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International Council for the  
Exploration of the Sea

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Demersal Fish (Northern) Committee

REPORT OF THE WORKING GROUP ON GREENLAND HALIBUT

IN REGION 1

Charlottenlund, 7 - 11 March 1977

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x) General Secretary,  
ICES, Charlottenlund Slot,  
2920 Charlottenlund,  
Denmark.

Report of the Working Group on Greenland Halibut in Region 1

1. Participants

J Møller Jensen	Denmark
M Liwoch	Poland
C J Rørvik	Norway
A Sigurdsson	Iceland
E Smidt	Denmark
G Speiser	Germany (Federal Republic of)
B Vaske (Chairman)	German Democratic Republic

ICES Statistician, Dr V M Nikolaev, also attended the meeting.

Messrs. Liwoch and Speiser could only attend a part of the meeting as the Working Group partly overlapped with the meeting of the Working Group on Herring.

No representative was present from U.S.S.R., but the Convenor had got extensive data about the U.S.S.R. trawl fishery in Sub-areas I and II in the period 1965-76 from Dr V Ponomarenko.

2. Terms of Reference

The meeting was convened in accordance with the resolution (C.Res.1976/2:11) adopted by the Council at the 1976 Statutory Meeting:

"It was decided, that:

a Working Group to be referred to as 'The Working Group on Greenland Halibut in Region 1' should meet at Charlottenlund from 7-11 March 1977 to assess TACs for Greenland halibut. The Group should be convened by Mr B Vaske".

In addition to that, following the decision of the November 1976 Mid-Term Meeting of NEAFC, the Chairman of ICES Liaison Committee requested the Working Group to prepare a review of general biology, exploitation and relation of the following stocks to the 200-mile zones under national fisheries jurisdiction:

<u>Species</u>	<u>Fishing Area</u>
Greenland halibut	SAI and II, SAV, SAXIV
Halibut, Witch	SAV, SAXIV
Plaice, Common dab, Long rough dab, Megrin, Lemon sole	} SAV

3. The Stocks of Greenland Halibut in Region 1

Regarding the data available on the biology of Greenland halibut in Sub-areas I and II, there seems to be only one stock in these two areas. Therefore, the Working Group decided to combine the data from them.

The data from Sub-area V and Sub-area XIV were combined, as it has been assumed that there is only one stock of Greenland halibut in the two areas. This assumption is based on a strong probability that the spawning grounds are the same for both areas.

#### 4. Greenland Halibut in Sub-areas I and II

##### 4.1 Nominal catches

The total nominal catches for the main fishing areas are given in Table 1 for the period 1966-76. Tables 2, 3, and 4 present the nominal catches by country for each fishing area.

For assessment purposes, the catches in Sub-areas I and II are summarised in Table 5.

In the period under consideration the total catch of Greenland halibut in Sub-areas I and II increased from a minimum catch of 24 267 tons in 1967 to a maximum catch of 89 484 tons in 1970. Since 1970 the catches have decreased to a level of 29 938 tons in 1973. In 1974 the total nominal catch has increased slightly to 37 763 tons. Since then, the total catches have been relatively constant. The provisional catch in 1976 is 33 775 tons.

Table 5 also shows the total catches taken in the Norwegian long-line fishery in Sub-areas I and II. These catches have declined since 1968 for reasons described in the Appendix.

##### 4.2 Catch per unit effort and effort data

Catch figures per hour trawling were available from the U.S.S.R. fishery for the period 1965 to 1976 (Table 10). Figure 1 shows the trends in the catch per unit effort for this period together with the catches from 1950 to 1976. Using the catches and the catch per unit effort, the effort in the U.S.S.R. trawl fishery and the effort on the total trawl fishery was estimated (Table 10).

##### 4.3 Virtual Population Analysis

###### 4.3.1 Age composition of landings

Age compositions of national landings in the trawl fishery were available as number landed in each age group for the U.S.S.R. for the period 1965-76, and the German Democratic Republic for the year 1971 and the period 1972-76. To obtain the age composition for the total trawl fishery in each year, these available age compositions were raised to the total trawl landings.

For Norwegian long-line fishery, age compositions were presented for the period 1970-74. For the years 1975 and 1976 the same age composition as for 1974 was assumed, because the Norwegian long-line landings were small compared with the total landings in these years.

For the period 1966-69 from 34% to 86% of the total annual catches were taken in the Norwegian long-line fishery. Because of this and a different age composition in trawl catches and long-line catches (see Figure 2), the Working Group considered it not proper to apply the U.S.S.R. age compositions to the total catch for these years.

The age compositions of the total landings were, therefore, prepared for only the years 1970-76 (Table 11).

Time did not allow the Group to do a VPA for males and females separately.

###### 4.3.2 Natural mortality

A trial was made to estimate the natural mortality by plotting Z versus the total trawl effort. Z was estimated from the catch per unit effort ratio of the fully recruited year classes and successive years in the U.S.S.R. trawl fishery. The trawling effort corresponding to the Z value

between two successive years was estimated as the average total trawling effort for the same two years. This analysis was done for both sexes combined and for males only for the years 1970 to 1976 during which trawl catches dominated (Table 5). However, the results were regarded as inconclusive as the intercepts which, according to theory, should be an estimate of  $M$ , were negative. Further refinements of this analysis were not carried out because of the limited time available.

We would expect  $M$  to be low for a species with a longevity like Greenland halibut, especially for the females (Figure 3).

For this year's analysis, the Working Group chose an  $M$  value of 0.15 for the combined sexes. However, the value of  $M$  should be a matter for further investigation.

#### 4.3.3 Estimation of the input fishing mortalities in the VPA

In a preliminary run of the VPA we set  $F_{16}$  equal to 0.50 for 1970 and 1971, and equal to 0.30 for the years 1972 to 1976. The initial guess of the  $F$  values for 1976 was 0.01, 0.02, 0.02, 0.06, 0.25 and age groups 3 to 7, and 0.30 for 8 years and older.

From the results of this preliminary run the unweighted mean  $F$  values for age group 8 to 13 ( $F_{8-12}$ ) were calculated for the years 1970 to 1974. A linear regression between the total trawl effort (in '000 hours) and  $F_{8-13}$  for these years is shown in Figure 4. A functional regression would not change this line very much because of the high correlation.

This linear regression predicted that a better  $F_{8-13}$  for 1976 would be 0.26 on the hours of the total trawl effort exerted that year. We chose  $F = 0.25$  for age groups 8-16 and decreased the  $F$  value for age group 6 proportionally from 0.06 to 0.05 and for age group 7 from 0.25 to 0.21. All the other  $F$  input values were left unchanged. The results of this final VPA run are shown in Tables 12 and 13.

#### 4.4 The state of the stock

On the basis of the VPA the biomass of the recruited stock, that is 4 years and older fish, and the spawning stock, that is 9 years and older, was estimated using the mean weights given in Table 14. The results are shown in Table 15.

There is a strong correlation ( $r = 0.98$ ) between the U.S.S.R. catch per unit effort and the recruited stock estimates for the years 1970-74 as shown in Figure 5.

Assuming that the same close relation also holds for the years 1965 to 1969, which is outside the range in which the relations were established, the recruited stocks for these years have been estimated by extrapolation (Table 15).

The estimated decrease on the stock size from 1965 to 1970 is  $(446 - 311) \times 10^3$  tons = 135 000, while the total catches in the same period was about 155 000 tons, i.e. only 20 000 tons difference. If 1971 instead of 1970 is used in the comparison, the difference is increased to 110 000 tons.

This difference between the catches and the estimated decrease in the stock size is an estimate of the surplus production of the stock in this period. The average surplus production per year then becomes 110 000/6 or nearly 20 000 tons. For comparison, the average catch was nearly 37 000 tons in the period 1972 to 1976 when the stock seems to have been fairly stable as judged from the VPA (Table 15) and the catch per unit effort (Table 10).

Figure 1 shows the total catches from 1950 onwards. Although this is more speculative, it seems likely from this figure that the low catches in the 1950s and the somewhat larger catches in 1959 to 1964 reduced the stock, but not very much below its maximum level. The 1965 stock is estimated to have been nearly 450 000 tons; may be the maximum stock as it was in the 1950s was around 500 000 tons. If this is the case, the present stock is roughly half the maximum size. Thus, it seems not unreasonable that together with the reduction in the stock size the surplus production increased from 20 000 tons on the average in the years 1965 to 1971 to nearly 40 000 tons in the period 1972 to 1976 as indicated above.

The yield per recruit curve with the present exploitation pattern (Figure 6) described in Section 4.5 indicates that the present exploitation rate which is around 0.25 on the fully recruited age groups (Table 12) is close to the one giving maximum yield per recruit. This, as well as the above consideration, indicate that the stock might be near the optimum level under the present exploitation pattern.

#### 4.5 Calculation of total allowable catch (TAC)

Catch predictions have been made for the period 1977-78. In addition, the stock size at the beginning of 1979 was calculated. The stock size in 1977 was calculated from the stock size in 1976, as estimated from the VPA and corresponding fishing mortality rates.

A yield per recruit curve (Figure 6) was calculated for the present exploitation pattern, and the average weights per age group as shown in Table 14. For Greenland halibut in Sub-areas I and II the present level of fishing mortality on the fully exploited age groups is about  $F = 0.25$ . This fishing mortality corresponds with the  $F$  on the fully recruited age groups which gives maximum yield per recruit (Figure 6). In accordance with this, the fishing mortality values for catch predictions have been assumed on the same level as for 1976.

The year class strength for the three year old recruits in 1976-78 was set equal to  $68 \times 10^6$  fish, which is the average for the years 1970-74 as estimated from the VPA.

Mean weights per age group used in catch prediction were derived from the average mean weights per age in the U.S.S.R. fishery in the period 1970-76. These weights were reduced by 5% to give relatively correct catch figures for the period 1970-76 (e.g. the sum of the mean weights x estimated number per age group corresponds with the observed catch figures).

The natural mortality in catch predictions was set equal to 0.15 as assumed in the VPA. The results of these calculations are summarised in the text table below:

	1976	1977	1978	1979
Catch (tons)	33 775	38 385	39 475	
Fishing mortality on fully exploited age groups	0.25	0.25	0.25	
Total stock biomass (4+) (thousand tons)	248	260	264	266
Spawning stock biomass (9+) (thousand tons)	99	107	110	127

In the above strategy the total stock biomass and spawning stock biomass increase slightly. In the prognoses years the stock biomass

will be at nearly the same level which the Working Group felt is close to the optimum level.

Therefore, the Working Group recommends that the TAC for Greenland Halibut for 1978 in Sub-areas I and II should be set at 40 000 tons.

5. Greenland Halibut in Sub-areas V and XIV

5.1 Nominal catches

The total nominal catches for Divisions Va and Vb and Sub-area XIV are given in Table 1 for the period 1966 to 1976. Tables 6, 7 and 8 present the nominal catches by each area and by country. Table 9 gives the combined catches from all three areas by year and by country.

5.2 Catch per unit effort data

Only few c.p.u.e. data were available from the Icelandic long-line fishery for the years 1969 to 1972. The catch per unit effort, given in tons per 1 000 hooks were as follows:

1969	.721 tons
1970	.470 tons
1971	.572 tons
1972	.390 tons

These figures may indicate a declining stock during the years 1969 to 1972.

5.3 Age and length distributions available

From the Icelandic long-line fishery the catch in number per age group was available for the following years: 1972, 1973, 1974 and 1976, separated for each sex. Furthermore, some effort data for the years 1969-72 were available.

From the trawler fishery, only few data, from the German Democratic Republic, were available, i.e. length composition with an age/length key for 1971, and a length composition for 1975. These samples originated from the area where the major part of the trawl fishery took place, i.e. north and west of Iceland.

A third length composition for 1974 was also available. Unfortunately the length composition originated from the fishing grounds east of Iceland and here the immature fish are dominating in the catches, whereas on the fishing grounds north and west of Iceland, the mature fish dominate in the catches. It was, therefore, not possible to use the East Icelandic sample to split the trawl catches which mostly are taken west of Iceland.

A combination of the Icelandic samples from the long-line fishery and the samples from the trawl fishery is not possible, due to the fact that these two types of fishery, even if they are carried out in the same area, have a completely different size composition.

Furthermore, no catch figures from the United Kingdom and the U.S.S.R. were available for the year 1976, and the Group found it impossible to set the catch figures for 1976, because the pattern of the fishery has changed very much.

5.4 Conclusions

The Working Group concluded that better data on the age composition must be available of the annual trawl catches from this stock before a VPA can be done. From the Group's experience with the analysis of

the Greenland halibut stock in Sub-areas I and II, it was felt that catch per unit effort data from the trawl fishery would also be very useful to have, if possible.

The Group found it impossible to estimate a TAC on the basis of the available data.

6.

Reference

RICKER, W E, 1975. Computation and interpretation of biological statistics of fish populations. Bull.Fish.Res.Bd. Can.(191).

Table 1 Greenland Halibut

Total nominal catch by main fishing areas (metric tons)

Year	Sub-area I	Division IIb	Division IIa	Division Va	Division Vb	Sub-area XIV	Total catch
1966	1 200	8 726	16 319	7 515	478	40	34 278
1967	2 198	6 712	15 357	8 955	442	200	33 864
1968	2 488	8 935	14 745	7 501	647	189	34 505
1969	8 393	25 010	10 386	23 135	906	280	68 110
1970	4 011	70 523	14 950	30 001	-	3 822	123 307
1971	5 413	62 764	10 857	15 049	11	13 913	108 007
1972	8 549	18 873	15 633	10 666	417	15 389	69 527
1973	5 667	16 081	8 190	7 386	358	12 719	50 401
1974	5 251	24 660	7 852	7 866	325	28 089	74 043
1975 <sup>*)</sup>	6 495	28 511	3 166	3 308	560	19 627	61 667
1976 <sup>*)</sup>	2 241	28 602	2 201	2 959	285	194	36 482

\*) preliminary

Table 2 Greenland Halibut

Nominal catch (metric tons) in Sub-area I

Country	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976 <sup>*)</sup>
Faroe Islands	- <sup>1)</sup>	21 <sup>1)</sup>	23 <sup>1)</sup>	256 <sup>1)</sup>	- <sup>1)</sup>	14 <sup>1)</sup>	- <sup>1)</sup>	-	-	5	-
German Dem. Rep.	-	13	-	689	-	-	-	25	22	6	1
Germany, Fed. Rep.	209	312	1 488	5 314	1 675	1 951	3 116	2 947	2 167	2 160	1 703
Norway	-	-	-	-	-	7	117	-	1	-	2)
Poland	-	-	-	-	-	-	949	995	732	550	2)
U.K. (Engl. & Wales)	991 <sup>1)</sup>	852 <sup>1)</sup>	977 <sup>1)</sup>	2 134	2 336	3 441	4 366	1 700	2 329	3 774	528
U.S.S.R.	-	-	-	-	-	-	-	-	-	-	-
Total	1 200	2 198	2 488	8 393	4 011	5 413	8 549	5 667	5 251	6 495	2 241

\*) preliminary

1) from national statistics

2) no information available



Table 3 Greenland Halibut

Nominal catch (metric tons) in Division IIIa.

Country	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976 <sup>*)</sup>
Faroe Islands	- 1)	928 <sup>1)</sup>	- 1)	501 <sup>1)</sup>	441)	353 <sup>1)</sup>	1 069 <sup>1)</sup>	- 52)	656	172	-
German Dem. Rep.	88 <sup>1)</sup>	25	+	+	2 131 <sup>1)</sup>	3	3	+	49	41	354
Germany, Fed. Rep.	7	14 404	14 744	9 885	6 408	4 974	11 715	7 861	6 593	2 265	1 785
Norway	16 224	-	-	-	6 291	5 036	2 643	137	499	66	312)
Poland	-	-	-	-	-	-	182	118	55	107	-
U.K. (Engl. & Wales)	-	-	-	-	76	491	21	22	-	515	17
U.S.S.R.	-	-	-	-	-	-	-	-	-	-	-
Total	16 319	15 357	14 745	10 386	14 950	10 857	15 633	8 190	7 852	3 166	2 201

Table 4 Greenland Halibut

Nominal catch (metric tons) Division IIb

Country	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976 <sup>*)</sup>
Faroe Islands	24 <sup>1)</sup>	15 <sup>1)</sup>	233 <sup>1)</sup>	3 031 <sup>1)</sup>	16 598 <sup>1)</sup>	2 582 <sup>1)</sup>	563 <sup>1)</sup>	3 902	5 258	8 295	8 601
German Dem. Rep.	-	-	-	71	-	-	-	34	17	47	5
Germany, Fed. Rep.	1	1 812	6 282	4 282	7 788	2 541	1 152	3 181	31	433	341
Norway	-	-	-	-	12 971	7 234	5 221	2 003	4 646	3 579	3 5262)
Poland	-	-	-	-	-	-	131	122	79	74	-
U.K. (Engl. & Wales)	- 1)	4 885 <sup>1)</sup>	2 420 <sup>1)</sup>	17 626	33 166	50 407	11 806	6 839	14 629	16 083	16 129
U.S.S.R.	8 701 <sup>1)</sup>	-	-	-	-	-	-	-	-	-	-
Total	8 726	6 712	8 935	25 010	70 523	62 764	18 873	16 081	24 660	28 511	28 602

\*) preliminary

1) from national statistics

2) no information available

Table 5 Greenland Halibut

Nominal catch (metric tons) in Sub-areas I and II, 1966 - 1976  
(Data for 1966 - 1975 from Bulletin Statistique)

Country	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976 <sup>*)</sup>
Faroe Islands	112 <sup>1)</sup>	964 <sup>1)</sup>	257 <sup>1)</sup>	3 788 <sup>1)</sup>	44 <sup>1)</sup> 18 729 <sup>1)</sup>	2 949 <sup>1)</sup>	1 633 <sup>1)</sup>	3 954	5 914	8 472	8 955
German Dem. Rep.	7	38	-	71	-	3	3	59	88	94	20
Germany, Fed. Rep.	-	-	-	-	1 638	2 309	9 656	10 217	4 656	1 686	2 000 <sup>3)</sup>
Norway	16 434	17 528	22 514	14 856	14 233	7 157	6 327	3 772	4 135	3 172	1 829 <sup>3)</sup>
Poland	-	-	-	5 314	19 262	12 277	7 981	2 140	5 146	3 645	3 566 <sup>4)</sup>
U.K. (Engl. & Wales)	-	-	-	-	-	-	1 262	1 235	866	731	731 <sup>4)</sup>
U.S.S.R.	9 692 <sup>1)</sup>	5 737 <sup>1)</sup>	3 397 <sup>1)</sup>	19 760	35 578	54 339	16 193	8 561	16 958	20 372	16 674
Total	26 245	24 267	26 168	43 789	89 484	79 034	43 055	29 938	37 763	38 172	33 775

Table 6 Greenland Halibut

Nominal catch (metric tons) in Division Va

Country	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976 <sup>*)</sup>
Faroe Islands	2 018 <sup>1)</sup>	5 064 <sup>1)</sup>	6 247 <sup>1)</sup>	7 768 <sup>1)</sup>	4 122 <sup>1)</sup>	1 316 <sup>1)</sup>	1 180	188	41	2	360
German Dem. Rep.	5 491	3 890	1 253	1 488	14 958 <sup>1)</sup>	3 317 <sup>1)</sup>	159 <sup>1)</sup>	320	388	-	-
Germany, Fed. Rep.	6	1	1	5 856	-	882	1 119	826	1 786	887	915
Iceland	-	-	-	54	7 343	5 020	4 640	2 115	2 842	1 212	1 684
Norway	-	-	-	-	338	369	186	-	-	-	-
Poland	-	-	-	-	1 127	899	31	-	485	-	-
U.K. (England & Wales)	-	-	-	-	-	-	2 223	3 648	2 314	1 207	2 <sup>2)</sup>
U.S.S.R.	-	-	-	7 969	2 113	3 246	1 128	289	10	-	2 <sup>2)</sup>
Total	7 515	8 955	7 501	23 135	30 001	15 049	10 666	7 386	7 866	3 308	2 959

\*) preliminary

1) from national statistics

2) no information available

3) assumed split between gears

4) no data. Estimated landings set equal to the 1975 landings in the assessments.

Table 7 Greenland Halibut

Nominal catch (metric tons) in Division Vb

Country	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976 <sup>⊘</sup>
Faroe Islands	-	218 <sup>1)</sup>	69 <sup>1)</sup>	855 <sup>1)</sup>	-	-	-	-	7	6	-
German Dem. Rep.	476	224	579	51	-	11	405	287	147	91	-
Germany, Fed. Rep.	-	-	-	-	-	-	-	-	163	437	285
Norway	-	-	-	-	-	-	-	-	-	7	-
Poland	-	-	-	-	-	-	-	9	-	18	-
U.K. (Engl. & Wales <sup>2)</sup> )	-	-	-	-	-	-	12	61	-	+	-2)
U.S.S.R.	-	-	-	-	-	-	-	1	8	-	-2)
Total	478	442	647	906	-	11	417	358	325	560	285

Table 8 Greenland Halibut

Nominal catch (metric tons) in Sub-area XIV

Country	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976 <sup>⊘</sup>
German Dem. Rep.	-	-	-	42 <sup>1)</sup>	2 981 <sup>1)</sup>	3 491 <sup>1)</sup>	7 328 <sup>1)</sup>	8 806	25 266	16 872	-
Germany, Fed. Rep.	40	200	187	183	-	270	5	7	+	64	192
Greenland	-	-	2	+	-	2	3	4	2	1	+
Iceland	-	-	-	24	2	+	-	3	11	+	2
Poland	-	-	-	-	732	7 910	7 847	3 122	1 057	1 054	-2)
U.K. (Engl. & Wales)	-	-	-	-	-	-	1	1	1	2	-2)
U.S.S.R.	-	-	-	31	107	2 240	205	776	1 762	1 634	-
Total	40	200	189	280	3 822	13 913	15 389	12 719	28 089	19 627	194

⊘) preliminary

1) from national statistics

2) no information available

Table 2. Greenland Halibut

Nominal catch (metric tons) in Sub-Areas V and XIV, 1966-76.  
(Data for 1966-75 from Bulletin Statistique)

Country	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976*
Faroe Islands	- 1)	- 1)	- 1)	-	4 122	1 316	1 180	188	48	8	360
German Dem. Rep.	2 060	5 282	6 315	8 665	17 939	6 808	7 487	9 126	25 801	16 963	-
Germany, Fed. Rep.	5 967	4 314	2 019	1 686	-	1 163	1 529	1 120	1 949	1 388	1 392
Greenland	-	-	2	+	-	2	3	4	2	1	-
Iceland	6	1	1	5 880	7 345	5 020	4 640	2 118	2 843	1 212	1 686
Norway	-	-	-	-	338	369	186	-	-	7	-
Poland	-	-	-	-	1 859	8 809	7 878	3 131	1 542	1 072	- 2)
UK (Eng. & Wales)	-	-	-	-	-	-	2 236	3 710	2 323	1 209	- 2)
U.S.S.R.	-	-	-	8 000	2 220	5 486	1 333	1 066	1 772	1 634	-
Total	8 033	9 597	8 337	24 231	33 823	28 973	26 473	20 463	36 280	23 494	3 438

Table 10. Greenland Halibut in Sub-Areas I and II

Effort and catch per unit effort in the trawl fishery

Year	USSR catch/hour trawling (tons)	Hours trawling (USSR effort)	Total effort in trawl fishery (raised to the total trawl catch)
1966	.64	15 144	15 330
1967	.58	9 891	11 619
1968	.54	6 291	6 767
1969	.44	44 909	65 757
1970	.44	80 859	171 025
1971	.38	142 997	189 150
1972	.31	52 235	118 477
1973	.30	28 537	87 220
1974	.32	52 994	105 087
1975	.31	65 716	112 903
1976*	.34	49 041	93 959

\*) preliminary

1) from national statistics

2) no information available

Table 11. Greenland Halibut in Sub-Areas I and II

Age composition of catches 1970-76 used as input data for Virtual Population Analysis (thousands of fish)

Age Group	1970	1971	1972	1973	1974	1975	1976
3						22	
4	34		461	19	276	334	93
5	526	80	1 109	212	917	840	778
6	2 792	4 486	3 521	1 117	2 519	2 337	2 786
7	10 464	12 712	9 605	3 923	6 204	6 520	5 417
8	18 562	12 283	6 438	3 515	3 838	4 118	4 616
9	10 034	6 130	2 775	2 551	1 834	2 265	2 667
10	6 671	4 339	1 734	1 919	1 942	1 654	1 254
11	2 517	2 703	1 368	1 536	1 622	1 857	881
12	1 250	1 660	1 234	1 127	1 338	1 536	1 144
13	616	1 044	675	716	734	1 122	645
14	1 104	300	200	251	531	600	552
15	266	123	40	70	137	270	238
16	15	20	40	56	79	98	97

Table 12. Greenland Halibut in Sub-Areas I and II

Fishing mortalities (F) calculated by VPA, 1970-76

Age \ Year	1970	1971	1972	1973	1974	1975	1976
3	.00	.00	.00	.00	.00	.00	.01
4	.00	.00	.01	.00	.00	.01	.02
5	.01	.00	.03	.00	.02	.01	.02
6	.06	.14	.14	.03	.07	.07	.05
7	.27	.37	.46	.21	.26	.24	.21
8	.59	.53	.31	.29	.32	.26	.25
9	.54	.37	.21	.18	.22	.30	.25
10	.58	.45	.16	.20	.19	.31	.25
11	.46	.46	.23	.20	.25	.27	.25
12	.46	.60	.37	.29	.25	.37	.25
13	.60	.83	.49	.36	.29	.33	.25
14	1.41	.63	.34	.32	.46	.39	.25
15	1.69	.52	.15	.18	.27	.42	.25
16	.50	.50	.30	.30	.30	.30	.25
$\bar{F}_{8-13}$	.54	.54	.30	.25	.25	.31	.25

Table 13. Greenland Halibut in Sub-Areas I and II

Estimates of stock size 1970-76 calculated by VPA (thousands of fish)

Year Age	1970	1971	1972	1973	1974	1975	1976
3	56 827	65 318	61 270	97 972	57 518	58 259	1 077
4	39 469	48 911	56 219	52 735	84 324	49 505	50 123
5	43 828	33 939	42 097	47 961	45 371	72 331	42 300
6	54 134	37 236	29 138	35 206	41 084	38 202	61 478
7	48 111	44 007	27 899	21 821	29 267	33 028	30 716
8	44 333	31 743	26 149	15 161	15 155	19 458	22 402
9	25 648	21 080	16 012	16 562	9 803	9 501	12 943
10	16 291	12 837	12 488	11 216	11 896	6 742	6 086
11	7 281	7 883	7 050	9 145	7 880	8 444	4 276
12	3 635	3 947	4 293	4 804	6 451	5 283	5 552
13	1 452	1 976	1 870	2 557	3 094	5 316	3 130
14	1 545	683	743	988	1 540	1 985	2 679
15	344	324	312	455	618	836	1 155
16	41	54	166	232	327	406	471

Table 14. Greenland Halibut in Sub-Areas I and II

Parameters used in the catch prediction

Age group	Stock size 1978 ( '000)	Present exploitation pattern	Average weight (kg)
3	68 000 <sup>1)</sup>	.004	.190
4	58 480 <sup>1)</sup>	.008	.419
5	50 234 <sup>1)</sup>	.08	.539
6	36 339	.20	.700
7	29 239	.84	1.025
8	35 144	1.00	1.350
9	14 365	1.00	1.756
10	10 056	1.00	2.167
11	5 810	1.00	2.743
12	2 732	1.00	3.085
13	1 920	1.00	4.087
14	2 492	1.00	4.684
15	1 405	1.00	5.477
16	1 203	1.00	5.993

1) Based on average recruitment  $\bar{R}_3$  for yearclasses 1967-71

Table 15. Greenland Halibut in Sub-Areas I and II

The biomass of the recruited stock  $B(N_{4+})$  and the biomass of the spawning stock  $B(N_{9+})$ , estimated from the stock composition estimates of VPA.  $B_{GM}(N_{4+})$  is the biomass of the recruited stock as estimated from the relation between the USSR catch per hour trawling and  $B(4+)$  (see Figure 5)

Year	$B(N_{4+})$ $\times 10^{-3}$ tons	$B(N_{9+})$ $\times 10^{-3}$ tons	$B_{GM}(N_{4+})$ $\times 10^{-3}$ tons
1965			446
1966			429
1967			393
1968			370
1969			311
1970	314	127	311
1971	265	112	276
1972	232	102	234
1973	228	112	229
1974	249	110	240
1975	(251)	(105)	234
1976	(245)	( 99)	252

**Figure 1.** Greenland Halibut in Sub-areas I and II.  
 Catch per hour trawling (USSR fishery) and total catch.

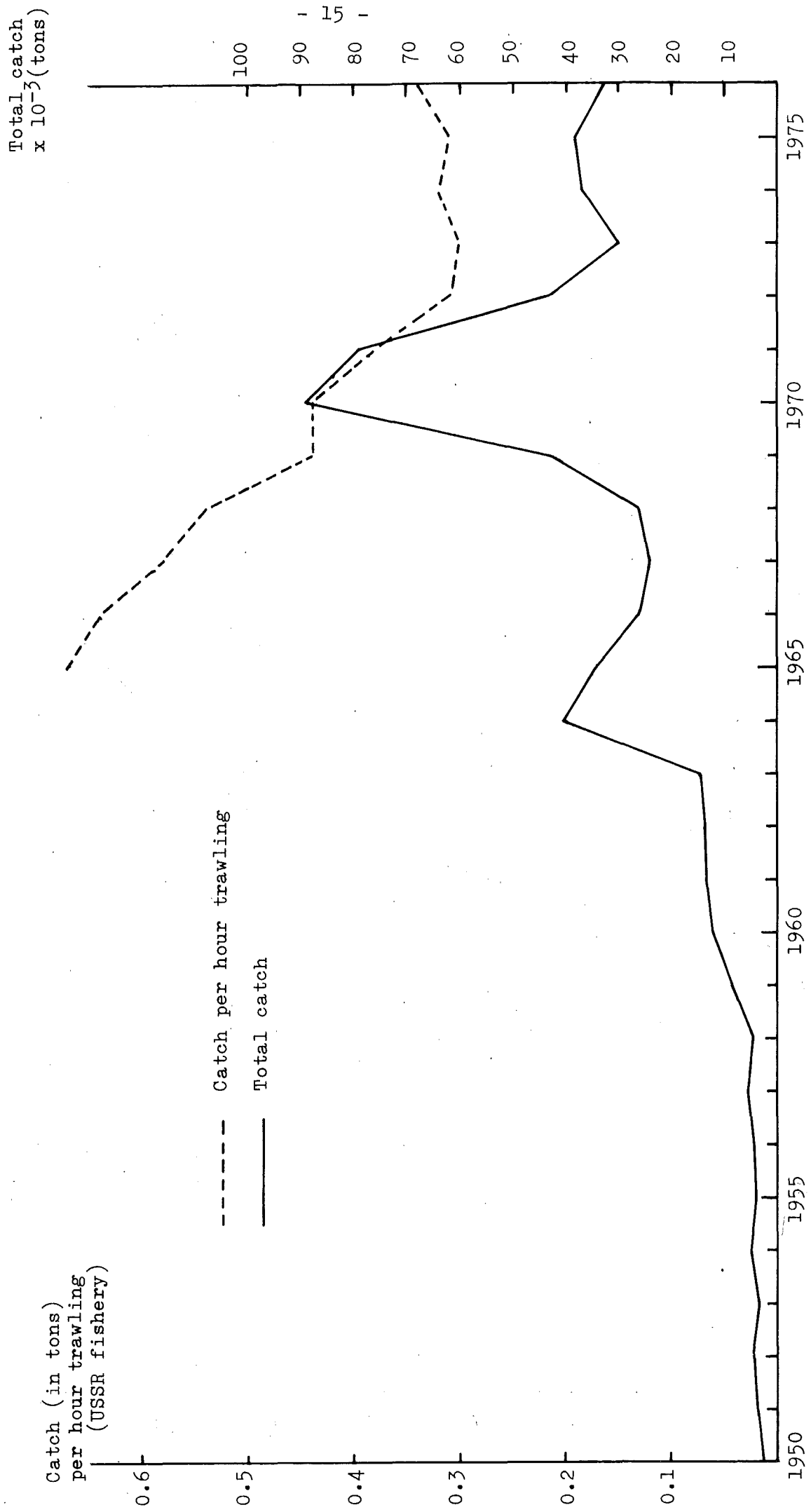




Figure 2. Greenland Halibut in Sub-areas I and II.  
The age distribution in per mille in the USSR catches and the  
Norwegian long-line catches in 1970 and 1971.

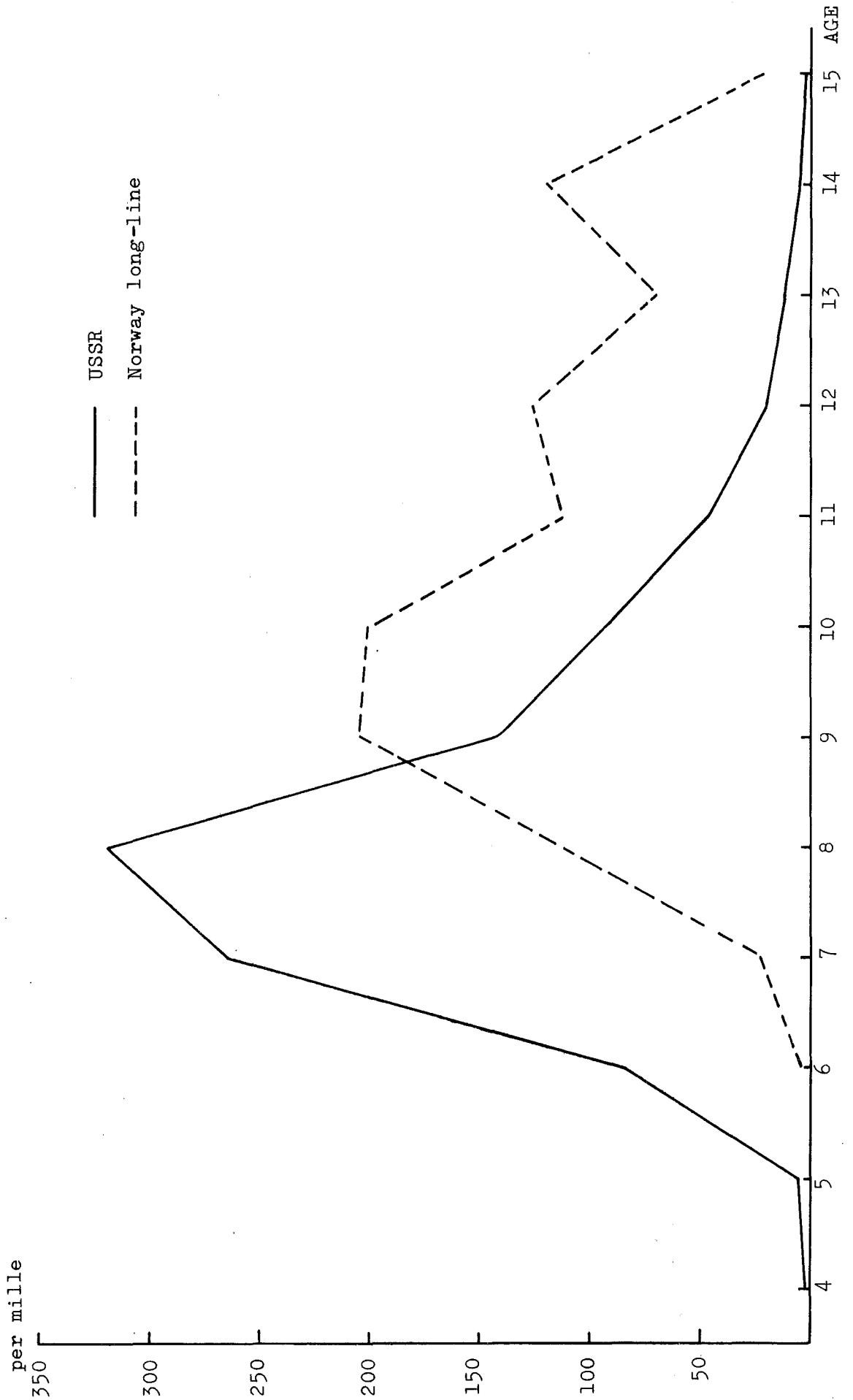


Figure 3. Greenland Halibut in Sub-areas I and II.  
The age distribution in the USSR trawl catches of  
Greenland Halibut in 1966.

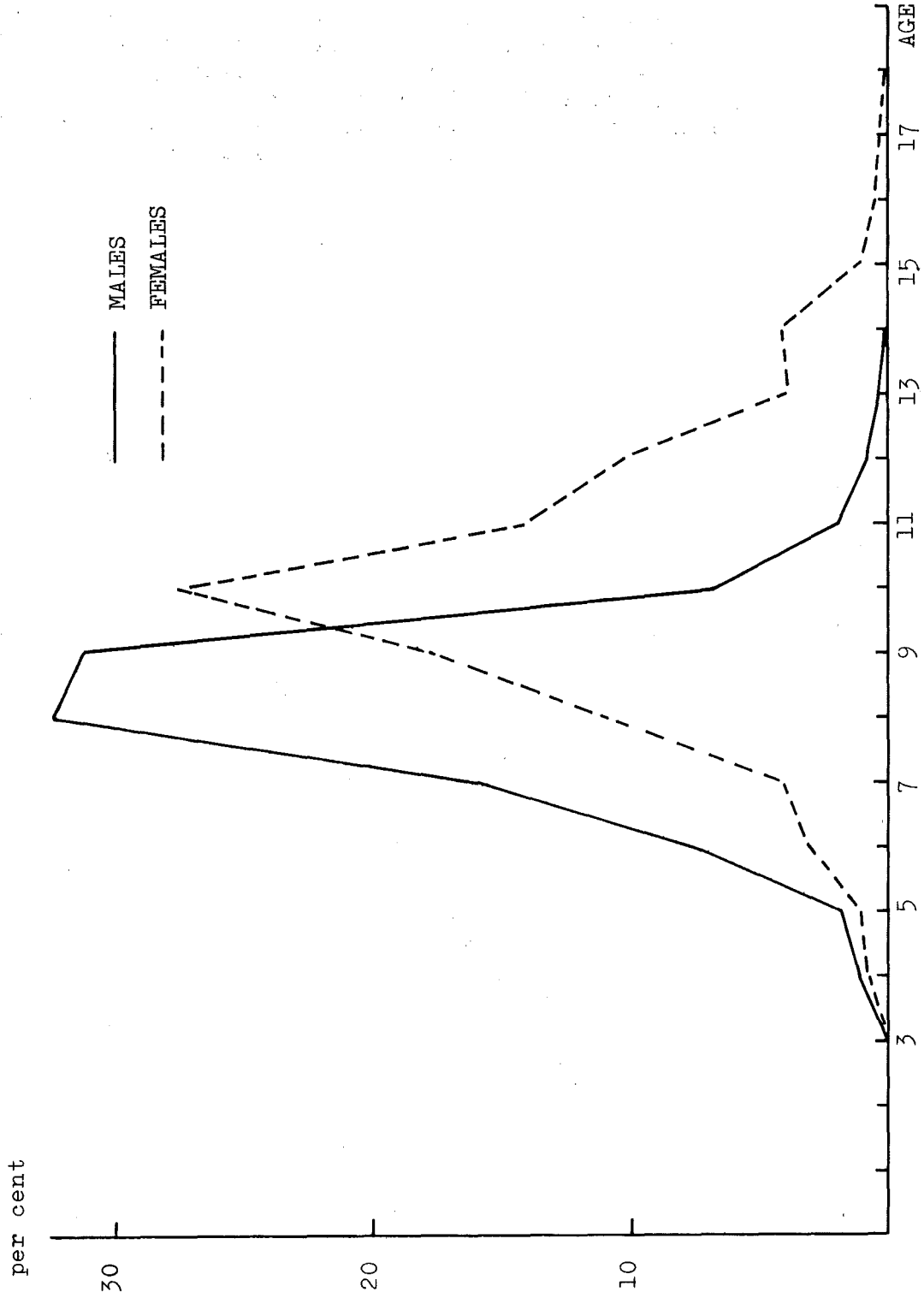


Figure 4. Greenland Halibut in Sub-areas I and II. The relation between the mean fishing mortalities on 8 to 13 year old Greenland Halibut in Sub-areas I and II and the total trawl effort in thousand hours trawling. The  $\bar{F}_{8-13}$  values are estimated from a preliminary run of VPA for the years 1970 to 1976, and the relation is used to estimate the fishing mortalities in 1976 in the final VPA run on the basis of the total trawl effort on that year.

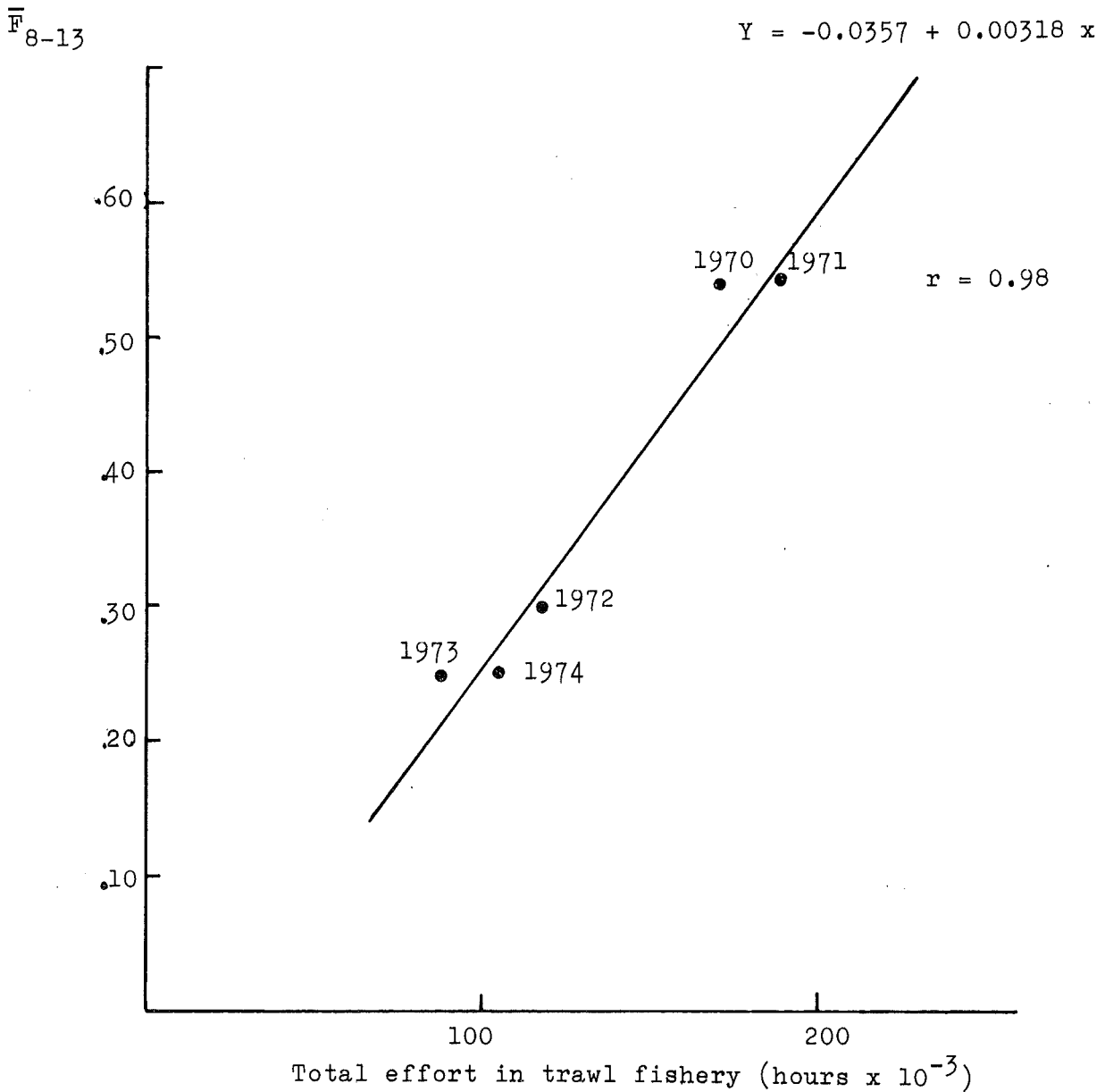


Figure 5. Greenland Halibut in Sub-areas I and II. The relation between the biomass of the recruited stock (4+) estimated from the VPA and the catch per hour trawling in the USSR trawl fishery. The line is the geometric mean regression line (Ricker, 1975, p.351).

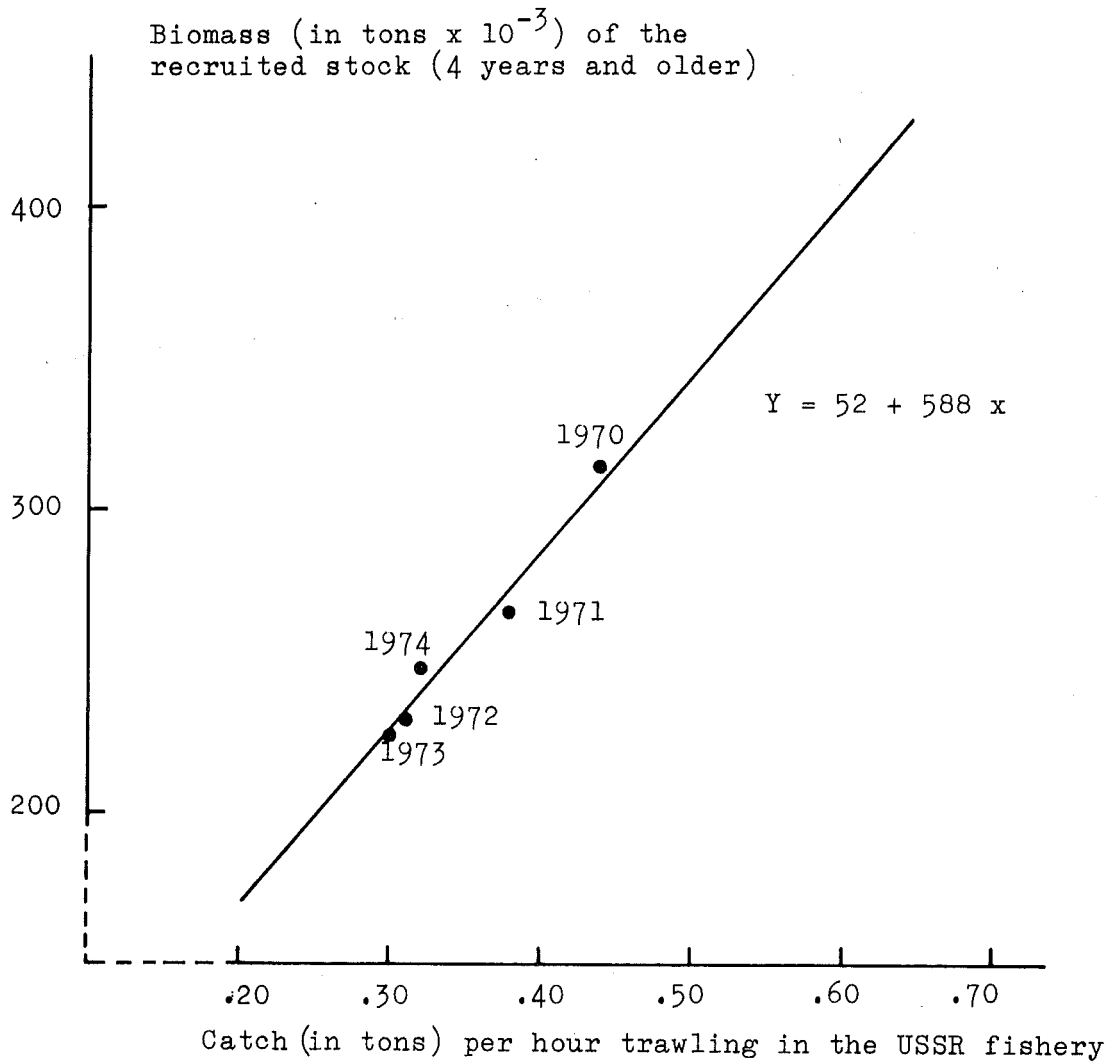


Figure 6. Greenland Halibut in Sub-areas I and II.  
Yield per recruit under the present  
exploitation pattern.

