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An assessment of Subarea 2+Division 3K Redfish

by

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INTRODUCTION

The status of the redfish stock in Subarea 2+Division 3K was evaluated in 1974 (Parsons et al, 1976) using the general production model as modified by Gulland (1961) and updated in 1977 (McKone and Parsons, 1977) and 1978 (McKone, 1978). This paper re-evaluates the stock using a simple production model. The standardization method uses information from the bycatch to determine a redfish-directed level of fishing effort.

MATERIALS AND METHODS

In previous assessments, redfish-directed catches were defined as those in which 50% or greater of the catch was redfish. As no single country was consistently represented over the years in the redfish-directed effort data, tonnage class formed the basis for standardization of effort. Tonnage class 7 was used as a standard with conversion factors for tonnage classes 4, 5 and 6. The country composition of the tonnage classes varied from year to year.

From multilinear regression analysis of catch and effort data (Gavaris, C., 1979; Gavaris, S., 1979) it was found that differences between countries of the same tonnage class were often large. Differences between Poland and USSR tonnage class 7 otter trawl were noted by McKone and Parsons (1977) in their assessment of the stock and contributed to anomalous results for effort in 1975. In addition the percentage of the total nominal redfish catch taken by a redfish directed fishery has been relatively low since 1967 (Table 2).

For this assessment, USSR tonnage class 7 otter trawl, which has generally taken a substantial proportion of the nominal redfish catch over the years of the fishery, was chosen as the standard. However, most of its redfish catch has been a by-catch of a mixed or groundfish fishery with a low percentage of the catches consisting of 50% or greater redfish. This by-catch information can be used to determine the catch rate which would be obtained if fishing effort were redfish directed, using the method described by Chikuni (1976).

A positive linear relationship between percentage of redfish in the catch and catch rate was assumed. For each year, a least squares regression of catch rate versus percentage of redfish in the catch by division and month was performed for USSR tonnage class 7 otter trawl catches. The resulting equations were used to predict the catch rate which would be obtained if the fishing effort were redfish directed.

To determine what percentage of redfish in the catch would be characteristic of redfish directed effort, the historical catches in Subarea 2 + Division 3K were examined. In 1958 and 1959, when USSR tonnage

class 7 otter trawl reported redfish-directed catches, the percentage of redfish in the catches was over 85%. Poland tonnage class 7 otter trawl has reported redfish-directed catches sporadically over the years from 1961 to 1977 which contained from 38% to 79% redfish. Canada (Maritimes-Quebec and Newfoundland) tonnage class 5 otter trawl vessels reported catches of 75 to 85% redfish in 1976 and 1977. In this assessment, 70% redfish was chosen as an appropriate "average" level to describe a redfish directed fishery over the years.

Similar calculations were performed for Poland tonnage class 7 otter trawl vessels. A linear regression of the catch rate at 70% redfish for the years 1961 to 1977 of Poland versus USSR tonnage class 7 otter trawl did not produce satisfactory results. Since a conversion factor could not be obtained for the Poland vessels, USSR alone was used as a standard.

The advantages of this approach to the standardization of effort were:

1. catch rates based on the same level of percentage redfish caught were compared from year to year.
2. the same country-gear-tonnage category used as a standard from year to year may better reflect changes in the condition of the stock than would a combination of country-tonnage class types where their inter-relationship is not well defined.

The disadvantages were:

1. the relationship between percentage redfish in the catch and catch rate may not be linear throughout all possible values, making prediction outside the range of observed values particularly dangerous.
2. the percentage of redfish in the catch defined as characteristic of redfish-directed effort may vary from year to year in response to the condition of the stock.

The simple production model was applied to the standardized effort

and catch data as information for the years 1964 to 1966 was inadequate and averaged effort could not be calculated. The years 1958 to 1960 were disregarded in the analysis as the extremely high catches of the early years would not reflect an equilibrium condition.

Age frequencies of male and female redfish in Divisions 2J and 3K from the 1977 Canadian research survey are shown (Fig. 4). The length frequencies of the redfish stock by depth from the 1978 research surveys to Subarea 2 + Division 3K are shown in Figs. 6-8 and the associated mean catch per tow at length are listed in Tables 3-5.

The length frequencies by month of redfish in Division 3K, as sampled from the 1978 Canadian commercial catch are shown in Fig. 5.

RESULTS AND DISCUSSION

The prediction equations for catch rate, given the percentage of redfish in the catch, based on USSR tonnage class 7 otter trawl, were calculated and the catch rate associated with 70% redfish catch found (Table 1). In all cases the regression coefficients were significant ($p<0.01$).

Trends in the nominal catch, catch per unit effort and total standardized effort for both the previously used standard and that based on the"Chikuni" method are shown in Table 2. Discrepancies between the two methods are apparent. This may be due to differences in calculating catch per unit effort on a daily versus hourly basis, the percentage of the total catch accounted for by each method, or the country composition

of the tonnage class categories of the previously used standard changing from year to year while the presently used standard lacks the additional information from other countries.

Catches in the 1970's have been fairly variable, ranging from 39 thousand tons in 1973 to 17 thousand tons in 1977. It is highly unlikely that this period would represent an equilibrium condition for the stock. Therefore the results from using the simple production model which follow, should be interpreted with caution.

The regression of catch per unit effort on standard effort resulted in a significant regression coefficient ($P<.01$) of -0.688 (Fig. 1). The yield curve based on the regression (Fig. 2) gave a maximum sustainable yield estimate of 38 thousand tons for 39 thousand hours of effort. The sustainable yield at two-thirds the effort at MSY was 34 thousand tons. The 1977 point was located slightly above the curve, corresponding to the lowest reported redfish catch in the history of the fishery. The yield curve, based as it is on unaveraged effort, would not reflect equilibrium conditions.

The yield curves from the 1978 analysis of the stock (McKone, 1978) are shown in Fig. 3 with the 1977 point included. The yield estimates at two-thirds the effort at MSY were 36, 39 and 42 thousand tons for the 10, 8 and 6 year averaging of effort respectively, based on catch and effort data up to 1972. The estimates are higher than they would be if the early years of the fishery (1958-60) had been omitted from the calculations. The 1977 point, as with all years since 1965, was located below the yield curve.

The age frequencies for redfish sampled during the 1977 Canadian research survey in Divs. 2J, 3K showed the bulk of the stock to be between 8 and 20 years of age.

The year classes entering the fishery did not appear to be unusually strong.

The mean number per standard tow at length obtained by the Canadian research cruise to Div. 3K in 1978 (Table 3) suggested that the 17-19 cm groups were relatively stronger than the neighbouring groups of pre-recruits. This showed up in both the mean numbers per tow for the 201-300 m depth zone and in the overall mean for the division. The same apparent strength was not evident in Divs. 2G, 2H or 2J (Tables 4 and 5). A comparison of the mean catch per tow between Divs. 2J and 3K (Tables 3 and 4) showed that the larger fish were more abundant in 2J. Divs. 2H and 2G are not strictly comparable with Divs. 2J and 3K as different survey methods were used and not all "redfish" depths were sampled in 2G and 2H.

Of the commercial fishing for redfish in Subarea 2 + Div. 3K, most has been carried out in Divs 2J, 3K. From the length frequency by month obtained from samples of the Canadian (Nfld.) commercial redfish catch in 3K in 1978 (Fig.5), the bulk of the catch was comprised of 27-38 cm fish, with fish larger than 38 cm abundant only at the greater depths. The tendency for larger fish to be found at greater depths was shown by the length frequencies by depth from both commercial and research sources.

CONCLUSION

The two methods of standardization of effort referred to in this paper did not account for all years. Therefore the averaging of effort, which would correspond to equilibrium conditions (Gulland, 1961), was not possible. The results of the simple production model analysis must be interpreted with caution.

The sustainable yield at two-thirds the effort at MSY suggested by the simple production model was 34 thousand tons. Earlier assessments, based

on catch and effort data up to 1972 set the yield at two-thirds the effort at MSY at 36, 39 and 42 thousand tons for the 10, 8 and 6 year averaging of effort respectively.

The age frequencies of the redfish stock in Divisions 2J and 3K sampled in 1977 by a Canadian research cruise did not show any unusually strong year classes entering the fishery. The significance to the fishery in the near future of the small-sized redfish which showed up in the 1978 research sampling in Div. 3K is not known.

REFERENCES

Chikuni, S. 1976. Problems in monitoring abundance in multi-species multi-gear groundfish fisheries in the Bering Sea. In: Monitoring of fish stock abundance: The use of catch and effort data. FAO Fish Tech. Pap. 155: 23-36.

Gavaris, C. 1979. Flemish Cap redfish assessment. ICNAF Res. Doc. 62. Ser. No. 5403 (mimeographed).

Gavaris, S. 1979. Assessment of the cod stock in Division 2GH. ICNAF Res. Doc. 47. Ser. No. 5386 (mimeographed).

Gulland, J.A. 1961. Fishing and the stocks at Iceland Fish. Invest. Land. (2), 23(4): 52 p.

McKone, W.D. 1978. A general production model assessment of Subarea 2 + Division 3K redfish. CAFSAC Res. Doc. 78/22 (mimeographed).

McKone, W.D. and D.G. Parsons. 1977. An update of the assessment of redfish from Subarea 2 + Division 3K, Division 3M, Division 3LN and Division 30 ICNAF Res. Doc. 18. Ser. No. 5038 (mimeographed).

Parsons, L.S., A.T. Pinhorn and D.G. Parsons. 1976. An evaluation of the Northern Newfoundland-Labrador and Flemish Cap Redfish Fisheries ICNAF Res. Bull. No. 12, p. 37-48.

Table 1. Least squares regression equations of CPUE (y) against percentage of redfish in the catch (x) for USSR 70T. The predicted CPUE at the 70% level, considered to represent a redfish directed fishery, was calculated and used as the standard CPUE.

YEAR	EQUATION	r^2	X = 70%
1960	$\hat{Y} = -0.064 + 0.024\ X$	.628	1.616
1961	$\hat{Y} = 0.224 + 0.011\ X$	.553	1.008
1962	$\hat{Y} = 0.109 + 0.015\ X$	.555	1.159
1963	$\hat{Y} = -0.028 + 0.032\ X$	.771	2.191
1967	$\hat{Y} = -0.001 + 0.025\ X$	.558	1.749
1968	$\hat{Y} = -0.032 + 0.031\ X$	.715	2.138
1969	$\hat{Y} = -0.012 + 0.021\ X$	.981	1.458
1970	$\hat{Y} = -0.047 + 0.023\ X$	.928	1.563
1971	$\hat{Y} = 0.048 + 0.010\ X$	.908	0.748
1972	$\hat{Y} = 0.022 + 0.015\ X$	.974	1.104
1973	$\hat{Y} = 0.030 + 0.016\ X$	.893	1.150
1974	$\hat{Y} = -0.025 + 0.021\ X$	.788	1.445
1975	$\hat{Y} = 0.006 + 0.017\ X$	.880	1.196
1976	$\hat{Y} = 0.036 + 0.019\ X$	.773	1.366
1977	$\hat{Y} = -0.113 + 0.031\ X$	.936	2.057

Table 2. Total catch, catch per effort, and total effort in Div. 2+3K for the standards where - (1) represents tonnage classes 7,6,5 and 4 where 50% or greater of the catch was redfish and (2) USSR 7 OT using the Chikuni method and predicted CPUE at 70% redfish.

YEAR	TOTAL CATCH	(1) % OF TTL.CATCH	STANDARD C/DAY	TOTAL STAN. EFFORT	(2) % OF TTL.CATCH	STANDARD C/ HOUR	TOTAL STAN. EFFORT ('000 HRS.)
1958	150,428	30	39.78	3,781			
1959	186,837	43	32.34	5,777			
1960	129,773	40	22.85	5,679	42	1.616	80.305
1961	55,455	35	13.25	4,185	33	1.008	55.015
1962	19,657	28	17.54	1,121	24	1.159	16.960
1963	23,671	64	20.09	1,177	24	2.191	10.804
1964	56,178	35	13.36	4,205	7		
1965	42,653	50	17.36	2,457	2		
1966	32,730	49	11.67	2,804	8		
1967	26,162	43	13.23	1,977	22	1.749	14.958
1968	18,913	8	14.31	1,319	27	2.138	8.846
1969	24,786	15	14.30	1,720	50	1.458	17.000
1970	21,970	4	14.95	1,458	47	1.563	14.056
1971	19,356	18	11.70	1,650	50	0.748	25.877
1972	20,033	11	12.84	1,560	67	1.104	18.146
1973	38,965	16	16.84	2,314	62	1.150	33.883
1974	30,145	30	16.38	1,840	34	1.445	20.861
1975	25,559	5			44	1.196	21.370
1976	25,965	35	17.15	1,514	55	1.366	19.008
1977	17,351	43	14.34	1,210	44	2.057	8.435

Table 3. Mean number caught at length per half-hour tow for male and female redfish in Div. 3K from 1978 Canadian research sampling.

Length (cm) \ Depth (m)	Males 201-300	301-400	401-500	501-750	All Depths	Females 201-300	301-400	401-500	501-750	All Depths
8	1									
9	1									
10	1				1	1				
1	3				2	3				2
2	7				4	6				3
3	7				4	6				3
4	4				2	4				2
15	3				2	3				1
6	7	1			4	6				3
7	15	1	1		8	12	1	1		7
8	21	2	2		11	17	2	1		9
9	16	2	1		9	15	1	1		8
20	4	2	1		3	4	1	0		3
1	2	6	1		3	1	7	1		3
2	2	10	1		4	1	12	0		4
3	1	29	2		10	1	23	1		8
4	2	70	2	2	23	2	39	2	1	14
25	2	86	4	2	29	2	55	3	3	19
6	2	102	5	5	34	1	78	5	1	26
7	2	60	5	2	21	1	52	3	6	18
8	2	68	7	9	24	1	56	6	7	20
9	3	47	6	16	18	1	37	7	14	14
30	2	44	9	22	17	1	38	6	13	14
1	3	33	8	26	15	1	20	5	19	9
2	3	35	6	18	14	1	20	4	26	9
3	2	29	3	14	11	1	15	3	16	7
4	1	21	3	23	9	1	8	2	13	4
35	1	22	2	21	9	1	13	1	20	6
6	1	14	2	15	6	1	4	2	19	3
7	2	9	1	24	5	0	2	2	23	3
8	1	8	1	22	5	0	10	1	24	5
9	1	6	2	13	3	0	5	1	20	3
40		2		4	1	0	4	1	5	2
1				2		0	3	0	6	1
2				1		0	6	0	2	2
3				0		1	3	0		1
4				0		1	5	0		2
45				0		1	3	0		1
6				1		1	4	0		2
7						1	2	1		1
8						1	2			1
9							1			

Table 4. Mean number caught at length per half-hour tow for male and female redfish in Div.2J from 1978 Canadian research sampling.

Length (cm) \ Depth (m)	201-300	301-400	401-500	501-750	All Depths	201-300	301-400	401-500	501-750	All Depths
	Males					Females				
7	1					1				
8	2	1			1	2	1			1
9	2	1			1	1	1			1
10	1	0			1	1	0			
1	1	0			0	0	0			
2	1	0			0	0	0			
3	0	0			0	0	0			
4	0	0			0	0	0			
15	0	0			0	0	0			
6	0	1			0	0	0			
7	0	0			0	0	0			
8	1	0		1	1	1	0			1
9	2	1		0	1	1	0			1
20	1	1		0	1	2	1	1		1
1	1	4	1	0	2	2	2	1		2
2	4	18	3	0	6	4	11	1		4
3	6	36	8	2	11	6	21	4	3	8
4	7	49	10	5	15	7	35	7	2	11
25	7	45	15	5	15	5	42	19	3	13
6	5	47	19	5	14	6	34	21	9	13
7	4	44	21	11	14	4	30	21	11	11
8	3	31	21	12	11	3	26	22	14	11
9	3	36	26	22	14	2	33	25	19	12
30	2	41	37	22	15	1	32	24	13	11
1	1	53	32	27	17	2	24	44	24	13
2	1	75	36	29	22	1	22	22	20	9
3	1	73	31	21	19	1	26	19	24	10
4		61	30	25	18	1	26	16	27	10
35		37	38	35	15	1	27	22	23	10
6		28	36	39	14		26	14	27	9
7		19	44	39	13		23	32	45	13
8		13	**26**	47	11		28	31	38	13
9		14	25	29	9		12	34	34	10
40		7	4	13	3		11	28	21	8
1		0	6	5	1		6	27	12	6
2		1	2	1			5	12	4	3
3			1				2	11	2	2
4							0	11	1	2
45							0	6	1	1
6							1	2		1
7								2		
8								3		
9								1		

Table 5. Mean number caught at length per half hour tow for male and female redfish in Divs. 2G and 2H from 1978 Canadian research sampling.

	2G MALES		2G FEMALES		2H MALES	2H FEMALES
Depth (m)	301-	401-	301-	401-	301-	301-
Length (cm)	400	500	400	500	400	400
15						1
6						1
7					1	1
8	1				2	1
9	1		1		3	1
20	1		1	1	2	1
1	3	1	4	0	3	1
2	4	1	7	0	4	4
3	8	4	6	5	6	4
4	9	6	7	7	8	5
25	8	10	11	8	7	5
6	10	9	11	10	7	6
7	8	6	4	7	9	6
8	9	7	9	13	8	7
9	10	11	6	8	8	9
30	9	9	10	6	9	9
1	17	12	5	4	12	6
2	14	25	8	12	15	8
3	17	10	6	7	13	9
4	6	12	6	8	13	8
35	7	9	4	12	8	11
36	4	9	7	13	11	9
7	2	14	3	12	4	8
8	2	11	5	14	8	8
9	1	9	2	14	6	7
40		4	1	7	4	6
1		1	5	5	4	8
2		1	1	3	2	7
3				1		7
4				0		4
45				1		1
6				1		1
7						
8						
9						

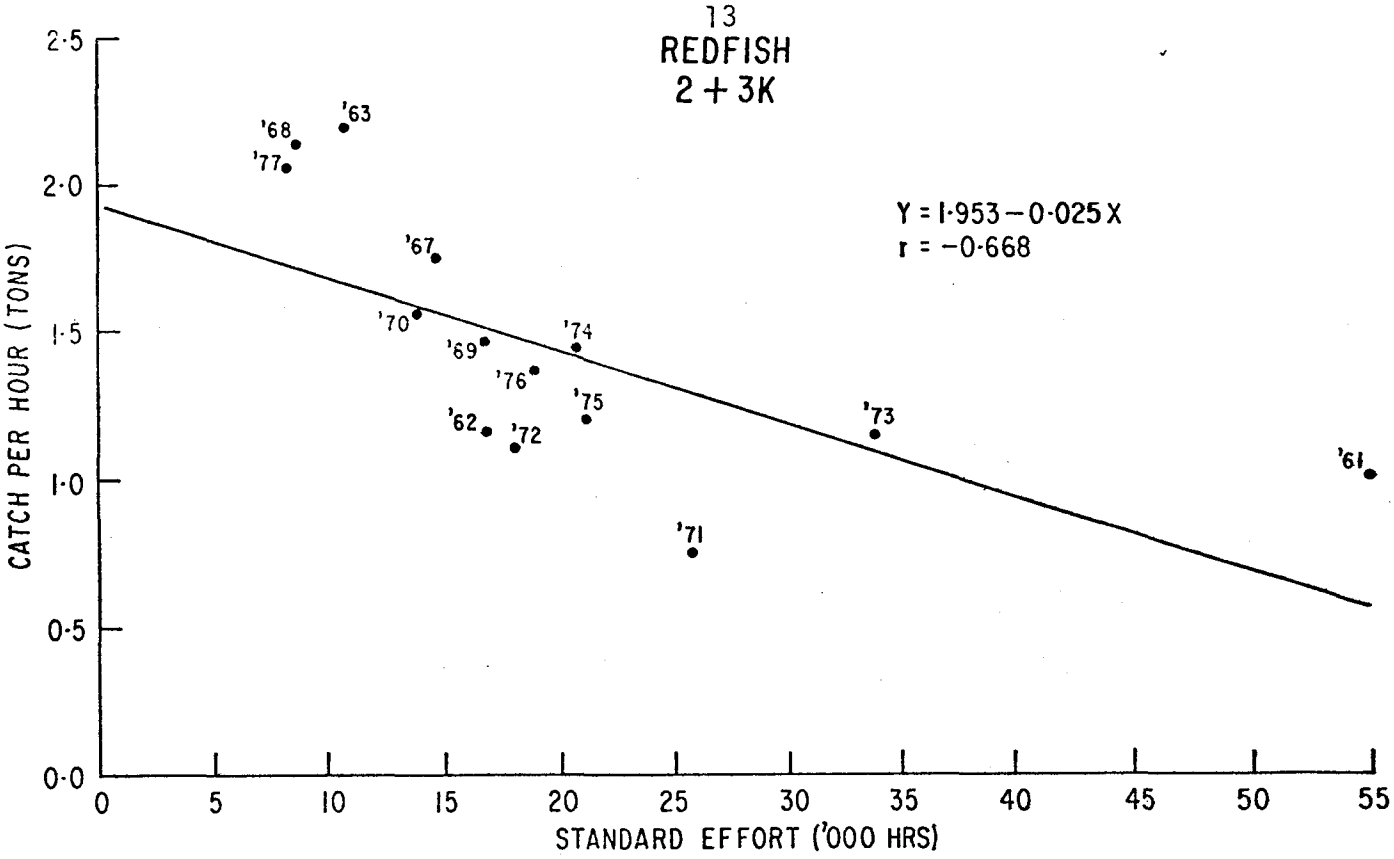

Fig. 1. Least squares regression of catch per standard hour fished against standard hour fished (USSR 7 OT).

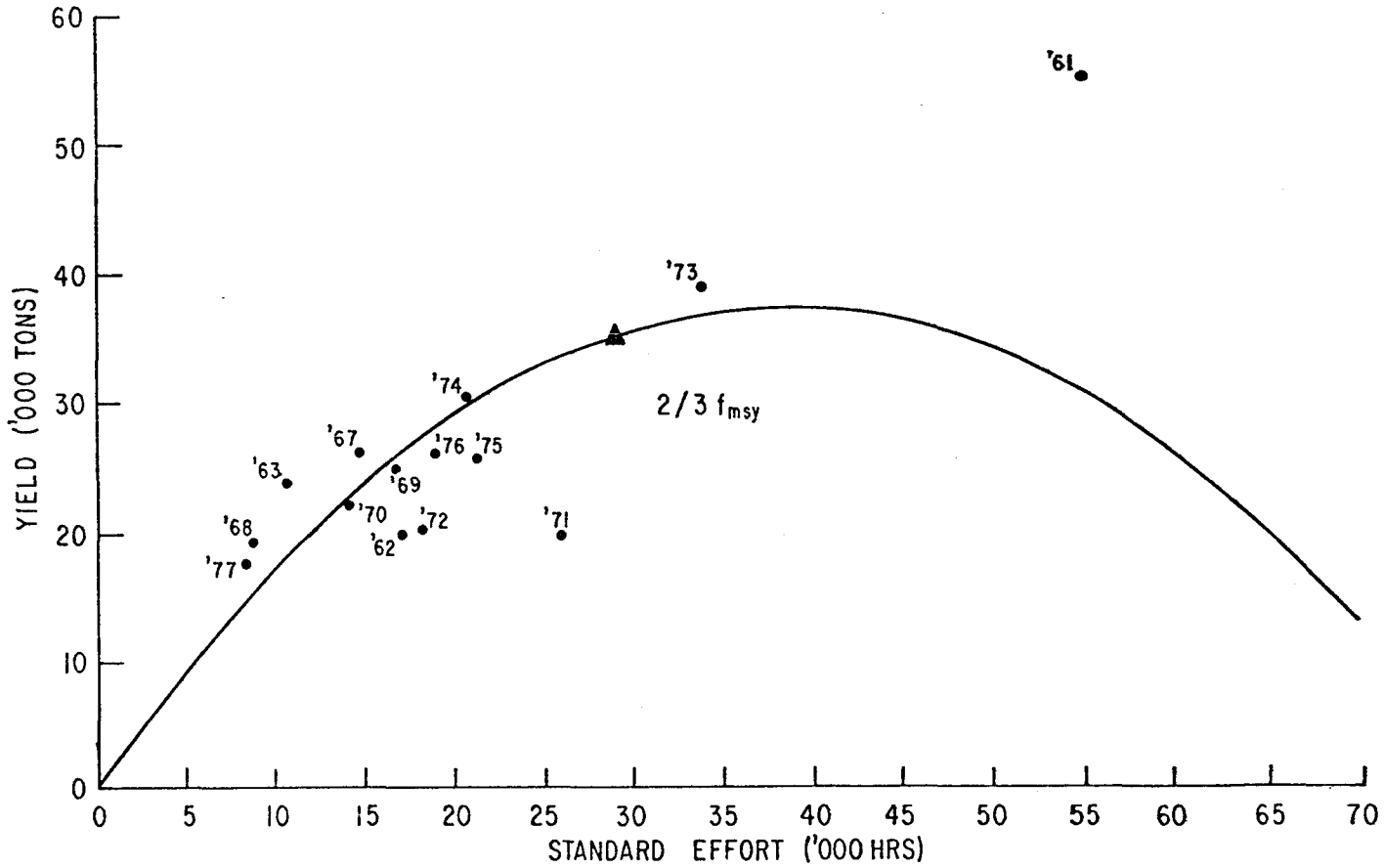

Fig. 2. Yield curve derived from the regression shown in Fig. 1.

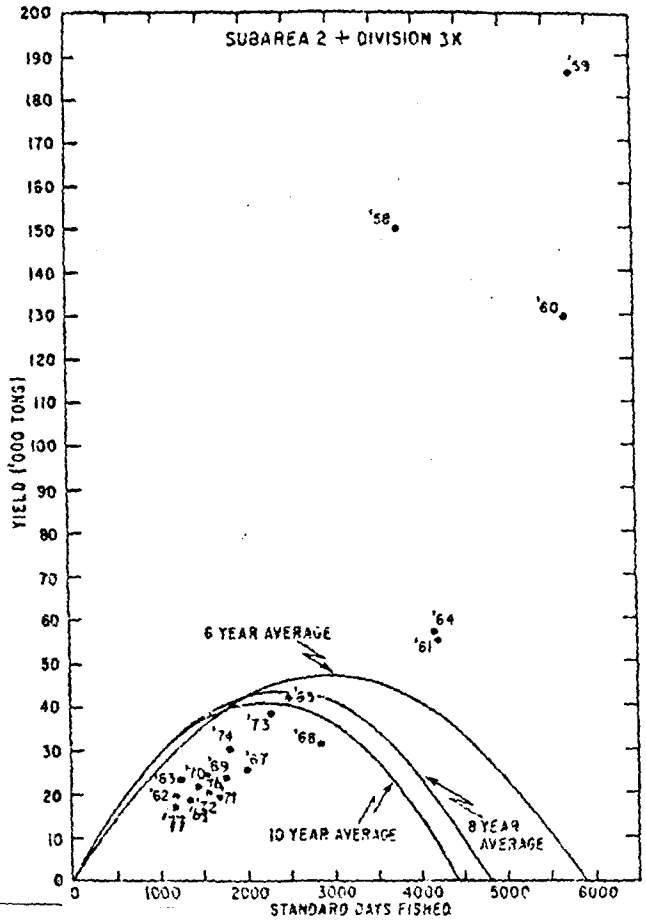

Figure 3. Yield curves for redfish Subarea 2 + Division 3K derived from catch per unit effort using 6 year, 8 year, and 10 year running averages of standard days fished from Parsons et al 1976 extended to include 1973-1977.

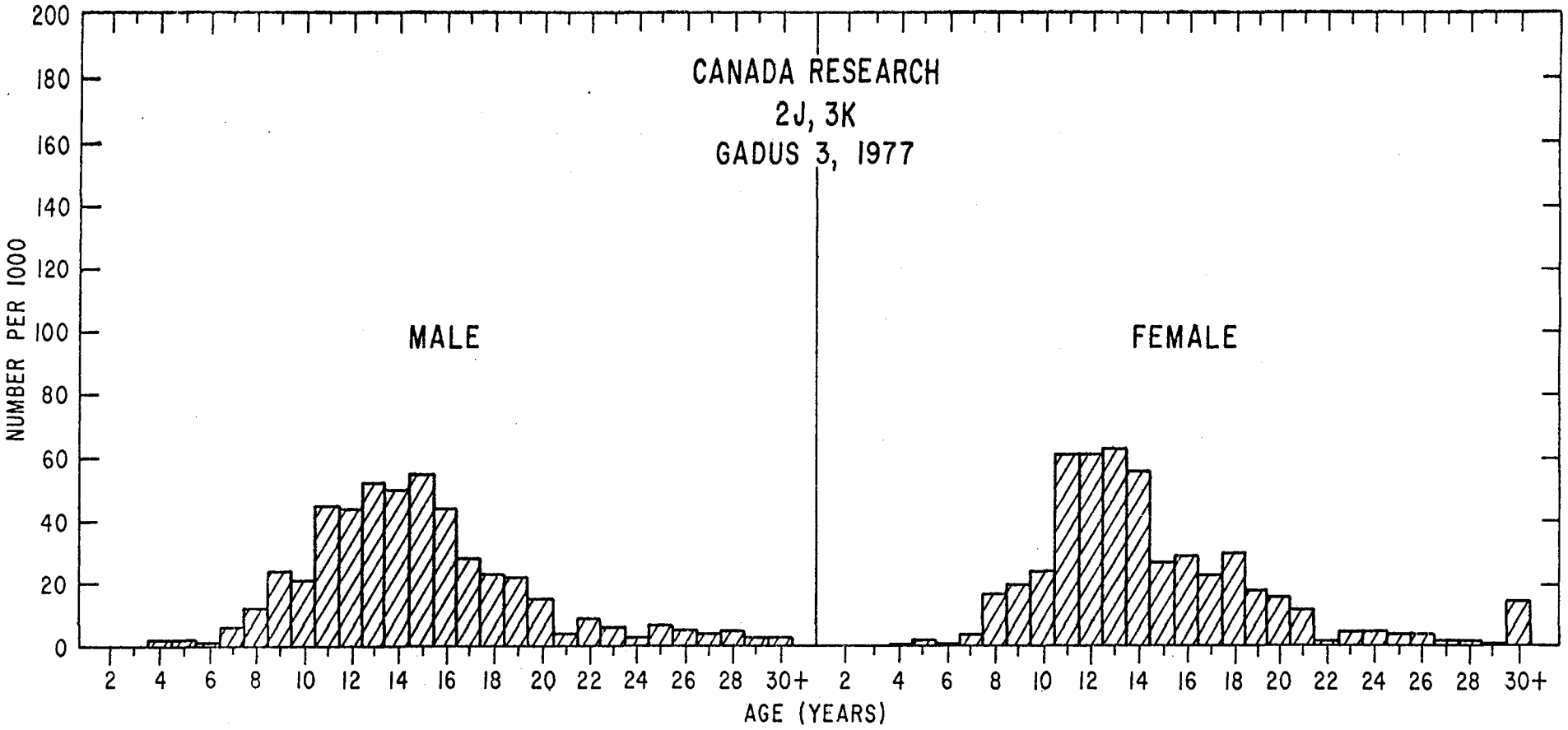

Fig. 4. Age frequencies of the 1977 Canadian research sampling in Divisions 2J, 3K.

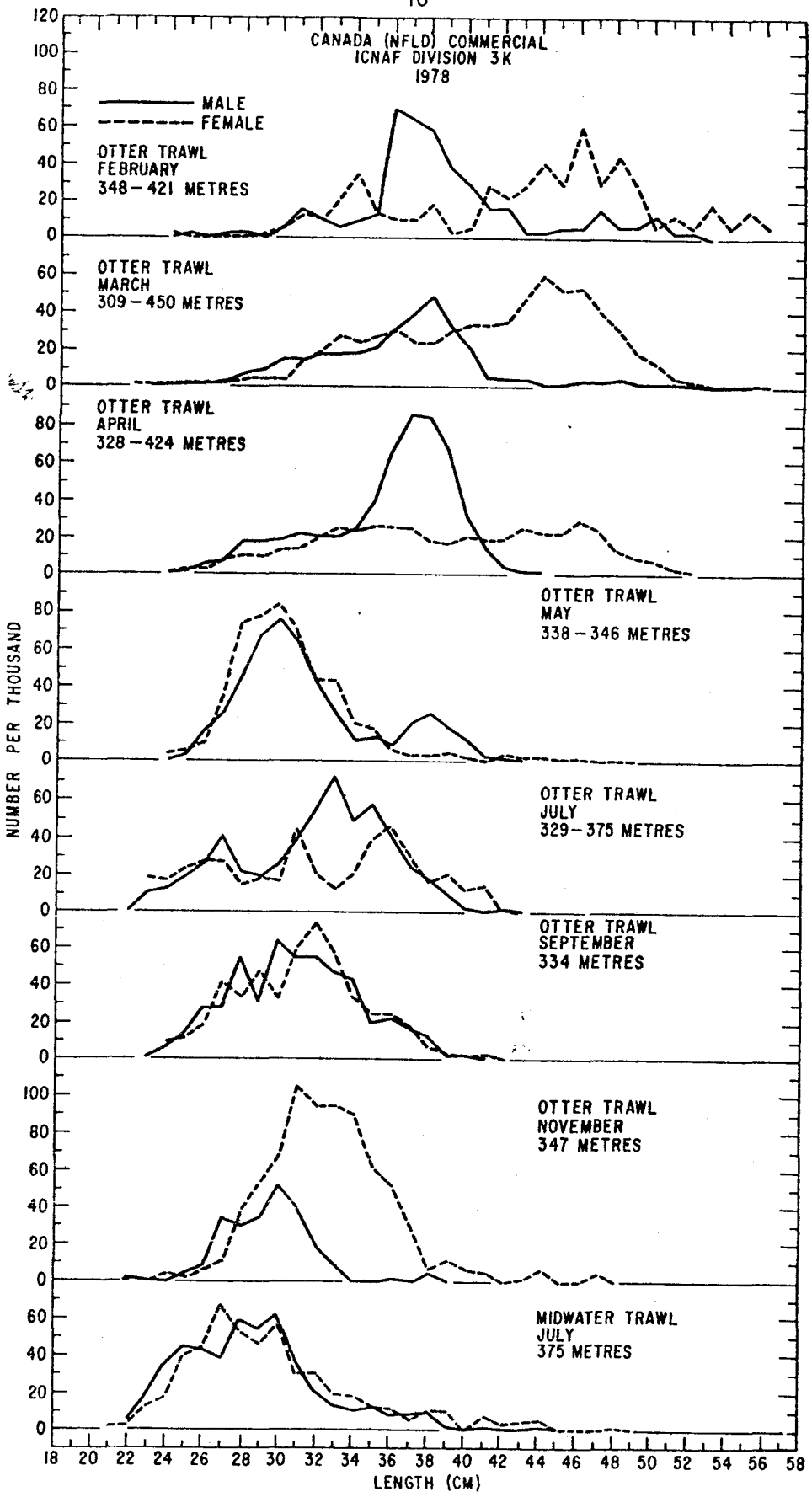

Fig. 5. Length frequencies of redfish in Div. 3K from Canadian commercial catches in 1978. Otter trawl catches at greater depths contained larger sized redfish than those at shallow depths

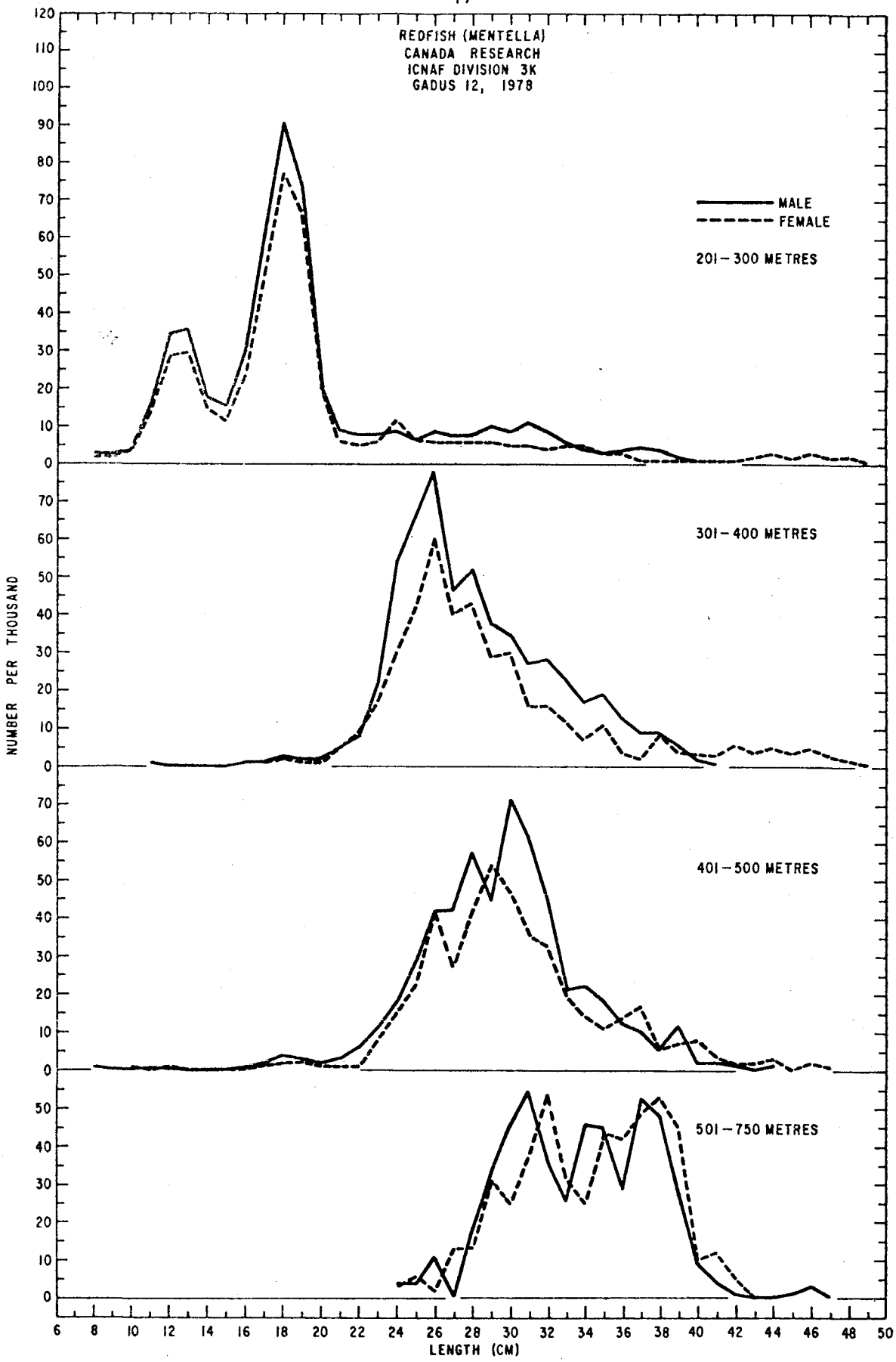

Fig. 6. Length frequencies of male and female redfish from Canadian research random stratified samples in Div. 3K in 1978. An increase in size of redfish with depth is clearly shown.

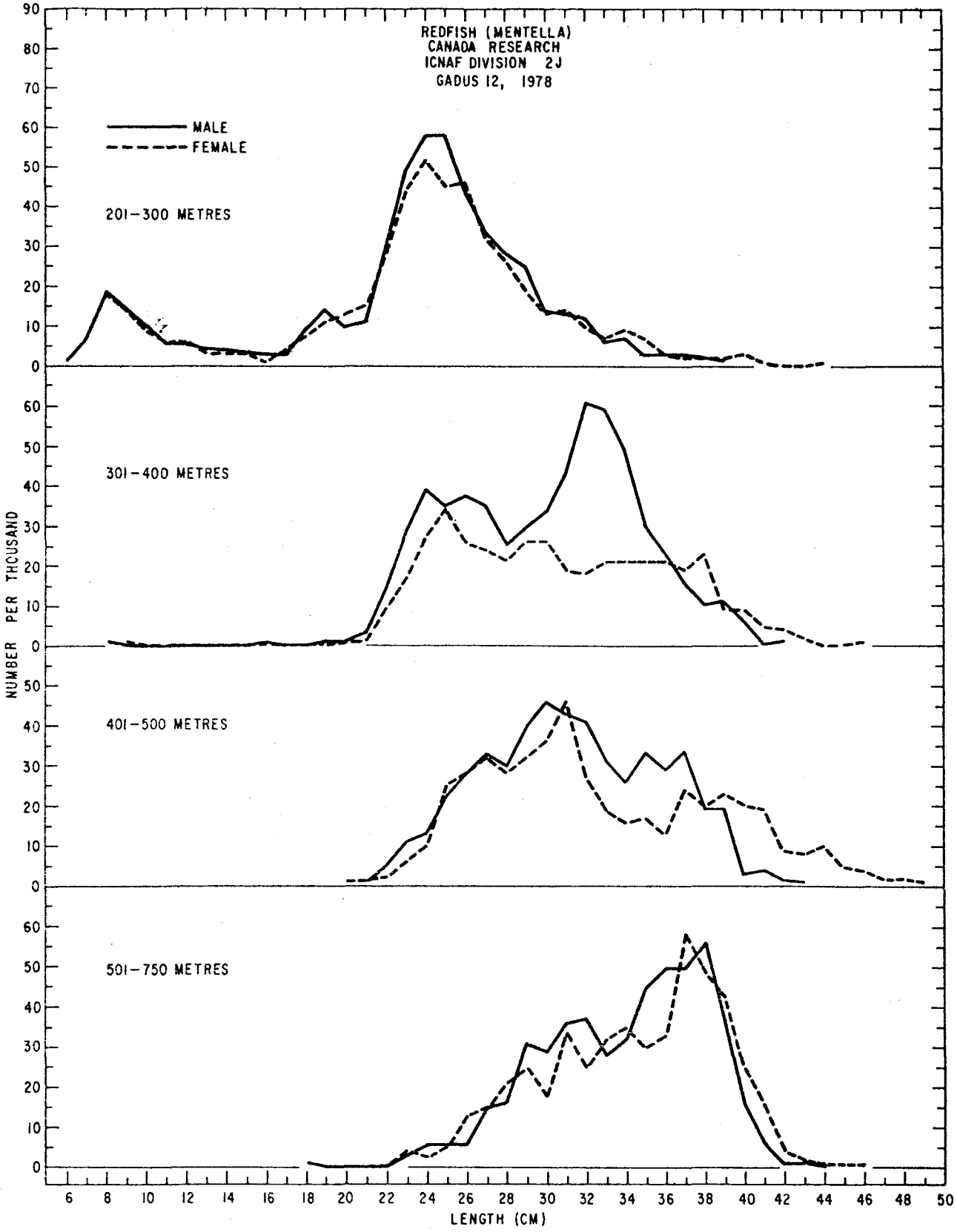

Fig. 7. Length frequencies of male and female redfish in Div. 2J from Canadian research sampling using a random stratified design.

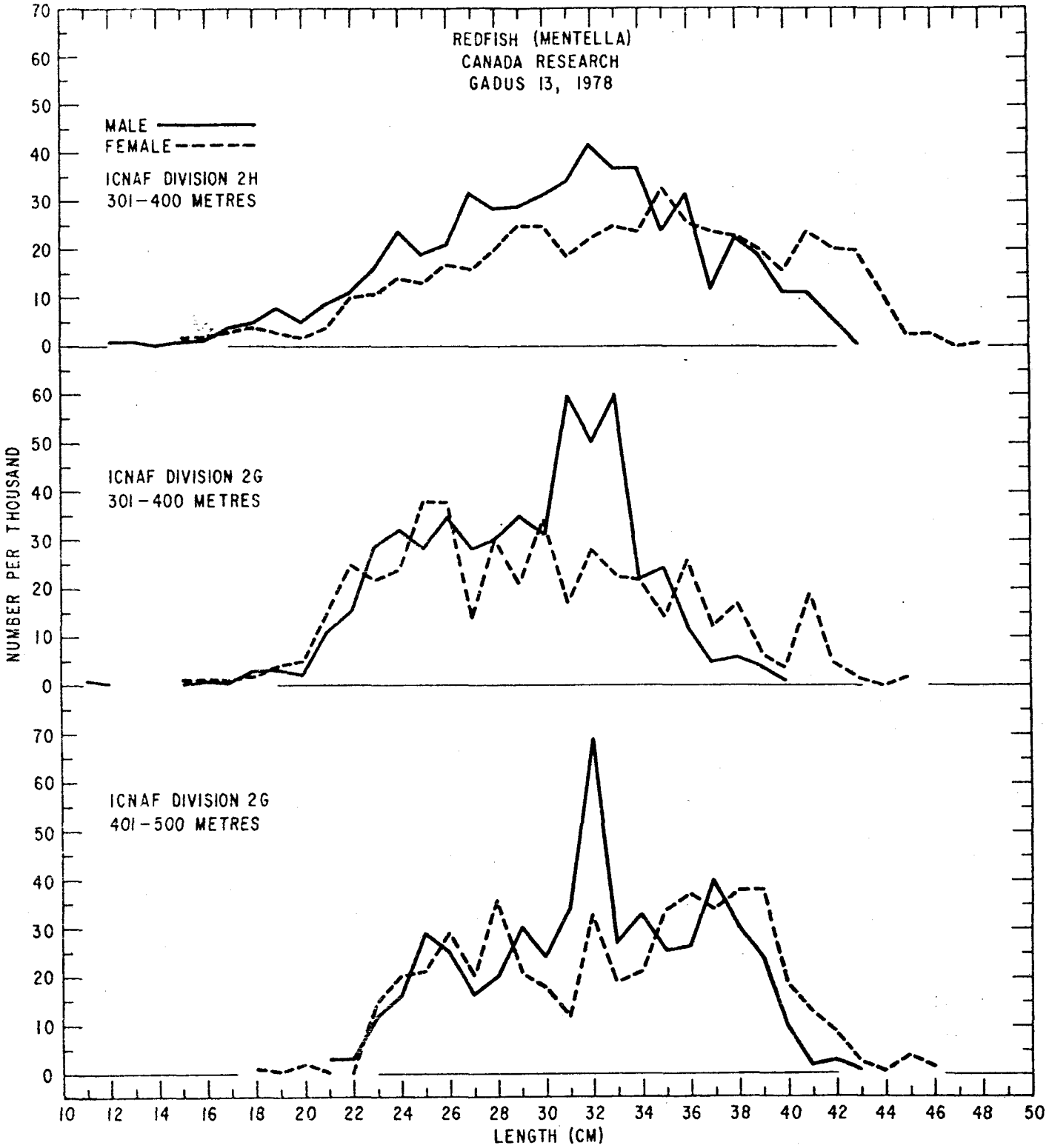

Fig. 8. Length frequencies of male and female redfish in Div. 2H and Div. 2G from Canadian research sampling by line survey.