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Cod Stock Estimation and Yield-per-recruit Analysis for Div. 3NO

by

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ABSTRACT

Estimates of the South Newfoundland cod stock obtained from the trawl surveys in Divs. 3NO for the period from 1977 to 1987 are set forth. Abundance and biomass indices for 1977-82 are corrected with regard to stratification scheme of Div. 3NO. According to length-at-weight data and age composition of catches the length-weight-age relationship is obtained. The parameters of these values are used for yield-per-recruit analysis.

INTRODUCTION

In line with the advice of the NAFO Scientific Council the work is done to revise the data from the Soviet trawl surveys carried out until 1983, to validate the stock estimate comparability and also to make analysis of the yield-per-recruit-stock. Necessary computations were performed and the data are presented in the paper.

METHODS

The methods of trawl surveys in Subarea 3 and those of stock estimation applied in the Polar Institute until 1983 differed from the methods used in subsequent years (Bulatova and Chumakov, 1986). In order for a series of observations to remain valid and to obtain comparable indices of the fish abundance and biomass the data for previous years were corrected. The trawl stations per-

tained to strata by positions and depth of trawling. The mean catches per hour trawling were reduced to catches per 30-minute trawling in the area halved to 0.0135 sq. miles. The strata without hauls or with zero cod catches were ignored. Further the abundance and biomass indices were estimated following the NAFO methods.

In view of the standard bottom trawl and also similar in tonnage stern trawlers (BMRT) being used during surveys in 1977-82 and 1983-87 (except for 1985 when the vessel of PST type with lesser tonnage being used), the obtained data are considered to be quite comparable.

RESULTS

According to data from the Soviet trawl surveys carried out in Divs. 3NO from 1977 to 1987 the highest cod numbers were recorded in 1985 and the highest biomass - in 1985-86 (Tables 1-5). In 1987 these values were lower than in 1986 (Table 5). The lowest stock estimates were obtained in Div. 3N due to prevalence of small cod being on the average 27.2 cm long (Tables 1 and 2). In Div. 3O where large (on the average 67.8 cm) specimens constituted the bulk of catches the cod biomass remained at the 1986 level despite the low numbers (Tables 3 and 4).

The low stock values resulted from underestimation of fish due to a lower level of their concentrations in March-April in the shallow large strata of the bank, especially in Div. 3N where the major schools of undersized cod were found on the slope, in small strata. In May-June the dense cod concentrations were formed in the central part of the shoal (mainly strata 375, 361) owing to approach of spawning capelin (Mamylov, MS 1988). The concentrations numbered 56 mill. spec., which was much greater than abundance in the whole area of two Divisions (54 mill. spec.) in March-April. Specimens 39-56 cm long prevailed in the catches, the mean length was 49.5 cm. It is possible that following capelin the part of cod of these length groups left Div. 3L.

Thus, the stock estimates would be higher if the survey is carried out later.

Though lower as compared to 1986 the cod biomass (290 thou.t)

in 1987 was higher than the mean one (202 thou.t) for 1977-87. According to data of Canadian ichthyologists the cod biomass (405 thou.t) in 1987 was the highest for the period of observations in Divs. 3NO since 1971 (Bishop and Baird, 1987).

Against relatively high biomass and many-aged stock structure the abundance of South Newfoundland cod decreased apparently due to natural and fishing mortalities of the portion of rich 1980-1982 year-classes while successive 1983-1984 year-classes were poor (Tables 6 and 7). Judging from the catches of two-year-olds the 1985 year-class is estimated tentatively as abundant.

Mature fish accounted for 19% of the total number of surveyed cod (Table 8). Cod at an age of 9 and older were mature.

Analysis of yield-per-recruit-stock. Since the Soviet vessels did not conduct any directed fishery for cod in Divs. 3NO there are no data available on age composition of catches and, consequently, on fishing mortality by age groups. The analysis of yield-per-recruit-stock was made using the data from trawl surveys. In so doing it turned possible to use the short-cut analysis described by Beverton and Holt (1969).

Length, weight and age parameters were taken from catch data on cod caught with the fine-meshed net for the last three years (Table 9). In fact no specimens older 16 were observed in the catches. For each year the weight-length relation was determined by allometric growth equation $W = al^b$ (I) and the length-age relation - by the von Bertalanffy equation $l_t = L_\infty (1-e^{-K(t-t_0)})$(2). The obtained parameters a_1, b, L_∞, K, t_0 are listed in Table 10.

The parameter for all three years is close to 3; it indicates the isometric growth of cod and allows to use the von Bertalanffy equation for determination of the weight growth:

$$W_t = W_\infty \ (1-e^{-K(t-t_0)})^3 \qquad (3)$$

The yield-per-recruit-stock was calculated for the last three years by the formula:

$$\frac{Y_w}{R} = F \cdot W_\infty \cdot e^{-M(t_\rho' - t_\rho)} \cdot \sum_{n=0}^{3} \frac{\Omega_n e^{-nK(t_\rho' - t_0)}}{F + M + nk} \cdot$$

$$\cdot \left(1 - e^{-(F+M+nK)(t_1 - t_\rho')}\right), \qquad (4)$$

where W_∞, K_1, t_0 - parameters of the von Bertalanffy equation;

M - coefficient of natural mortality equal to 0.2;

t'_ρ - age of the year-class entering the fishery equal to 3 years;

t_ρ - age of the year-class available to fishery assumed to be 3 years;

Ω_n - takes on a value of 1, -3, 3, -1;

F - coefficient of fishing mortality;

t_λ - maximum age of cod equal to 25 years.

Assuming F from 0.05 to 1.5 and using parameters from Table 10 we made yield-per-recruit analysis at different coefficients of fishing mortality. The results of calculations are given in Table 11. The curves of catch per recruit-stock are shown in Fig.1.

Calculated $F_{0.1}$ values do not differ, as a matter of fact, from each other and they are 0.10, 0.12 and 0.11 for 1985, 1986 and 1987 respectively. At the same time the calculated F_{max} values are more variable and equal to 0.13, 0.17 and 0.14 for each of above mentioned years respectively.

Since equation (4) considers only growth parameter variations the increase in the yield-per-recruit-stock in 1987 compared to 1986 is caused by variations of growth parameters (Table 10). The increase in the yield-per-recruit-stock in 1987 is indicative of a higher stock size this year compared with the previous one.

CONCLUSIONS

The low estimates of cod stock obtained by the data from trawl survey in 1987 were due to underestimation caused by a lower level of fish concentrations during the survey.

The analysis of yield-per-recruit-stock showed that the cod stock in 1987 was at a higher level than in 1986.

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Table 1. Cod numbers by the data from trawl surveys in Div. 3N in 1977-87, thou.spec.

Depth range, m	No.of stratum	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
0-55	375	8044	1977	1431	570	2478	7788	20896	5003	7945	3776	325
	376	2776	222	347	788	1332	2543	736	4242	16794	83	83
56-92	360	8200	8200	887	3977	1862	5818	7890	883	9024	89	709
	361	10157	67417	1512	549	480	5593	6245	15648	18647	6863	446
	362	21933	5087	1353	2302	3453	6767	16707	38920	153160	46107	1344
	373	2022	5682	156	1736	4270	4884	5297	12227	37613	32443	149
	374	3310	-	69	759	-	2655	2793	2276	11701	362	207
	383	-	-	-	-	-	-	749	116	3961	33	12
93-183	359	10812	1949	1306	7176	1102	28246	1335	6842	148	1068	460
	377	1702	609	198	310	667	925	657	511	1961	32	2
	382	9082	1342	511	3650	1833	767	4739	2332	2268	-	-
184-274	358	14608	4304	1636	925	4846	1778	138	1450	6592	667	8530
	378	3740	487	11058	2808	-	3717	4543	2965	3331	178	154
	381	239	1092	244	852	753	1931	676	719	2319	2233	20
275-365	357	4009	27	61	804	33	398	44	128	3966	468	1005
	379	2840	18	10	-	291	952	830	2640	1068	2285	374
	380	1687	77	416	406	683	165	1676	1598	1572	427	321
366-547	723	1128	-	-	-	-	1309	23	-	83	-	224
	725	3177	-	12	-	8	-	-	-	3	612	78
	727	12	53	59	-	160	287	1184	65	12	577	312
Total, mill.spec.		109.48	98.52	25.01	27.61	24.25	76.52	77.16	98.57	282.17	98.30	14.76
Maximum, mill.spec.		136.00	212.71	28.03	38.58	33.35	123.09	106.31	131.58	445.14	156.50	27.26
Minimum, mill.spec.		82.95	-15.66	21.99	16.65	15.15	29.96	48.00	65.55	119.20	40.11	2.26
Mean per haul, spec.		91.26	87.27	20.74	23.44	21.53	62.89	61.30	82.40	223.80	81.42	12.11
No. of hauls		43	42	45	51	42	52	69	71	76	67	72

Table 2. Cod biomass by the data from trawl surveys in Div. 3N in 1977-87, t.

Depth range, m	No.of stratum	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
0-55	375	13727	2301	3452	1632	4622	15045	68814	4262	12433	19836	5959
	376	5913	333	167	1621	12061	2432	985	4048	15340	822	1374
56-92	360	14517	17398	443	6563	2726	7646	2283	764	2124	31	71
	361	10706	42894	1787	2128	2128	13726	5376	18659	41266	18297	5734
	362	16380	5227	2380	2644	3033	67200	23310	61632	139109	72665	9072
	373	7280	5289	156	3957	7560	8898	8470	14875	38766	40137	2128
	374	4793	-	310	2586	-	3862	506	1805	12708	2610	569
	383	-	-	-	-	-	-	1614	616	5244	135	4
93-183	359	3577	1305	846	2772	411	16025	505	2927	17	446	29
	377	702	341	123	243	319	507	130	107	461	7	2
	382	2141	1134	240	4960	1857	515	2127	1839	741	-	-
184-274	358	6642	1812	858	1217	2623	1280	71	1685	4944	290	780
	378	1660	340	7254	1503	-	2144	3007	2328	2341	40	55
	381	273	1055	465	1072	504	2801	735	808	2090	1726	224
275-365	357	3927	33	131	988	149	337	62	93	3449	242	711
	379	1853	31	14	-	171	1078	493	1612	535	1036	160
	380	1007	103	3454	784	1046	120	1487	1118	1552	375	653
366-547	723	1019	-	-	-	-	672	37	-	94	-	574
	725	1614	-	14	-	27	-	-	-	7	488	83
	727	47	65	142	-	151	406	994	101	13	211	154
Total, thou.t		97.80	79.66	22.23	34.67	39.39	84.21	121.00	119.28	283.23	159.39	28.35
Maximum, thou.t		119.39	151.67	24.48	47.79	55.74	119.47	179.11	178.30	459.73	229.69	39.49
Minimum, thou.t		76.17	7.76	19.99	21.55	23.03	48.96	62.90	60.26	106.73	89.10	17.22
Mean per haul, kg		80.87	70.56	18.44	29.43	34.97	69.21	96.10	99.80	224.50	132.01	23.24
No.of hauls		43	42	45	51	42	52	69	71	76	67	72

Table 3. Cod numbers by the data from trawl surveys in Div. 30 in 1977-87, thou.spec.

Depth range, m	No.of stratum	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
56-92	330	3133	2708	2527	890	2166	1522	2811	3443	1805	5168	1207
	331	-	-	135	-	245	-	2089	18454	1464	687	193
	338	9771	1845	2601	4780	633	32424	6046	7170	3280	5061	16965
	340	4449	-	445	1462	3178	1080	4449	31693	2161	15889	5339
	351	6673	9473	2613	1773	3127	4433	29711	28037	40805	118113	1269
	352	13416	3631	3306	4423	2389	15518	9078	34706	27950	18872	6450
	353	2279	-	1828	95	1045	380	1971	3039	285	2469	380
93-183	329	5036	2135	3654	892	765	255	1211	21034	8244	1052	3442
	332	1264	897	830	2239	-	3307	1745	7019	144502	233	291
	337	2668	527	1036	263	-	70	12	1018	4740	421	819
	339	-	-	-	-	-	-	1018	644	2152	419	332
	354	2206	375	310	930	31	711	18	4085	386	47	1170
184-274	333	7	-	4	266	-	4	20	34	-	1238	-
	336	571	2	7	-	4	-	-	49	-	412	-
	355	278	32	42	141	-	11	-	252	755	7	404
275-365	334	-	-	3	3	-	3	-	-	3	1159	82
	335	-	-	-	4	-	-	1	-	-	155	17
	356	-	-	6	5	2	136	3	2	8	47	36
366-547	717	2	-	-	-	-	2	-	-	-	28	14
	719	-	-	-	-	-	-	-	-	-	23	995
	721	-	-	-	-	-	-	-	-	2	-	17
Total, mill.spec.		51.75	21.63	19.35	18.17	13.58	59.86	60.18	160.70	238.54	171.50	39.42
Maximum, mill.spec.		69.98	28.87	29.67	25.24	16.31	102.82	92.11	250.00	503.06	277.20	71.74
Minimum, mill.spec.		33.53	14.38	9.03	11.09	10.86	16.89	28.25	71.37	-25.97	65.80	7.10
Mean per haul, spec.		41.73	21.62	15.13	14.65	12.29	48.17	47.45	112.20	182.48	128.10	29.77
No. of hauls		42	37	42	48	29	40	45	59	55	78	66

Table 4. Cod biomass by the data from trawl surveys in Div. 30 in 1977-87, t.

Depth range, m	No.of stratum	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
56-92	330	5996	1741	1831	1161	1547	3224	1702	10143	2017	7393	1835
	331	-	-	169	-	144	-	749	10918	995	1294	311
	338	9385	1652	1371	10685	406	19701	4054	14196	3018	19660	147402
	340	2860	-	191	4640	3813	3559	5720	21020	5842	19578	6969
	351	4573	11013	2333	2380	3827	17127	30209	35451	43165	120619	5227
	352	16321	4634	8122	10388	6326	36330	16029	37794	29839	72445	74677
	353	5484	-	3917	427	285	712	95	7441	291	12260	206
93-183	329	3394	1928	6735	1673	1370	510	1637	5788	7202	1536	12302
	332	566	427	1621	2055	-	1219	241	873	64325	1068	1280
	337	1475	70	70	676	-	193	23	669	12981	1023	5688
	339	-	-	-	-	-	-	1333	1628	4193	680	419
	354	1557	252	257	2066	35	579	7	1393	189	179	101
184-274	333	10	-	6	271	-	15	34	14	-	2690	-
	336	710	2	9	-	3	-	-	24	-	954	-
	355	463	64	88	146	-	27	-	138	362	10	74
275-365	334	-	-	5	14	-	14	-	-	14	3930	445
	335	-	-	-	13	-	-	5	-	-	428	87
	356	-	-	16	14	5	526	8	3	37	126	74
366-547	717	3	-	-	-	-	7	-	-	-	61	38
	719	-	-	-	-	-	-	-	-	-	80	4269
	721	-	-	-	-	-	-	-	-	5	-	71
Total, thou.t		52.80	21.78	26.74	36.61	17.76	83.74	61.85	147.49	174.47	266.02	261.47
Maximum, thou.t		70.64	32.00	48.15	50.78	23.15	130.51	87.45	195.75	297.95	405.31	575.18
Minimum, thou.t		34.96	11.57	5.33	22.44	12.37	36.98	36.24	99.24	51.00	126.73	-52.23
Mean per haul, kg		42.57	21.78	20.91	29.52	16.07	67.40	46.20	122.2	133.47	198.7	197.46
No. of hauls		53	37	42	48	29	40	45	59	55	78	66

Table 5. Cod biomass and numbers, mean catches (spec., kg) per unit of fishing area (0.0135 sq.mile) in Divs. 3NO in 1977-87.

Indices	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Area surveyed, sq. mile	33198	28741	33535	32636	30121	33203	34583	33894	34748	34371	34330
Mean catch, spec.	65.6	56.4	17.9	18.9	17.0	55.5	53.6	103.3	202.3	106.0	21.3
Mean catch, kg	61.2	47.6	19.7	29.4	25.6	68.3	71.4	106.3	177.8	167.1	113.9
Numbers, mill. spec.	161.2	120.2	44.4	45.8	37.8	136.4	137.3	259.3	520.7	269.8	54.2
Biomass, thou. t	150.6	101.4	49.0	71.3	57.2	168.0	182.8	266.8	457.7	425.4	289.8

Table 6. Mean number of cod of different age groups trawled per half an hour per unit of area (0.0135 sq.mile) in Divs.3NO in 1977-87

Age, years	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
I	0.3	0.2	I.5	0.I	0.5	0.8	3.I	I.2	3.4	0.2	0.8
2	I4.8	3.7	2.I	5.4	0.9	I3.4	4.7	I7.6	I8.0	4.4	II.2
3	23.0	I8.4	3.8	3.6	6.6	I0.0	I2.4	33.4	64.3	I2.4	2.I
4	I3.I	I6.8	3.8	2.4	4.2	I0.3	9.4	25.I	50.4	4I.7	I.0
5	7.5	I0.8	3.4	2.6	I.9	I0.2	7.7	I2.5	40.3	23.2	I.0
6	3.7	4.0	I.4	2.2	I.2	3.8	7.6	5.9	I2.7	I0.2	I.0
7	I.8	I.6	0.8	I.2	0.8	2.5	3.3	3.5	6.7	4.6	0.8
8	0.8	0.6	0.4	0.7	0.4	2.0	2.0	I.8	2.8	4.2	0.8
9	0.3	0.2	0.2	0.3	0.2	I.2	I.9	I.I	I.2	2.5	0.8
I0	0.I	0.I	0.2	0.2	0.I	0.7	0.9	0.8	I.2	I.3	0.7
II	0.I	+	0.I	0.I	0.I	0.3	0.4	0.2	0.6	0.6	0.5
I2	0.I	+	0.I	+	0.I	0.2	0.I	0.I	0.4	0.4	0.4
I3	+	+	+	+	+	0.I	+	+	0.2	0.2	0.I
I4	+	-	+	+	+	+	+	0.I	-	+	0.I
I5	+	-	+	+	+	+	0.I	-	+	+	+
I6	+	-	+	-	+	+	-	-	+	-	+
I7	-	-	+	-	-	-	-	-	-	-	-
I8	-	-	-	-	-	-	-	-	-	+	-
Mean number per haul spec.	65.6	56.4	I7.9	I8.9	I7.0	55.5	53.6	I03.3	202.3	I06.0	2I.3

Table 7. Mean catches (kg) of cod by age groups trawled per half an hour per unit of area (0.0135 sq.mile) in Divs. 3NO

Age	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	+	+	+	+	+	+	0.1	0.1	0.1	-	0.1
2	2.8	0.6	0.3	0.9	0.2	1.7	0.5	2.4	2.0	0.7	2.4
3	10.5	7.3	1.4	1.5	3.6	3.1	3.5	12.9	18.4	4.6	1.7
4	11.1	11.5	2.6	2.3	3.5	7.8	4.8	19.1	29.0	27.5	1.9
5	11.0	11.8	3.5	4.2	2.8	11.0	7.2	15.1	40.0	29.7	3.4
6	9.2	7.2	2.5	5.8	3.1	7.1	11.1	12.6	21.7	19.0	5.1
7	6.6	4.0	2.0	4.5	3.1	7.7	14.9	11.5	18.2	14.7	6.2
8	3.8	2.1	1.8	3.8	2.4	9.4	6.8	8.2	12.1	21.8	10.5
9	1.8	1.0	1.3	2.4	1.6	7.3	9.9	9.7	7.3	16.3	17.9
10	1.4	0.6	1.4	1.9	1.8	5.8	5.6	9.7	12.6	13.2	20.3
11	0.9	0.3	0.8	0.9	1.4	3.1	3.7	2.6	8.2	7.6	16.5
12	0.8	0.6	0.8	0.6	1.1	1.9	1.5	0.6	4.6	6.0	15.8
13	0.7	0.6	0.4	0.3	0.6	1.2	0.2	0.4	2.0	4.0	7.3
14	0.1	-	0.1	0.2	0.2	0.6	0.3	1.4	-	1.0	3.7
15	0.2	-	0.2	0.1	0.1	0.5	1.3	-	0.8	0.2	0.5
16	0.3	-	0.5	-	0.1	0.1	-	-	0.8	-	0.6
17	-	-	0.1	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-	-	0.8	-
Mean catch per haul, kg	61.2	47.6	19.7	29.4	25.6	68.3	71.4	106.3	177.8	167.1	113.9

Table 8. Per cent of mature fish by age groups according to data from trawl surveys in Divs. 3NO in 1985-87

Age, years	1985	1986	1987
I	-	-	-
2	-	-	-
3	0.8	-	I.I
4	0.9	I.I	6.0
5	I3.2	20.3	8.6
6	48.2	35.2	27.I
7	77.3	68.2	46.4
8	93.8	83.6	74.I
9	I00.0	82.4	95.5
I0	I00.0	90.0	96.8
II	I00.0	96.6	I00.0
I2	I00.0	I00.0	I00.0
I3	I00.0	I00.0	I00.0
I4	I00.0	I00.0	I00.0
I5	I00.0	I00.0	I00.0
I6	I00.0	-	I00.0
I7	-	I00.0	-
I8	-	I00.0	-
Percentage of mature specimens of the total number of fish caught	II.74	I8.69	I8.72

Table 9. Mean weight (kg) and length (cm) at age for cod trawled in Divs. 3NO.

Age	1985			1986			1987		
	Weight	Length	Number	Weight	Length	Number	Weight	Length	Number
I	0.02I	I3.29	3I	0.0II	II.50	I8	0.0I6	I2.86	44
2	0.I02	22.48	63	0.II6	22.24	75	0.076	2I.63	73
3	0.292	3I.35	I2I	0.290	30.74	58	0.297	34.46	92
4	0.603	39.89	III	0.580	40.28	95	0.668	44.26	50
5	I.II3	49.53	II4	I.270	53.46	74	I.I69	53.I8	58
6	I.954	59.84	83	I.975	62.28	54	I.939	62.45	59
7	3.083	69.22	88	3.230	72.32	44	2.708	69.9I	56
8	4.63I	78.64	66	5.I52	82.49	67	4.932	8I.98	58
9	6.6I8	86.68	34	6.533	88.33	55	8.I44	92.98	66
I0	II.0I7	99.34	4I	I0.26I	I00.24	49	9.858	98.83	62
II	I3.807	I06.88	24	II.2I2	I02.79	28	I2.493	I05.I6	54
I2	I4.306	I08.25	I2	I4.00I	I09.86	2I	I5.44I	II2.26	56
I3	I8.795	II9.80	5	I6.664	II5.90	I0	I7.865	II8.03	29
I4	-	-	-	I9.604	I23.00	3	I9.305	I20.35	I4
I5	23.II5	I33.00	2	I8.256	I2I.00	I	I9.875	I27.50	2
I6	26.040	I39.00	2	-	-	-	28.325	I37.50	2
I7	-	-	-	-	-	-	-	-	-
I8	-	-	-	34.205	I39.00	2	-	-	-

Table 10. Parameters of allometric growth and Bertalanffy equations for cod from Divs. 3NO

Year	Parameters				
	a	b	L_∞	k	t_o
1985	$0.697 \cdot 10^{-5}$	3.083	427.7	$2.478 \cdot 10^{-2}$	$-1.367 \cdot 10^{-2}$
1986	$0.632 \cdot 10^{-5}$	3.097	184.2	$7.265 \cdot 10^{-2}$	$-3.944 \cdot 10^{-2}$
1987	$0.394 \cdot 10^{-5}$	3.195	281.7	$4.144 \cdot 10^{-2}$	$-2.234 \cdot 10^{-2}$

Table 11. Results of the analysis of cod yield-per-recruit-stock for Divs. 3NO

Fishing mortality coefficient	Yield-per-recruit-stock		
	1985	1986	1987
0.05		1.018	1.232
0.10	$F_{0.1}$ - 1.513	1.383	1.601
0.11	1.530	1.417	$F_{0.1}$ - 1.628
0.12	1.539	$F_{0.1}$ - 1.444	1.645
0.13	F_{max} - 1.540	1.463	1.654
0.14	1.535	1.477	F_{max} - 1.657
0.15	1.526	1.486	1.655
0.16	1.514	1.491	1.649
0.17	1.499	F_{max} - 1.492	1.640
0.18	1.482	1.491	1.628
0.19	1.464	1.488	1.614
0.20	1.444	1.482	1.599
0.30	1.238	1.380	1.416
0.40	1.068	1.262	1.250
0.50	0.942	1.160	1.120
1.00	0.641	0.873	0.792
1.50	0.533	0.755	0.668

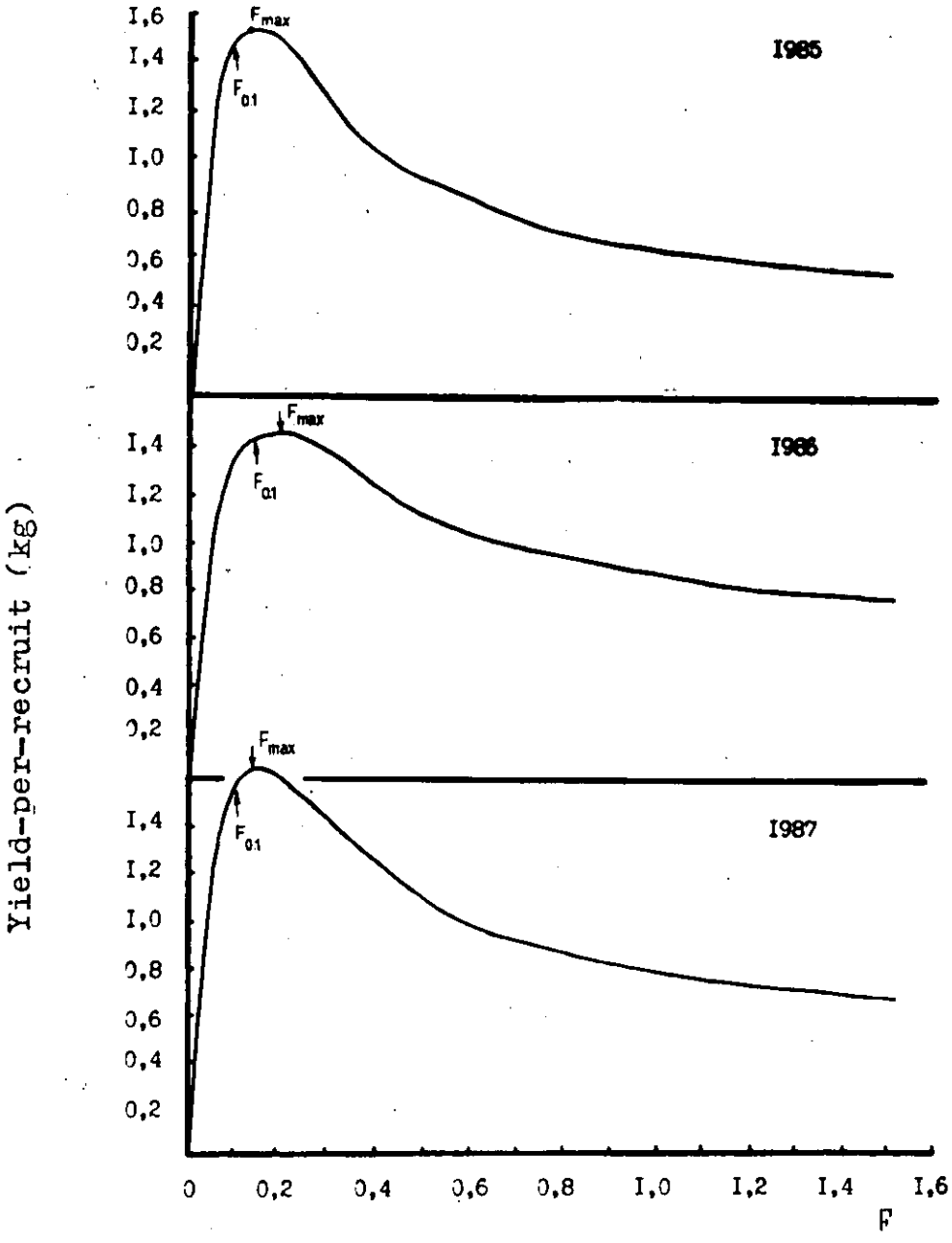

Fig.1 Cod yield-per-recruit-stock for Divs. 3NO