CAFSAC
Research Document 80/25

An Assessment of Subarea 2 + Division 3K Redfish

by

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Abstract

A simple surplus production model which indicated a yield at two-thirds effort MSY of 34,000 t was updated based on the 1978 CPUE of the standard (USSR TC7 ØT). The 1978 catch rate, down from 1977, was close to the expected catch rate at two-thirds effort MSY. To account for the increasing participation of Canadian vessels in the fishery, a new effort standard based on Canada (Nfld) TC 5 otter trawlers was developed. Both standards indicated a generally stable condition for the stock. A preliminary cohort analysis was presented but no projections were made due to the too few years of data available.

Résumé

Un simple modèle de production excédentaire qui indiquait un rendement de 34,000 t avec les deux tiers de l'effort de RMS a été mis à jour en se fondant sur les prises par unité d'effort de 1978, selon la norme d'effort des chalutiers de l'URSS (CT7). Le taux de capture de 1978, en baisse par rapport à celui de 1977, se rapproche du taux de capture anticipé avec les deux tiers de l'effort de RMS. Afin de tenir compte de la participation accrue des bateaux canadiens aux opérations de pêche, une nouvelle norme d'effort, fondée sur les chalutiers canadiens de classe de tonnage 5(T.-N.), a été établie. Les deux normes indiquent une condition généralement stable du stock. Cet article présente une analyse préliminaire par cohortes, sans toutefois faire de prédictions, à cause du peu d'années pour lesquelles on ait des données.

Introduction

Since the mid-60's, catches of redfish in 2+3K have generally averaged between 20 and 30 thousand tonnes. In the last few years, Canadian participation in the fishery has increased greatly so that in 1978 and 1979 more than 80% of the catch was harvested by Canadian vessels. This has necessitated a change in the effort standard used for the most recent years.

Ageing of the commercial catch over the past four years has made possible a preliminary cohort analysis of this stock.

Materials and Methods

Standardization of CPUE data

For the purpose of updating last year's general production model, the 1978 catch rate of USSR 70T vessels was calculated, using the Chikuni method (Gavaris, 1979), and added to the equilibrium curve (Fig. 1).

To obtain an effort standard with which the estimates from cohort could be compared, the standardizing procedure described by Gavaris (1980) was used. Redfish directed catches were defined as those in which 50% or greater of the catch was redfish. Effort data for the major participants in the fishery were obtained from ICNAF records and for 1979 from Economics reports. Catch rates were weighted by effort and the variable categories used in the regression were country-year-tonnage class combination, division, months and years.

Numbers at age

Age/length keys derived from the commercial fishery were applied to the commercial catch to give the age composition of the catch from 1976 to 1979 (Table 2). The sampling coverage has improved over the four years, presently consisting of Canadian sampling from almost all months.

Research surveys

Research surveys to 2J, 3K have been conducted in 1978 and 1979, with the coverage in 1978 being more extensive. Catch at age was available from a 1977 research cruise which sampled mainly in division 2J.

Estimation of Parameters

Standardization of CPUE

The results of the multilinear regression were significant (multiple R^2 = 0.55) with the assumptions of the model satisfactorily met. Canada (Newfoundland) tonnage class 5 ottertrawl vessels were chosen as the new reference category on the basis of a lower average coefficient of variation of their predicted catch rates than those of other vessels. A summary of the historical catches and the catch rates and effort of the two standards (Can N 5 ØT and USSR 7 ØT) is given in Table 1.

Partial recruitment and mean weight at age

An estimate of the partial recruitment vector used in the cohort analysis and yield per recruit was calculated from the ratio of the precent composition of the catch at age between the commercial and research catch. As only one year of ageing was available from the research survey data, the estimate was based on only one year's data. The partial recruitment vector is shown along with the mean weight at age in Table 3.

Natural and fishing mortalities

A natural mortality of 0.1 was assumed for all cohort runs as a "reasonable" estimate for a long-lived species such as redfish. A range of fishing mortalities from 0.05 to 0.25 was used.

Results

The general production model, as calculated last year, suggested a MSY and a two-thirds effort at MSY of 38 and 34 thousand tonnes respectively. The 1978 catch-effort point was located close to the equilibrium curve, the catch rate being approximately equal to the expected at 2/3 f_{MSY}.

The catch at age data for males and females combined from the 1977 research cruise was used to calculate a catch curve (Fig. 2). A Zvalue of 0.23 was found which would suggest a fishing mortality of 0.13 (m = 0.10).

The catch at age matrix (Table 4) showed an abundance of young redfish which may reflect good recruitment. The greater commercal acceptance of small fish may also be an important factor. An attempt was made to calculate survival rates (Paloheimo method) for the fully recruited age classes (14-28) from the commercial catch at age and effort data over a single and two year period. Years 1976-1977 and 1977-1978 estimate F at approximately 0.20. The 1979 effort, derived from Newfoundland data only, could be an underestimate of effort, leading to the anomolous result of survival between 1978 and 1979. The unusual result obtained from a two year period may have been caused by large changes in effort between the years.

A yield per recruit analysis, using the mean weight at age and partial recruitment vectors of Table 3 gave an F0.1 and Fmax of 0.13 and 0.28 respectively (Table 5).

The population numbers and fishing mortalities from the cohort runs, using terminals F's of 0.10 and 0.15 are shown in Table 6. Both these levels of fishing mortality would suggest that the stock biomass was in a stable condition. The relationship between the population biomass of ages 6 to 29 years from the various cohort trials and CPUE is shown in Table 7. The rank correlation, a non-parametric measure of the agreement in trends (+1 denotes perfect agreement, -1 perfect disagreement) was calculated using all years and without the 1979 CPUE. In the first case, the trends in CPUE agree most highly with the biomass trends using terminal F = 0.10. In the second case, terminal F's of 0.05 - 0.15 agree equally well (or poorly).

The correlations between effort and F values for various terminal F's are presented in Table 8.

Conclusions

The catch rates of the two standards (USSR TC 7 and Canada (Nfld.) TC 5 otter trawlers) indicated a generally stable condition for the stock. The simple surplus production model presented in a previous assessment which gave a yield at 2/3 f_{MSY} of 34,000 t, was updated with the 1978 catch/effort point (USSR TC 7 otter trawlers as the effort standard). The 1978 catch rate, down from 1977, was close to the expected catch rate at 2/3 f_{MSY}. The preliminary cohort analysis suggested that the stock was in stable condition. Catch projections were not made due to the too few years of data involved in the calculations.

References

Gavaris, C. 1979. An assessment of subarea 2+ division 3K redfish. CAFSAC Res. Doc. 79/33.

Gavaris, S. 1980. Assessment of the cod stock in division 3M. NAFO Scr. Doc. 25.

Table 1. Historical catches and CPUE of the two standards used in the assessment.

Year	Catch	USSR 7 OT C/HR	USSR 7 OT Effort
1959	186,837		
1960	129,773	1.616	80,305
1961	55,455	1.008	55,015
1962	19,657	1.159	16,960
1963	23,671	2.191	10,804
1964	56,178		
1965	42,653		
1966	32,730		
1967	26,162	1.749	14,958
1968	18,913	2.138	8,846
1969	24,786	1.458	17,000
1970	21,970	1.563	14,056
1971	19,356	0.748	25,877
1972	20,033	1.104	18,146
1973	38,965	1.150	33,883
1974	30,145	1.445	20,861
1975	25,559	1.196	21,370
1976	25,965	1.366	19,008
1977	17,539	2.057	8,435
1978	28,896	1.281	22,575
1979	30,409		

Year	Can N 5 OT C/HR	Can N 5 OT STD.ER.	Can N 5 OT EFFORT
1976	0.553	0.098	46953
1977	0.616	0.099	28472
1978	0.574	0.053	50341
1979	0.704	0.098	43195

Table 2. Catch at age 2 + 3K redfish.

C A T C H M A T R I X

AGE/YEAR	1976	1977	1978	1979
6	7.	22.	4.	240.
7	30.	102.	400.	2159.
8	136.	219.	1241.	5678.
9	1265.	612.	3297.	8798.
10	2067.	843.	4071.	9251.
11	3866.	1569.	4495.	6700.
12	5580.	1930.	5806.	4011.
13	7818.	2241.	6207.	7374.
14	8652.	3315.	6267.	6646.
15	5615.	3162.	5265.	6571.
16	2700.	2776.	5331.	6075.
17	1826.	2504.	3969.	5544.
18	946.	1812.	2250.	1796.
19	757.	1778.	1488.	1241.
20	1128.	1638.	1495.	1391.
21	968.	895.	1084.	1412.
22	885.	940.	950.	789.
23	1100.	555.	591.	573.
24	1005.	618.	883.	599.
25	684.	598.	828.	930.
26	678.	514.	746.	569.
27	512.	435.	509.	590.
28	632.	418.	535.	589.
29	284.	200.	139.	283.

Table 3. The mean weight at age and partial recruitment of redfish in 2 + 3K.

Age	Mean Weight	Partial Recruitment
6	0.103	0.16
7	0.135	0.22
8	0.169	0.29
9	0.205	0.40
10	0.243	0.48
11	0.282	0.54
12	0.322	0.56
13	0.362	0.76
14	0.403	1.00
15	0.443	1.00
16	0.482	1.00
17	0.521	1.00
18	0.559	1.00
19	0.596	1.00
20	0.631	1.00
21	0.665	1.00
22	0.698	1.00
23	0.730	1.00
24	0.759	1.00
25	0.788	1.00
26	0.815	1.00
27	0.841	1.00
28	0.866	1.00
29	0.889	1.00

Table 4. Survival and fishing mortality rates calculated for the fully recruited age classes from catch at age data.

Years	Age group	S	F (M = 0.10)
76-77	14-28	0.672	0.197
77-78	14-28	0.671	0.199
78-79	14-28	1.051	
76-78 (2 years)	14-27	0.841	0.074
76-77	14-27	1.133	
77-78	15-28	0.624	0.372

Table 5. Yield per recruit analysis using partial recruitment vector and mean weight at age from Table 3.

	FISHING MORTALITY	CATCH (NUMBER)	YIELD (KG)	AVG. WEIGHT (KG)	YIELD PER UNIT EFFORT
	0.1000	0.337	0.127	0.378	1.000
F0.1---	0.1342	0.394	0.140	0.355	0.818
	0.2000	0.471	0.150	0.319	0.589
FMAX---	0.2911	0.539	0.153	0.284	0.413
	0.3000	0.544	0.153	0.281	0.400
	0.4000	0.594	0.151	0.255	0.297
	0.5000	0.631	0.149	0.236	0.234
	0.6000	0.659	0.146	0.222	0.191
	0.7000	0.683	0.144	0.211	0.161
	0.8000	0.703	0.141	0.201	0.139
	0.9000	0.719	0.139	0.194	0.121
	1.0000	0.734	0.137	0.187	0.108
	1.1000	0.747	0.135	0.181	0.097
	1.2000	0.759	0.134	0.176	0.088
	1.3000	0.769	0.132	0.172	0.080
	1.4000	0.778	0.131	0.168	0.073
	1.5000	0.787	0.129	0.165	0.068

Table 6a. Fishing mortalities and population numbers at age using Terminal F = 0.100

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

AGE/YEAR	1976	1977	1978	1979
6	.000	.000	.000	.016
7	.000	.000	.002	.022
8	.001	.001	.005	.029
9	.012	.004	.015	.040
10	.014	.009	.029	.048
11	.037	.012	.054	.054
12	.053	.021	.051	.056
13	.078	.024	.077	.076
14	.093	.039	.079	.100
15	.156	.040	.072	.100
16	.111	.096	.080	.100
17	.075	.128	.174	.100
18	.039	.089	.145	.100
19	.052	.086	.088	.100
20	.104	.135	.087	.100
21	.090	.101	.112	.100
22	.058	.107	.134	.100
23	.107	.042	.082	.100
24	.096	.073	.079	.100
25	.069	.069	.118	.100
26	.124	.061	.103	.100
27	.290	.098	.072	.100
28	.627	.362	.151	.100
29	.627	.362	.174	.100

P O P U L A T I O N N U M B E R S

AGE/YEAR	1976	1977	1978	1979
6	319889.	255386.	115212.	15887.
7	284403.	289441.	231062.	104244.
8	186791.	257310.	261800.	208693.
9	112502.	168886.	232615.	235706.
10	154286.	100593.	152232.	207343.
11	113258.	137638.	90218.	133873.
12	114381.	98803.	123047.	77357.
13	109308.	98189.	87565.	105815.
14	102184.	91469.	86713.	73327.
15	40973.	84229.	79612.	72500.
16	27119.	31733.	73206.	67027.
17	26652.	21970.	26072.	61169.
18	26009.	22379.	17498.	19816.
19	15842.	22634.	18526.	13692.
20	11979.	13614.	18789.	15347.
21	11790.	9766.	10760.	15579.
22	16560.	9747.	7986.	8705.
23	11412.	14142.	7925.	6322.
24	11496.	9280.	12268.	6609.
25	10742.	9446.	7809.	10261.
26	6120.	9069.	7979.	6278.
27	2137.	4893.	7717.	6510.
28	1427.	1447.	4013.	6499.
29	638.	690.	911.	3122.

POPULATION BIOMASS AGES 6 TO 29

YEAR	1976	1977	1978	1979
BIOMASS	443140.	461092.	471763.	458563.

Table 6b. Fishing mortalities and population numbers at age using Terminal F = 0.15.

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

AGE/YEAR	1976	1977	1978	1979
6	.000	.000	.000	.024
7	.000	.001	.003	.033
8	.001	.001	.007	.044
9	.017	.006	.022	.060
10	.020	.013	.042	.072
11	.051	.017	.079	.081
12	.073	.029	.074	.084
13	.108	.034	.111	.114
14	.127	.055	.114	.150
15	.200	.056	.104	.150
16	.143	.129	.115	.150
17	.100	.172	.246	.150
18	.053	.123	.206	.150
19	.068	.119	.127	.150
20	.137	.184	.125	.150
21	.121	.138	.160	.150
22	.080	.148	.190	.150
23	.142	.059	.117	.150
24	.129	.100	.113	.150
25	.095	.095	.169	.150
26	.161	.086	.148	.150
27	.346	.133	.104	.150
28	.728	.467	.214	.150
29	.728	.467	.246	.150

P O P U L A T I O N N U M B E R S

AGE/YEAR	1976	1977	1978	1979
6	215910.	171628.	77224.	10633.
7	193301.	195357.	155275.	69871.
8	128146.	174877.	176669.	140118.
9	78648.	115822.	158027.	158677.
10	108441.	69961.	104218.	139853.
11	81871.	96155.	62501.	90428.
12	83349.	70403.	85513.	52278.
13	80618.	70109.	61867.	71852.
14	76001.	65510.	61306.	50076.
15	32491.	60539.	56122.	49510.
16	21259.	24058.	51770.	45773.
17	20083.	16667.	19128.	41772.
18	19341.	16435.	12699.	13532.
19	12116.	16601.	13147.	9351.
20	9273.	10242.	13330.	10481.
21	8961.	7318.	7710.	10639.
22	12168.	7187.	5770.	5945.
23	8725.	10168.	5609.	4317.
24	8710.	6848.	8672.	4513.
25	7960.	6925.	5609.	7007.
26	4783.	6552.	5697.	4287.
27	1840.	3683.	5440.	4445.
28	1285.	1178.	2919.	4438.
29	574.	561.	668.	2132.

POPULATION BIOMASS AGES 6 TO 29

YEAR	1976	1977	1978	1979
BIOMASS	321964.	326474.	328474.	311051.

Table 7. Comparison of trends in CPUE and biomass estimates from cohort for a range of terminal F values.

a. Actual values

		Population Biomass				
Year	CPUE	F = 0.05	F = 0.10	F = 0.15	F = 0.20	F = 0.20
1976	0.553	806,872	443,140	321,964	261,427	225,145
1977	0.616	865,152	461,092	326,474	259,217	218,904
1978	0.574	901,859	471,763	328,474	256,881	213,967
1979	0.704	901,306	458,563	311,051	237,346	193,164

b. Ranked

		Population Biomass				
Year	CPUE	F = 0.05	F = 0.10	F = 0.15	F = 0.20	F = 0.25
1976	1	1	1	2	4	4
1977	3	2	3	3	3	3
1978	2	4	4	4	2	2
1979	4	3	2	1	1	1
Rank correlation (all years)		0.40	0.60	-0.40	-0.80	-0.80
Rank correlation (without 1979)		0.50	0.50	0.50	-0.50	-0.50

Table 8. Correlation of effort with fishing mortality, given a range of terminal F's.

	Years	Effort		Age group 6-28	10-28	14-28
Terminal F 0.05	1976	46953		.016	.035	.055
	1977	28472		.009	.021	.037
	1978	50341		.019	.035	.048
	1979	43195		.029	.037	.050
			r^2	.31	.83	.72
Terminal F 0.10	1976			.030	.063	.096
	1977			.018	.039	.067
	1978			.037	.068	.092
	1979			.058	.075	.100
			r^2	.26	.72	.75
Terminal F 0.15	1976			.043	.087	.128
	1977			.026	.054	.093
	1978			.054	.099	.131
	1979			.087	.112	.150
			r^2	.24	.64	.59
Terminal F 0.20	1976			.055	.107	.154
	1977			.033	.068	.115
	1978			.070	.127	.168
	1979			.116	.149	.200
			r^2	.23	.55	.47
Terminal F 0.25	1976			.065	.124	.176
	1977			.040	.081	.135
	1978			.086	.154	.201
	1979			.145	.187	.250
			r^2	.21	.47	.36

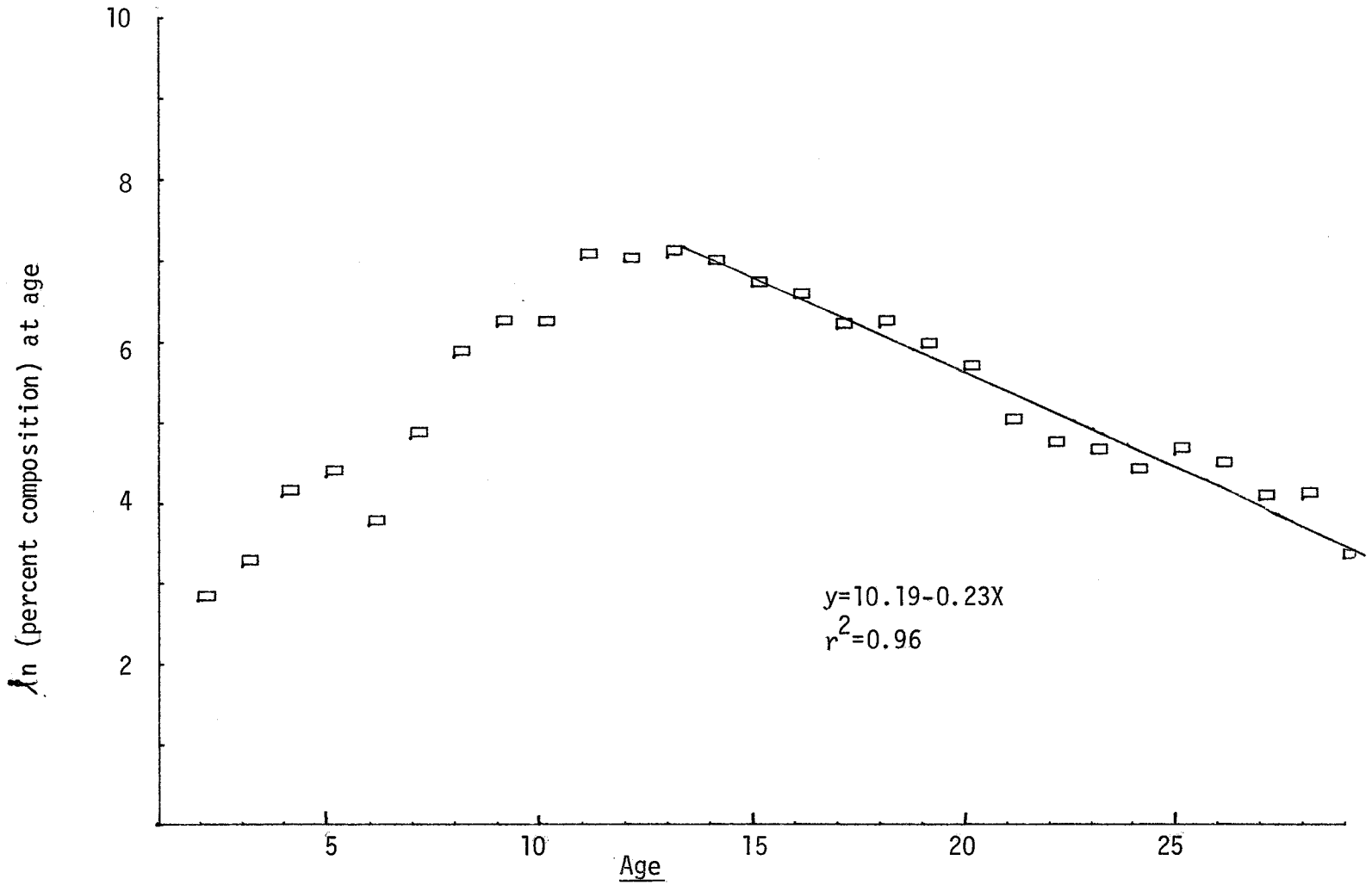

Fig. 1. Catch curve derived from catch at age data (males and females combined) collected on 1977 Canadian research cruise to Division 2J.

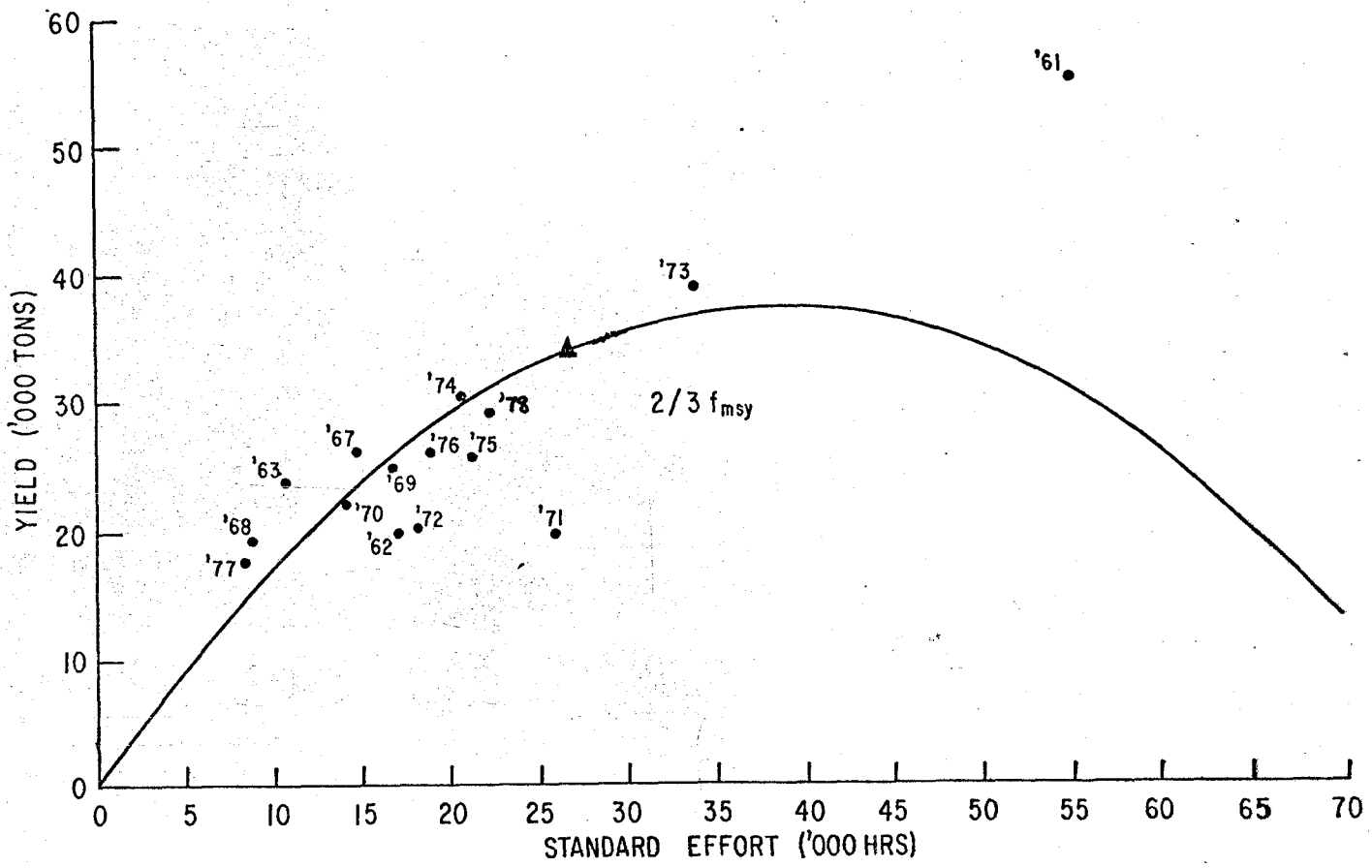

Fig. 2. Equilibrium yield curve based on USSR TC 7 ottertrawl standards, years 1961-77, with 1978 point added.