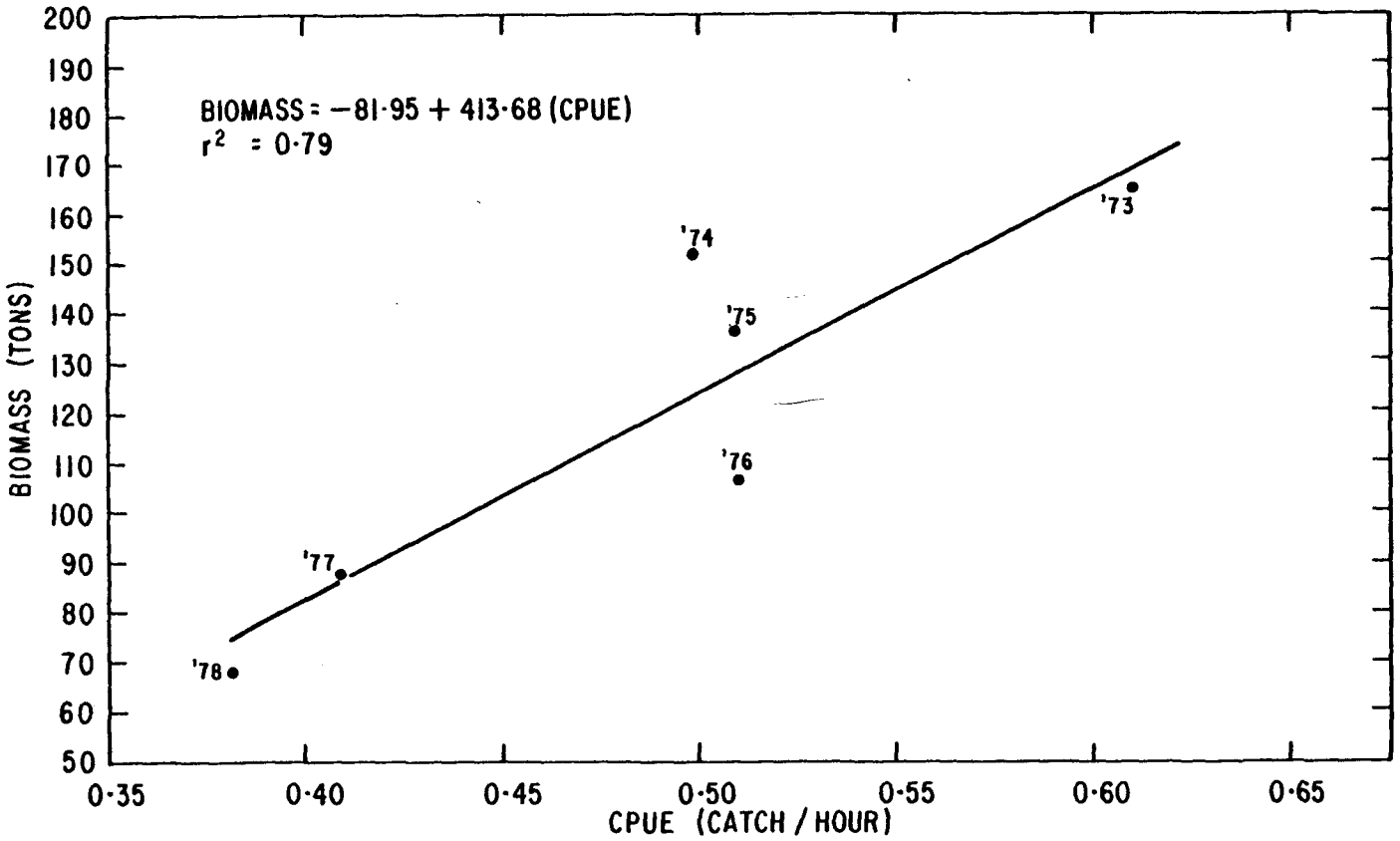

Fig. 3. Biomass of 13^{+} from cohort analysis (F_t = 0.15) on CPUE (catch/hr) from commercial for 3P Redfish.

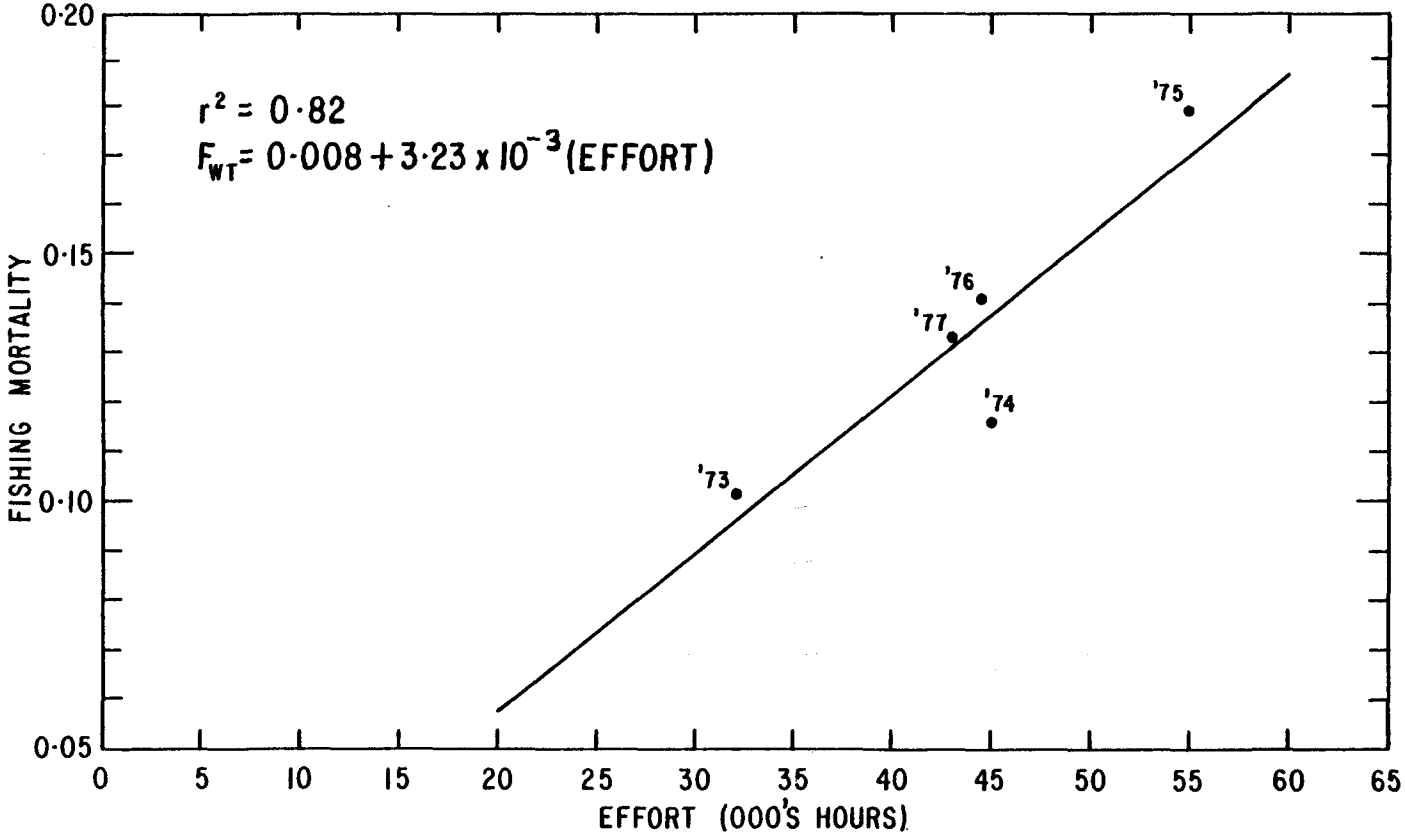

Fig. 4. Regression of fishing mortality on effort for 3P redfish (13+).

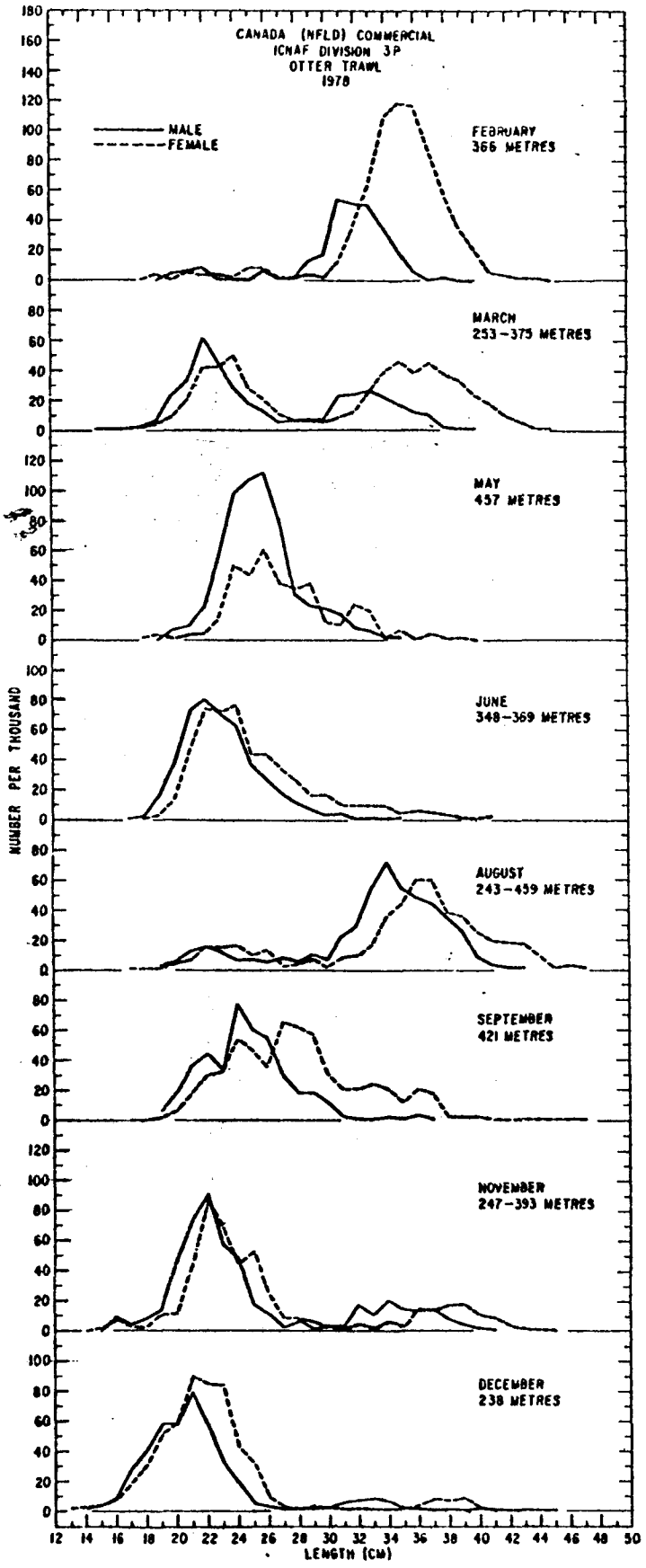

FIGURE 5: COMMERCIAL (O.T.) LENGTH FREQUENCIES FROM 3P IN 1978

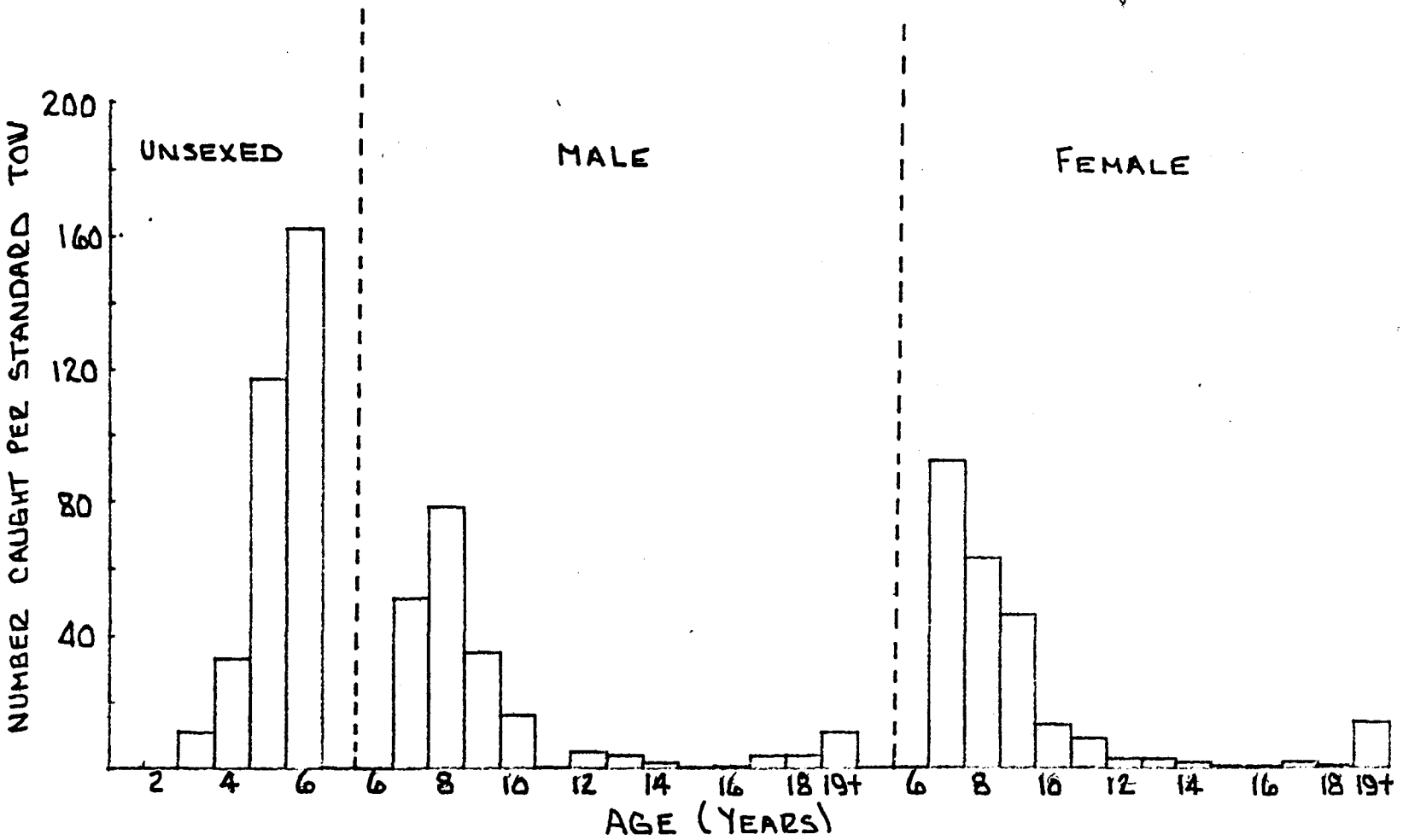

FIGURE 6 NUMBER REDFISH CAUGHT AT AGE PER STANDARD TOW IN 3P DURING 1978 RESEARCH CRUISE.

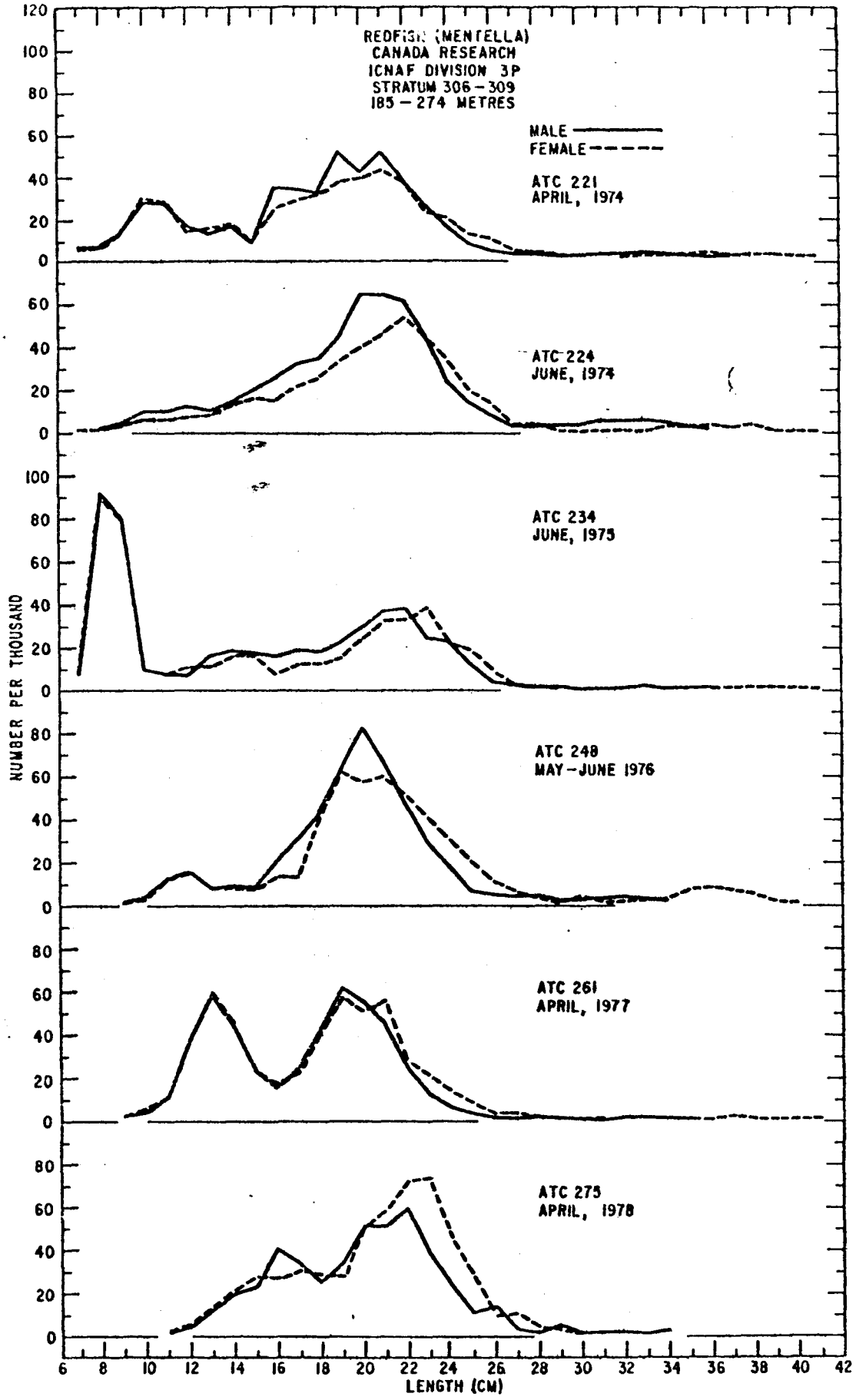

FIGURE 7a: RESEARCH FREQUENCIES 3P REDFISH 1974-1978 BY STRATA

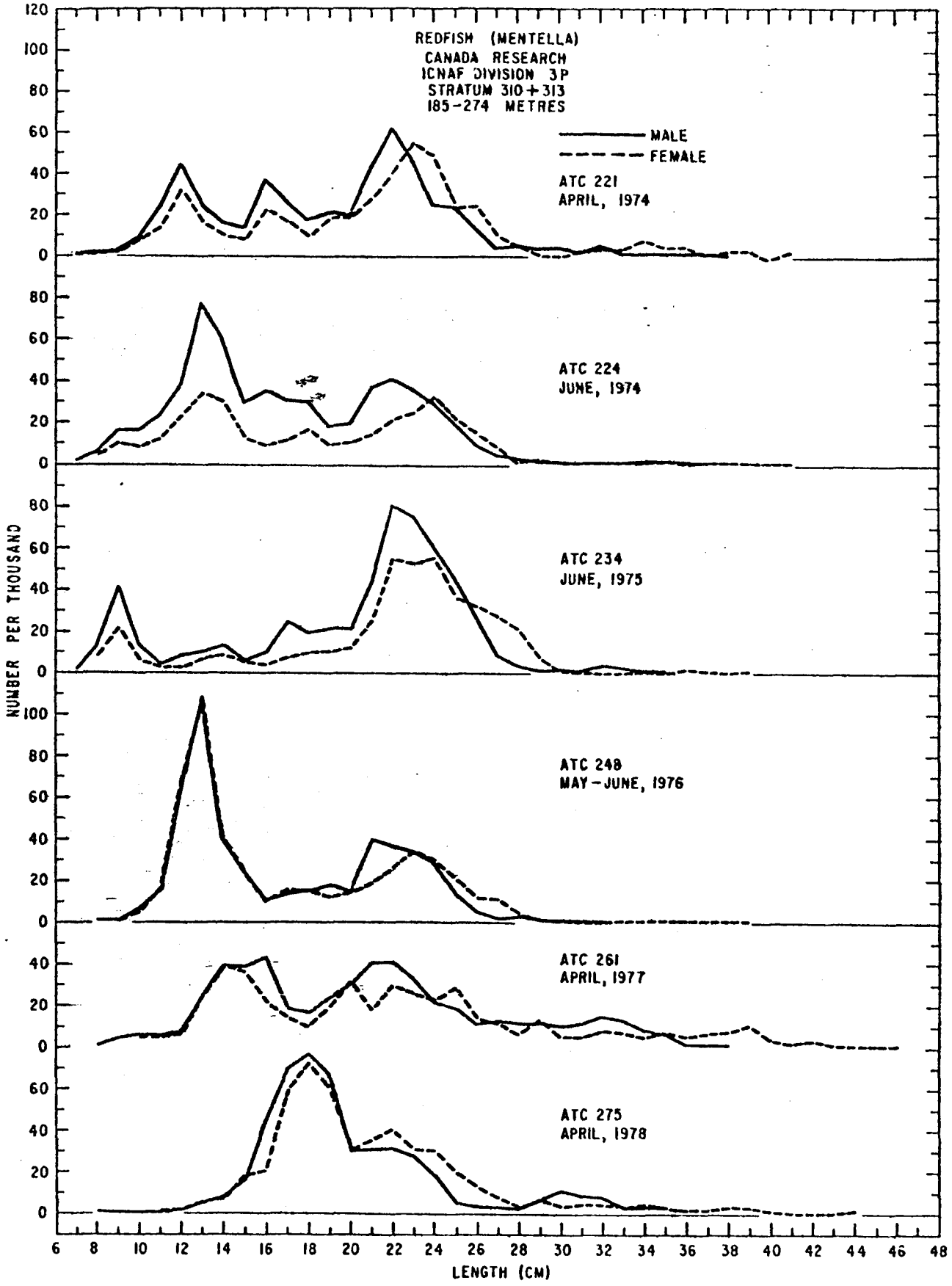
REDFISH (MENTELLA)
CANADA RESEARCH
ICNAF DIVISION 3P
STRATUM 310+313
185-274 METRES
MALE
FEMALE
ATC 221
APRIL, 1974
ATC 224
JUNE, 1974
ATC 234
JUNE, 1975
ATC 248
MAY-JUNE, 1976
ATC 261
APRIL, 1977
ATC 275
APRIL, 1978
NUMBER PER THOUSAND
LENGTH (CM)

FIGURE 7b

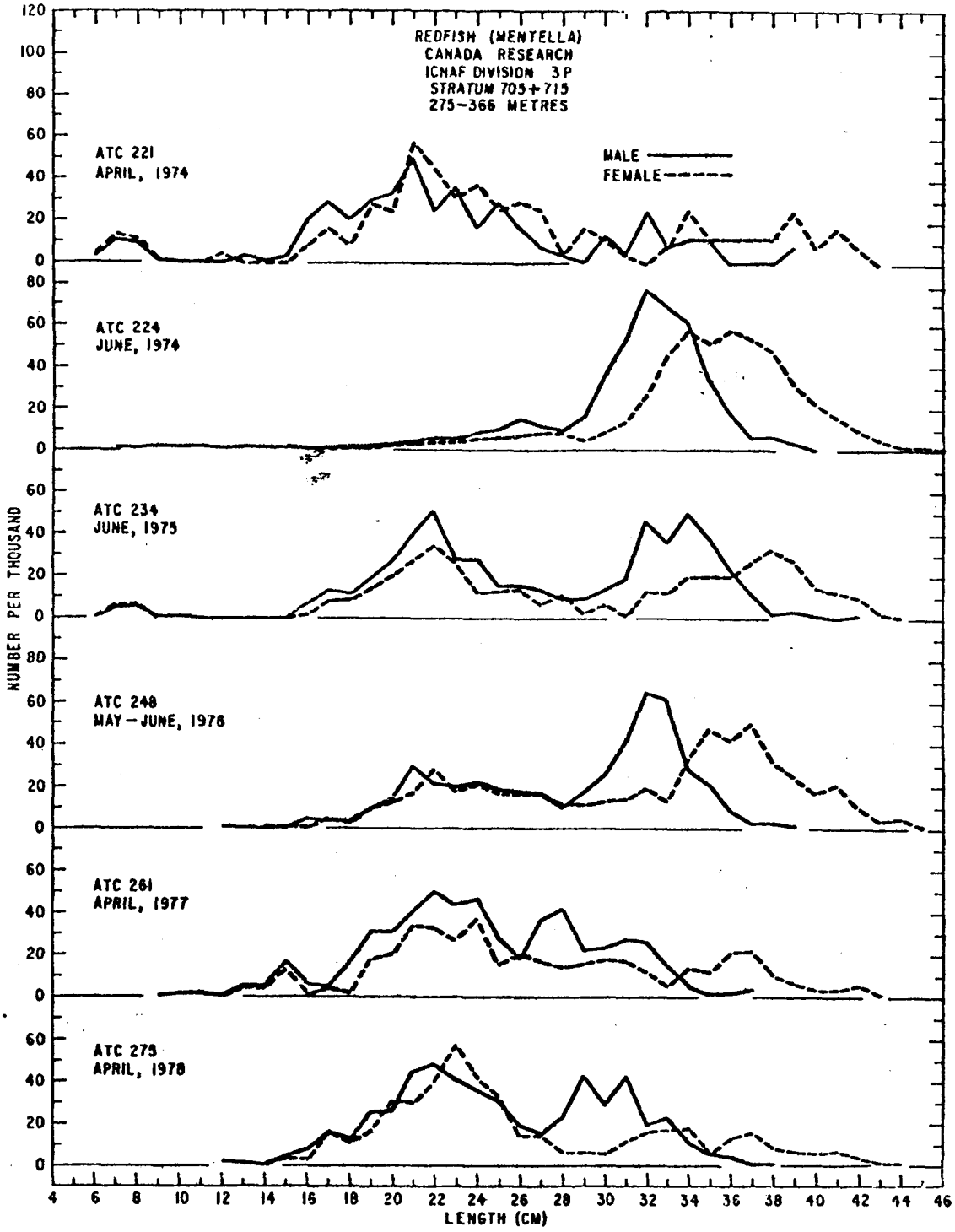
REDFISH (MENTELLA)
CANADA RESEARCH
ICNAF DIVISION 3P
STRATUM 705+715
275–366 METRES
ATC 221
APRIL, 1974
MALE
FEMALE
ATC 224
JUNE, 1974
ATC 234
JUNE, 1975
ATC 248
MAY–JUNE, 1976
ATC 261
APRIL, 1977
ATC 275
APRIL, 1978
NUMBER PER THOUSAND
LENGTH (CM)

FIGURE 7c

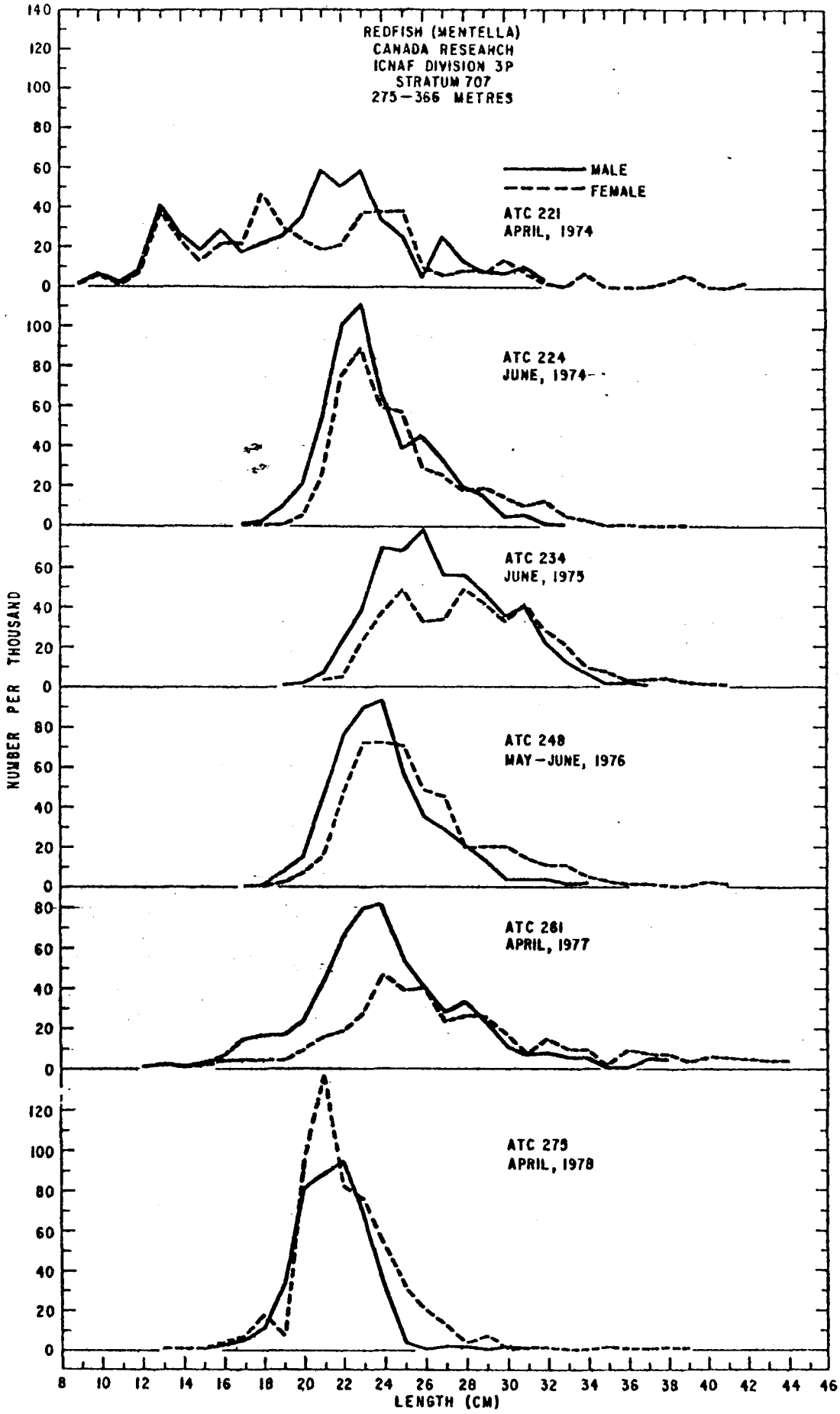
REDFISH (MENTELLA)
CANADA RESEARCH
ICNAF DIVISION 3P
STRATUM 707
275–366 METRES
MALE
FEMALE
ATC 221
APRIL, 1974
ATC 224
JUNE, 1974
ATC 234
JUNE, 1975
ATC 248
MAY–JUNE, 1976
ATC 281
APRIL, 1977
ATC 275
APRIL, 1978
NUMBER PER THOUSAND
LENGTH (CM)

FIGURE 7d

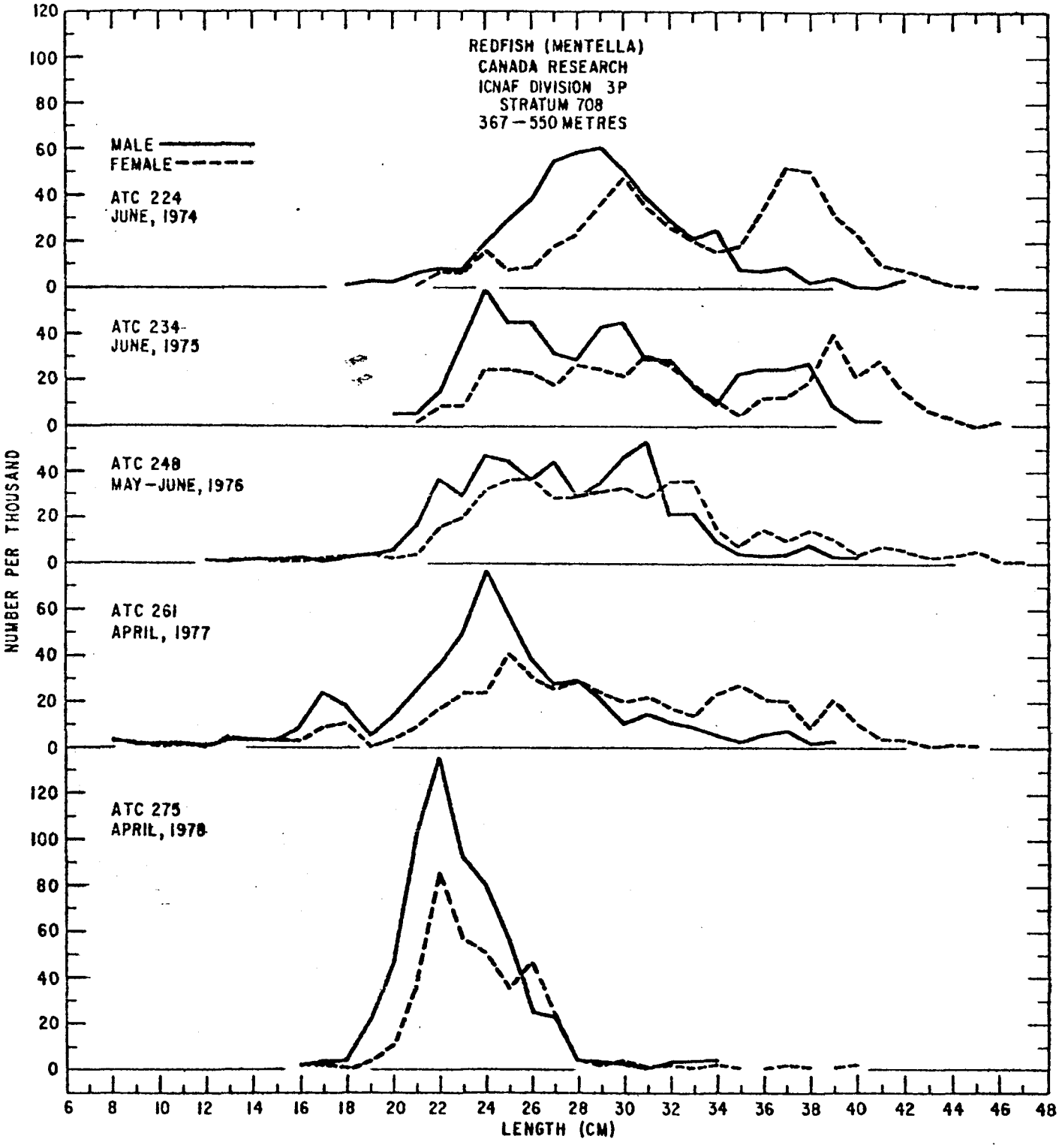
REDFISH (MENTELLA)
CANADA RESEARCH
ICNAF DIVISION 3P
STRATUM 708
367 – 550 METRES
MALE
FEMALE
ATC 224
JUNE, 1974
ATC 234
JUNE, 1975
ATC 248
MAY – JUNE, 1976
ATC 261
APRIL, 1977
ATC 275
APRIL, 1978
NUMBER PER THOUSAND
LENGTH (CM)

FIGURE 7e