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Virtual population assessment of the cod stock in ICNAF Division 3M

by

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Introduction

Landings of cod from the Flemish Cap averaged about 27 thousand metric tons in the period 1959-71 and ranged from 7 to 54 thousand tons. Some of the effects of the fishery upon this stock are assessed.

Materials and Methods

Data pertaining to length and age structure were obtained from the Sampling Yearbooks and supplemented where necessary by data derived from Canada (Nfld.) research vessel surveys. This material was treated in a way similar to that used in previous assessments. Length frequencies were adjusted by month and quarter to the numbers landed. Age frequencies were obtained by applying age-length keys to the quarterly length frequencies. The information concerning discards was scanty and the age frequencies have been adjusted to the numbers landed.

Data were generally incomplete. No age-length keys were available for 1967, 1969, 1970 and 1971. Age composition of cod taken in 1967 was estimated from those of 1966 and 1968. In no year were there sufficient length frequencies available to adjust to each separate quarter, nor were there age-length keys for each quarter in any one year. It was therefore necessary usually to combine length frequencies into half-yearly periods before adjusting them by age-length keys.

Values of 0.2 and 0.438 were used for natural mortality and $E(1-e^{-Z})$ respectively. Growth rate was derived from data of the 1964-68 period.

Results

Age compositions of the catches

The numbers caught at each age for the years 1959-68 are listed in Table 1. It is remarkable that even though landings for the years 1953-58 were small (Fig. 1), the age compositions of the catches in 1959 and 1960 include very few old fish.

Fishing mortalities

Estimates of F for cod at each age are shown in Table 2. Full recruitment over the period 1963-68 took place at age 7, and 50% recruitment at age 6.

Yield per recruit

Yield-per-recruit values were calculated incorporating the partial recruitment rates listed in Table 2 and are shown in Fig. 2. The maximum yield per recruit was available at $F = 0.5$. A yield of about 93% of the maximum could be obtained at $F = 0.2$.

Stock size

Numbers of cod present at the beginning of the year are shown in Table 3. Stock size at ages 3 and 4 varies considerably from year to year.

Maximum catch estimates

The yield per 4-year-old recruit at F_{max} (0.5) was 1.01 Kg. The average stock size of 4-year-old cod in the period 1959-63 was about 37 million. At F_{max} the average yield would have been 37 thousand metric tons. This yield is considered to approximate the maximum yield for most of the 1960's. The average stock size of 4-year-old cod in the period 1964-68 was about 34 million. At F_{max} the average yield would have been about 34 thousand metric tons. This yield is considered to apply to the late 1960's and early 1970's.

Effort data reported by Portugal and Spain were used to derive yearly catch-per-hour and total hours fished for the period 1962-71 in order to construct a Schaefer type curve. No significant relationship was found between catch-per-hour and various running averages of effort.

Discussion and Conclusions

The degree of variation in stock size at age and the relative scarcity of older age groups in the catches in 1959 and 1960 even after a period

of very low catches would seem to indicate wide fluctuations in year-class strength. For the year-classes of 1961-69, catches per hour of cod at age 3 varied from 1 to 41 fish (Bulatova. ICNAF Res. Doc. 73/22, this meeting).

Catches in the period 1965-68 have resulted in F values somewhat beyond that at which maximum sustained catches might have been obtained. Catches at F_{max} have been estimated at about 35 thousand metric tons for the early 1970's.
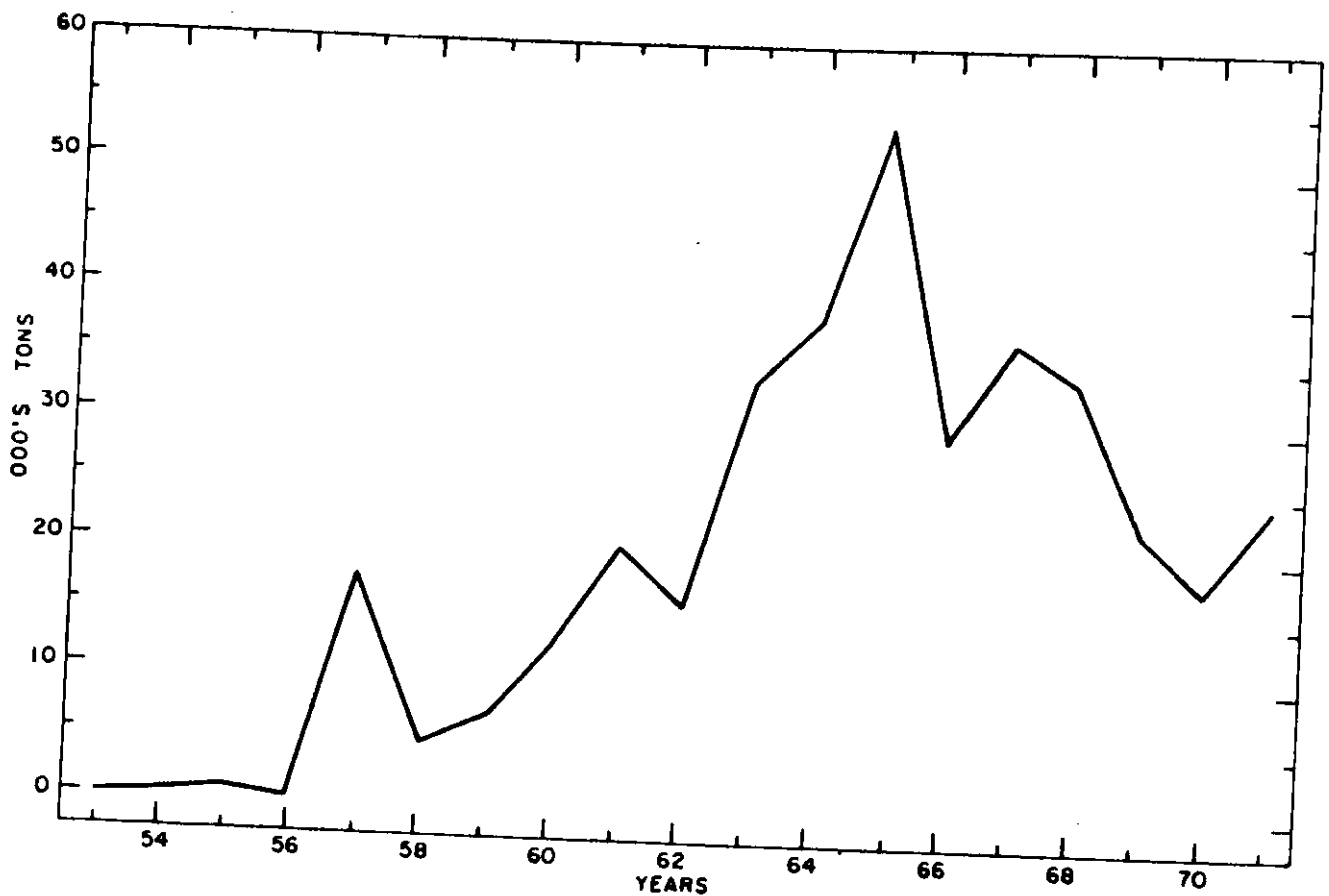

Fig. 1. Landings (000's metric tons) of cod in ICNAF Division 3M in the years 1953-71.
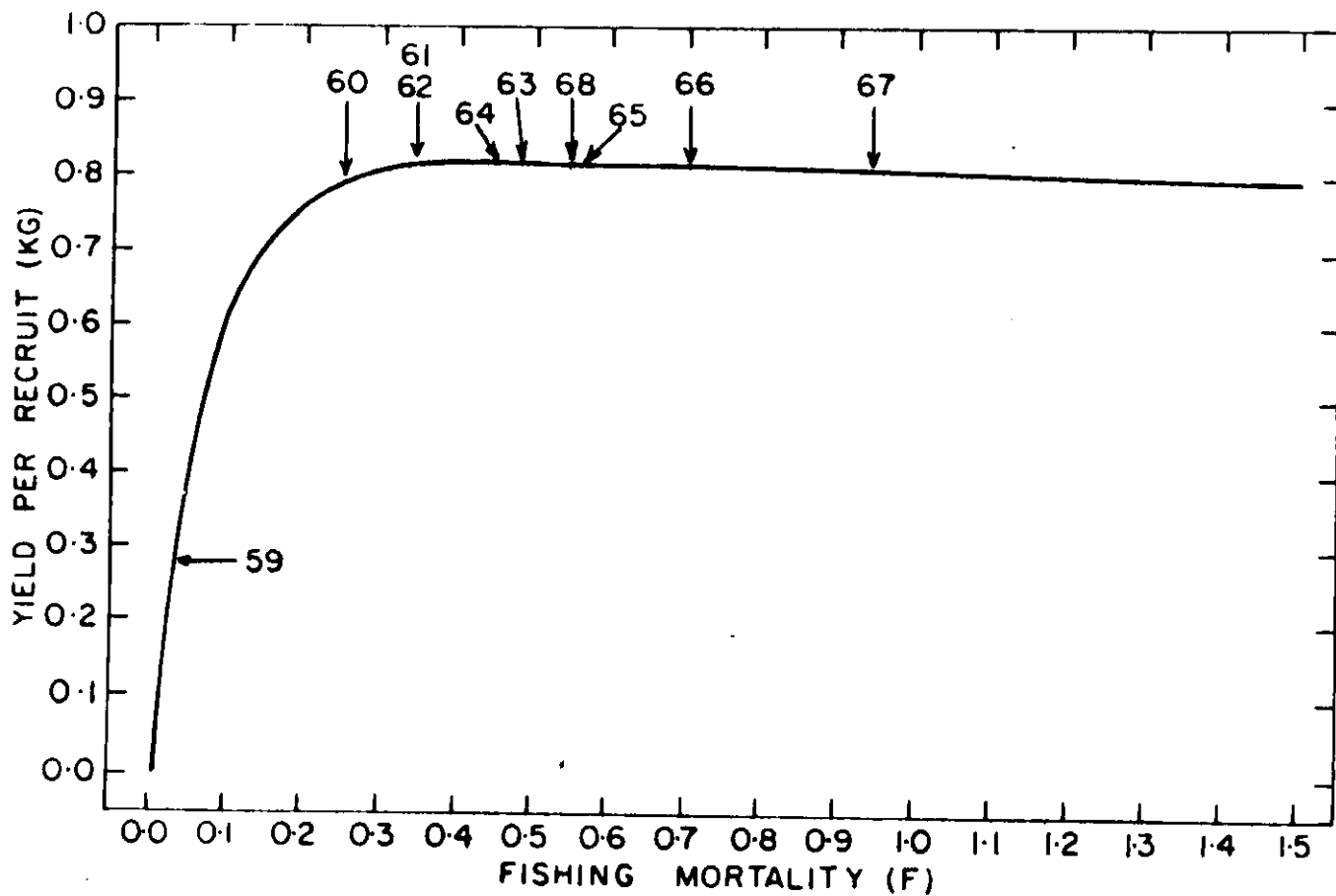
Fig. 2. Yield per 3-year-old recruit in ICNAF Division 3M.

Table 1. Numbers of cod (000's) caught at each age by year during the period 1959-68 in ICNAF Division 3M.

Age \ Year	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
2	118	348	21	33		233	747	20	289	27
3	153	767	3,117	376	309	581	1,597	873	423	52
4	828	562	6,771	2,154	6,738	3,093	4,440	570	4,778	2,426
5	3,035	320	2,943	2,960	6,219	1,836	7,232	2,504	2,042	6,842
6	772	3,547	627	1,437	2,797	7,637	15,334	3,209	3,114	1,985
7	66	2,122	2,883	436	1,718	5,111	3,035	3,903	2,594	1,051
8	51	211	2,050	1,521	2,005	1,098	518	1,116	2,724	569
9	36	237	179	1,176	619	106	521	269	660	568
10	15	262	193	134	241	835	826	737	114	133
11		674	105	94	75	396	142	662	289	21
12		106	147	177	119			98	162	62
13		98	31	45	44			55	55	16
14		33	12	13						
15		12	5	11						
16	36			8						
17				9						
Total	5,110	9,299	19,084	10,584	20,884	18,926	34,392	14,016	17,244	13,752

Table 2. Fishing mortality estimates of cod at each age by year during the period 1959-68 in ICNAF Division 3M.

Age \ Year	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	Average F 1963-68	% recruited
3	.007	.016	.037	.011	-	.034	.009	<.001	(.106)	.003	.015	2
4	.061	.034	.19	.032	.011	.15	.12	.013	.009	.025	.055	8
5	.12	.030	.25	.12	.13	(.083)	.33	.059	.089	.063	.13	20
6	.064	.19	.075	.19	.39	.21	.53	.31	.31	.18	.32	49
7	.034	.25	.24	(.068)	.66	.35	.86	.48	.81	.55	.62	100
8	.046	.15	.41	.19	.41	.60	.70	.55	.93	.73	.65	100
9	.026	.31	.18	.44	.40	(.039)	.64	.61	.99	.53	.63	100
10	.011	.27	.44	.20	.44	.29	.27	.84	.93	.57	.56	100
11		(.96)	.17	.40		.56	.53	.76	1.15	.39	.68	100
12			.57	.46			.40	1.14	.78	.68	.75	100
13				.34				.53	1.02	.37	.64	100
14										.24		100
Av. F 7-13	.029	.25	.34	.34	.48	.45	.57	.70	.94	.55		

Table 3. Numbers of cod (000's) present in the stock at the beginning of the year in ICNAF Division 3M, 1959-68.

Age \ Year	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
3	24,198	53,302	94,620	37,917	-	(19,166)	91,972	-	3,165	9,945
4	15,422	19,106	42,993	75,039	30,932	(24,439)	15,359	74,593	(52,080)	2,327
5	29,554	11,910	14,645	28,982	60,330	25,316	17,278	11,129	61,037	43,026
6	13,725	22,003	9,525	9,228	21,021	44,040	19,183	10,258	8,437	45,996
7	2,177	10,540	15,057	7,286	6,251	11,629	29,170	9,240	6,150	5,090
8	1,251	1,695	6,700	9,615	5,594	2,667	6,622	10,053	4,662	2,218
9	1,547	977	1,185	3,624	6,606	3,049	1,196	2,671	4,736	1,509
10	1,513	1,225	590	815	1,907	3,650	2,412	516	1,187	1,431
10+	-	2,523	2,448	1,227	1,232	1,397	2,189	2,548	1,355	665
Total	89,387	123,281	187,763	173,733	133,873	135,353	185,381	121,008	142,809	112,207