

3P Redfish Assessment

by

D.B. Atkinson, W.D. McKone, and W.E. Legge
Department of Fisheries and Oceans
P.O. Box 5667
St. John's, Newfoundland
A1C 5X1

Abstract

The TAC of 16,000 t in 1979 was not achieved, with only 11,000 t being landed. An analytical assessment of this stock was carried out and a number of regressions run in order to determine the best terminal F. Although no one regression series proved conclusive, the overall indication was that a terminal F of 0.10 was most appropriate. Projections suggested a TAC of 18,000 t in 1981 fishing at the $F_{0.1}$ level of 0.146. Research surveys in 1979 indicated the higher than average abundance of several length groups that will be available to the commercial fishery in the near future.

Résumé

Le contingent de 16 000 t de sébaste pour 1979 n'a pas été atteint, les prises n'ayant été que de 11 000 t. On a fait une évaluation analytique de ce stock et essayé plusieurs régressions afin de déterminer le meilleur F terminal. Bien qu'aucune régression n'ait donné de résultat conclusif, un F terminal de 0,1 semble le plus approprié. Les projections pour 1981 suggèrent un TPA de 18 000 t à $F_{0.1}$ de 0,146. Des relevés par navire de recherche en 1979 indiquent la présence de plusieurs classes d'âge abondantes qui rallieront le stock dont disposera la pêche commerciale dans un avenir prochain.

INTRODUCTION

As a result of poor recruitment in the mid-1960's, the 3P redfish stock has shown a decline which resulted in the lowering of the TAC from 25,000 MT in 1974 to 11,000 MT in 1979. Based on an assessment presented to CAFSAC in 1979 (Atkinson et al. 1979) which indicated the recruitment of several strong year-classes (aged 7-12) into the fishery, the 1979 TAC was raised to 16,000 MT and was set at 18,000 MT for 1980. This paper presents an update of the assessment of this stock.

METHODS AND RESULTS

Trends in catch and catch per unit effort

Catch per hour was calculated using Canadian (Nfld.) tonnage class 4 (OTB1) as the standard and all catches comprising > 50% redfish were used (Table 1).

Nominal catches rose from 9700 MT in 1961 to a high of 37,000 MT in 1970 but since then declined to 11,000 MT in 1979 (with a minor peak of 28,000 MT in 1975) (Fig. 1). Catch rates, after rising to 0.91 MT per hour in 1965, have declined steadily to 0.36 MT per hour in 1979. The amount of effort has fluctuated, increasing to a high of 56,000 standard hours in 1975 and subsequently decreasing to 30,000 standard hours in 1979.

Numbers at age

As in the past, commercial length frequencies and age/length keys were applied to the total reported commercial catch to determine the numbers caught at age. These calculations were done separately for males and females then combined for the cohort run. The resulting catch matrix for 1973-1979 can be seen in Table 2.

Weight at age

The average weight at age was calculated from the commercial age/length keys from 1974 to 1979 using the following:

$$Wt_{\text{male}} = 0.1659l^{2.9543}$$

$$Wt_{\text{female}} = 0.1372l^{3.0210}$$

The resulting weights at age from each key were then averaged and smoothed ($\frac{a+2b+c}{4}$) to obtain the resulting vector (males and females combined) (Table 3).

Partial recruitment

Partial recruitment was calculated by comparing the numbers caught at age (ages 5-18, sexes combined) in the commercial fishery (expressed as a percent of the total number caught in this age range) with the numbers caught at age (ages 5-18, sexes combined) per standard tow during a research cruise in the spring of 1979 (again expressed as a percent). Ratios of the percent commercial to the percent research (at age) were calculated and averaged over 3 ages. The partial recruitment vector was determined by assuming that all fish aged 14 and over are fully recruited and by calculating the percent recruited at the younger ages. The resulting vector can be seen in Table 3.

Terminal fishing mortality

Attempts to establish the terminal fishing mortality were carried out in a number of ways. Linear regressions of biomass (ages 14-29, 10-29 and 6-29) on CPUE were run from 1973-1979 in order to check the coefficient of correlation (Table 4). Similar regressions were run from 1973-1978 in order to determine which curve would best predict the 1979 biomass given the 1979 CPUE. These results are summarized in Table 5.

The CPUE was converted from MT/hr to numbers/hr and two sets of regressions were run as above. These are summarized in Tables 6 and 7.

Linear regressions were run of numbers from cohort (ages 6-19) on numbers per tow from research surveys (ages 6-19, 1974-1978, 1979). These results are shown in Table 8.

Finally, regressions were run of total F (ages 6-28, 10-28 and 14-28) on effort and these results are shown in Tables 9 and 10.

The final method used was a comparison of Paloheimo Z's with the Z's calculated from cohort (Winters, personal comm.). The method used is as follows: Paloheimo Z's were calculated between 1977 and 1979 (ages 14-27 and 16-29) to obtain a two-year estimate of Z. A comparable estimate (two-year) of Z was obtained from cohort runs using the formula

$$\frac{Z_{77} + 2Z_{78} + Z_{79}}{2}$$

The results are summarized in Table 11.

The regressions of biomass on CPUE do not give any clear indication of a suitable terminal F. Similarly regressions of numbers on CPUE don't suggest a terminal F except that in Table 7 the prediction error changes from negative to positive between F's of 0.05 and 0.10 for ages 10-29 perhaps suggesting that the terminal F lies in this range. The results in Table 8 can be considered to be totally unreliable as the slopes are all negative. These results are due to the

fact that the research cruises have not consistently fished all the strata in 3P. The regressions of F on effort suggest a terminal F of 0.10 based upon the coefficient of correlation (Table 9, ages 10-28) and also based upon the closeness of prediction (Table 10, ages 14-28). The final method tried suggests a terminal F slightly below 0.15 (Table 11).

From the above, it would appear that terminal F lies between approximately 0.075 and 0.15. In 1979 a terminal F of 0.15 was accepted and the projections carried out with $F_{0.1}$ of 0.145. This resulted in a suggested TAC for 1979 of 16,000 MT. In 1979, however, only 11,000 MT were caught and if the 1979 cohort and projection are accepted as being reasonably correct, the terminal F would be below 0.145, probably in the area of 0.10. A cohort run with terminal F of 0.10 is shown in Table 12.

Table 13 and Fig. 2 show the yield per recruit curve using the method of Thompson and Bell (1934). Projections at terminal F of 0.10 were done in two ways. First the 1980 TAC was entered for 1980 and $F_{0.1}$ for 1981 and second, $F_{0.1}$ was input for 1980 and 1981. In both runs the geometric mean of age 6 fish determined from cohort was used for recruitment. The results of the projections can be seen in Table 14.

Abundance indices

Commercial length frequencies indicate that the fishery was concentrated on 20-30 cm length groups for both sexes early in the year but as the year progressed, fish 30-40 cm came to predominate (Fig. 3). This shift may have occurred as a result of a shift in fishing pattern by the vessel captains who voluntarily avoided fishing in the areas where concentrations of the smaller fish were found (north of Burgeo Bank and the Hermitage Channel Area).

The numbers caught per standard tow in 1978 and 1979 both indicate a predominance of younger fish which are barely large enough to enter the commercial fishery (i.e. under age 10) (Fig. 4).

Length frequencies from research cruises for certain strata (Fig. 5) fished consistently from 1974-1979 indicate the presence of several strong length groups in the Hermitage Channel Area and north of Burgeo Bank that will be available to the fishery in the near future (Fig. 6, 7). In the south also are present fish 18-26 cm (Fig. 8, 9) which will soon be available to the commercial fishery although there is no indication of their presence in this area as smaller fish and thus it may be postulated that they migrate here from other areas at this size.

REFERENCES

- Atkinson, D.B., McKone, W.D., and W.E. Legge. Assessment of 3P Redfish. CAFSAC Res. Doc. 79/42.
- Thompson, W.F., and F.H. Bell, 1934. Biological Statistics of the Pacific Halibut Fishery. 2. Effect of Changes in Intensity upon Total Yield and Yield per Unit of Gear. Rep. Int. Fish. (Pacific Halibut) Comm. 8: 49 p.

Table 1. Catch, effort (standard) and catch per unit effort for 3P redfish 1960-1979.

Year	Catch (MT)	CPUE	Effort hr.	Effort (10 yr. av.)
1960	9,225	0.573	16,099	
1961	9,776	0.611	16,000	
1962	13,439	0.512	26,248	
1963	13,747	0.682	20,157	
1964	13,807	0.692	19,952	11,777
1965	18,733	0.905	20,699	13,376
1966	20,868	0.874	23,876	15,443
1967	32,991	0.804	41,034	19,307
1968	13,884	0.780	17,800	20,701
1969	32,051	0.736	43,458	24,541
1970	37,270	0.707	52,716	28,203
1971	27,500	0.619	44,426	31,046
1972	26,037	0.679	38,346	32,255
1973	18,368	0.612	30,013	33,241
1974	22,158	0.494	44,851	35,731
1975	28,250	0.508	55,610	39,222
1976	19,167	0.510	37,582	40,593
1977	17,163	0.416	41,257	40,615
1978	15,005	0.381	39,383	42,764
1979*	10,655	0.356	29,930	41,438

*Provisional

C A T C H M A T R I X

AGE/YEAR	1973	1974	1975	1976	1977	1978	1979
6	13.	105.	401.	41.	257.	1339.	1979
7	11.	895.	694.	56.	491.	4146.	487.
8	16.	1876.	1868.	263.	499.	7359.	1673.
9	8.	1647.	883.	581.	790.	7382.	2994.
10	20.	1528.	486.	386.	835.	5203.	3167.
11	536.	1830.	1112.	434.	777.	2358.	1779.
12	1004.	1399.	623.	506.	971.	2049.	992.
13	3076.	3602.	1016.	990.	849.	857.	1130.
14	6099.	3058.	1123.	1119.	1022.	1085.	791.
15	9314.	3173.	2206.	1072.	1438.	1162.	786.
16	5866.	7661.	3613.	1796.	793.	927.	549.
17	7300.	2597.	8428.	1124.	1298.	791.	497.
18	1842.	3930.	6040.	4154.	1005.	1067.	668.
19	878.	1063.	12060.	1897.	2659.	852.	607.
20	1149.	1326.	3015.	6345.	1490.	1883.	588.
21	589.	701.	2323.	1463.	4659.	520.	726.
22	385.	1555.	2080.	2387.	2281.	1534.	1131.
23	404.	2821.	1758.	1957.	2398.	1040.	749.
24	484.	1410.	790.	1310.	2031.	1080.	1399.
25	168.	2147.	1205.	2269.	1083.	1053.	810.
26	2.	1887.	995.	1613.	619.	674.	1166.
27	2.	2.	687.	868.	396.	532.	765.
28	2.	2.	2.	575.	307.	339.	503.
29	2.	2.	2.	2.	289.	187.	382.
							229.

Table 2. Catch matrix for 3P redfish 1973-1979 (sexes combined) (000's).

AGE MEAN WEIGHT PROPORTION RECRUITED

	(GMS)	
6	105.00	.050
7	142.00	.090
8	177.00	.150
9	213.00	.210
10	247.00	.270
11	286.00	.380
12	331.00	.600
13	369.00	.830
14	406.00	1.000
15	445.00	1.000
16	481.00	1.000
17	516.00	1.000
18	553.00	1.000
19	587.00	1.000
20	621.00	1.000
21	657.00	1.000
22	688.00	1.000
23	724.00	1.000
24	770.00	1.000
25	816.00	1.000
26	865.00	1.000
27	913.00	1.000
28	948.00	1.000
29	985.00	1.000

NATURAL MORTALITY RATE IS .100

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

Table 4. Coefficient of correlation from regressions of biomass (cohort) on CPUE (MT/hr) for 1973-79.

Terminal F	r^2 for biomass on CPUE (1973-79)					
	r^2	<u>6-29</u> Slope	r^2	<u>10-29</u> Slope	r^2	<u>14-29</u> Slope
0.05	.7068	-	.7420	+	.8561	+
0.10	.0269	+	.8156	+	.8530	+
0.15	.6450	+	.8310	+	.8517	+
0.20	.7677	+	.8372	+	.8509	+

Table 5. Coefficients of correlation from regressions of biomass (cohort) on CPUE (MT/hr) for 1973-78 and the closeness of the prediction of 1979 biomass.

Terminal F	r^2 and prediction error (%)								
	r^2	<u>6-29</u> %	Slope	r^2	<u>10-29</u> %	Slope	r^2	<u>14-29</u> %	Slope
.05	.5784	-9.3	-	.7631	-10.7	+	.7947	+4.8	+
.10	.1384	-7.3	+	.7800	-8.8	+	.7927	+6.6	+
.15	.6183	-5.5	+	.7847	-7.0	+	.7918	+8.4	+
.20	.7135	-3.6	+	.7869	-5.3	+	.7913	+10.1	+

Table 6. Coefficients of correlation from regressions of numbers (cohort) on CPUE (no/hr) for 1973-79.

Terminal F	r^2 for numbers on CPUE (1973-79)					
	r^2 $\frac{6-29}{\text{Slope}}$		r^2 $\frac{10-29}{\text{Slope}}$		r^2 $\frac{14-29}{\text{Slope}}$	
0.05	.1745	-	.4147	+	.3458	+
0.10	.1255	-	.4367	+	.3576	+
0.15	.0579	-	.4308	+	.3622	+
0.20	.0002	-	.4254	+	.3646	+

Table 7. Coefficients of correlation from regressions of numbers (cohort) on CPUE (no/hr) for 1973-1978 and the closeness of the prediction of 1979 numbers.

Terminal F	r^2 and prediction error (%)								
	6-29			10-29			14-29		
	r^2	%	Slope	r^2	%	Slope	r^2	%	Slope
0.05	.0888	- 27.5	-	.4481	- 8.9	+	.2585	+ 41.3	+
0.10	.0518	- 21.1	-	.3871	+ 7.4	+	.2721	+ 67.9	+
0.15	.0123	- 14.8	-	.3661	+23.2	+	.2774	+ 93.3	+
0.20	.0087	- 8.6	+	.3551	+38.5	+	.2803	+117.5	+

Table 8. Coefficients of correlation from regressions of numbers (cohort, ages 6-19) on numbers per standard tow (research, ages 6-19) for 1974-1979 and for 1974-1978 with closeness of prediction for 1979 numbers.

Terminal F	r^2 for numbers (cohort) on numbers/tow (research)				
	1974-1979		1974-1978		
	r^2	Slope	r^2	%	Slope
0.05	.8759	-	.8520	-8.8	-
0.10	.8812	-	.8559	-5.9	-
0.15	.8795	-	.8524	-3.0	-
0.20	.8593	-	.8323	-0.2	-

Table 9. Coefficients of correlation from regressions of F (cohort) on effort for 1973-1979.

Terminal F	r^2 for F on f (1973-1979)					
	6-28		10-28		14-28	
	r^2	Slope	r^2	Slope	r^2	Slope
0.05	.3390	+	.7566	+	.6463	+
0.10	.4600	+	.8115	+	.6271	+
0.15	.5596	+	.7206	+	.4899	+
0.20	.6385	+	.5598	+	.3944	+

Table 10. Coefficients of correlation from regressions of F (cohort) on effort for 1973-1978 and closeness of prediction of 1979 F.

Terminal F	r^2 and prediction error (%)								
	r^2	6-28			10-28			14-28	
		%	Slope	r^2	%	Slope	r^2	%	Slope
0.05	.1956	+120.9	+	.7476	+68.8	+	.5415	+23.1	+
0.10	.3206	+73.5	+	.7974	+39.7	+	.5549	+1.4	+
0.15	.4351	+47.2	+	.6330	+22.9	+	.4813	-7.8	+
0.20	.5320	+33.2	+	.4611	+9.1	+	.3944	-20.5	+

Table 11. Paloheimo Z's and Z's from cohort (2 yr) (1977-1979)

Terminal F	Z from cohort	P_Z
0.05	0.32	
0.10	0.43	
0.15	0.53	0.50
0.20	0.62	

Table 12a. Population numbers from cohort with terminal F = 0.10

3P REDFISH

POPULATION NUMBERS

AGE/YEAR	1973	1974	1975	1976	1977	1978	1979
6	46808.	56614.	116271.	226199.	263166.	218246.	102603.
7	27645.	42341.	51126.	104825.	204634.	237878.	196204.
8	21980.	25004.	37461.	45601.	94797.	184693.	211297.
9	18179.	19873.	20840.	32119.	41011.	85301.	160117.
10	17961.	16441.	16415.	18017.	28510.	36357.	70161.
11	22373.	16232.	13423.	14391.	15935.	25002.	27948.
12	23021.	19734.	12947.	11088.	12609.	13680.	20380.
13	27874.	19876.	16525.	11122.	9552.	10485.	10429.
14	33981.	22295.	14558.	13986.	9122.	7835.	8672.
15	65580.	24946.	17265.	12104.	11591.	7282.	6057.
16	37927.	50480.	19553.	13524.	9933.	9120.	5484.
17	74821.	28738.	38389.	14256.	10528.	8233.	7370.
18	30783.	60757.	23533.	26719.	11830.	8292.	6697.
19	37908.	26101.	51237.	15548.	20225.	9748.	6488.
20	27860.	33465.	22606.	34889.	12264.	15771.	8010.
21	19521.	24116.	29019.	17587.	25533.	9680.	12479.
22	17489.	17103.	21154.	24048.	14522.	18672.	8264.
23	11712.	15459.	13996.	17163.	19489.	10970.	15436.
24	7922.	10213.	11304.	10992.	13668.	15353.	8937.
25	6330.	6708.	7900.	9477.	8700.	10435.	12865.
26	15.	5568.	4027.	6002.	6417.	6842.	8440.
27	14.	12.	3243.	2698.	3896.	5217.	5550.
28	9.	11.	9.	2281.	1615.	3149.	4215.
29	9.	6.	8.	6.	1517.	1170.	2527.

Table 12b. Fishing mortalities from cohort with terminal $F = 0.10$

3P REDFISH

F I S H I N G M O R T A L I T I E S

AGE/YEAR	1973	1974	1975	1976	1977	1978	1979
6	.000	.002	.004	.000	.001	.006	.005
7	.000	.022	.014	.001	.003	.018	.009
8	.001	.082	.054	.006	.006	.043	.015
9	.000	.091	.046	.019	.020	.095	.021
10	.001	.103	.032	.023	.031	.163	.027
11	.026	.126	.091	.032	.053	.104	.038
12	.047	.077	.052	.049	.084	.171	.060
13	.123	.211	.067	.098	.098	.090	.083
14	.209	.156	.085	.088	.125	.157	.100
15	.162	.144	.144	.098	.140	.184	.100
16	.177	.174	.216	.150	.088	.113	.100
17	.108	.100	.262	.087	.139	.106	.100
18	.065	.070	.314	.178	.094	.145	.100
19	.025	.044	.284	.137	.149	.096	.100
20	.044	.043	.151	.212	.137	.134	.100
21	.032	.031	.088	.092	.213	.058	.100
22	.023	.100	.109	.110	.180	.090	.100
23	.037	.213	.142	.128	.139	.105	.100
24	.066	.157	.076	.134	.170	.077	.100
25	.028	.410	.175	.290	.140	.112	.100
26	.147	.440	.301	.332	.107	.109	.100
27	.164	.193	.252	.413	.113	.113	.100
28	.280	.219	.268	.308	.223	.120	.100
29	.280	.440	.314	.413	.223	.184	.100

Table 12c. Population numbers, biomass and total F (fully recruited) with Terminal F = 0.10

TOTAL POPULATION NUMBERS AGES 6 TO 29

YEAR	1973	1974	1975	1976	1977	1978	1979
TOTAL N	577722.	542093.	562811.	684641.	851062.	959411.	926629.

YEAR	1973	1974	1975	1976	1977	1978	1979
TOTAL N	463110.	398261.	337113.	275897.	247455.	233292.	256408.

YEAR	1973	1974	1975	1976	1977	1978	1979
TOTAL N	371881.	325978.	277802.	221279.	180850.	147768.	127490.

POPULATION BIOMASS AGES 6 TO 29

YEAR	1973	1974	1975	1976	1977	1978	1979
BIOMASS	246395.	229134.	214115.	206929.	217237.	229544.	232490.

POPULATION BIOMASS AGES 10 TO 29

YEAR	1973	1974	1975	1976	1977	1978	1979
BIOMASS	229792.	208518.	183577.	153380.	135032.	121989.	122351.

POPULATION BIOMASS AGES 14 TO 29

YEAR	1973	1974	1975	1976	1977	1978	1979
BIOMASS	201052.	185949.	165300.	137040.	115735.	97461.	86434.

FISHING MORTALITY-WINTERS METHOD AGES 14 TO 28

YEAR	1973	1974	1975	1976	1977	1978	1979
TOTAL F	.103	.114	.193	.153	.148	.110	.100

Table 13 . SUMMARY OF YIELD PER RECRUIT CALCULATED FROM
PARTIAL RECRUITMENT AND AVERAGE WEIGHT AT AGE
OVER AGES 6 TO 29

F	Y/R(KG)
.001	.0026
.050	.0886
.100	.1281
.150	.1463
.200	.1549
.250	.1591
.300	.1611
.350	.1619
.400	.1621
.450	.1619
.500	.1615
.550	.1610
.600	.1604
.650	.1597
.700	.1591
.750	.1584
.800	.1577
.850	.1570
.900	.1563
.950	.1557
1.000	.1550
1.050	.1544
1.100	.1537
1.150	.1531
1.200	.1525
1.250	.1519
1.300	.1514
1.350	.1508
1.400	.1502
1.450	.1497
1.500	.1492
1.550	.1487
1.600	.1482
1.650	.147
1.700	.1472
1.750	.1468
1.800	.1463
1.850	.1459
1.900	.1454
1.950	.1450
2.000	.1446

F0.1 IS .1460

Table 14a. CATCH PROJECTION FOR 1980 USING POPULATION ESTIMATES FROM COHORT WITH TERMINAL F OF .100
using 1980 TAC=18,000MT

AGE	POPULATION NUMBERS (000S)	POPULATION WEIGHT (MT)	FISHING MORTALITY	CATCH NUMBERS (000S)	CATCH WEIGHT (MT)	RESIDUAL NUMBERS (000S)	RESIDUAL WEIGHT (MT)
6	122363.	12848.	.008	977.	103.	109790.	11528.
7	92376.	13117.	.015	1323.	188.	82327.	11690.
8	175942.	31142.	.025	4180.	740.	155225.	27475.
9	188343.	40117.	.035	6234.	1328.	164494.	35037.
10	141869.	35042.	.046	6008.	1484.	122658.	30297.
11	61793.	17673.	.064	3650.	1044.	52444.	14999.
12	24345.	8058.	.101	2230.	738.	19910.	6590.
13	17367.	6408.	.140	2160.	797.	13663.	5042.
14	8685.	3526.	.169	1284.	521.	6640.	2696.
15	7100.	3160.	.169	1049.	467.	5428.	2415.
16	4959.	2385.	.169	733.	353.	3791.	1824.
17	4490.	2317.	.169	664.	342.	3433.	1771.
18	6034.	3337.	.169	892.	493.	4613.	2551.
19	5483.	3219.	.169	810.	476.	4192.	2461.
20	5312.	3299.	.169	785.	488.	4061.	2522.
21	6558.	4309.	.169	969.	637.	5014.	3294.
22	10217.	7029.	.169	1510.	1039.	7811.	5374.
23	6766.	4899.	.169	1000.	724.	5173.	3745.
24	12638.	9731.	.169	1868.	1438.	9662.	7440.
25	7317.	5971.	.169	1081.	882.	5594.	4565.
26	10533.	9111.	.169	1557.	1347.	8053.	6965.
27	6910.	6309.	.169	1021.	932.	5283.	4823.
28	4544.	4308.	.169	672.	637.	3474.	3293.
29	5519.	5436.	.169	816.	803.	4219.	4156.
TOTAL	937463.	242749.		43473.	18000.	806950.	202552.

Table 14b. CATCH PROJECTION FOR 1981 USING POPULATION ESTIMATES FROM COHORT WITH TERMINAL F OF .100 using $F_{0.1}=0.146$.

AGE	POPULATION NUMBERS (000S)	POPULATION WEIGHT (MT)	FISHING MORTALITY	CATCH NUMBERS (000S)	CATCH WEIGHT (MT)	RESIDUAL NUMBERS (000S)	RESIDUAL WEIGHT (MT)
6	122363.	12848.	.007	847.	89.	109913.	11541.
7	109790.	15590.	.013	1364.	194.	98045.	13922.
8	82327.	14572.	.022	1697.	300.	72879.	12900.
9	155225.	33063.	.031	4461.	950.	136212.	29013.
10	164494.	40630.	.039	6053.	1495.	143087.	35343.
11	122658.	35080.	.055	6302.	1802.	104996.	30029.
12	52444.	17359.	.088	4189.	1387.	43473.	14390.
13	19910.	7347.	.121	2164.	799.	15959.	5889.
14	13663.	5547.	.146	1768.	718.	10683.	4337.
15	6640.	2955.	.146	859.	382.	5192.	2310.
16	5428.	2611.	.146	703.	338.	4244.	2041.
17	3791.	1956.	.146	491.	253.	2964.	1530.
18	3433.	1898.	.146	444.	246.	2684.	1484.
19	4613.	2708.	.146	597.	350.	3607.	2117.
20	4192.	2603.	.146	543.	337.	3278.	2035.
21	4061.	2668.	.146	526.	345.	3175.	2086.
22	5014.	3449.	.146	649.	446.	3920.	2697.
23	7811.	5655.	.146	1011.	732.	6108.	4422.
24	5173.	3983.	.146	669.	516.	4045.	3114.
25	9662.	7884.	.146	1251.	1020.	7555.	6165.
26	5594.	4839.	.146	724.	626.	4374.	3783.
27	8053.	7352.	.146	1042.	952.	6296.	5749.
28	5283.	5008.	.146	684.	648.	4131.	3916.
29	7693.	7578.	.146	996.	981.	6015.	5925.
TOTAL	929313.	245183.		40034.	15907.	802837.	206740.

Table 14c. CATCH PROJECTION FOR 1980 USING POPULATION ESTIMATES FROM COHORT WITH TERMINAL F OF .100
using $F_{0.1}=0.146$.

AGE	POPULATION NUMBERS (000S)	POPULATION WEIGHT (MT)	FISHING MORTALITY	CATCH NUMBERS (000S)	CATCH WEIGHT (MT)	RESIDUAL NUMBERS (000S)	RESIDUAL WEIGHT (MT)
6	122363.	12848.	.007	847.	89.	109913.	11541.
7	92376.	13117.	.013	1148.	163.	82494.	11714.
8	175942.	31142.	.022	3628.	642.	155750.	27568.
9	188343.	40117.	.031	5413.	1153.	165274.	35203.
10	141869.	35042.	.039	5220.	1289.	123407.	30481.
11	61793.	17673.	.055	3175.	908.	52895.	15128.
12	24345.	8058.	.088	1945.	644.	20181.	6680.
13	17367.	6408.	.121	1888.	697.	13921.	5137.
14	8685.	3526.	.146	1124.	456.	6791.	2757.
15	7100.	3160.	.146	919.	409.	5552.	2470.
16	4959.	2385.	.146	642.	309.	3878.	1865.
17	4490.	2317.	.146	581.	300.	3511.	1812.
18	6034.	3337.	.146	781.	432.	4718.	2609.
19	5483.	3219.	.146	710.	417.	4287.	2517.
20	5312.	3299.	.146	688.	427.	4154.	2579.
21	6558.	4309.	.146	849.	558.	5128.	3369.
22	10217.	7029.	.146	1322.	910.	7989.	5496.
23	6766.	4899.	.146	876.	634.	5290.	3830.
24	12638.	9731.	.146	1636.	1260.	9882.	7609.
25	7317.	5971.	.146	947.	773.	5721.	4669.
26	10533.	9111.	.146	1363.	1179.	8236.	7124.
27	6910.	6309.	.146	894.	817.	5403.	4933.
28	4544.	4308.	.146	588.	558.	3553.	3368.
29	5519.	5436.	.146	714.	704.	4315.	4251.
TOTAL	937463.	242749.		37897.	15725.	812243.	204711.

Table 14d. CATCH PROJECTION FOR 1981 USING POPULATION ESTIMATES FROM COHORT WITH TERMINAL F OF .100 using $F_{0.1}=0.146$

AGE	POPULATION NUMBERS (000S)	POPULATION WEIGHT (MT)	FISHING MORTALITY	CATCH NUMBERS (000S)	CATCH WEIGHT (MT)	RESIDUAL NUMBERS (000S)	RESIDUAL WEIGHT (MT)
6	122363.	12848.	.007	847.	89.	109913.	11541.
7	109913.	15608.	.013	1366.	194.	98155.	13938.
8	82494.	14601.	.022	1701.	301.	73027.	12926.
9	155750.	33175.	.031	4476.	953.	136673.	29111.
10	165274.	40823.	.039	6081.	1502.	143766.	35510.
11	123407.	35294.	.055	6341.	1813.	105637.	30212.
12	52895.	17508.	.088	4225.	1398.	43847.	14513.
13	20181.	7447.	.121	2194.	810.	16176.	5969.
14	13921.	5652.	.146	1802.	732.	10885.	4419.
15	6791.	3022.	.146	879.	391.	5310.	2363.
16	5552.	2670.	.146	719.	346.	4341.	2088.
17	3878.	2001.	.146	502.	259.	3032.	1564.
18	3511.	1941.	.146	454.	251.	2745.	1518.
19	4718.	2770.	.146	611.	358.	3689.	2166.
20	4287.	2662.	.146	555.	345.	3352.	2082.
21	4154.	2729.	.146	538.	353.	3248.	2134.
22	5128.	3528.	.146	664.	457.	4010.	2759.
23	7989.	5784.	.146	1034.	749.	6247.	4523.
24	5290.	4074.	.146	685.	527.	4137.	3185.
25	9882.	8064.	.146	1279.	1044.	7727.	6305.
26	5721.	4949.	.146	741.	641.	4474.	3870.
27	8236.	7519.	.146	1066.	973.	6440.	5880.
28	5403.	5122.	.146	699.	663.	4225.	4005.
29	7868.	7750.	.146	1018.	1003.	6153.	6060.
TOTAL	934606.	247542.		40475.	16152.	807208.	208641.

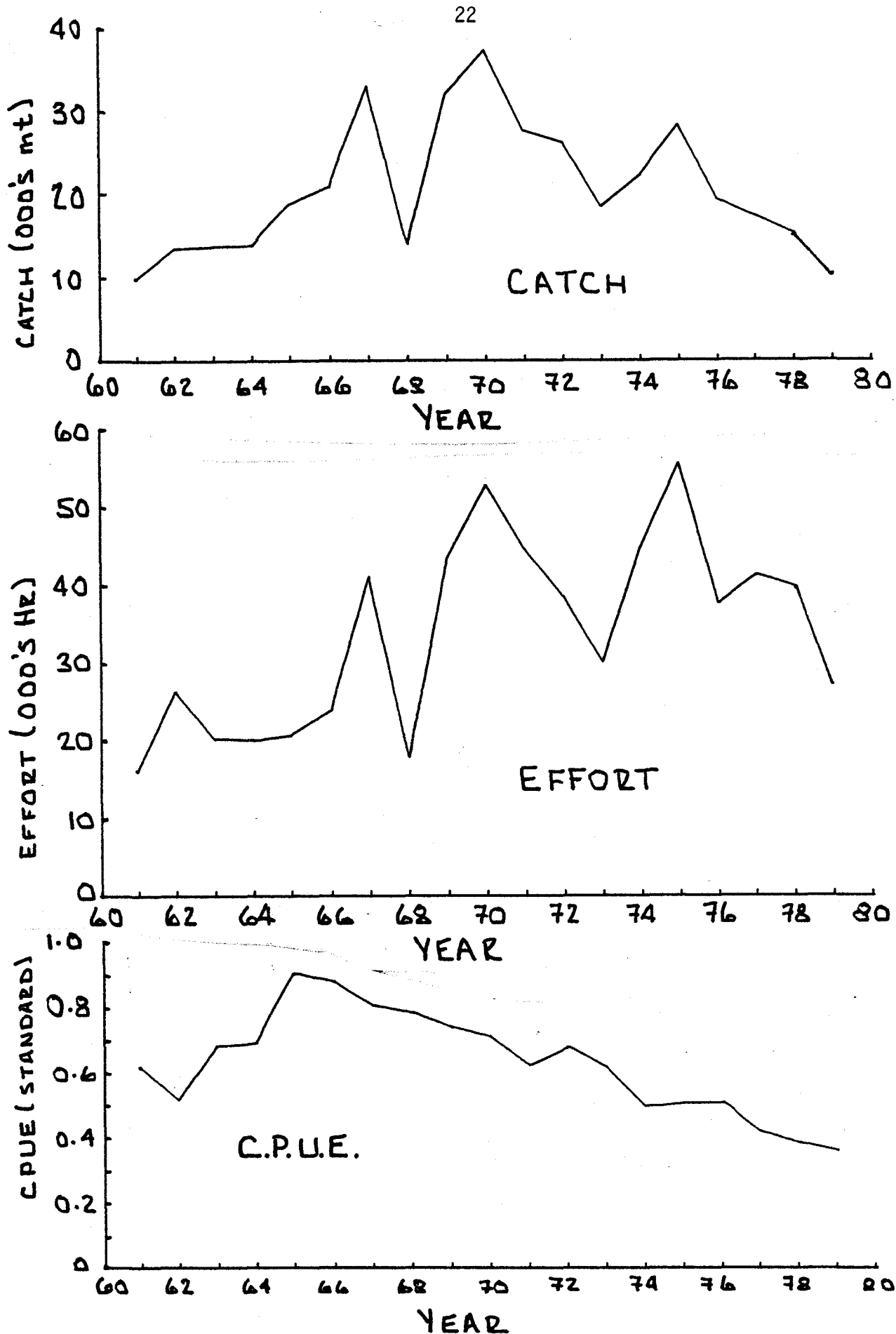


Fig. 1. Catch effort and CPUE for Redfish in 3Pn.
 (Standard is Newfoundland T.C. & OTB)

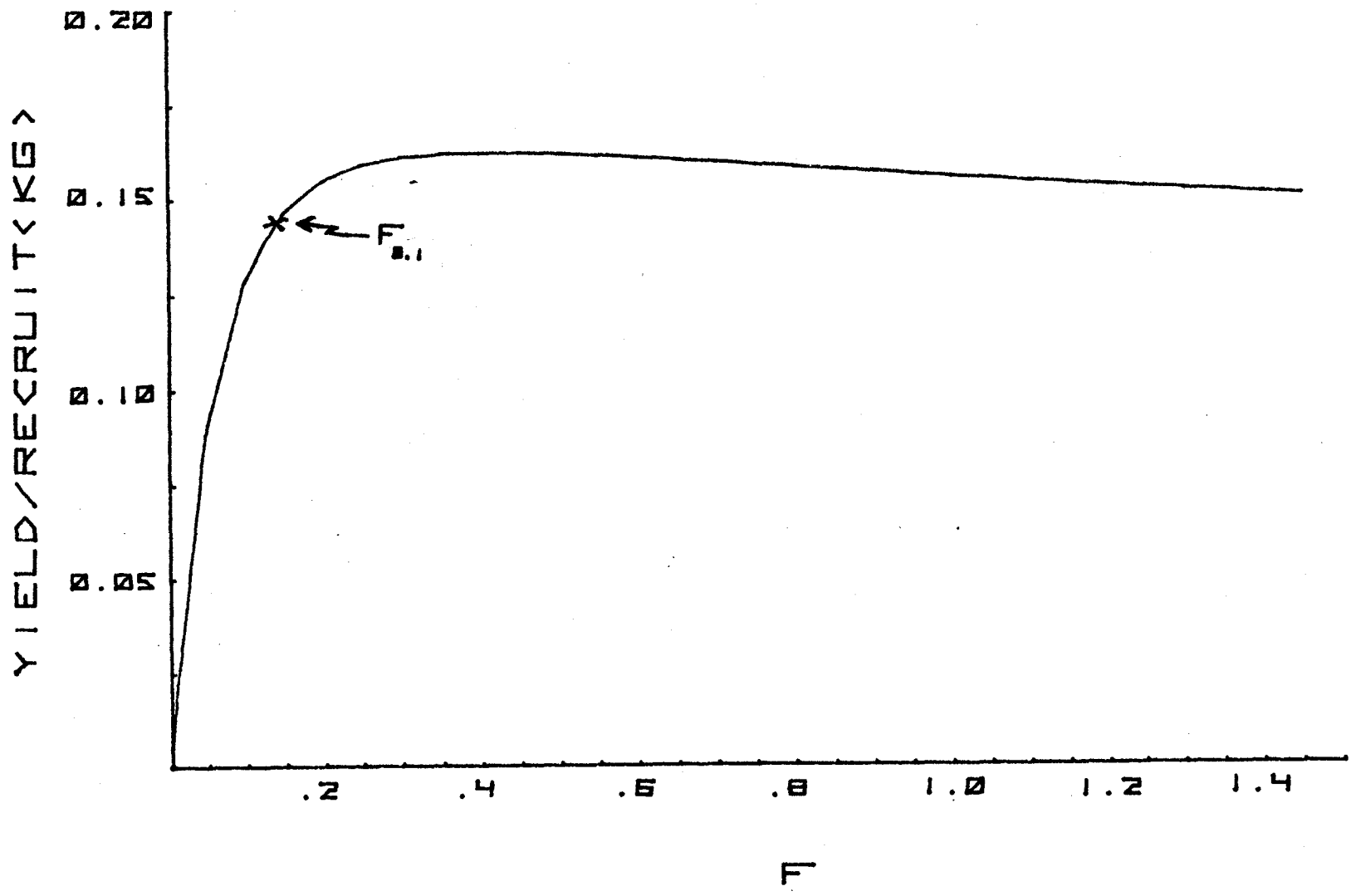


Fig. 2. Yieldper recruit curve showing $F_{0.1}$ (Thompson and Bell, 1934).

3PS
CANADA (NFLD)
OTTER TRAWL
1979

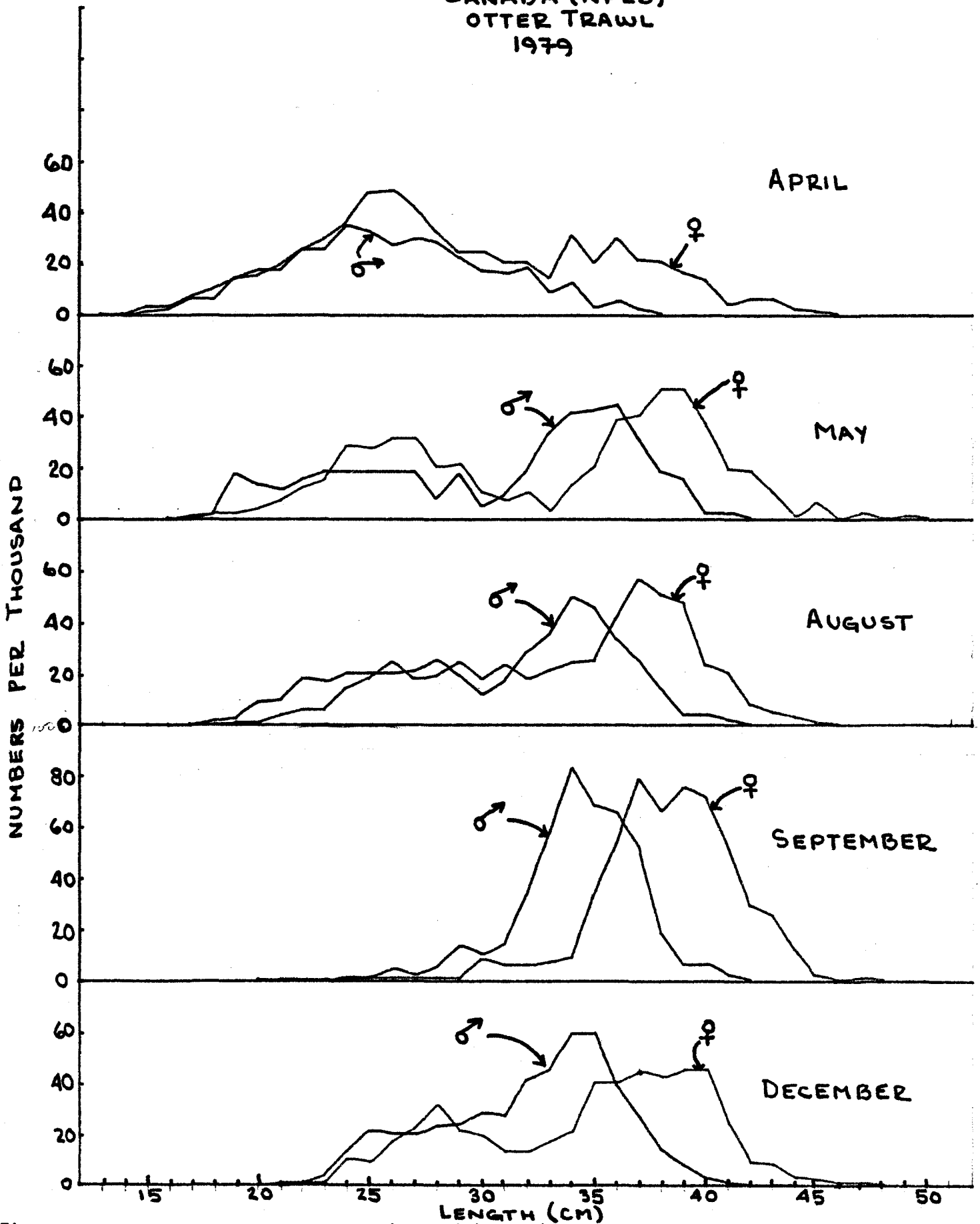


Fig.3. Commercial catches 3P, 1979 (Can. (N) O.T.)

3P
 REDFISH < MENTELLA >

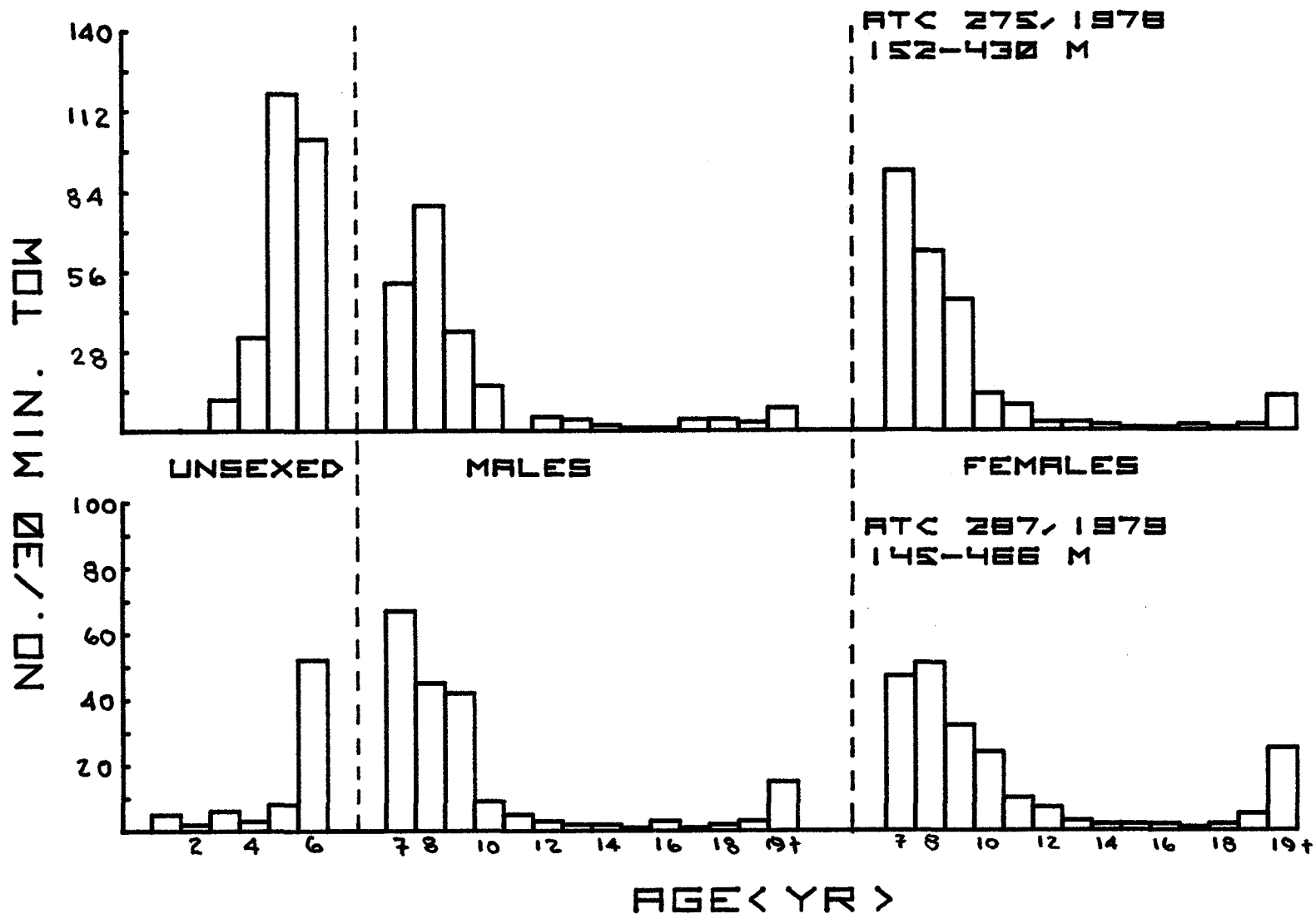
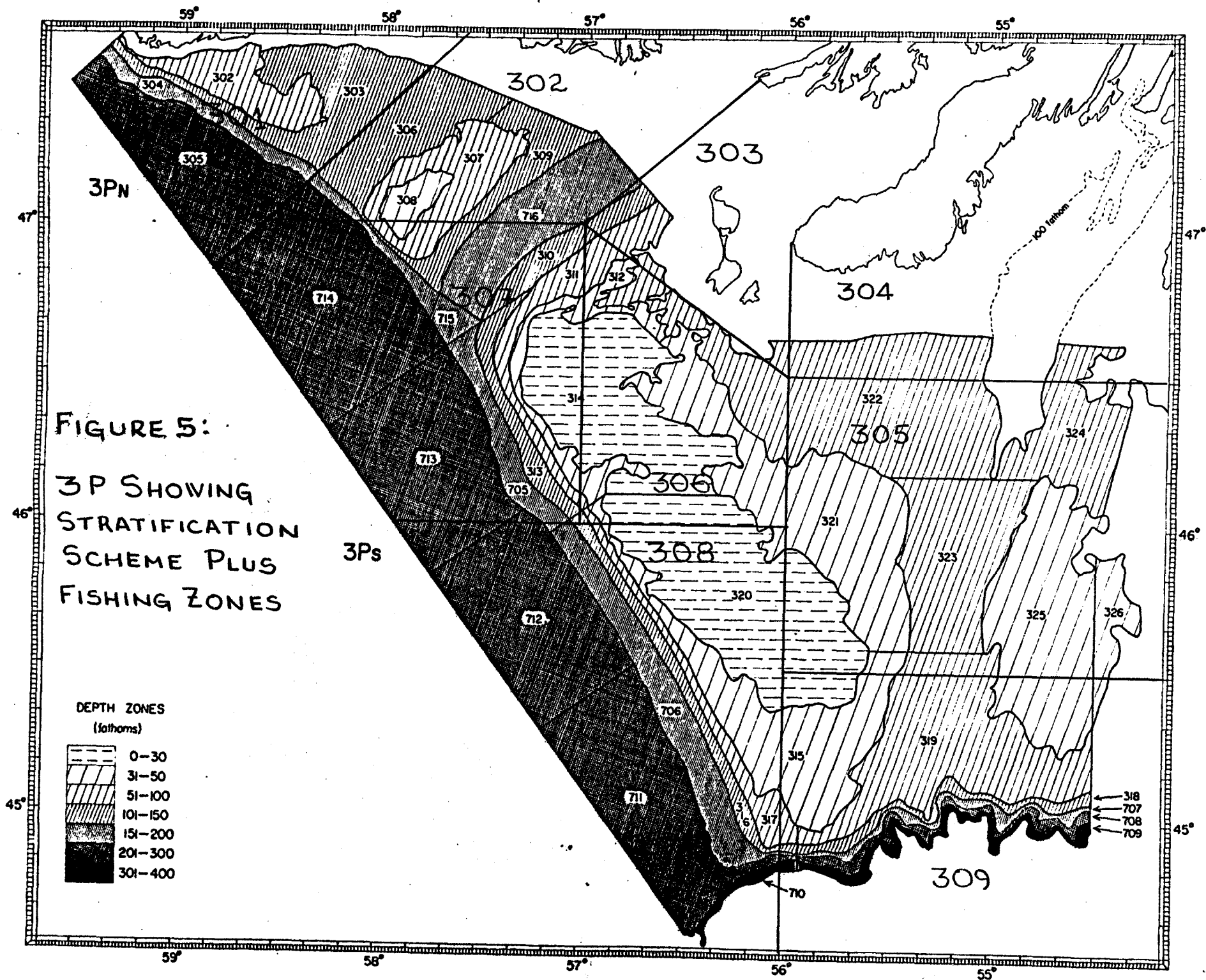


Fig. 4. Numbers at-age per standard tow from research cruises in 3Pn 1978 and 1979.



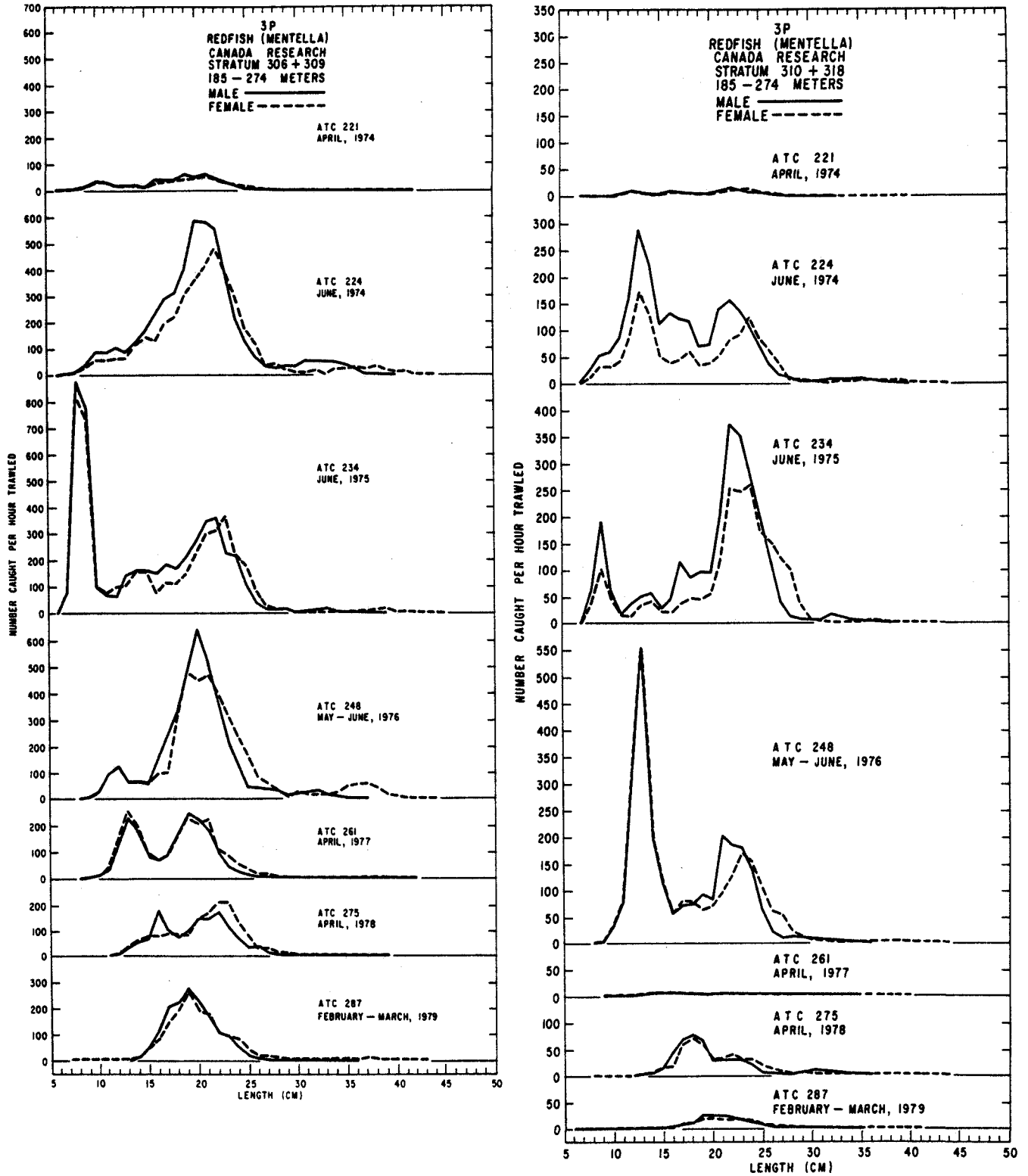


Fig. 6. Redfish research frequencies for selected 3P strata (number caught per hour).

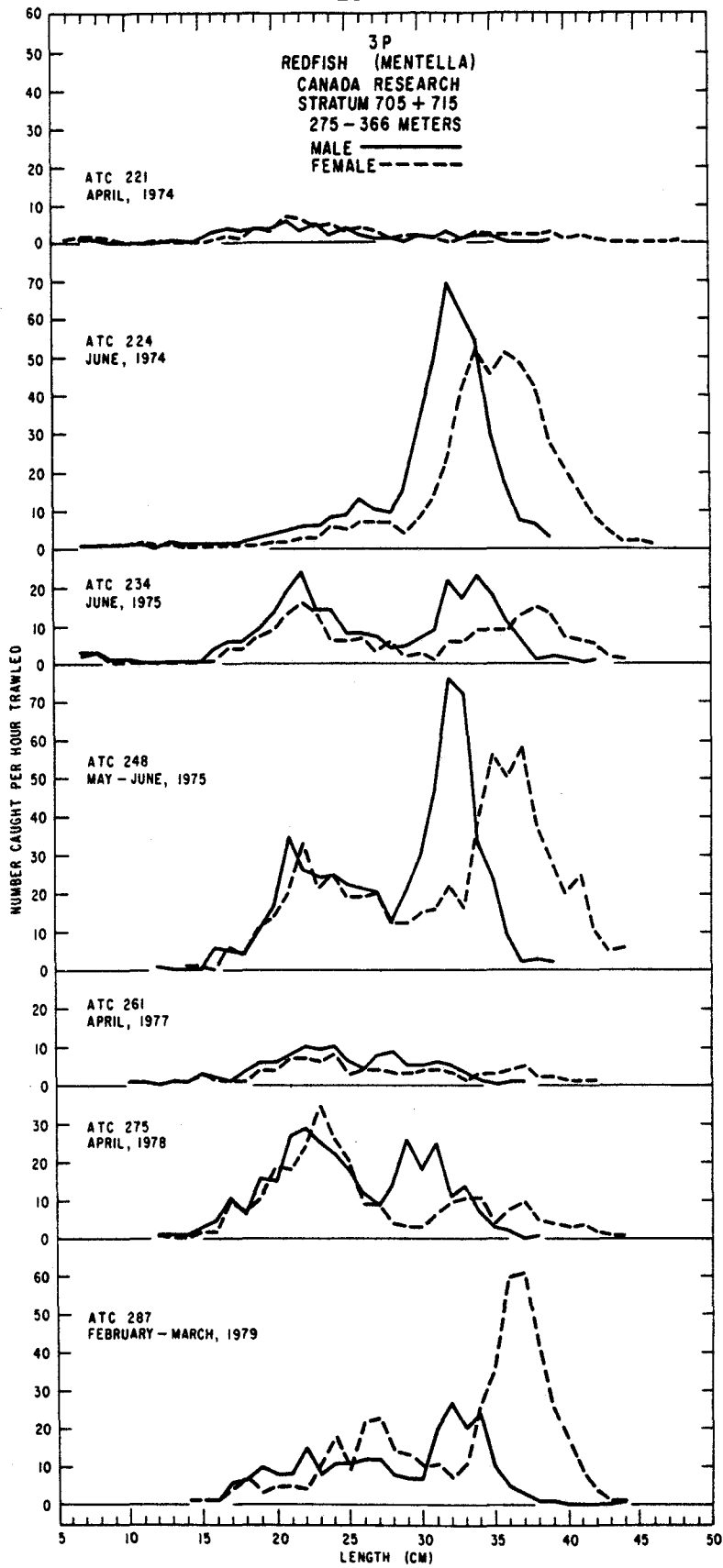


Fig. 7. Redfish research frequencies for selected 3P strata (number caught per hour).

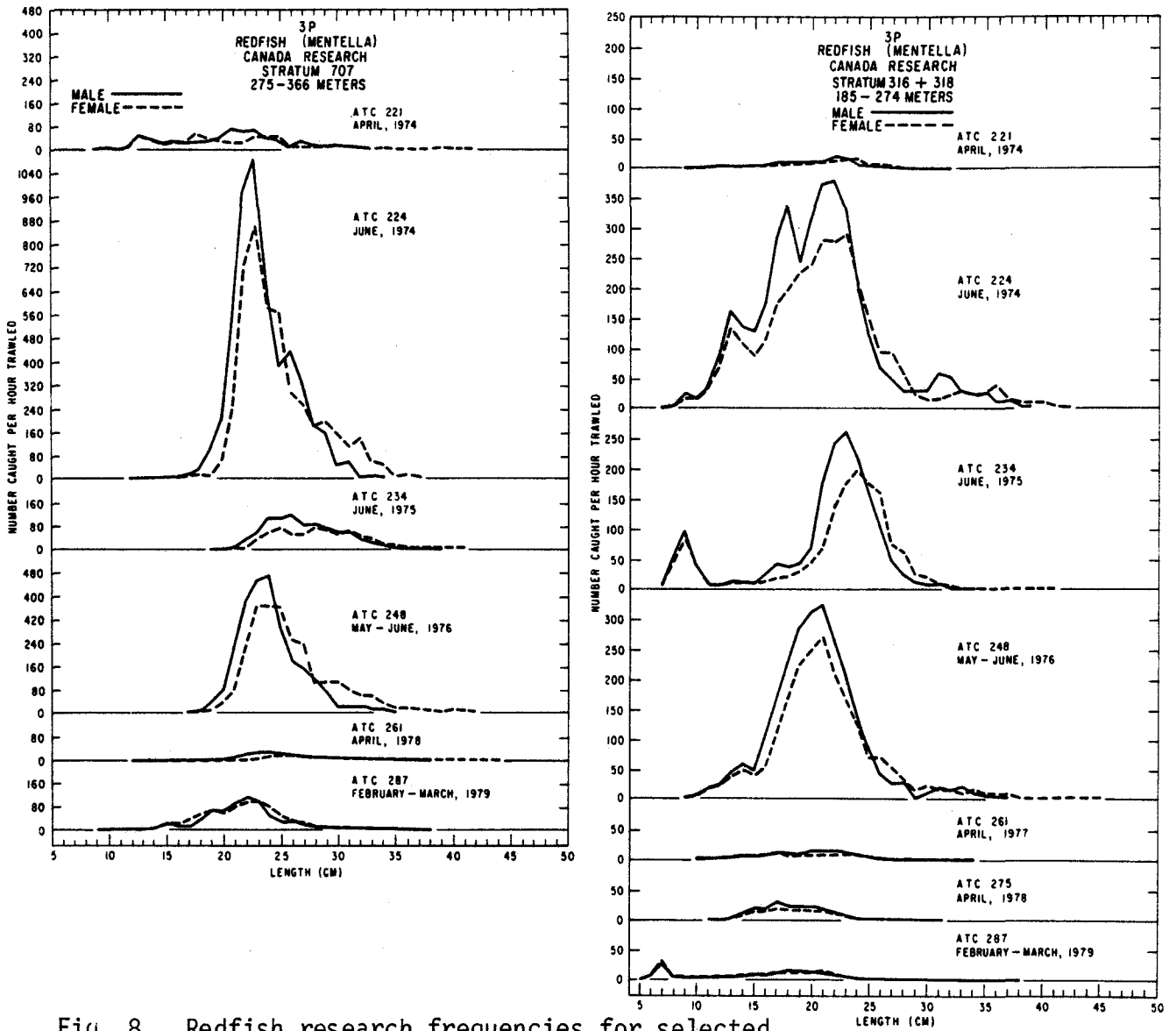


Fig. 8. Redfish research frequencies for selected 3P strata (number caught per hour).