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REPORT OF THE WORKING GROUP ON ASSESSMENT OF DEMERSAL STOCKS IN THE BALTIC

Riga, 25 February - 1 March 1974

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Report of the Working Group on Assessment of Demersal Stocks in the Baltic

1. INTRODUCTION

At the Statutory Meeting of the International Council for the Exploration of the Sea held in Lisbon 1973 it was decided (C.Res.1973/2:6) that the Working Group on Assessment of Demersal Stocks in the Baltic should meet in order to assess the present state of the stocks of cod and flatfish in the Baltic. The Working Group is requested to carry out these tasks with a view to enabling the Liaison Committee to give advice as to regulations which may be needed for approaching the optimum yield from the stocks of the said species.

The Working Group met in Riga 25 February - 1 March 1974 and consisted of the following:

Dr O Bagge (Convenor)	Denmark
Dr M Berner	G.D.R.
Dr H Borrmann	G.D.R.
Dr S Hoziosky	U.S.S.R.
Mr H Knudsen (Rapporteur)	Denmark
Mrs M Kosior	Poland
Mrs I Lablaika	U.S.S.R.
Dr K Lemcke	G.D.R.
Mr J Netzel	Poland
Dr G Otterlind	Sweden
Prof.Dr F Thurow	F.R.G.
Mr M Vitinsh	U.S.S.R.

The Group agreed to deal first with the cod.

The Report of the Working Group on Assessment of Demersal Stocks in the Baltic (ICES Doc. C.M.1973/F:6) was reviewed and new data obtained in recent years were presented. Total catches, definition of the stocks, growth parameters, mortalities and state of exploitation were discussed.

2. COD

2.1 Catch Statistics

The annual catches of cod in the early sixties were on the level of 134 000 to 145 000 tons (Table 1, p. 7). In 1966 the catch increased to 175 000 tons. Later, from 1967 to 1973, the catches fluctuated between 160 000 and 200 000 tons. The increment in annual catches was due partly to good recruitment to the exploited stock and partly to the intensified exploitation. Catch data according to countries and statistical areas (ICES) are given in Tables 2 and 3 (p.8-9).

The main landings in the whole period 1960-1973 are from Areas 25 and 26 (Table 3). The landings from Area 25 have been more stable than those from Area 26, and from 1967 they increased to a very high level of 64 000 - 83 000 tons. The landings from Area 26 were always on a high level but fluctuated between 40 000 and 74 000 tons. A steadily increasing tendency is shown in the landings from Area 22. The catches increased in that area from 10 500 tons in 1960 to 36 500 tons in 1973. Very large fluctuations from year to year are seen in the landings from Area 24. Areas 27, 28 and 30 are of smaller importance to the fishery than the others mentioned.

According to U.S.S.R. data (Table 4, p.9) on the mean catch per unit effort in the years 1960-1972, an abrupt change in the catch per unit effort level occurred in 1966, which might be due to an improved stock and/or an improved fisheries technique.

2.2 Stock Definition

The 1971 ICES Special Meeting on Cod and Herring in the Baltic (ICES Doc. C.M.1971/F:28) agreed that the stock of cod in the Baltic is divided into two populations which are best separated by a line running from Sweden through Bornholm to Poland, that means between Areas 24 and 25. This opinion was confirmed by tagging experiments on mature cod. There is also some evidence to suggest that the eastern cod form one autonomous stock, distributed in the Bornholm, Gdańsk and southern Gotland Basin spawning areas, but always mixing to a considerable extent.

On the other hand, the western cod must be separated from eastern cod. The western cod form small spawning communities in Arkona Basin, Mecklenburg Bay, Kiel Bay and in the Belt Sea. Further investigations may show to which extent these cod may be treated as an autonomous stock.

2.3 Growth Parameters

Data on mean length, weight and growth parameters for the eastern stock of cod (east of Bornholm) are given in Tables 5 and 6. (p.10). Data for the western stock are scarce. It was therefore decided to discuss mainly the eastern cod population. Estimates of growth parameters are highly variable, which is thought to be partly due to the heterogenous material and partly to the different methods used for calculations. It was decided to examine, for assessment purposes, three values of K in such a way as to cover the supposed range of values (0.12 - 0.20). For the same purpose L_∞ was chosen as 105 cm.

2.4 Mortality

The data on total mortality (Z) estimated from catch per effort (c.p.u.e) and age compositions are summarised in Table 7, p.11. In that Table the underlined values of Z have been considered to be the most reliable, being calculated as weighted means.

There are fluctuations in the values of total mortality from year to year and between periods of years, which may be due not only to fluctuations in fishing intensity but also to differential distribution of fish caused by changes in hydrographic conditions. The mean values are therefore considered to be the best values for characterizing the level of total mortality for both stocks: for the eastern stock (east of Bornholm) in all areas it may be approximately 1.0, and for the western stock in Kiel Bay 1.5 (the best estimates from Polish data are for age groups IV-X as samples are collected in the first quarter of the year, when the third age group is not yet fully recruited). It seems that in the last year (1972/73) the total mortality of cod in Areas 22 and 26 was somewhat higher than the mean.

No new information was at hand concerning independent estimates of natural mortality, but it was agreed that M must be higher than 0.2. For the sake of security, however, the range from 0.2 - 0.4 was chosen.

2.5 State of Exploitation

As mentioned in paragraphs 2.3 and 2.4 above, the growth parameters and mortalities considered to be the most reliable in the Baltic proper (east of Bornholm) are:

$$K = 0.12 - 0.20$$

$$L_\infty = 105 \text{ cm}$$

$$M = 0.2 - 0.4$$

$$Z = 0.97 - 1.07$$

Data presented on length of fish at first capture gave values of 25.6 and 33.5 cm. However, the latter value concerns only a very small proportion of the total catch. Furthermore, a part of the total landings is derived from mixed fisheries. It is therefore concluded that l_c = 25 cm is the best estimate for the present l_c. The yield curves in Figures 1 and 2 (p.17/18) have been calculated from these parameters.

The most recent estimates of growth parameters show rather low values of K and therefore K equal to 0.12 was adopted. The upper value of l_c is taken to be 32.0 cm, which corresponds to a mesh size of 93 mm (stretched) using the selection factor of 3.43 (Bohl & Seydlitz, 1972), and disregarding the legal size limits enforced by different countries.

Following the usage of the 1972 ICNAF mid-term Assessment Report, $F_{0.1}$ has therefore been ascertained. An increase in fishing beyond this value will only increase the yield by an amount that is low compared to the increase in effort. $F_{0.1}$ defines that point of the yield curve, where the net addition to the total catch produced by a fishing unit of effort is only one-tenth of the catch per unit in a very lightly exploited stock.

From Figures 1 and 2 it is seen that the present state of exploitation is well beyond the peak of the curve. A decrease in fishing mortality from the present level of about 0.8 to 0.2 (keeping l_c constant) would give an increase in yield per recruit of 58%.

Keeping the present effort constant but increasing l_c from 25.0 to 32.0 cm, the yield per recruit should increase 34%. If l_c is increased as mentioned and F decreased at the same time, an additional gain of 30% would be obtained.

Working with a value of M = 0.4, Figure 2 shows that a decrease in fishing mortality from 0.6 to 0.4 would mean an increase in yield of 4% while an increase in l_c from 25.0 to 32.0 cm would produce a gain of 15%. There is no extra gain by reducing the fishing effort at this stage.

Some higher values of K mentioned in the range have been tried. It appeared from the resulting curves that the conclusions regarding measures to improve the yield per recruit were not seriously affected.

The Working Group could not analyse the relationship between adult stocks and subsequent recruitment. It is therefore not possible to state definitely how the amount of fishing affects the long-term yield.

The above assessments show that the overall fishing effort has exceeded $F_{0.1}$ and even F_{max}, but the quality of the data on which this assessment is based do not allow conclusions about the extent to which the effort should be reduced. An increase, however, will undoubtedly lead to a less rational exploitation of the stock.

It is therefore recommended that the effort be stabilized at the present level.

It may be safely concluded that an increase in the size at first capture will increase the yield and thus help to stabilize the fishery on an acceptable level.

3. FLOUNDER

3.1 Catch Statistics

In the period 1960-1963 the yearly total catch of flounder in the Baltic was about 9 000 tons (Table 8, p. 12), the missing data from F.R.G. and G.D.R. being assessed as 1 600 and 450 tons, respectively. In the period 1964-1971 the catches increased from 11 000 to 14 000 tons, and in 1972 the largest catch of 15 655 tons was obtained.

The combined catches of Denmark, G.D.R., Poland and U.S.S.R. amount to about 94% of the total. Table 9 (p.12) shows the following distribution of the main national catches:-

Country	Area
Denmark	22, 23
F.R.G.	22
G.D.R.	22, 24, 25, 26
Poland	25, 26
Sweden	25, 27, 28
U.S.S.R.	28, 29.

In Table 10 (p.13) the catch of flounder according to ICES area is shown.

Owing to the fact that the new statistical areas (ICES system 27.3.02.00) have been introduced only recently (1971), the data cannot be completely split up according to this system. The largest catches are obtained in Areas 24+25+26, followed by 27+28+29+30 and Areas 22+23. The catches in Areas 24+25+26 show an increasing trend, while the catches in the other areas have been almost constant.

3.2 Spawning Population

Many tagging experiments have been carried out to date and these show that the flounder undertake seasonal spawning and feeding migrations, but usually not over long distances. It has been assumed, therefore, that there is very little mixing of spawning populations. Considering the flounder as a rather stationary species it may be further assumed that there will be autonomous populations in most spawning areas, that is in the Belt Sea, Arkona Basin, Bornholm Basin, Gdańsk Basin and in the eastern and western parts of the Gotland Basin. Apart from tagging experiments there have been no other investigations into stock separation.

3.3 Growth Parameters

In Table 11 (p. 14) are given growth parameters from various areas eastward from Arkona area (24) to eastern Gotland (28). In the areas of Arkona, Bornholm Basin and Gdańsk recent data indicate that L_∞ lies between 45 and 50 cm; older material shows that the L_∞ was about 35.0 cm. The value of K fluctuates between 0.13 and 0.49. For the area of eastern Gotland various authors have given values of L_∞ in the range 35.1 - 39.9 cm, and K of between 0.18 - 0.25.

Excluding older material and aberrant observations a simple mean for the Bornholm-Gdańsk area was calculated using the three sources marked with an asterisk in Table 11. This gave: L_∞ = 46.23 cm and K = 0.21. For the Gotland area the mean values were L_∞ = 37.3 and K = 0.21, respectively.

3.4 Mortality

The data on total mortality (Z) estimated by different methods for several stocks are summarised in Table 12 (p. 15). There are some fluctuations due to the difference in methods of calculation used, but in general it can be seen that the total mortality is greater in the central Baltic (Areas 25 and 26) than in the eastern regions (Area 28). No major trends can be observed over the years.

Summarised fishing mortality (F) data are given in Table 13. The fishing mortality in the eastern Gotland area (28) appears to be lower than in other regions.

Using independent estimates of Z = 0.7 and F =0.35 from Soviet data, natural mortality (M) appears to be about 0.35. This may be an overestimation because the F estimated from tagging data seems to be somewhat underestimated. The real value of M seems to be within the interval 0.2 - 0.3. It seems most realistic for assessment purposes to regard the total mortality in the Gotland area(28) as being 0.69, in the Gdańsk area(26) as 1.09 and in the Bornholm area 0.72.

3.5 State of Exploitation

For the Bornholm area (Figure 3, p. 19) it may be seen that the rate of exploitation is rather close to the values giving the maximum yield so that little could be gained by increasing the fishing effort. However, assuming a natural mortality of 0.2 a change in l_c from 21 cm to 24 cm or 27 cm would result in an increase in the yield of about 9% and 17% respectively.

In the Gdańsk area (Figure 3), assuming a natural mortality of 0.2, the exploitation rate is in excess of the value giving the maximum yield. A decrease of F from 0.9 to the region of 0.5 would increase the yield by about 14%. Keeping the effort at the present level, but increasing the length at first entry to the fishery from 21 cm to 24 cm or 27 cm would mean a gain of 15% and 28% respectively. Assuming a natural mortality of 0.3, it is seen that very little would be gained by a change in fishing mortality. An increase in the length at first capture to 27 cm would mean an increase in the yield of about 10%.

In the Gotland area the fishery is reasonably well adjusted and only minimal changes could be expected following changes in F or l_c (Figure 4, p. 20).

The above assessment shows that in the Gotland area no change in the fisheries is needed.

For the Bornholm and Gdańsk area it is evident that nothing can be gained by an increase in fishing effort. Therefore, it is recommended to stabilise the fishing intensity and increase the length at first entry to the fisheries.

As a mean of keeping the fishing effort constant the importance of closed seasons should be stressed.

4. PLAICE

In the Western Baltic and the Belt Sea the plaice is the most important species, whereas it is only of minor importance in the Central Baltic as it is a more haline species than the flounder.

4.1 Growth Parameters

The existing (published) growth data are given in Table 14 (p.16). They are rather poor and only one set of von Bertalanffy parameters seems to be satisfactory (those from the Western Baltic (Kiel Bay)). The Working Group agreed to use these parameters in the yield assessment.

The yield assessment (Figure 5) shows that the present level of exploitation is far to the right of the optimum yield. A reduction of F from 1.35 to 0.30 will increase the yield by 20% (l_c = 25 cm) and 14% (l_c = 27 cm).

At the present level of exploitation an increase of l_c from 25.0 cm to 27.0 cm will give a gain of 8%.

5. TURBOT AND DAB

The data available on these species do not allow any conclusions to be given with regard to alteration of the already existing regulations. Further data are needed before any discussion on this subject may take place.

6. CONCLUSIONS

Since the mid-sixties the catches of cod and flounder in the Baltic have been almost stable.

The Working Group agreed that it was most likely that the effort has increased during the same period, in spite of the fact that no detailed statistics on effort were available.

The yield curve for cod shows that the present level of exploitation has far exceeded $F_{0.1}$ and F_{max}. In order to increase the yield, F should be reduced and/or the length at first capture increased. The Working Group agreed that available data are poor and that the only recommendations which can be made are that effort should be stabilised at the present level and the length at first capture increased.

Data on flounder were found to be poor. It was agreed that in the Gotland area no changes in the fisheries are needed, and that in the Bornholm-Gdańsk area fishing intensity should be stabilised and the length at first capture should be increased.

Data on plaice were available only from Kiel Bay. These indicated that the length at first capture should be increased.

The data available on turbot and dab did not allow any conclusions to be drawn.

7. RECOMMENDATIONS

In order to meet its terms of reference more effectively in the future, the Working Group recommends that the following research activities be carried out on the demersal species of the Baltic:

7.1 a. Investigation of unit stocks, using tagging as well as morphological and biochemical methods which would also lead to the development of improved methods for determining age and growth rate.

b. Investigation of the influence of pollution, as well as fishing activities, on reproduction, feeding, mortality and other population parameters.

c. Research into the predator/prey relationships of demersal and pelagic species.

d. The organisation of coordinated young fish and larval surveys.

e. The development of routine methods of collecting monthly catch statistics and biological information by ICES statistical rectangles.

f. The collection of data on catch in numbers, so that a Virtual Population Analysis may be carried out in the future.

7.2 The Working Group strongly recommends that these topics be investigated by uniform methods.

7.3 The Working Group further recommends that it should meet again, as soon as adequate information becomes available, in order to update and improve the assessments presented in this Report.

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Table 1. Total catch of Cod in the Baltic (in tons).

Year	Denmark	F.R.G.	G.D.R.	Poland	Sweden	U.S.S.R.	Total
1961	36 804	8 200	7 116	37 892	28 370	25 270	143 652
1962	35 064	5 400	7 175	40 942	25 297	31 330	145 208
1963	35 302	10 850	7 771	47 514	23 882	30 550	145 869
1964	34 220	14 553	5 092	39 735	16 672	24 490	134 762
1965	35 313	13 957	5 306	41 498	15 861	22 420	134 355
1966	37 070	11 152	5 978	56 007	16 678	38 270	175 155
1967	39 105	12 154	7 736	56 003	17 509	42 980	175 487
1968	44 109	14 858	14 613	63 245	17 599	43 610	197 034
1969	44 061	15 674	21 498	60 749	16 500	40 760	199 242
1970	42 392	17 935	16 979	68 440	13 506	33 230	192 482
1971	41 178	14 649	9 816	54 151	12 735	21 150	159 332
1972	55 717	13 895	11 488	57 093	13 886	30 000	186 079
1973*	60 715	23 291	13 500	45 796	16 000	19 710	184 912

* Provisional data.

Area / Year	Denmark		F.R.G.				G.D.R.		Poland	
	22	25[b]	22	24	25	26[c]	22	24[e]	25	26
1960	10 459								14 412	35 000
1961	11 548	25 276					2 384	4 732	9 892	28 000
1962	12 980	22 084					2 284	4 891	11 924	29 000
1963	11 735	23 567	7 439	2 052	1 368		2 824	4 947	14 514	33 000
1964	13 963	20 257	9 607	2 968	1 978		2 242	2 850	17 735	22 000
1965	13 863	21 450	9 365	2 755	1 837		2 020	3 286	19 998	21 500
1966	14 412	22 658	8 295	1 714	1 143		2 444	3 534	22 467	33 540
1967	13 266	25 839	9 885	1 361	907	1	2 466	5 270	23 881	32 122
1968	15 789	28 320	10 308	2 729	1 820	1	2 986	11 627	37 448	25 797
1969	14 690	29 371	9 345	3 797	2 532		4 177	17 321	29 848	30 901
1970	14 378	28 014	10 961	4 184	2 790		4 495	12 484	33 904	34 536
1971	16 831	30 000	10 953	2 216	1 477	3	3 602	6 214	27 581	26 570
1972	17 717	42 000	9 736	2 199	1 466	494	4 145	7 343	24 296	32 167
1973[d]	21 415	45 200	11 020	5 351	3 568	3 352	4 000	9 500	20 608	25 188

Area / Year	Sweden[a]					U.S.S.R.	
	24	25	27	28	30	26	28
1960	1 481	19 454	2 575	779	63	38 970	5 400
1961	1 270	20 016	2 163	427	54	21 830	3 440
1962	1 526	18 601	1 818	445	66	25 430	5 900
1963	1 474	20 293	1 515	219	81	27 150	3 400
1964	1 419	13 644	1 024	186	26	22 240	225
1965	1 539	13 306	624	253	14	17 840	4 580
1966	1 460	13 394	865	363	19	24 970	13 300
1967	1 454	13 996	839	521	6	33 370	961
1968	1 430	14 621	702	588	2	33 230	10 380
1969	977	14 133	514	411	5	34 680	608
1970	908	11 391	528	324	1	28 190	5 040
1971	1 053	10 857	689	199	38	16 300	4 850
1972	934	11 457	725	364	30	23 840	6 160
1973[d]	1 104	13 552	864	432	48	14 460	5 250

Table 2. Catch statistics of Baltic Cod according to countries and ICES areas.

a) Swedish catches do not include those taken by vessels from the west coast fishing in the Baltic.

b) Includes Areas 24 and 26.

c) Includes Area 28.

d) 1973 data for G.D.R., Poland and Sweden are provisional.

e) Includes Areas 25 and 26.

Table 3. Catch statistics of Baltic Cod according to ICES areas.

Year	Areas							Total**
	22	24	25	26	27	28	30	
1960	10 459	1 481	33 866	73 970	2 575	6 179	63	128 593
1961	13 932	6 002	55 184	49 830	2 163	3 867	54	131 032
1962	15 264	6 417	52 609	54 430	1 818	6 345	66	136 949
1963	21 998	8 473	59 742	60 150	1 515	3 619	81	155 578
1964	25 812	7 237	53 614	44 240	1 024	411	26	132 364
1965	25 248	14 817	56 591	39 340	624	4 833	14	141 467
1966	25 151	6 708	59 662	58 510	865	13 663	19	164 578
1967	25 617	8 085	64 623	65 493	839	1 482	6	166 145
1968	29 083	15 786	82 209	59 028	702	10 968	2	197 778
1969	28 212	22 095	75 884	65 581	514	1 019	5	193 310
1970	29 834	17 576	76 099	62 726	528	5 364	1	192 128
1971	31 386	9 483	69 915	42 873	689	5 049	38	159 433
1972	31 598	10 476	79 489	56 501	725	6 524	40	185 713
1973*	36 435	15 955	82 928	43 000	864	5 682	48	184 912

* Provisional data.

** Totals do not include catches made in the Baltic by Swedish west coast vessels.

Table 4. Catches of Cod per boat-day (in kg).

Year/Area	Poland		U.S.S.R.***				Annual Mean
	Jan-Mar		Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	
	25*	26**	26	26	26	26	26
1960	-	-	1 420		1 780	1 280	1 490
1961	-	-	1 780	1 700	1 520	890	1 470
1962	-	-	1 620	1 600	1 600	2 160	1 740
1963	-	-	1 580	1 320	1 780	1 540	1 550
1964	-	-	1 480	1 610	1 210	1 310	1 400
1965	-	1 351	680	900	2 100	2 290	1 490
1966	511	1 874	1 730	2 120	2 520	3 050	2 360
1967	618	2 537	2 460	2 060	2 320	3 340	2 550
1968	826	1 708	2 730	1 090	2 570	3 960	2 590
1969	544	2 648	1 030	3 070	2 760	3 960	2 560
1970	940	3 216	1 180	2 740	2 270	3 500	2 280
1971	449	1 821	1 690	1 780	2 080	4 850	2 590
1972	496	2 594	2 580	2 150	2 530	3 090	2 590
1973	446	1 466	2 700	1 820	1 360	-	-

* 17 m cutter (bottom pair trawl)

** 24 m cutter (bottom trawl)

*** boat of 80-150 hp (bottom trawl).

Table 5. Mean lengths and mean weights of Baltic Cod.

Age	Length (cm)							
	Area	25	26	25	25	26	26	26
	Source	Poland	Poland	Poland	Thurcw	Poland	U.S.S.R.	U.S.S.R.	U.S.S.R. (mean)
		1972	1972	1973	1974	1973	1972	1973	1971-73
1					13.0		16.9	13.1	15.6
2		29.6	30.7	30.1	38.0	31.6	28.6	24.5	26.6
3		37.8	38.9	37.5	45.2	38.4	35.9	36.9	35.5
4		43.3	44.1	43.3	52.3	44.5	42.7	44.6	43.0
5		54.6	51.7	51.9	59.0	51.8	50.3	53.6	51.5
6		59.4	60.2	60.4	66.6	60.0	59.7	62.7	61.0
7		68.4	67.8	72.9	69.0	68.1	67.5	69.4	69.1
8		74.7	68.1	77.3	74.1	69.9		80.7	76.5
9		82.0		91.0		76.0			
10				99.0		82.0			

Age	Weight (g)								
	Area	25	26	25	26	26	26	26	25	25
	Source	Poland	Poland	Poland	Poland	U.S.S.R	U.S.S.R	U.S.S.R.	G.D.R.	G.D.R. (spawning)
		1972	1972	1973	1973	1972	1973	Mean 1971-3	1972	1972
1						50	24	41	45	
2		215	335	284	362	229	121	175	207	258
3		561	654	568	657	449	493	440	542	588
4		1 169	940	871	957	802	861	789	828	847
5		1 492	1 427	1 544	1 550	1 298	1 420	1 320	1 420	1 338
6		2 164	2 123	2 483	2 307	1 976	2 027	2 086	2 429	2 043
7		3 382	3 089	4 195	3 371	2 849	3 086	2 995	3 499	2 956
8		4 290	3 180	4 395	3 829		3 704	3 457	5 094	5 017
9							5 085	5 085		

Table 6. Growth parameters of Baltic Cod.

Parameter	Area 22, Denmark (excl. age 1)	Area 25 Thurow 1974 (excl. age 1)	Area 26 Poland (excl. ages 1-2)	Area 26 U.S.S.R. (estimated from older data)	Area 25 G.D.R. (excluding ages 1-2)
K	0.176	0.117	0.154	0.10 - 0.12	0.1334
L_∞	121.26 cm	109.6 cm	102.04 cm	110 - 120 cm	W_∞ = 12.321 kg
t_o	-0.375	-1.63	0.1481		-0.386

Table 7. Total mortality (Z) for Cod.

Area	Kiel Bay, 22			Bornholm Basin, 25				Gdańsk Bay, 27			Gotland Basin, 26
Country	Denmark		F.R.G.	Denmark		Poland		Poland			U.S.S.R.
Data used	c.p.u.e		c.p.u.e	c.p.u.e		c.p.u.e		c.p.u.e			Age comp.
Age / Year	III-VI		II-X	III-VI		III-VII	III-X IV-X	III-VII	III-X	IV-X	IV-IX
	*	+		*	+	*	+ +	*	+	+	
1965/66	0.52	0.39						0.60	0.49	0.67	0.85
1966/67	1.76	2.15	1.55			1.61	1.17 1.34	1.37	0.94	1.46	(1965-67)
1967/68	1.10	1.19	1.31			0.77	0.73 0.57	1.19	1.24	0.94	
1968/69	1.53	1.25	1.38	2.44	1.27	1.79	1.46 1.55	0.90	0.53	1.02	1.04
1969/70	1.80	2.31	1.11	0.85	0.38	0.54	0.40 0.91	0.82	0.48	0.65	(1968-71)
1970/71	1.91	2.05	1.75	2.05	1.64	1.65	1.23 1.17	1.22	0.54	0.99	
1971/72	1.18	1.39	1.73	1.38	1.24	1.11	0.38 0.89	1.13	0.03	0.79	
1972/73	2.37	2.78	1.67	0.85	0.95	1.21	0.75 1.07	1.34	1.14	1.20	1.08 (1972-73)
Mean	1.52*	<u>1.49</u>+	1.57	1.51*	<u>1.06</u>+	1.21*	0.87+ <u>1.07</u>+	1.04*	0.68+	<u>0.97</u>+	<u>1.00</u> (1965-73)

* The mean calculated as an arithmetic mean. + The mean calculated as a weighted mean.

Note: the underlined values are considered to be the most reliable (See Section 2.4).

Table 8. Total catch of Flounder in the Baltic (in tons).

Year	Denmark	F.R.G.	G.D.R.	Poland	Sweden	U.S.S.R.	Total
1960*	2 597			1 523	642	2 160	6 922
1961**	2 550		1 594	1 621	688	2 540	8 993
1962**	2 466		1 461	2 467	631	2 180	9 205
1963	2 136	466	1 821	1 937	679	2 550	9 589
1964	2 434	564	1 996	1 257	576	4 440	11 267
1965	2 356	413	1 642	1 797	586	5 570	12 364
1966	2 596	303	1 964	2 886	632	5 660	14 041
1967	3 165	363	2 169	2 036	642	4 060	12 435
1968	2 965	366	2 499	3 058	616	3 010	12 514
1969	2 961	334	2 520	2 987	559	3 300	12 661
1970	3 159	305	2 147	3 464	484	3 680	13 239
1971	3 364	319	2 281	2 409	444	4 080	12 897
1972	3 753	315	2 970	4 171	466	3 980	15 655
1973+	4 497	355				2 600	

* Data from F.R.G. and G.D.R. not available.

** Data from F.R.G. not available.

\+ Data from G.D.R., Poland and Sweden not available.

Table 9. Catch of Flounder in the Baltic according to countries and ICES Areas (in tons).

Country	Denmark*		F.R.G.		G.D.R.		Poland		Sweden					U.S.S.R.			Total
Year/Area	22+23	24+25	22	24+25+26	22	24+25+26	25	26	24	25	27	28	30	26	28	29	
1960	2 022	575					386	1 137	42	187	204	209		270	960	930	6 922
1961	2 013	537			306	1 288	627	994	51	159	264	214		110	1 890	540	8 993
1962	1 885	581			369	1 092	971	1 496	38	172	256	165		240	1 450	490	9 205
1963	1 622	514	452	14	702	1 119	1 287	650	32	121	308	218		220	1 640	690	9 589
1964	1 976	458	514	50	816	1 180	204	1 053	23	106	291	155	1	220	3 850	370	11 267
1965	1 881	475	390	23	591	1 051	755	1 042	28	117	262	179		430	4 640	500	12 364
1966	1 811	785	275	28	586	1 378	1 187	1 699	27	133	308	164		490	4 100	1 070	14 041
1967	1 903	1 262	320	43	435	1 734	683	1 353	23	139	325	155		240	2 490	1 330	12 435
1968	1 771	502	357	9	476	2 023	1 301	1 757	21	136	253	205	1	560	1 710	740	11 822
1969	2 098	314	323	11	644	1 876	1 158	1 829	13	103	244	199		600	1 750	950	12 112
1970	2 065	457	294	11	535	1 612	709	2 755	10	109	226	139		440	1 940	1 300	12 602
1971	1 935	327	312	7	536	1 745	1 173	1 236	17	118	190	119		510	2 300	1 270	11 795
1972	2 071	324	312	3	532	2 438	1 468	2 703	16	140	166	143	1	770	1 890	1 320	14 297
1973+	1 803	967	349	6										40	1 740	820	

* Industrial landings from 1968 to 1973 from Denmark are not included.

\+ Catches by G.D.R., Poland and Sweden in 1973 not available.

Table 10. Catch of Flounder in the Baltic according to ICES areas.[4]

Year	IIIc	IIId			Grand Total
	(22+23)	(24+25+26)	(27+28+29+30)	Total	
1960[1]	2 022	2 597	2 303	4 900	6 922
1961[2]	2 319	3 766	2 908	6 674	8 993
1962[2]	2 254	4 590	2 361	6 951	9 205
1963	2 776	3 957	2 856	6 813	9 589
1964	3 306	3 294	4 667	7 961	11 267
1965	2 862	3 921	5 581	9 502	12 364
1966	2 672	5 727	5 642	11 369	14 041
1967	2 658	5 477	4 300	9 769	12 435
1968	2 604	6 309	2 909	9 218	11 822
1969	3 065	5 904	3 143	9 047	12 112
1970	2 894	6 103	3 605	9 708	12 602
1971	2 783	5 133	3 879	9 012	11 795
1972	2 915	7 862	3 520	11 382	14 297
1973[3]	2 152	1 013	2 560	3 573	

1) Data from F.R.G. and G.D.R. not available.

2) Data from F.R.G. not available.

3) Data from G.D.R., Poland and Sweden not available.

4) Industrial landings from Denmark 1968 to 1973 not included.

Table 11. Growth parameters of Flounder.

Area	Arkona(24)	Bornholm(25)		Gdańsk(26)					
Source	G.D.R. 1971	G.D.R. 1971	Poland 1974	Poland 1974	Kändler 1932	Mulicki 1959	Ann.biol. 1962	Cieglewicz 1969	Cieglewicz/Hoppe 1969
L_∞ (cm)	48.38	33.66	45.8*	45.6*	35.3	35.2	36.5	47.3*	52.3
K	0.132	0.331	0.191	0.210	0.23	0.49	0.49	0.229	0.165
t_o	-1.302	-0.529	-	-0.503	-0.15	-0.86	-0.93	-0.503	-0.294

ctd.

Area	Eastern Gotland (28)			
Source	U.S.S.R. 1974	Kändler 1932	Zemskaja 1959	U.S.S.R. Ann.biol.1959-71
L_∞ (cm)	36.9*	34.8	35.1*	39.9*
K	0.19	0.24	0.25	0.18
t_o	-	-0.69	-0.91	-1.53

* See Section 3.3

Table 12. Total mortality (Z) for Flonnder.

Area: Western Baltic (22)				Bornholm (25)						
Years	Z	Ages	Material	Years	Z	Ages	Material	Years	Z	Material
1957	1.44	III-VII	Kändler, Thurow (1959)	1967-71	0.56	IV-VIII	Polish ICES Ann. biol.	1960-63	0.79	Polish age comp. %
1971-73	1.20	III-VII	unpubl. Danish	1972-73	1.16	III-VIII	unpubl. Danish	1964-67	0.58	
								1968-71	0.60	
								1968-72	0.92	Polish c.p.u.e

ctd.

Area:				Gdańsk Bay (26)			Eastern Gotland (28)						
Years	Z	Ages	Material	Years	Z	Material	Years	Z	Ages	Material	Years	Z	Material
1955-71	1.07	III-VIII	Polish ICES Ann. biol.	1937-38	1.06	Polish age comp. %	1957-71	1.09	IV-VIII	USSR ICES Ann. biol.	1967-69	0.68	USSR tagging data
				1945-47	1.05						1967-73	0.70	USSR simple catch curve
				1957-59	1.46								
				1960-63	0.89								
				1964-67	1.12								
				1968-71	0.99								
				1968-72	1.04	Polish c.p.u.e							

Table 13. Fishing mortality (F) for Flounder.

Area	Years	F	Method	Source
Belt Sea(22)	1960-62	0.81	Tagging	Bagge(1966)
Western Baltic (22)	1960-62	0.43	Tagging	Bagge(1966)
Sound (23)	1960-62	0.46	Tagging	Bagge(1966)
Bornholm Basin-Bay of Gdańsk (25-26)	1960-62	0.72	Tagging	Cieglewicz (1963)
Bornholm Basin(25)	1968-72	0.62	From Z = 0.92 if assumed M = 0.3	Cieglewicz et al. unpubl.
Bay of Gdańsk (26)	1968-72	0.74	From Z = 1.04 if M=0.3	"
Eastern Gotland (28)	1967-69	0.28-0.35	Tagging	Vitinsh, Hoziosky, unpubl.
	1970-71	0.35	Tagging	"
	1967-71	0.32	Tagging	"

Table 14. Growth parameters of Plaice.

Area	Western Baltic(22)	Arkona(24) Oder Bank	Bay of Gdańsk (26)
Source	Denmark unpubl.	Ann.biol. 1962	Ann.biol. Catches 1960-61
L_∞	47.0	73.6	55.1
K	0.22	0.053	0.124
t_o	-3.0	-4.7	-1.29

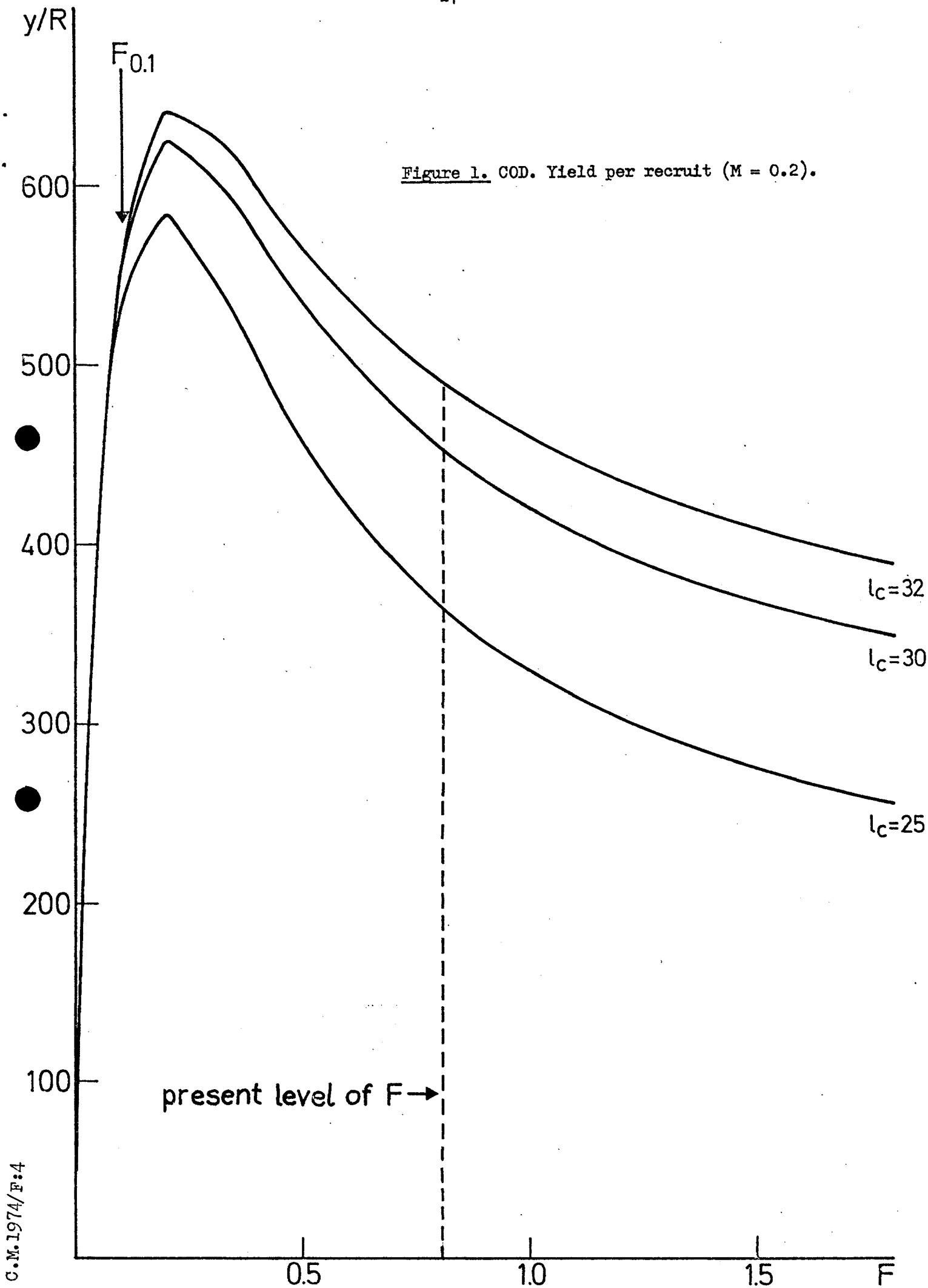
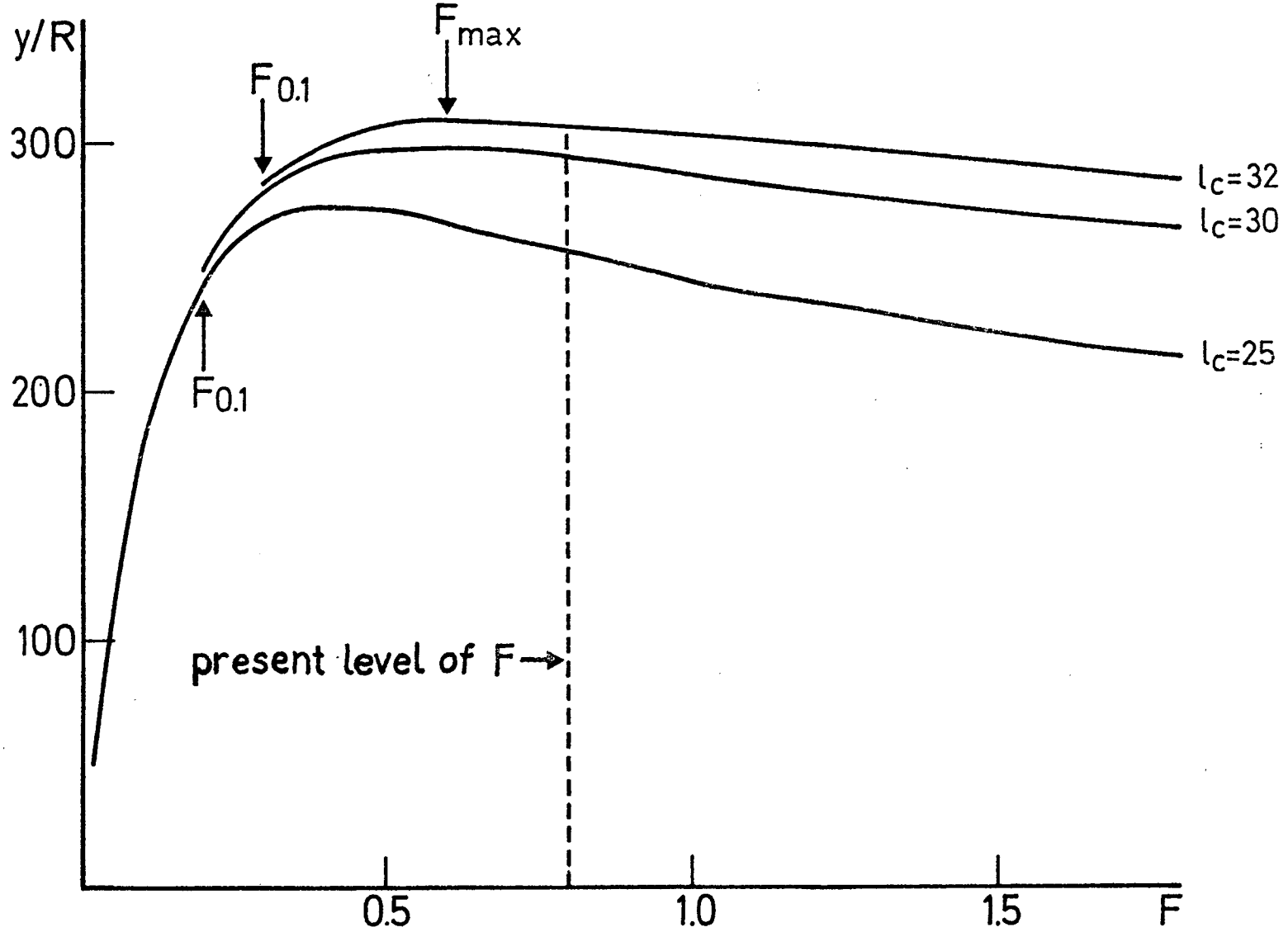


Figure 1. COD. Yield per recruit (M = 0.2).

Figure 2. COD - East of Bornholm.
Yield per recruit (M = 0.4).



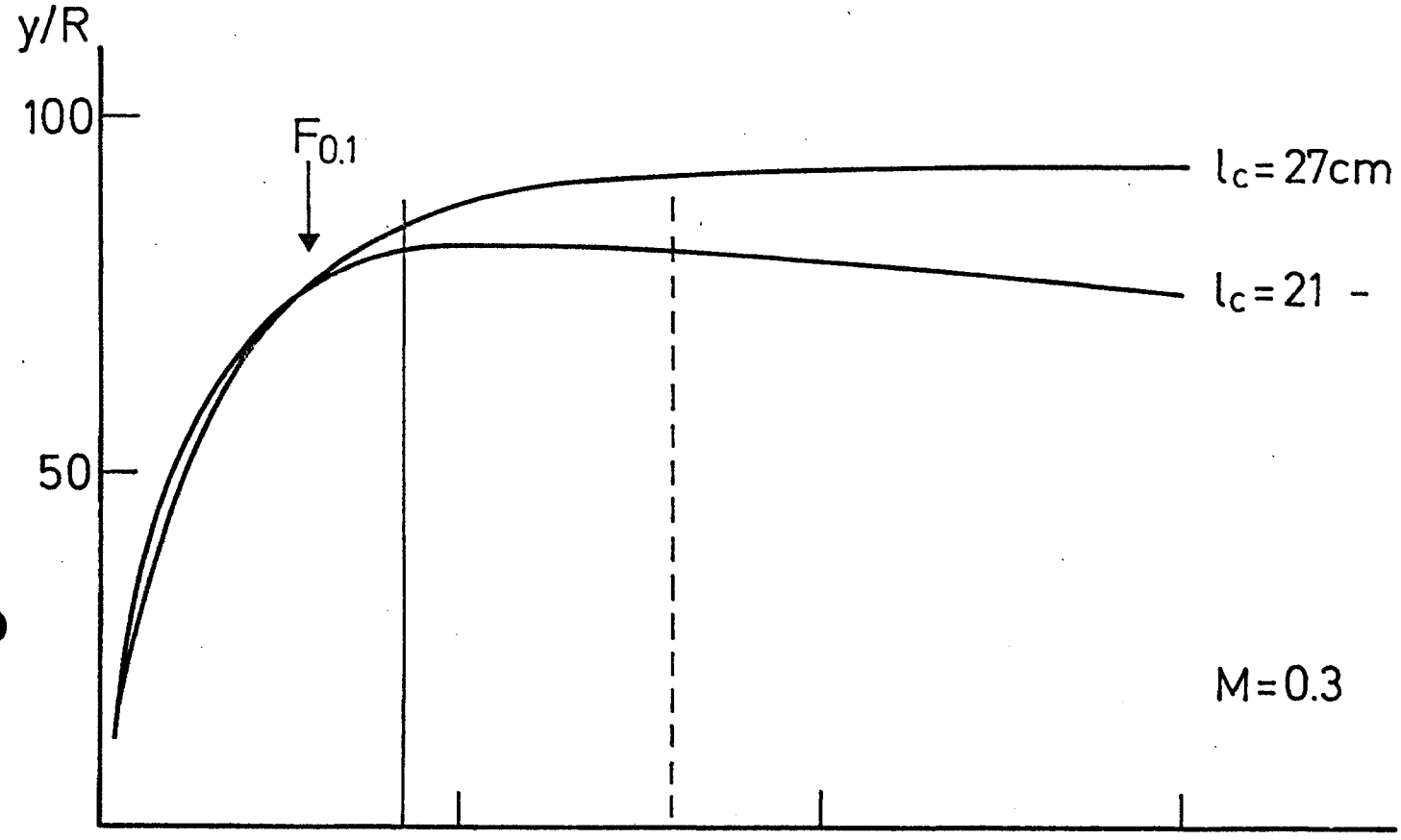


Figure 3. FLOUNDER (Gdańsk and Bornholm Basin). Yield per recruit (M = 0.2 and 0.3). Full drawn line represents level of exploitation in the Bornholm Basin. Dotted line represents level of exploitation in the Gdańsk area.

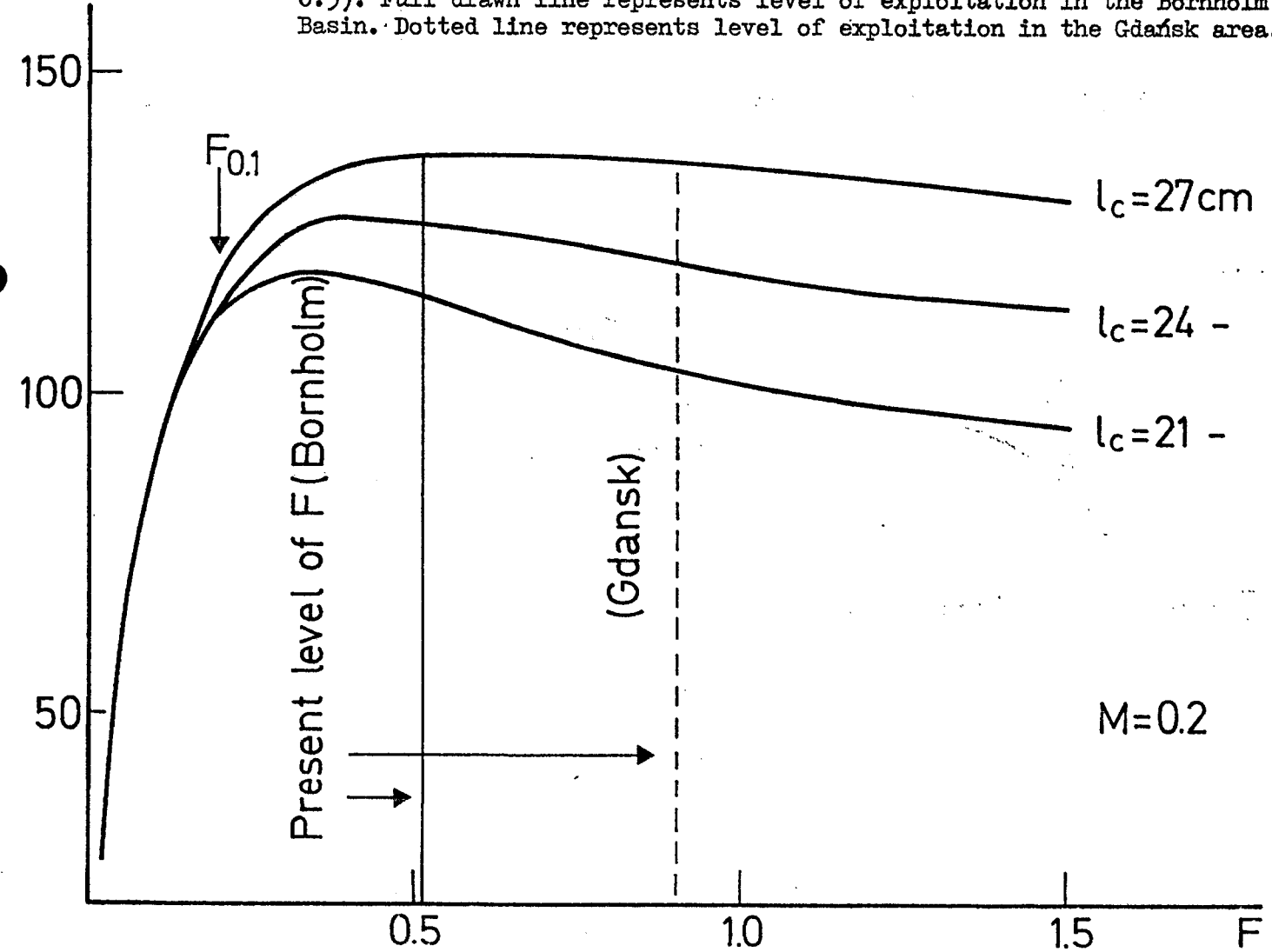
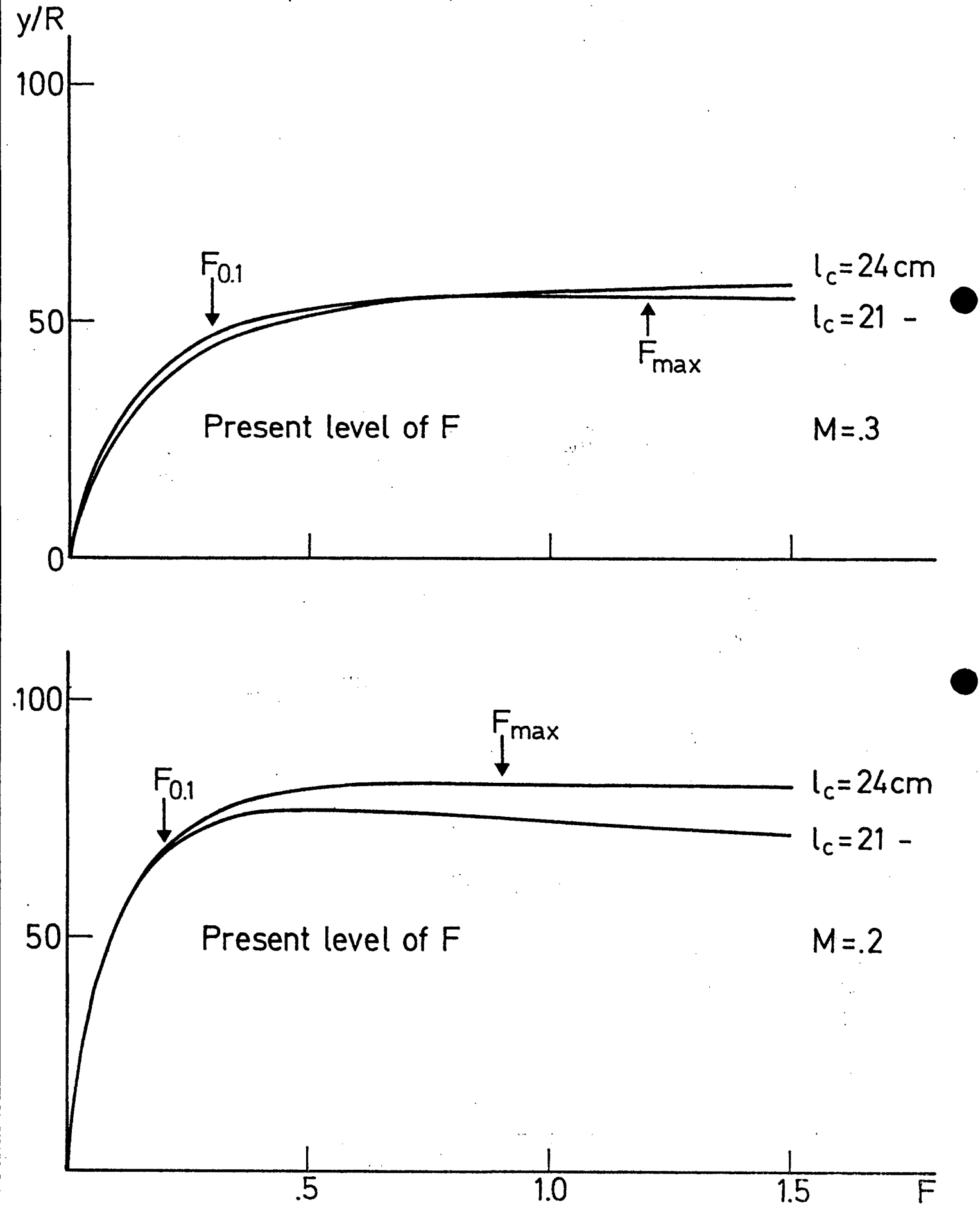


Figure 4. FLOUNDER, (Gotland area). Yield per recruit (M = 0.2 and 0.3).



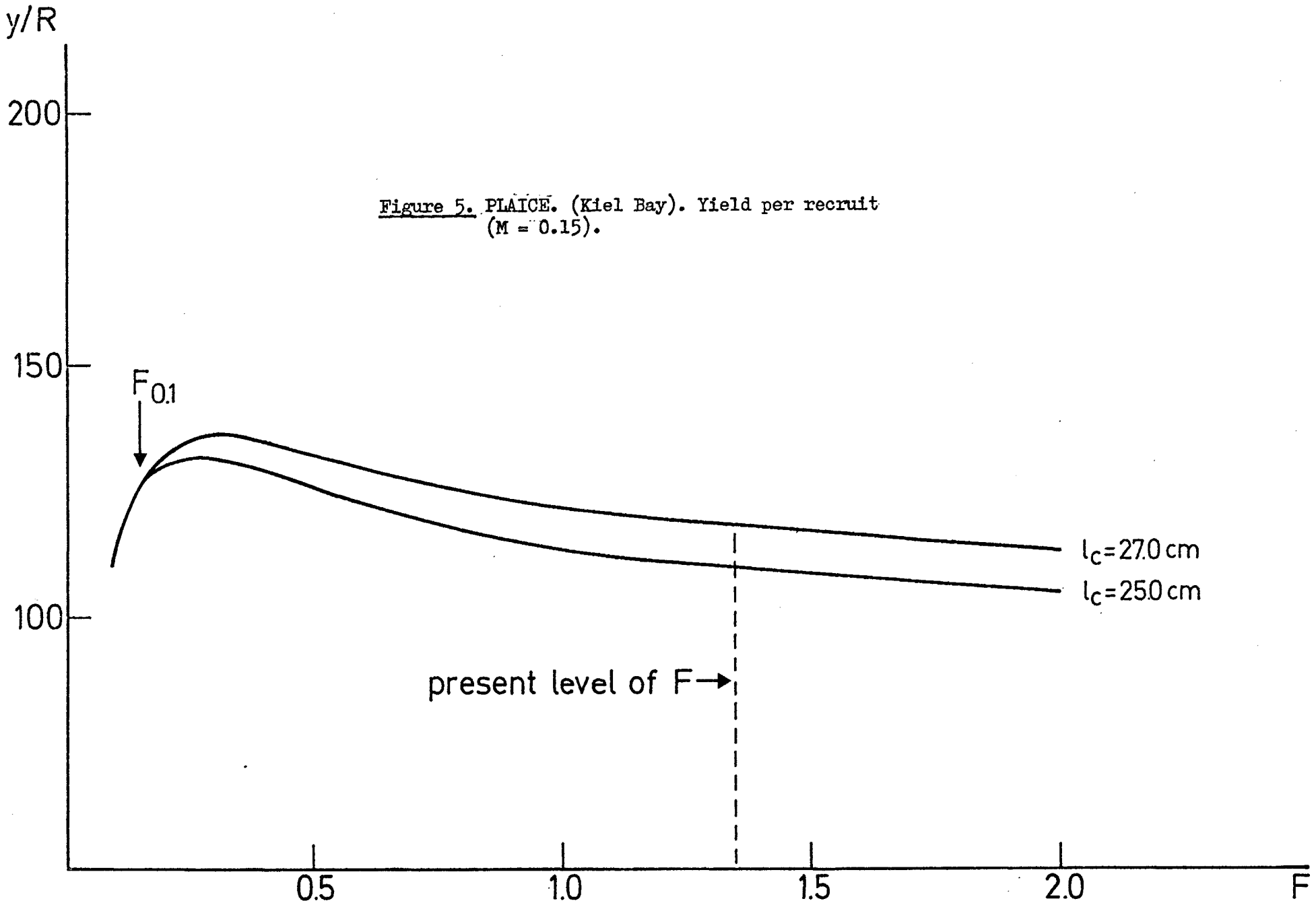


Figure 5. PLAICE. (Kiel Bay). Yield per recruit (M = 0.15).