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REPORT OF THE ARCTIC FISHERIES WORKING GROUP

(Copenhagen, 5 - 10 May 1980)

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2. TERMS OF REFERENCE

At the 67th Statutory Meeting the Council decided (C.Res.1979/2:42):-

"that the Arctic Fisheries Working Group should
meet at ICES Headquarters 5 - 10 May 1980 to assess
TACs for 1981 for cod and haddock".

3. NORTH-EAST ARCTIC COD

3.1 Status of the Fisheries (Table 1-6)

Final figures for cod landings in 1978 amounted to 698 715 tonnes, about 14 500 tonnes higher than the preliminary figure used in the previous Working Group Report (Doc. C.M.1979/G:20). This is 151 285 tonnes (about 18%) lower than the total TAC of 850 000 tonnes, Murman cod included, and represents a substantial reduction in yield compared to 1977 (905 301 tonnes). Preliminary figures for the 1979 fishery indicate a futher reduction of about 39% to a level of 427 500 tonnes. This reduction in catch was repeated from all areas and was very pronounced in Sub-area I (-57%) and Division IIb (-53%). The catch figure for Sub-area I of about 182 000 tonnes is the lowest on record since 1960. The further reduction in catch in Division IIb is a continuation of the trend observed in 1978 when the catch dropped by 84% from the. 1977 level.

The reduced catch in Sub-area I might be partially explained by a more westward distribution of cold water masses and a corresponding westward movement of the cod concentrations resulting in low stock density in this area. Consequently, fishing activity of the different fleets was adapted to the new distribution pattern. This trend was already observed in 1978 and did continue in 1979. Total international effort on cod decreased by about 32%.

Catch per unit of effort figures continued to decline in 1979 except for the United Kingdom fishery in Division IIa. United Kingdom effort in Division IIa was reduced by 50% compared to 1978 to the lowest level on record and presumably United Kingdom fishermen tended to select the most profitable part of the season. Therefore, the slight increase in cpue of this fishery in Division IIa should not be interpreted as an indication of an increase in stock abundance.

3.2   Stock Abundance

Stock abundance has been estimated from the Norwegian Acoustic survey for the
period 1976 - 1980.   The method used in the survey is described in a paper
by Dalen and Smedstad (1979).   Data obtained from the survey in 1977-1980 are
assumed to be the most reliable.

Abundance estimates are given in Table 7.   Year class abundance estimates for
the period 1977-1979 differ to a small extent from the figures given by Dalen
and Smedstad (1979).   These differences are caused by a change made in the
density coefficient used in the calculations, the change having been made
possible by the new information about this parameter.

The data in Table 7 indicate that the survey gives underestimates of the abundance
of I- and II-groups.   As mature fish have passed the survey area in February
on their way to spawning, the abundance estimates of age groups 7 and older
are underestimates.   This may also be true for the 6 year olds, but to a lesser
extent.

The survey does not cover Division IIb which means that the abundance estimates
even for the 3-5 year olds are underestimates.   However, in the period 1977-1980
the year classes 1973-1977, which are of most interest for the catch predictions
at present, were poor in that area (Table 13).

The results of the survey indicate large reductions in the biomasses of young cod
and haddock, both from 1978 to 1979 and from 1979 to 1980 (see Tables 7 and 18).
Preliminary results of the USSR groundfish survey in April-May 1979 and 1980
indicate a similar but somewhat smaller reduction in the abundance indices of
cod.

The final results of the USSR survey will be made available to ICES.   A great
change in the distribution of cod and haddock has been observed from 1978 to
1979 and 1980 (Figure 1).   In 1978 cod and haddock were observed as far east
as 50°E and 43°E respectively.   Later Norwegian observations showed a westward
shift in the distribution in 1979 and 1980 to west of 36°E and 34°E respectively
(Dalen and Smedstad, 1979).

Such a shift in the distribution will create a higher availability of fish,
especially 3 and 4 year olds, in 1979 and 1980, compared with earlier years.
This is expected to cause a bias in the cpue data for the fleets which have been
concentrating their fishery in the more western areas for a long time.   The
high cpue observed for the Norwegian and the English trawler fleets for cod
and haddock in 1979 would therefore to a certain degree be an effect of the change
in distribution.

Under this condition the total effort estimated for 1979 in Sub-area I in
United Kingdom units (Tables 3 and 16) will be underestimates for both cod and
haddock.

The English trawler catch per unit of effort is now based on very low fishing
effort and must consequently be interpreted with caution.

3.3   Fishing Mortality versus Effort

Mean fishing mortalities for 4-7 year olds derived from a preliminary VPA run
were plotted on the estimate of total international effort derived in Table 3.
A line was fitted through the origin and the mean values for 1967-75.   In

selecting input F values for these age groups, account has been taken of the total effort in 1978 and 1979. The mean F values from the final VPA run have been used in Figure 6. It was felt that the effort data which have been based on English trawler catch per unit effort might be unrealistic for the most recent years where the United Kingdom catch was greatly reduced. However, additional regressions of fishing mortality in Region I against international effort based on Norwegian and USSR effort units resulted in basically similar estimates for the fishing mortality on 4-7 year old fish in 1979.

No correlation exists between fishing mortalities of 8-12 year olds and the estimate of the international effort. As has been shown earlier, these data are derived from English trawler catch per unit effort and in recent years their catch rates may be biased in Division IIa. As much of the fishing mortality in Division IIa is generated by passive gears, the increase in efficiency of these resulting in increased fishing mortality may not be reflected in the international effort estimate. It has been estimated that 53% of the fishing mortality on the 8-12 year olds was generated by these gears for the period 1967-1977. It is clearly important that a method for estimation of the mortalities on these older ages should be developed since the spawning stock estimate is based on these ages.

3.4 Virtual Population Analysis (VPA)

The age compositions used for the 1978 landings were adjusted for the final catch figures and preliminary age compositions were derived for 1979 (Table 8).

The assessment of stock size has been made using a natural mortality of 0.2.

Fishing mortalities for 4-7 year olds were chosen following the reasoning discussed in Section 3.3. The mean mortality of 4-7 year olds was set at .29. The distribution of F with age was set using the exploitation pattern given in Table 9 which is the same as used in the previous report (C.M.1979/G:20).

In addition to the relation between fishing mortality on 4-7 year olds and fishing effort (Figure 6), the relationships between the final VPA estimates of stock of 3, 4, and 5 year olds and the catches per unit effort in the English trawl fishery in Sub-area I were also considered. These are given in Figures 7-9. All are highly correlated and the position of the estimated cpue for 1979 is shown.

In view of the fact that 53% of the fishing mortality on 8-12 year olds is generated by the passive gears, and that they may still be increasing in efficiency, the Working Group considered that the fishing mortality on these age groups would not be likely to differ greatly from the 1970-75 average. A level of F = 0.70 would give a catchability coefficient (q) for 1979 consistent with the recent values for each of the gears (Figures 2 and 3). The lower value of F used in the VPA, however, which results from using the standard exploitation pattern, suggest a drop in "q" for these gears which is probably unrealistic (Figures 2 and 3). There is obviously a need to generate a predictor for fishing mortalities on these older ages which may be used independently of the estimate of the age 4-7 fishing mortalities. This might change the exploitation pattern to be used in future assessments.

The calculated estimates of fishing mortalities for earlier years resulting from VPA are given in Table 10, and stock size estimates in Table 11.

3.5 Recruitment

The correlation of the VPA results from last year's report and the USSR young
fish survey for recruits at age 3 (Table 13) is shown in Figure 10. The year
classes 1976 and 1977 have been estimated as poor in earlier surveys and the
most recent survey has confirmed the previous results. The year classes 1978
and 1979 so far seem to be even poorer which would mean that there are four
consecutive poor year classes entering the fishery. A comparably low level
of recruitment over a long period has previously been recorded only for the
year classes 1965-68.

3.6 Mean Weight at Age

The problem of the age-weight relationship was considered and, though some
weight differences between the Working Group data and recent USSR data were estab-
lished, it was decided to use the former for assessments since the differences
between the reported catch and the calculated catch weight (sum of products)
were relatively small in 1978 (0.4%) and 1979 (6.0%). However, the dynamics
of weight at age should be given special attention in the future so that proper
adjustments are made if required. Mean weights at age are given in Table 12.

3.7 Yield and Spawning Stock Biomass per Recruit

Curves for yield per recruit and spawning stock biomass per recruit are shown in
Figures 11 and 12. They are based on the exploitation pattern and mean weight
at age data used in last year's report (see Tables 8 and 12) and thus remain
unchanged.

4. NORTH-EAST ARCTIC HADDOCK

4.1 Status of the Fisheries (Tables 14-17).

The final figure for the catch of haddock of 95 422 tonnes in 1978 differs
only slightly from the preliminary figure given in the previous report. The
catch in 1978 is 14 736 tonnes (-13%) less than the catch of 1977. The pre-
liminary catch figure for 1979 of 101 429 tonnes shows an increase of about
6 000 tonnes (+6%) over the 1978 level. The increase is exclusively due to the
higher catch in Division IIa where it is 7 000 tonnes (+23%) higher than in
1978.

In 1979 the catch per unit effort followed an upward trend and was higher in
all areas than in 1978. This is particularly shown by the Norwegian data for
Sub-area I (an increase by about 3 times) where the catch per unit effort was
close to the 1973 level. However, this may have been partially due to the
westward shift in the distribution of haddock in 1979. The United Kingdom cpue
data were thought to be unrepresentative due to the lower effort in the United
Kingdom fishery in 1979. The increase in the catch per unit effort was mainly
due to 4-year-old fish of the good 1975 year class. Significant contributions
were also made by the 1974 and 1976 year classes which were estimated from the
USSR young fish survey data as moderate.

4.2 Stock Abundance

The Norwegian echo-survey in the Barents Sea referred to in Section 3.2 gives
abundance estimates for both cod and haddock. This survey underestimates the
abundance of the I-group haddock (Table 18). As for cod, the survey also
underestimates the fully and, to a lesser extent, also partly matured age groups,
which have passed the survey areas at the time when the survey takes place.

Therefore, the abundance of the 6 year and older fish is expected to be under-estimated by the survey.

The Norwegian survey does not cover Division IIb. However, usually only a very small part of the year classes is present in this area, and the addition to the survey data would be small.

4.3   Fishing Mortality versus Effort

Mean fishing mortalities for 3-6 year olds derived from a preliminary VPA run were plotted on the estimate of the total international effort derived in Table 16 (Figure 13). A line was fitted through the origin and the mean values for 1965-1976. The international effort level in 1979 was the lowest in the time series. This was possibly due to the United Kingdom catch rates on which the effort was estimated being based on very low levels of fishing compared to previous years. The effort levels for 1977 and 1978 were therefore also considered carefully when choosing the level of fishing mortality for 1979. An additional regression of fishing mortality in Region I against international effort based on Norwegian effort units led to essentially the same conclusions as Figure 13.

4.4   Virtual Population Analysis (VPA)

The age compositions used for the 1978 landings were adjusted for the final catch figures and preliminary age compositions were derived for 1979 (Table 20). The assessment has been made using a natural mortality of 0.2.

Fishing mortalities for 3-6 year olds were chosen following the reasoning given in Section 3.4. The mean fishing mortality of 3-6 year olds was set at .38. This was distributed over all ages using a revised exploitation pattern based on the average of the years 1970-75 (Table 20).

Estimates of fishing mortalities for earlier years resulting from VPA are given in Table 21. The stock size estimates are given in Table 22.

4.5   Recruitment

The number of recruits at age 3 as estimated in last year's Working Group Report are given in Table 17 together with the USSR young fish survey indices. The correlation between them is shown in Figure 14. The USSR survey indices indicate that the 1976 year class is of about average strength whereas so far the year classes 1977, 1978 and 1979 are estimated to be poor. Previous year classes with similar indices (1) from the USSR survey have averaged 44 millions 3 years old.

4.6   Mean Weight at Age

The 1979 Working Group Report noted the difference between the weight of the catches calculated from the catch in numbers and the average weight per age group used in previous reports on the one hand and the reported catches on the other. The latter were about 40% higher than the calculated catches because the average weight of young haddock used in the previous assessments was too low. Respective weight correction factor obtained from the regression against the proportion of 3 to 5 year old fish in the catches was used in the 1979 Working Group Report. This problem was discussed and it was decided that a revision of the mean weights at ages 3-8 was necessary. The USSR (1976-79) and United Kingdom (1979) data given in Table 23 were averaged and multiplied by a factor of 1.057 to adjust for the discrepancy between the sum of products of weights multiplied by the number landed at each age and the reported total catches in 1979. The United Kingdom weights at age were constructed from mean

length at age data for 1979 assuming a cubic relationship between length and weight.

The weight-at-age problem requires further consideration at the next Working Group meeting, particularly the possibility of systematic changes in growth for different year classes of fish.

4.7 Yield and Spawning Stock Biomass per Recruit

Yield per recruit and spawning stock biomass per recruit were calculated using a new exploitation pattern (Section 4.4) and new weight-at-age data (Section 4.6, Table 23). The resulting curves are shown in Figures 15 and 16. On the new yield-per-recruit curve $F_{max} = 0.27$ and $F_{0.1} = 0.14$ compared to values of 0.22 and 0.11 respectively in last year's report. At F_{max} the yield per recruit is more than 40% higher than at F_{max} on the curve presented last year. Nearly all of the difference is due to the new weight-at-age data.

5. CONCLUSIONS

The Working Group was not able to estimate fishing mortality for 1979 for either cod or haddock and therefore it was not possible to calculate stock size and catches for future years. Therefore, no scientific basis for advice on management can be provided to the ACFM at present for the following reasons:-

The cpue data from the United Kingdom conventional trawler fleet which have served in the past to estimate total international effort for both species are no longer reliable as explained in Section 3.2 of this report. Therefore, the estimate of fishing mortality from the regression of F from VPA against total international effort seems to be an underestimate for 1979. However, additional estimates using data from Norway and USSR indicate a reduction in total international effort for cod to 2/3 of the 1978 level which corresponds to the reduction in reported landings. The resulting $\overline{F}$ (age 4-7) from the regression is about 0.3. For haddock total international effort estimate for 1979 was only 1/4 of the 1978 level while total catch has increased by 6%. This is the result of the high cpue figures on which the estimate is based. The corresponding $\overline{F}$ (age 3-6) of 0.15 from the regression seems to be unrealistically low and therefore, as a result of the discussion on several preliminary VPA runs, fishing mortality has been adjusted to about half the level used in last year's report for 1978. It should be noted that the VPA results for both species given in this report are not intended to serve as a basis for further catch projections, they are included in the report only for the purpose of demonstrating the difficulties confronting the Working Group.

Two revisions of the previous assessment have been made during 1979 based on the results of the Norwegian acoustic survey (see Section 3.2 of this report) which were not available to the Working Group at the 1979 meeting. The revision of the cod assessment was done by the ACFM in July 1979 when the results of the Norwegian acoustic survey for that species were made available to the ACFM.

The haddock assessment has been revised by the Working Group at a meeting in Warsaw in October 1979 and the reassessment was accepted by the ACFM as a basis for management advice.

At the present meeting an assessment was done on the basis of the numbers per age group in the population as estimated by the Norwegian acoustic survey. Catches and fishing mortalities have been calculated which would account for the decrease in year class abundance from 1978 to 1979 and 1980. The results are given in

Table 24 together with the results from the VPA for the age groups covered by the survey.

The results of a comparison of the two assessments are:-

COD

The catch in numbers of 3 to 5 year old cod required to account for the decrease in year class abundance in the acoustic survey from 1978 to 1979 is 2.3 times higher than the reported catch for these age groups. It even exceeds the total catch in numbers for all ages in 1978 by about 50%. The corresponding figures for 1979 and 1980 are almost identical. This means that for both 1978 and 1979 an additional catch of about 200 000 tonnes of 3 to 5 year old fish is required to account for the annual decrease in abundance derived from survey data and thereby generating average fishing mortalities on these age groups which are 2.7 and 4.2 times higher for 1978 and 1979, respectively, compared to the VPA figures.

The size of the population of 3 to 5 year old cod at the beginning of 1978 as estimated from the survey is about the same as that derived from VPA. However, the high level of exploitation on these ages as indicated by the survey results for 1978 and 1979 reduces the population at the beginning of 1980, the basis for projecting catches and stock sizes for 1981, to 50% of the VPA level.

HADDOCK

Since the survey results for age 6 haddock are not reliable, the assessment based on the results of the Norwegian acoustic survey have been used only for the age groups 3 to 5.

The proportion of 3 to 5 year old haddock in the catches has always been higher than in the cod fishery and therefore the discrepancies between the VPA assessment and the acoustic survey assessment are even greater.

The catch in numbers of 3 and 4 year old haddock in 1978 required to account for a reduction in year-class abundance as indicated by the survey from 1978 to 1979 is 5.8 times larger compared to the reported catches of these ages and even 4.5 times higher than the total catch in numbers. The corresponding figures for 1979 are 4.8 and 3.5. For both 1978 and 1979, additional catches in the order of 200 000 tonnes of 3 and 4 year old haddock would be required to account for the annual reduction in the abundance of these age groups as estimated from the acoustic survey. Fishing mortalities estimated on this basis are 3.1 and 3.7 times higher than the VPA values for 1978 and 1979, respectively.

The size of the population of 3 and 4 year old haddock as estimated from the survey is about 2.6 times greater than that estimated from VPA for the beginning of 1978 and is reduced by the beginning of 1980 to about the same level as estimated by VPA.

The comparison of the two assessments demonstrates clearly the difficulties experienced by the Working Group in its efforts to produce a reliable and scientifically justifiable basis for advice on management for North-East Arctic cod and haddock.

Ignoring the results of the acoustic survey would mean completely disregarding valuable fisheries-independent data. The reliability of these data has not been questioned, and they have already served as a basis for management advice. On the other hand, accepting the survey data as a basis for an assessment would

imply that one accepts that total catches have not been reported completely and/or that the age compositions available to the Working Group are not representative of the age composition of the catches. The magnitudes involved are thought to be too large to be attributed entirely to discarding. Theoretically, one could expect complete agreement between fisheries-independent survey data on the one hand, and quantity and age composition of catches on the other. It is well known, however, that in practice both survey data and data from commercial fisheries are subject to a sometimes large margin of error. In realizing this, the Working Group made several attempts to bridge the gap between the results of the two assessments, but none of these approaches resulted in an estimate of fishing mortality and stock size for 1979 which could be considered as a sound scientific basis for developing further advice on management. All attempts to compromise or to combine the two sets of information required too much manipulation of data to be scientifically justified. In addition to the difficulties in assessing the 1980 stock size the definition of management objectives on the basis of reference points on the yield per recruit curve would create further difficulties for both stocks. The VPA results would suggest that fishing mortality in 1978 and 1979 was below the F_{max} point and probably approaching $F_{0.1}$ on the yield per recruit curve, whereas the estimates of F from acoustic surveys indicate F in 1978 and 1979 to be far on the right hand descending limit of the yield per recruit curve as in previous years.

After considerable discussion, the Working Group felt that in this conflicting situation a decision is required on which of these data sets is to be used for assessment.

In view of the problems outlined above, the Working Group could not make this decision. It felt that this problem might be of a general importance for the ICES assessment work and is therefore seeking the ACFM advice on this matter.

6.   CONSERVATION MEASURES

6.1   Mesh Size

Norway and the USSR which are responsible for the management of the cod and haddock stocks have decided to introduce a mesh size of 125 mm from not later than 1 January 1981.

The long-term effect by applying a 125 mm mesh size on the average situation for the period 1967 - 1977 would be 2-3% for cod and haddock as extrapolated from the 1979 Working Group report. Considering, however, the accuracy of the method, this would be hardly measurable. The beneficial result of this increase is expected to be a reduction in fishing mortality mainly on 3 and 4 year old fish.

The 1979 Working Group report gave both short and long term effects of applying a higher effective mesh size than that used at present. These were assessed on the basis of an average situation for the period 1967-1977 for the cod and haddock fisheries. These calculations showed that a higher effective mesh size for the level of fishing in the period 1967-1977 would create great benefit to the total fishery and the spawning stocks. At the same time, a higher effective mesh size will reduce discards in the total fishery.

Despite the long term gains to be expected from the average situation by applying a higher effective mesh size, the major concern of the Working Group was the spawning stock of cod. The year classes 1976-1979 are all indicated to be poor in the USSR young fish survey. The two rich year classes 1973 and

1975 have already suffered from heavy fishing before maturing. Under these conditions, the spawning stock is expected to be at a very low level in the mid-80s. In realising this situation, the ACFM recommended in 1979 to increase mesh size to 155 mm from 1 January 1980 and pointed out that "the spawning stock biomass can only be expected to reach the desired long-term level if the pattern of exploitation is improved considerably, or if fishing mortality is immediately set at much lower levels".

6.2 Minimum Landing Size

According to the agreement between Norway and USSR the minimum landing size for 1980 is 39 cm for cod and 35 cm for haddock. The minimum landing sizes will be further considered by Norway and USSR before 1981 when the 125 mm mesh size will be in use.

ACFM recommended that the minimum landing size should correspond to the 25% retention length of the mesh size in force. Following this recommendation the minimum landing sizes were calculated to be as follows for a mesh size of 120, 125, 135, and 155 mm:-

Minimum landing sizes (cm)
corresponding to mesh sizes

Species	Mesh size (mm)			
	120	125	135	155
Cod	43	45	49	56
Haddock	39	41	44	51

The parameters used in the calculation are the same as used by the Working Group (ICES, Doc. C.M.1979/G:20) in the mesh assessments (selection factor 3.96 for cod and 3.63 for haddock, ratio 75% to 50%, retention length 1.09 for cod and 1.10 for haddock).

In addition to the minimum landing size regulation the agreement between Norway and USSR allows for a by-catch of undersized cod and haddock of 15% by numbers in each catch.

6.3 Closed Areas

According to the ACFM report of 1979, an effective method of reducing exploitation of young cod and haddock, as an addition to mesh size regulation, would be a short-term closure of areas at times when small fish are dominant in catches: Such regulation has been introduced jointly by Norway and USSR. The minimum landing sizes as given in the agreement would be used as guidelines for closing the areas where fish below these sizes are dominant in the catches. The agreement between the two countries make it further possible to close an area when the undersized cod and haddock exceed 15% by numbers or weight.

In addition, the areas in the USSR fishing zone where young cod and haddock are concentrated are closed for fishery throughout the year or for certain periods during the year. The areas and the periods of closure may vary depending on the distribution of the young fish in a particular year.

Following the intention behind the cod TAC for 1980, the mortality had to be reduced on all components of the stock. In order to meet this requirement Norway introduced in the first weeek of April 1980 a total ban on the fishery for mature fish in the main spawning area (Lofoten).

6.4 Midwater Trawl

No new data were available for mid-water trawl fishery. Therefore, the effect on the exploitation by this gear on the cod and haddock stocks has not been further studied. However, the Working Group has recognised that Norway and the USSR have already agreed to allow only experimental midwater trawling in 1980 for cod and haddock.

7. SHORTCOMINGS AND GAPS IN DATA REQUIRED FOR STOCK ASSESSMENT PURPOSES

Since little progress was made during 1979, the Working Group reiterates the views expressed in Sections 8 and 9 of the previous Report.

Special emphasis should be given to expand survey work in spring in order to obtain fisheries-independent data for estimating abundance of age-groups and total mortality for both cod and haddock in the North-East Arctic.

REFERENCES

Dalen, J. and Smedstad, O.M. 1979. Acoustic Method for estimating absolute abundance of young cod and haddock in the Barents Sea. ICES, Doc. C.M.1979/G:51 (mimeo).

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Table 1   COD. Total nominal catch (tonnes)
by fishing areas (landings of Norwegian
coastal cod not included).

Year	Sub-area I	Division IIb	Division IIa	Total catch
1960	375 327	91 599	155 116	622 042
1961	409 694	220 508	153 019	783 221
1962	548 621	220 797	139 848	909 266
1963	547 469	111 768	117 100	776 337
1964	206 883	126 114	104 698	437 695
1965	241 489	103 430	100 011	444 930
1966	292 253	56 653	134 805	483 711
1967	322 798	121 060	128 747	572 605
1968	642 452	269 160	·162 472	1 074 084
1969	679 373	262 254	255 599	1 197 226
1970	603 855	85 556	243 835	933 246
1971	312 505	56 920	319 623	689 048
1972	197 015	32 982	335 257	565 254
1973	492 716	88 207	211 762	792 685
1974	723 489	254 730	124 214	1 102 433
1975	561 701	147 400	120 276	829 377
1976	526 685	103 533	237 245	867 463
1977	538 231	109 997	257 073	905 301
1978	418 265	17 293	263 157	698 715
1979[*]	182 106	8 088	237 264	427 458

[*]Provisional figures.

Table 2   COD.   Nominal catch (tonnes, whole weight) by countries.
(landings of Norwegian coastal cod not included).   (Sub-area I and Divisions IIa and IIb combined)
(Data provided by Working Group members).

Year	Faroe Islands	France	German Dem.Rep.	Germany Fed.Rep.	Norway	Poland	United Kingdom	USSR	Others	Total all countries
1960	3 306	22 321		9 472	231 997	20	141 175	213 400	351	622 042
1961	3 934	13 755	3 921	8 129	268 377	-	158 113	325 780	1 212	783 221
1962	3 109	20 482	1 532	6 503	225 615	-	175 020	476 760	245	909 266
1963	-	18 318	129	4 223	205 056	108	129 779	417 964	-	775 577
1964	-	8 634	297	3 202	149 878	-	94 549	180 550	585	437 695
1965	-	526	91	3 670	197 085	-	89 962	152 780	816	444 930
1966	-	2 967	228	4 284	203 792	-	103 012	169 300	121	483 704
1967	-	664	45	3 632	218 910	-	87 008	262 340	6	572 605
1968	-	-	255	1 073	255 611	-	140 387	676 758	-	1 074 084
1969	29 374	-	5 907	5 343	305 241	7 856	231 066	612 215	133	1 197 226
1970	26 265	44 245	12 413	9 451	377 606	5 153	181 481	276 632	-	933 246
1971	5 877	34 772	4 998	9 726	407 044	1 512	80 102	144 802	215	689 048
1972	1 393	8 915	1 300	3 405	394 181	892	58 382	96 653	166	565 287
1973	1 916	17 028	4 684	16 751	285 184	843	78 808	387 196	276	792 686
1974	5 717	46 028	4 860	78 507	287 276	9 898	90 894	540 801[1]	38 453	1 102 434
1975	11 309	28 734	9 981	30 037	277 099	7 435	101 834	343 580[1]	19 368	829 377
1976	11 511	20 941	8 946	24 369	344 502	6 986	89 061	343 057[1]	18 090	867 463
1977	9 167	15 414	3 463	12 763	388 982	1 084	86 781	369 876[1]	17 771	905 301
1978	9 092	9 394	3 029	5 434	363 088	566	35 449	267 138[1]	5 525	698 715
1979*)	6 320	+[2]	547	2 515	284 779	15	17 991	105 846	9 445	427 458

*)Provisional figures.   1)Murman cod included.   2) Estimated catch included in other countries' catches.

Year	SUB-AREA I National effort U.K.[1]	USSR[2]	SUB-AREA I Total international effort U.K. units	USSR units	DIVISION IIb National effort U.K.	USSR	DIVISION IIb Total international effort U.K. units	USSR units	DIVISION IIa National effort U.K.	Norway[3]	DIVISION IIa Total international effort U.K. units	Norwegian units
1960	95	43	500	89	42	11	87	30	39	9 489	232	52
1961	94	53	519	108	51	22	171	50	30	8 410	264	41
1962	93	61	596	93	51	16	166	30	34	7 812	212	35
1963	78	62	644	91	45	9	114	20	29	7 153	177	38
1964	42	30	357	56	49	17	137	32	36	6 103	150	22
1965	42	25	366	62	37	11	95	21	33	6 883	152	34
1966	63	33	395	70	23	16	73	30	46	6 796	201	34
1967	51	30	399	61	10	12	114	14	50	7 153	248	37
1968	86	45	584	59	9	24	156	22	52	7 930	290	32
1969	115	45	601	68	24	19	194	22	73	6 747	272	43
1970	122	35	604	75	24	15	86	11	55	6 893	369	38
1971	82	23	558	73	4	27	80	36	48	6 913	516	30
1972	71	41	419	58	7	11	65	18	35	8 674	610	29
1973	96	61	864	88	18	12	163	15	27	9 156	492	31
1974	92	48	916	80	9	18	240	33	29	6 590	444	37
1975	109	31	729	66	5	19	147	34	28	4 906	364	35
1976	96	44	878	80	21	18	128	35	34	5 862	678	62
1977	84	56	1 035	106	46	31	196	41	39	6 583	584	52
1978	35	68	686	113	9	5	39	24	26	6 145	720	37
1979[*]	26	25	398	50	2	5	30	14	13	6 079	555	37

[*] Provisional figures.   [1] hours fishing x average tonnage x 10^{-6} = millions of tonne-hours.

[2] hours fishing (catch/catch per hours fishing) x 10^{-4}.   [3] gill-net boat week at Lofoten x 10^{-3}.

Table 4   COD.   Catch per unit effort
(tonnes, round fresh)

Year	Sub-area I			Division IIb			Division IIa		
	Norway[1]	U.K.[2]	USSR[3]	Norway[1]	U.K.[2]	USSR[3]	Norway[1]	U.K.[2]	Norway[4]
1960		0.075	0.42		0.105	0.31		0.067	3.0
1961		0.079	0.38		0.129	0.44		0.058	3.7
1962		0.092	0.59		0.133	0.74		0.066	4.0
1963		0.085	0.60		0.098	0.55		0.066	3.1
1964		0.058	0.37		0.092	0.39		0.070	4.8
1965		0.066	0.39		0.109	0.49		0.066	2.9
1966		0.074	0.42		0.078	0.19		0.067	4.0
1967		0.081	0.53		0.106	0.87		0.052	3.5
1968		0.110	1.09		0.173	1.21		0.056	5.1
1969		0.113	1.00		0.135	1.17		0.094	5.9
1970		0.100	0.80		0.100	0.80		0.066	6.4
1971		0.056	0.43		0.071	0.16		0.062	10.6
1972	0.90	0.047	0.34	0.59	0.051	0.18	1.08	0.055	11.5
1973	1.05	0.057	0.56	0.43	0.054	0.57	0.71	0.043	6.8
1974	1.75	0.079	0.90	1.94	0.106	0.77	1.19	0.028	3.4
1975	1.82	0.077	0.85	1.67	0.100	0.43	1.36	0.033	3.4
1976	1.69	0.060	0.66	1.20	0.081	0.30	1.69	0.035	3.8
1977	1.54	0.052	0.50	0.91	0.056	0.25	1.16	0.044	5.0
1978	1.37	0.062	0.37	0.56	0.044	0.08	1.12	0.037	7.1
1979	0.85	0.046		0.62	-	0.06	1.06	0.042	6.4
1980*									5.0

* Provisional figure

1) Norwegian data - tonnes per 1000 tonne-hours fishing

2) United Kingdom data - tonnes per 100 tonne-hours fishing

3) USSR data - tonnes per hour fishing

4) Norwegian data - tonnes per gill-net boat week in Lofoten

Table 5   COD. Catch per unit effort. Data from the Lofoten Fishery
               are given in gutted weight with head off. The United
               Kingdom data are given in round fresh weight.

Year	Norwegian vessels			English trawlers	
	Catch (kg per man per day worked in the Lofoten Fishery (Division IIa)			t/100 tonne-hour of age groups $\geq$ 8	t/100 tonne-hour of 4 - 7 year olds
	Gill-net	Long-Line	Hand-Line	Division IIa	Sub-area I
1960	77.8	148.3	56.7	.0214	.064
1961	101.5	141.1	75.5	.0129	.067
1962	94.9	134.4	57.8	.0304	.084
1963	80.8	116.3	56.2	.0291	.082
1964	104.5	62.1	51.5	.0230	.055
1965	81.8	78.3	68.4	.0039	.053
1966	121.8	131.9	72.6	.0223	.056
1967	107.9	245.4	120.7	.0166	.076
1968	158.0	184.6	61.5	.0095	.105
1969	170.6	200.4	142.8	.0068	.110
1970	180.3	304.3	127.6	.0079	.089
1971	334.3	510.7	192.7	.0179	.036
1972	318.7	400.1	110.2	.0151	.021
1973	189.7	366.5	112.1	.0209	.038
1974	96.3	146.4	63.9	.0027	.076
1975	122.0	188.3	96.1	.0020	.069
1976	131.4	258.4	134.8	.0015	.047
1977	173.2	279.6	143.5	.0043	.046
1978	237.6	381.7	134.6	.0074	.037
1979	201.3	306.0	125.1		
1980[*]	169.9	207.8	100.9		

* Provisional figures

Table 6   COD. Catch per unit effort for Norwegian freezers and for
English conventional trawlers.

	Sub-area I		Sub-area II	
Country Year	Norway t/tonne-hour x 10^{-3}	England t/tonne-hour x 10^{-4}	Norway t/tonne-hour x 10^{-3}	England t/tonne-hour x 10^{-4}
1972	0.34	.047	0.40	.055
1973	0.53	.057	0.34	.043
1974	0.93	.079	0.70	.028
1975	0.78	.077	0.54	.033
1976	0.72	.060	0.79	.035
1977	0.90	.052	0.68	.044
1978	0.54	.062	0.58	.037
1979	0.45	.046	0.69	.042

Table 7.   North-East Arctic COD.   Estimates of year class abundance.
(No. x 10^{-6}) from the Norwegian Acoustic Survey.

Year	Year Class											Total No.
	1979	1978	1977	1976	1975	1974	1973	1972	1971	1970	Older	
1977				45	882	104	315	139	52	47	12	1 596
1978			9	56	1 009	125	194	36	10	4		1 443
1979		7	14	112	522	77	44	14	7	1		799
1980	1	9	26	80	182	17	8	2	+	+		325

Table 8. North-East Arctic COD.
Input catch data for VPA.

AGE	1962	1963	1964	1965	1966	1967
1	1	1	103	1	1	1
2	1713	4	675	2522	869	151
3	42416	13196	5298	15725	55937	34467
4	170566	106934	45912	25999	55644	160048
5	167241	205549	97950	78299	34676	69235
6	89460	95498	58575	68511	42539	22061
7	28297	35518	19642	25444	37169	26295
8	21996	16221	9162	8438	18500	25139
9	7956	11894	6196	3569	5077	11323
10	2728	3884	3553	1467	1495	2329
11	2603	1021	783	1161	380	687
12	1647	1025	172	131	403	316
13	392	498	387	67	77	225
14	280	129	264	91	9	40
15+	103	157	131	179	70	11
Total	537399	491579	248803	231604	252846	352331

AGE	1968	1969	1970	1971	1972	1973
1	1	1	1	38	1	1
2	1	275	591	2210	4701	8277
3	3709	2307	7164	7754	35536	294262
4	174585	24545	10792	13739	45431	131493
5	267961	238511	25813	11831	26832	61000
6	107051	181239	137829	9527	12089	20569
7	26701	79363	96420	59290	7918	7243
8	16393	26939	31920	52003	34385	8328
9	11597	13463	8933	12093	22315	19130
10	3657	5092	3249	2434	4572	4493
11	657	1913	1232	762	1215	677
12	122	414	260	418	353	195
13	124	121	106	143	315	81
14	70	23	39	42	121	59
15+	46	46	35	25	40	55
Total	612681	574302	324384	172315	196324	555874

AGE	1974	1975	1976	1977	1978	1979
1	115	1	706	1	3	3
2	21347	1184	1908	11288	802	203
3	91855	45232	85337	39594	78822	8006
4	437377	59798	114341	168609	45400	82903
5	203772	226646	79993	136335	38495	46635
6	47006	118567	118236	52925	56823	34750
7	12630	29522	47872	61821	25407	18762
8	4370	9353	13962	23333	31621	9345
9	2523	2617	4051	5659	9408	12631
10	5607	1555	936	1521	1227	2102
11	2127	1923	558	610	913	404
12	322	575	442	271	446	133
13	151	231	139	122	740	67
14	80	15	26	92	48	52
15+	62	37	53	54	51	77
Total	829347	497311	468560	502240	340414	216259

Table 9. North East Arctic COD. Relative Fishing pattern used for VPA Input in 1979

$\overline{F}_{8-12} = 1.00$

Age	Fishing Pattern
3	0.28
4	0.41
5	0.69
6	0.85
7	0.93
8	0.95
9	1.11
10	1.08
11	1.05
12	0.83
13	0.87
14	0.73
15	0.76

Table 10. North-East Arctic COD.
          Fishing mortalities from VPA. (M = 0.2)

AGE	1962	1963	1964	1965	1966	1967	1968	1969	1970
1	.000	.000	.000	.000	.000	.000	.000	.000	.000
2	.003	.000	.001	.001	.001	.001	.000	.001	.001
3	.066	.031	.017	.023	.040	.030	.024	.023	.040
4	.305	.236	.144	.111	.103	.153	.207	.219	.140
5	.648	.738	.352	.389	.211	.181	.409	.430	.377
6	.823	1.002	.480	.447	.380	.292	.466	.538	.570
7	.606	.963	.572	.397	.467	.428	.399	.767	.621
8	.654	.868	.718	.520	.564	.672	.522	.918	.834
9	.793	.934	1.031	.694	.694	.831	.775	1.141	.936
10	.963	1.260	.832	.742	.717	.820	.718	.983	.993
11	.777	1.334	.980	.731	.430	.884	.579	1.101	.686
12	.791	.833	.866	.420	.612	.783	.372	.919	.411
13	.707	.592	.912	1.060	.470	.852	.841	.782	.641
14	.756	.535	.737	.563	.375	.478	.713	.358	.630
15	.610	.490	.810	.960	.370	.750	.740	.680	.540

MEAN F FOR AGES >= 8 AND <= 12 (NOT WEIGHTED BY STOCK IN NUMBERS)

	.796	1.046	.885	.621	.603	.798	.593	1.012	.772
Ages 4-7	.596	.735	.387	.336	.290	.241	.370	.501	.427

AGE	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	.000	.000	.000	.000	.000	.001	.000	.000	.000
2	.002	.002	.013	.028	.002	.004	.012	.009	.002
3	.021	.039	.183	.196	.076	.143	.109	.111	.112
4	.101	.166	.196	.468	.189	.276	.460	.176	.164
5	.224	.293	.343	.525	.475	.413	.616	.470	.276
6	.232	.376	.383	.498	.672	.490	.533	.570	.340
7	.517	.307	.406	.430	.680	.640	.516	.532	.372
8	.834	.664	.614	.459	.662	.825	.761	.553	.380
9	.921	1.137	.989	.378	.555	.626	1.002	.823	.444
10	.728	1.188	.744	.928	.424	.393	.602	.615	.432
11	.672	1.050	.539	1.006	1.026	.264	.482	.923	.420
12	.527	.779	.459	.536	.855	.701	.193	.800	.332
13	.439	1.304	.404	.793	.960	.512	.422	1.230	.348
14	.571	.785	.503	.963	.160	.254	.774	.291	.292
15	.340	.910	.310	.700	.860	.430	.400	.530	.304

MEAN F FOR AGES >= 8 AND <= 12 (NOT WEIGHTED BY STOCK IN NUMBERS)

	.736	.964	.669	.662	.704	.574	.609	.743	.402
Ages 4-7	.269	.285	.334	.480	.504	.455	.531	.437	.288

Table 11. North-East Arctic Cod. Stock size in numbers from VPA.

AGE	1962	1963	1964	1965	1966	1967
1	506916	1162673	2364139	1931738	256192	169470
2	579995	415027	951915	1935500	1581573	209752
3	730267	473312	339792	778752	1582376	1294097
4	711706	559619	375601	273414	623389	1245043
5	382651	429397	361913	266142	200410	460209
6	173583	163820	168121	208344	147624	132867
7	68054	62390	49256	85152	109145	82679
8	50009	30410	19497	22751	46883	56043
9	15824	21287	10452	7783	11070	21828
10	4791	5862	6847	3053	3185	4529
11	5247	1497	1361	2440	1191	1273
12	3282	1974	323	418	962	634
13	843	1218	703	111	225	427
14	575	341	552	231	32	115
15+	137	221	163	216	108	18
Total	3233880	3329048	4650635	5516047	4564363	3678985
Spawning stock age ≥ 8	80708	62810	39898	37005	63655	84867

AGE	1968	1969	1970	1971	1972	1973
1	298037	610019	1539731	2822372	857839	1052190
2	138749	244012	499440	1260625	2310729	702338
3	171594	113597	199531	408373	1030116	1887618
4	1028398	137140	90922	156895	327346	811307
5	875145	684813	90189	64715	116065	227082
6	314433	476086	346929	50668	42337	70905
7	88921	161478	227518	160702	32911	23810
8	44106	48841	61413	100065	78469	19829
9	23426	21425	15971	21838	35588	33075
10	7781	8836	5603	5129	7119	9348
11	1632	3106	2708	1699	2027	1777
12	431	749	846	1116	711	580
13	237	243	245	459	540	267
14	149	84	91	105	242	162
15+	58	60	48	40	49	90
Total	2993099	2510488	3081185	5054803	4842086	4840379
Spawning stock age ≥ 8	77821	83344	86924	130452	124744	65128

AGE	1974	1975	1976	1977	1978	1979
1	1053503	631246	1245426	126150	136918	0
2	861459	862432	516819	1019031	103282	112096
3	567551	686029	705030	421412	824117	83836
4	1280465	381966	520820	500325	309322	603659
5	545848	656312	258879	323596	258479	212360
6	131134	264419	334209	140186	143028	132304
7	39589	65250	110562	167683	67385	66252
8	12990	21085	27051	47730	81918	32420
9	8787	6718	8906	9705	18258	38585
10	10075	4929	3158	3673	2317	6564
11	3639	3260	2641	1745	1647	1291
12	849	1089	957	1660	882	536
13	300	407	379	388	1115	325
14	146	111	127	186	209	251
15+	80	46	78	81	70	123
Total	4516416	3585298	3735042	2763553	1949547	1290607
Spawning stock ≥ 8	36866	37645	43297	65170	107016	80100

Table 12. North-East Arctic COD. Mean weight at age

Age	Mean Weights (kg)
3	0.65
4	1.00
5	1.55
6	2.35
7	3.45
8	4.70
9	6.17
10	7.70
11	9.25
12	10.85
13	12.50
14	13.90
15	15.00

Table 13   COD   Year class strength.   Number per hour trawling
for USSR Young Fish Surveys is for 3 year old fish.

Year class	USSR Survey No. per hour trawling			USSR assessment	O-group survey index	Virtual Population No. of 3 year olds x 10⁻⁶*
	Sub-area I	Division IIb	Mean			M = 0.2
1957	12	16	13	−Average		791
1958	16	24	19	+Average		919
1959	18	14	16	+Average		730
1960	9	19	13	Poor		473
1961	2	2	2	Poor		340
1962	7	4	6	Poor		779
1963	21	120	76	Rich		1 582
1964	49	45	46	Rich		1 294
1965	<1	<1	<1	Very poor	6	177
1966	2	<1	1	Very poor	<1	115
1967	1	<1	1	Very poor	34	201
1968	7	1	5	Poor	25	407
1969	11	6	9	Poor	93	1 030
1970	74	86	76	Rich	606	1 860
1971	37	24	32	Average	157	542
1972	53	17	40	Average	140	672
1973	74	5	46	Rich	684	685
1974	6	1	4	Poor	51	279
1975	93	4	62	Rich	343	(476)
1976	4	<1	3	Poor	43	
1977	2	<1	1	Poor	173	
1978	(<1)	(<1)	(<1)	Poor	106	
1979	(<1)	(<1)	(<1)	Poor	94	

( ) = estimated

*USSR Murman cod included for 1974-77.

Table 14.   HADDOCK. Total nominal catch (tonnes) by fishing areas
(Data provided by Working Group members)

Year	Sub-area I	Division IIb	Division IIa	Total
1960	125 675	1 854	27 925	155 454
1961	165 165	2 427	25 642	193 234
1962	160 972	1 727	25 189	187 888
1963	124 774	939	21 031	146 744
1964	79 056	1 109	18 735	98 900
1965	98 505	939	18 640	118 079
1966	124 115	1 614	34 892	160 621
1967	108 066	440	27 980	136 486
1968	140 970	725	40 031	181 726
1969	88 960	1 341	40 208	130 509
1970	59 493	497	26 611	86 601
1971	56 300	435	21 567	78 302
1972	221 183	2 155	41 979	265 317
1973	283 728	12 989	23 348	320 065
1974	159 037	15 068	47 033	221 138
1975	121 686	9 726	44 330	175 742
1976	94 064	5 649	37 566	137 279
1977	72 159	9 547	28 452	110 158
1978	63 965	979	30 478	95 422
1979*	63 434	517	37 478	101 429

* Provisional figures.

Table 15. HADDOCK. Nominal catch (tonnes) by countries.
(Sub-area I and Divisions IIa and IIb combined)
(Data provided by Working Group members)

Year	Faroe Islands	France	German Dem.Rep.	Germany Fed.Rep.	Norway	Poland	U.K.	USSR	Others	Total
1960	172	-	-	5 597	47 263	-	45 469	57 025	125	155 651
1961	295	220	-	6 304	60 862	-	39 650	85 345	558	193 234
1962	83	409	-	2 895	54 567	-	37 486	91 940	58	187 438
1963	17	363	-	2 554	59 955	-	19 809	63 526	-	146 224
1964	-	208	-	1 482	38 695	-	14 653	43 870	250	99 158
1965	-	226	-	1 568	60 447	-	14 345	41 750	242	118 578
1966	-	1 072	11	2 098	82 090	-	27 723	48 710	74	161 778
1967	-	1 208	3	1 705	51 954	-	24 158	57 346	23	136 397
1968	-	-	-	1 867	64 076	-	40 129	75 654	-	181 726
1969	2	-	309	1 490	67 549	-	37 234	24 211	25	130 820
1970	541	-	656	2 119	36 716	-	20 423	26 802	-	87 257
1971	81	-	16	896	45 715	43	16 373	15 778	3	78 905
1972	137	-	829	1 433	46 700	1 433	17 166	196 224	2 231	266 153
1973	1 212	3 214	22	9 534	86 767	434	32 408	186 534	2 501	322 626
1974	925	3 601	454	23 409	66 164	3 045	37 663	78 548[1)	7 348	221 157
1975	299	5 191	437	15 930	55 966	1 080	28 677	65 015[1)	3 163	175 758
1976	537	4 459	348	16 660	49 492	986	16 940	42 485[1)	5 358	137 265
1977	213	1 510	144	4 798	40 118	-	10 878	52 210[1)	287	110 158
1978	466	1 411	369	1 521	39 955	1	5 766	45 895[1)	38	95 422
1979*	343	+ 2)	10	1 952	65 116	2	6 454	26 365	1 187	101 429

* Provisional figures
1) Murman haddock included
2) Estimated catch included in other countries catches

Table 16.

HADDOCK. Catch per unit effort and estimated total international effort.

Year	Sub-area I		Division IIb		Division IIa		Estimated total international effort in U.K. units (Total catch in t x 10^{-3} t/100 tonne-hours in Sub-area I)
	Norway[1]	U.K.[2]	Norway[1]	U.K.[2]	Norway[1]	U.K.[2]	
1960		33		2.8		34	4.7
1961		29		3.3		36	6.7
1962		23		2.5		42	8.2
1963		13		0.9		33	11.3
1964		18		1.6		18	5.5
1965		18		2.0		18	6.6
1966		17		2.8		34	9.4
1967		18		2.4		25	7.6
1968		19		1.0		50	9.6
1969		13		2.0		42	10.0
1970		7		1.0		31	12.4
1971		8		3.0		25	9.8
1972	0.06	14	0.02	23.0	0.09	18	19.0
1973	0.35	22	0.18	20.0	0.39	20	14.5
1974	0.27	20	0.09	15.0	0.51	74	11.1
1975	0.26	15	0.06	4.0	0.44	60	11.7
1976	0.27	10	+	3.0	0.24	38	13.7
1977	0.11	4	+	0.2	0.14	16	27.5
1978	0.13	5	0.0	4.0	0.14	15	19.1
1979*	0.36	(33) 22	0.07	-	0.18	19	(3.1) 4.6

* Provisional figure

1) Norwegian data - tonnes per 1 000 tonne-hours fishing

2) United Kingdom data - tonnes per 100 tonne-hours fishing

Table 17.   HADDOCK.
Year class strength. The number per hour trawling for
USSR Young Fish Surveys is for 2 year old fish.

Year class	USSR Survey No. per hour trawling Sub-area I	0-group survey index	Virtual population No. of 3 year olds x 10^{-6}*
1957	9		242
1958	4		110
1959	14		241
1960	40		276
1961	50		319
1962	3		100
1963	9		241
1964	12		291
1965	<1	7	20
1966	<1	<1	17
1967	13	42	164
1968	<1	8	94
1969	69	82	1 017
1970	33	115	265
1971	3	73	54
1972	9	46	(45)
1973	8	54	(56)
1974	35	147	(116)
1975	96	170	(193)
1976	13	112	(170)
1977	<1	116	(100)
1978	(<1)	61	
1979	(<1)	69	

( ) = Estimated

  * = USSR Murman haddock included for 1974-77.

Table 18. North-East Arctic HADDOCK.

Estimates of year class abundance (No. x 10^{-6}) from the Norwegian Acoustic Survey.

Year	Year Class											Total No.
	1979	1978	1977	1976	1975	1974	1973	1972	1971	1970	Older	
1977				267	755	198	60	10	9	12	17	1 328
1978			80	209	717	46	1					1 053
1979		7	10	176	272	10	+					476
1980	4	1	8	66	61	2	+	1				143

Table 19.
North-East Arctic HADDOCK.
Input catch data for VPA.

AGE	1962	1963	1964	1965	1966	1967
1	1	3	149	1	1	1
2	4536	2151	831	3483	2559	53
3	39604	28567	22305	5911	26157	15918
4	30947	72995	49162	46161	22469	41373
5	49028	19035	30592	40032	62724	13505
6	33922	13627	5800	12578	28840	25736
7	3209	9290	3519	1672	5711	8878
8	1344	1243	2709	970	578	1617
9	1778	561	832	893	435	218
10	243	409	104	122	188	176
11	247	79	206	204	186	155
12	482	84	234	123	25	76
13	20	169	121	14	8	27
14	8	41	67	205	7	7
Total	165369	148254	116631	112369	149888	107740

AGE	1968	1969	1970	1971	1972	1973
1	1	1	480	15	133	1
2	33	1058	276	3535	9369	5915
3	657	1520	23004	1979	230229	70204
4	67632	1963	2408	24359	22246	258773
5	41267	44526	1870	1258	42849	24018
6	7748	18956	21995	918	3196	6872
7	15599	3611	7948	9279	1606	418
8	5292	4925	1974	3056	6736	422
9	655	1624	1978	826	2630	1680
10	182	315	726	1043	896	525
11	101	43	166	369	988	146
12	115	43	26	130	538	349
13	18	14	52	27	53	68
14	19	2	19	4	42	13
Total	139319	78601	62922	46798	321511	369395

AGE	1974	1975	1976	1977	1978	1979
1	281	1321	3475	184	46	0
2	3713	4355	7496	18456	2033	67
3	9684	10037	13989	55967	47311	17868
4	41701	14089	13443	22043	18312	39369
5	88111	33871	6808	7368	4076	12043
6	5827	49712	20789	2586	1389	1349
7	4138	2135	40044	7781	1626	947
8	382	1236	1247	11043	2596	570
9	617	92	1349	311	6215	1619
10	2043	131	193	388	162	2579
11	935	500	279	96	258	254
12	276	147	652	101	3	23
13	458	53	331	84	74	5
14	143	92	46	98	65	10
Total	158309	117771	110147	126506	84666	76773

Table 20. North-East Arctic HADDOCK

Relative fishing pattern used for VPA input in 1979.

$\overline{F}_{9 - 14} = 1.00$

Age	Fishing Pattern
3	0.582
4	1.075
5	1.493
6	1.403
7	1.194
8	1.060
9	1.0
10	1.0
11	1.0
12	1.0
13	1.0
14	1.0

Table 21.

North-East Arctic HADDOCK.
Fishing Mortalities from VPA. $(M = 0.2)$

AGE	1962	1963	1964	1965	1966	1967	1968	1969	1970
1	.000	.000	.000	.000	.000	.000	.000	.000	.000
2	.015	.006	.007	.013	.008	.002	.002	.006	.003
3	.200	.121	.080	.067	.127	.062	.038	.102	.167
4	.591	.680	.314	.236	.388	.303	.401	.152	.231
5	1.060	.920	.690	.457	.578	.428	.562	.505	.212
6	1.037	1.023	.828	.691	.707	.499	.469	.550	.504
7	.627	.941	.828	.607	.801	.491	.651	.416	.471
8	.646	.533	.816	.573	.436	.556	.618	.438	.423
9	.966	.621	.849	.711	.551	.291	.459	.388	.315
10	.398	.615	.218	.277	.312	.452	.421	.420	.300
11	.202	.216	.738	.865	.887	.459	.512	.165	.409
12	.753	.098	1.902	1.543	.233	1.235	.746	.428	.142
13	.167	.658	.198	.554	.353	.423	1.223	.182	1.493
14	.600	.600	.600	.600	.600	.600	.600	.400	.400

MEAN F FOR AGES >= 3 AND <= 6 (NOT WEIGHTED BY STOCK IN NUMBERS)

	.722	.686	.478	.363	.450	.323	.367	.327	.279

AGE	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	.000	.002	.000	.003	.007	.011	.001	.022	.000
2	.003	.030	.092	.064	.065	.048	.071	.016	.040
3	.022	.280	.326	.214	.245	.306	.595	.261	.195
4	.267	.372	.583	.328	.546	.602	1.135	.408	.360
5	.182	1.044	.888	.401	.484	.560	.799	.655	.500
6	.153	.945	.453	.555	.415	.627	.429	.334	.470
7	.413	.434	.293	.546	.405	.700	.510	.528	.400
8	.333	.601	.192	.476	.309	.440	.421	.318	.355
9	.314	.535	.291	.474	.199	.654	.185	.445	.335
10	.273	.665	.190	.690	.172	.816	.394	.139	.335
11	.245	.449	.210	.604	.355	.661	1.425	.498	.335
12	.657	.676	.273	.765	.175	1.110	.536	.131	.335
13	.214	.621	.163	.717	.316	.734	.391	.996	.335
14	.400	.600	.300	.600	.300	.500	.500	.600	.335

MEAN F FOR AGES >= 3 AND <= 6 (NOT WEIGHTED BY STOCK IN NUMBERS)

	.156	.660	.562	.374	.423	.523	.740	.414	.381

Table 22.
North-East Arctic HADDOCK.
Stock size in numbers from VPA.

AGE	1962	1963	1964	1965	1966	1967
1	479318	150235	364191	438314	29003	25883
2	341843	392432	123040	298040	358860	23745
3	240721	275780	319353	99986	240869	291499
4	75814	161428	200036	241342	76528	173628
5	81374	34387	66962	119598	156059	42489
6	57015	23092	11216	27502	62028	71648
7	7524	16550	6800	4014	11283	25034
8	3085	3291	5286	2431	1791	4146
9	3119	1324	1582	1913	1123	948
10	812	972	583	554	769	530
11	1488	447	430	383	344	461
12	993	996	295	168	132	116
13	143	383	739	36	29	86
14	19	99	162	496	17	1?
Total	1293267	1061468	1100676	1234778	938836	660230
Spawning stock (Age ≥6)	74197	47154	27093	37498	77517	102986

AGE	1968	1969	1970	1971	1972	1973
1	247551	146834	1548658	425888	90712	80676
2	21190	202677	120217	1267500	348674	74149
3	19393	17319	164982	98176	1034549	277011
4	224294	15284	12809	114353	78592	640010
5	104969	122948	10745	8320	71717	44374
6	22674	49008	60774	7114	5679	20663
7	35604	11619	23156	30054	4997	1807
8	12541	15209	6273	11834	16281	2651
9	1947	5536	8036	3366	6944	7305
10	580	1007	3075	4802	2913	3330
11	276	312	542	1865	2993	846
12	238	135	217	295	1195	1565
13	28	93	72	154	125	43
14	46	7	63	13	102	5?
Total	691332	587987	1959618	1973734	1664574	1154940
Spawning stock (age ≥ 6)	73935	82926	102207	59496	40329	38721

AGE	1974	1975	1976	1977	1978	1979
1	93195	214872	366450	168409	2352	0
2	66051	76048	174729	296885	137716	1884
3	55373	50727	58333	136290	226417	110916
4	163722	36618	32502	35186	61523	142822
5	292478	96579	17348	14582	9259	33492
6	14947	160394	48720	8126	5369	3938
7	10756	7022	86721	21302	4334	3148
8	1104	5102	3834	35243	10471	2092
9	1791	561	3066	2020	18948	6240
10	4471	913	377	1305	1374	3941
11	2254	1836	629	136	720	979
12	563	1009	1054	266	27	358
13	975	214	684	284	127	19
14	346	390	128	273	157	33
Total	708025	652286	794604	720309	478795	315869
Spawning stock (Age ≥ 6)	37206	177441	145222	68956	41529	26755

Table 23. North-East Arctic HADDOCK

Age	Mean Weights (kg)				
	70-79 WG	USSR 76-79	UK	Av. USSR + UK	Adjusted for S.O.P. discrepancy
3	.41	.53	.70	.62	.66
4	.62	.95	.99	.97	1.03
5	.97	1.61	1.77	1.69	1.79
6	1.59	2.23	2.27	2.25	2.38
7	2.33	2.65	2.76	2.71	2.86
8	2.72	3.15	3.15	3.15	3.33
9	3.56		3.5	3.5	3.70
10	4.41		3.74		4.41
11	5.40				5.40
12	6.70				6.70
13	7.40				7.40
14	8.00				8.00

Table 24. North-East Arctic COD and HADDOCK stock, catch, and fishing mortality values estimated on the basis of the Norwegian acoustic survey data versus those estimated by VPA.

| | COD | | | | | | | | | HADDOCK | | | | | | | | | |
AGE	Stock Numbers 1978	Catch Numbers 1978	Catch Weight 1978	F_{1978}	Stock Numbers 1979	Catch Numbers 1979	Catch Weight 1979	F_{1979}	Stock Numbers 1980	Stock Numbers 1978	Catch Numbers 1978	Catch Weight 1978	F_{1978}	Stock Numbers 1979	Catch Numbers 1979	Catch Weight 1979	F_{1979}	Stock Numbers 1980	AGE
FROM NORWEGIAN ACOUSTIC SURVEY																			
3	1 009	340	221	.459	112	13	8	.136	26	717	353	229	.769	176	88	57	.781	8	3
4	125	28	28	.285	522	275	275	.854	80	46	31	32	1.326	272	183	188	1.295	66	4
5	194	130	202	1.284	77	52	81	1.311	182					10				61	5
6					44				17										6
Total 3-5	1 328	498	451		711	340	364		288	763	384	261		448	271	245		74	Total 3+4
$\overline{F}$ 3-5				.676				.767					1.038				1.038		$\overline{F}$ 3+4
FROM VPA																			
3	824	79	51	.111	84	8	5	.112	92	226	47	31	.261	111	18	12	.195	2	3
4	309	45	45	.176	604	83	83	.164	62	62	19	20	.408	143	39	40	.360	75	4
5	258	89	138	.470	212	47	73	.276	420					33				82	5
6					132				132										6
Total 3-5	1 391	213	234		900	138	161		574	288	66	51		254	57	52		77	Total 3+4
$\overline{F}$ 3-5				.252				.184					.335				.278		$\overline{F}$ 3+4
Tot.Rep. Catch		340	699			216	427				85	95			77	101			

Note: Numbers x 10^6

Weight in thousand tonnes

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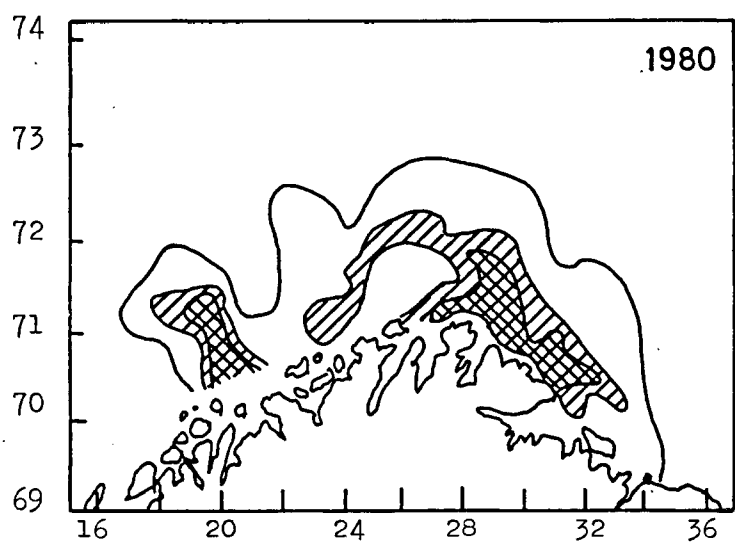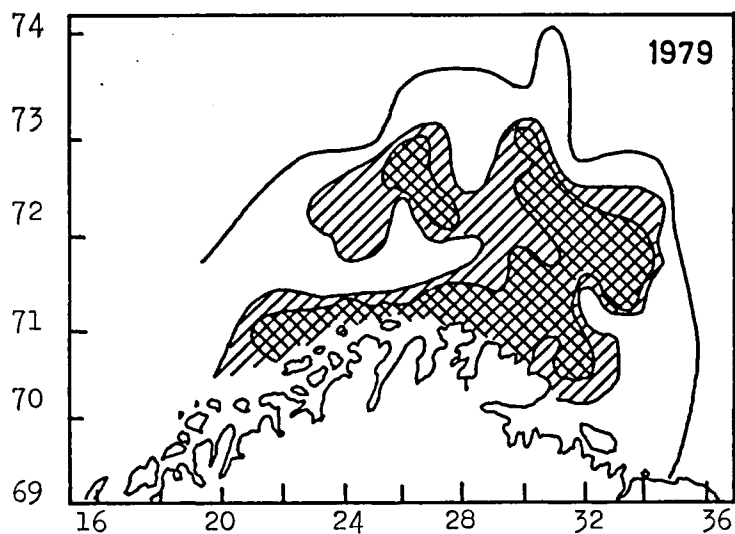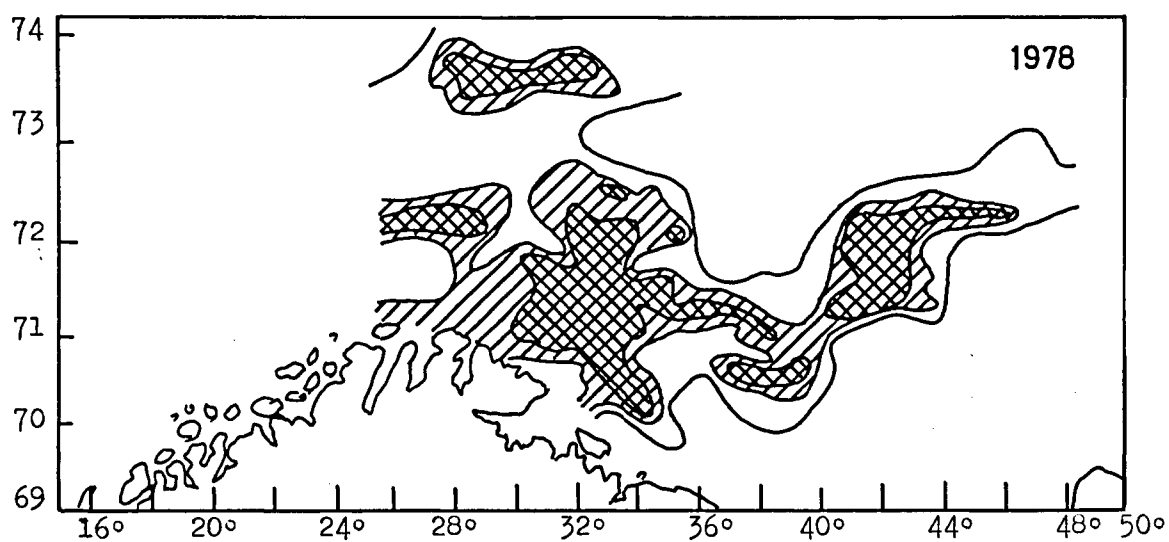
Figure 1. Distribution of Cod and Haddock during the Norwegian Acoustic Survey (1978-1980)

Figure 2. Catchability coefficient, q, for gillnets and handline in the Lofoten spawning fishery for COD 1962-80.
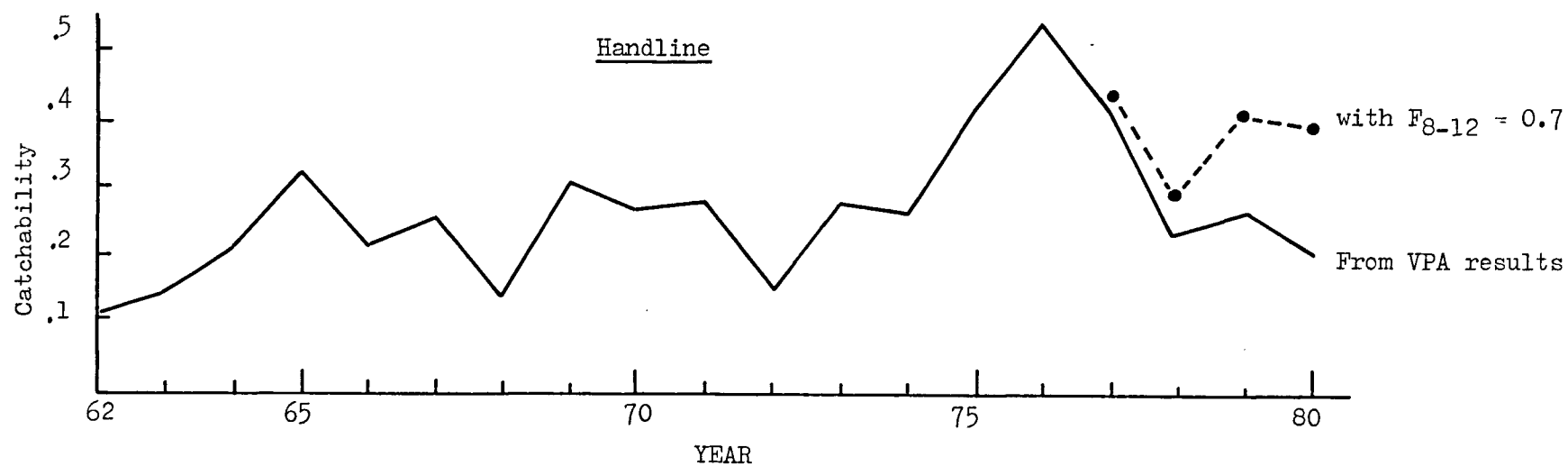
Figure 3. Catchability coefficient, q, for longline in the Lofoten spawning fishery for COD 1962-80
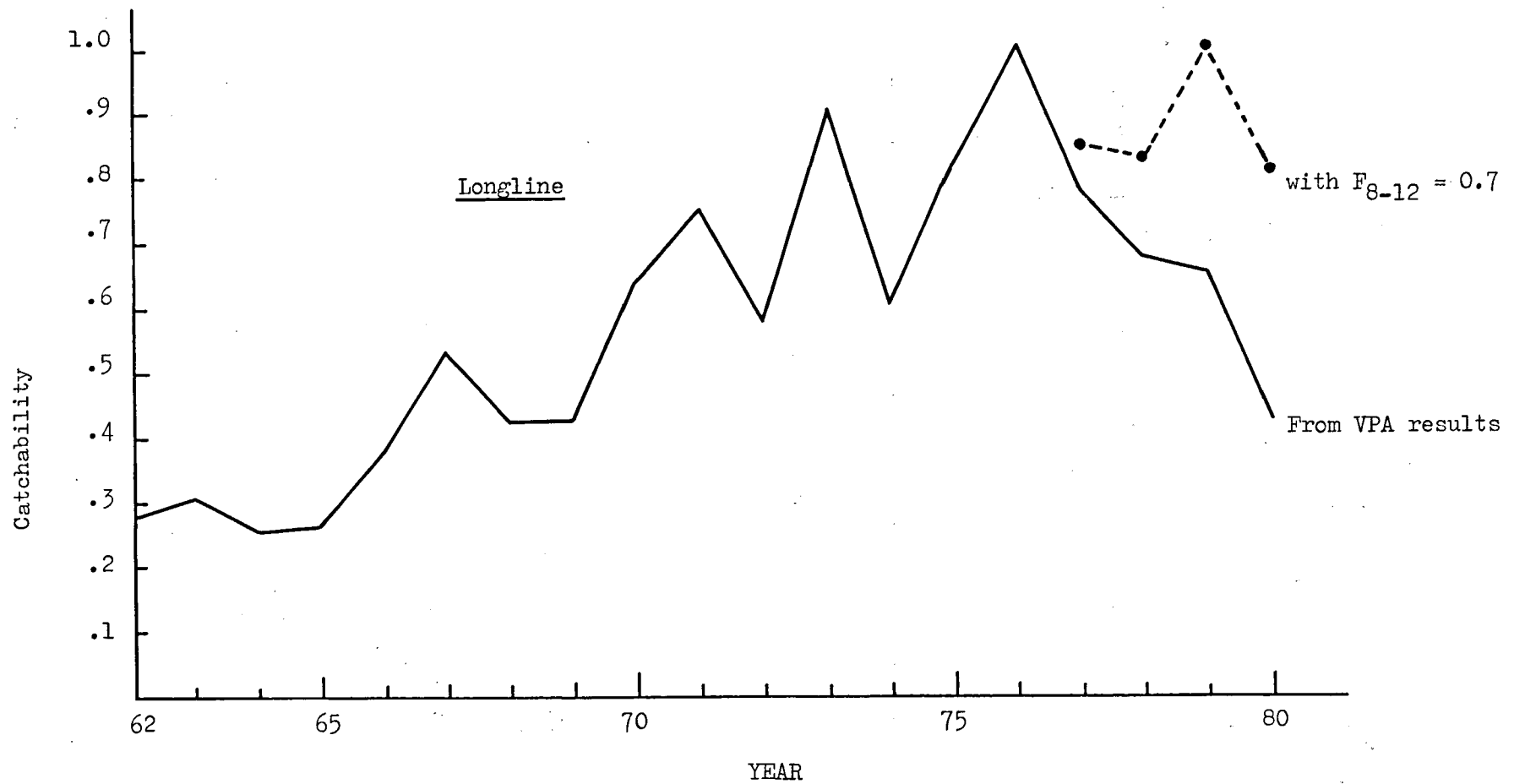
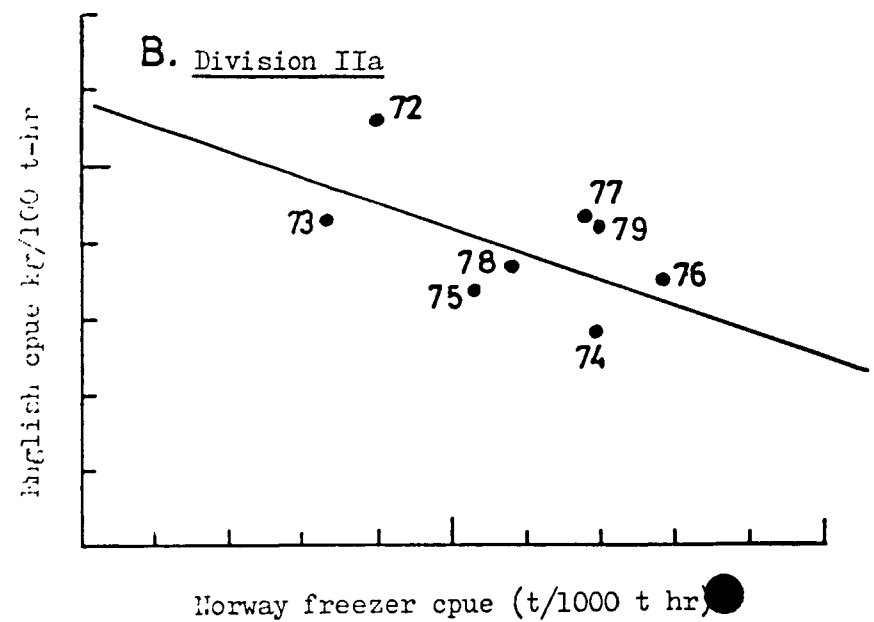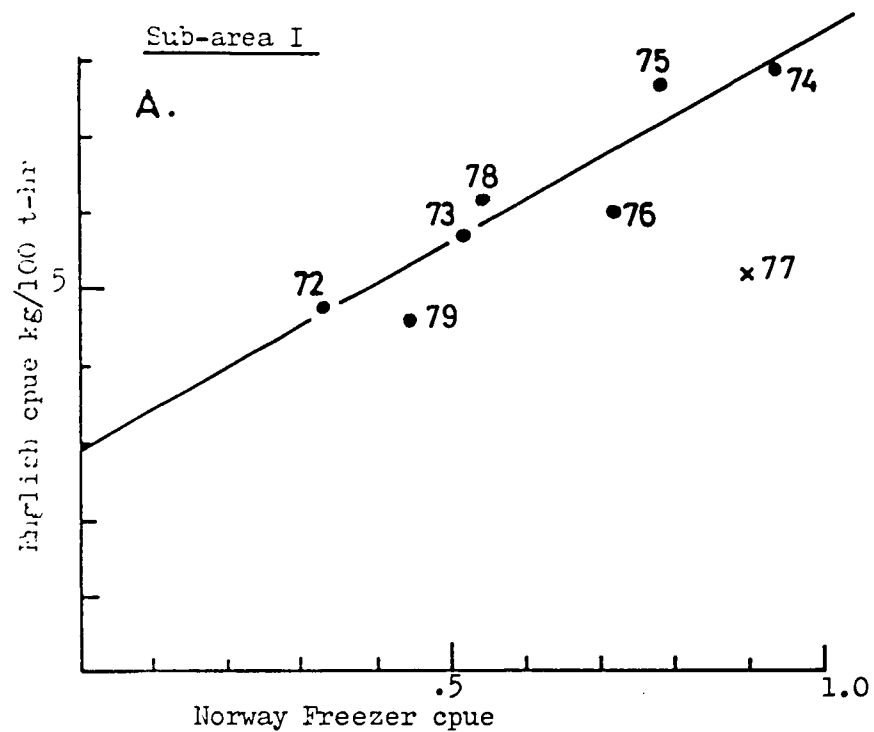Figure 4. Relation between English cpue data and Norwegian cpue data (from trawlers)
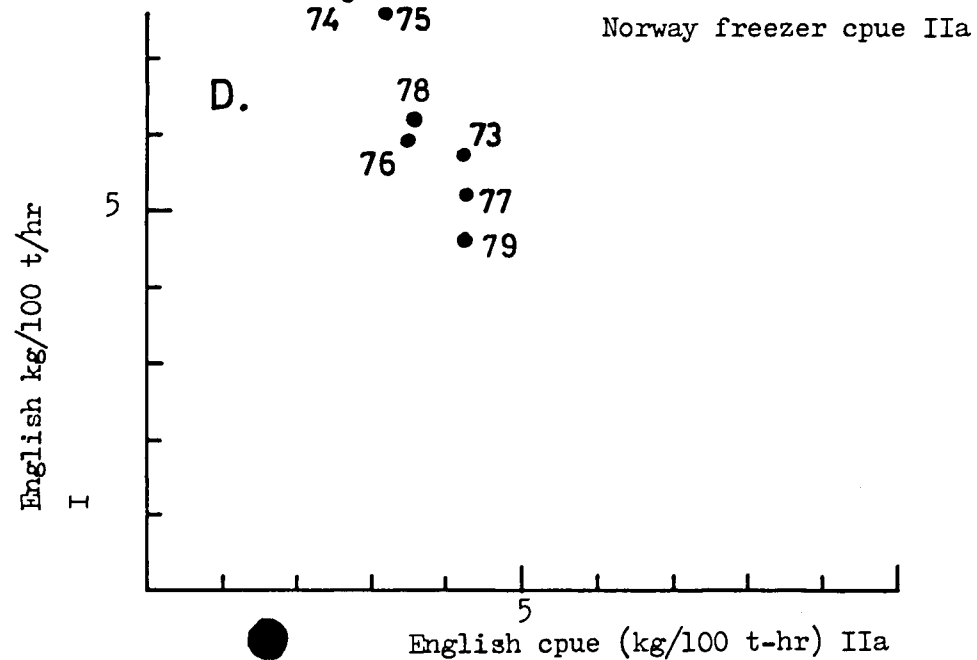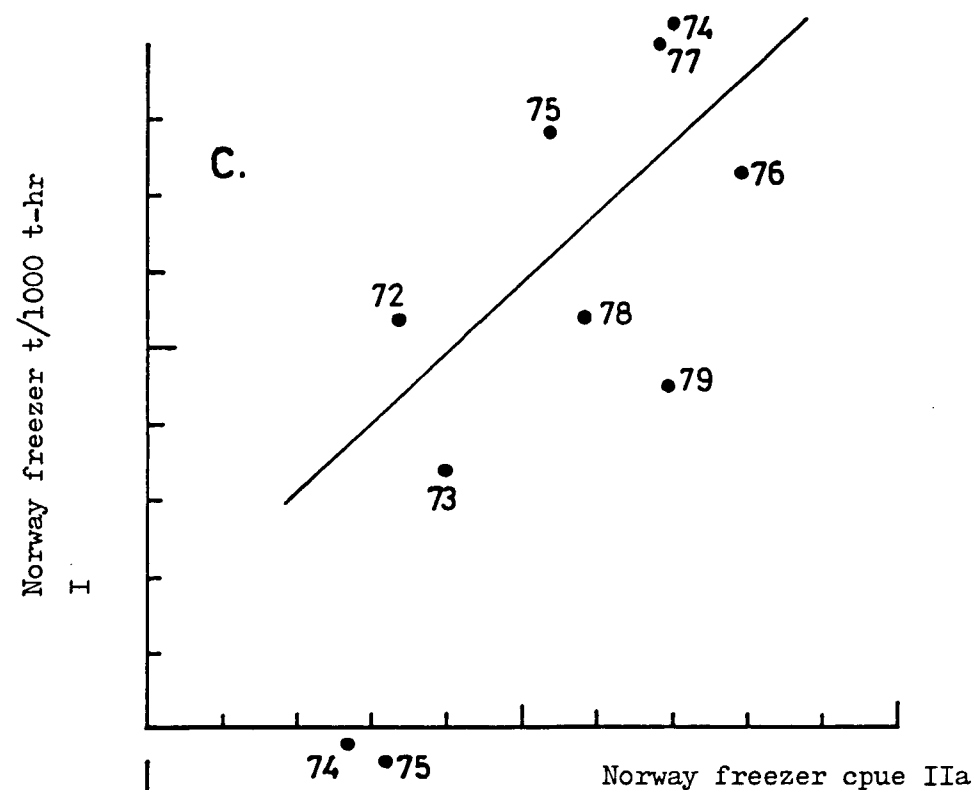
Figure 5. The correspondence between catch per unit effort
of 4-7 years old cod (tonnes per 100 tonne-hour trawling)
by English trawlers in Sub-area I, and the estimated stock
size of 4-7 year old cod.
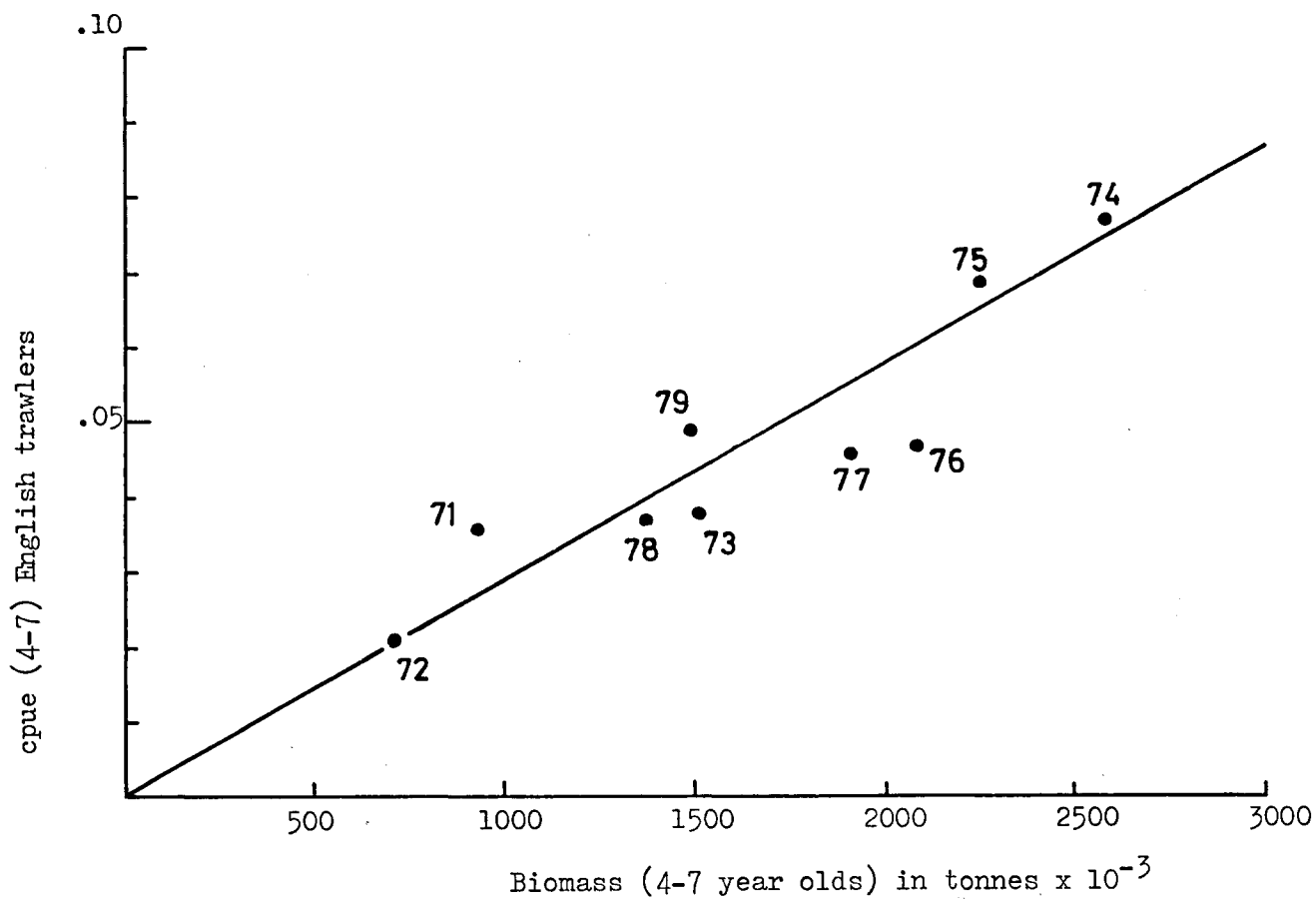
Figure 6. The average fishing mortality on 4 - 7 year old cod versus the total international effort (UK units)

$N_3 \times 10^{-6}$
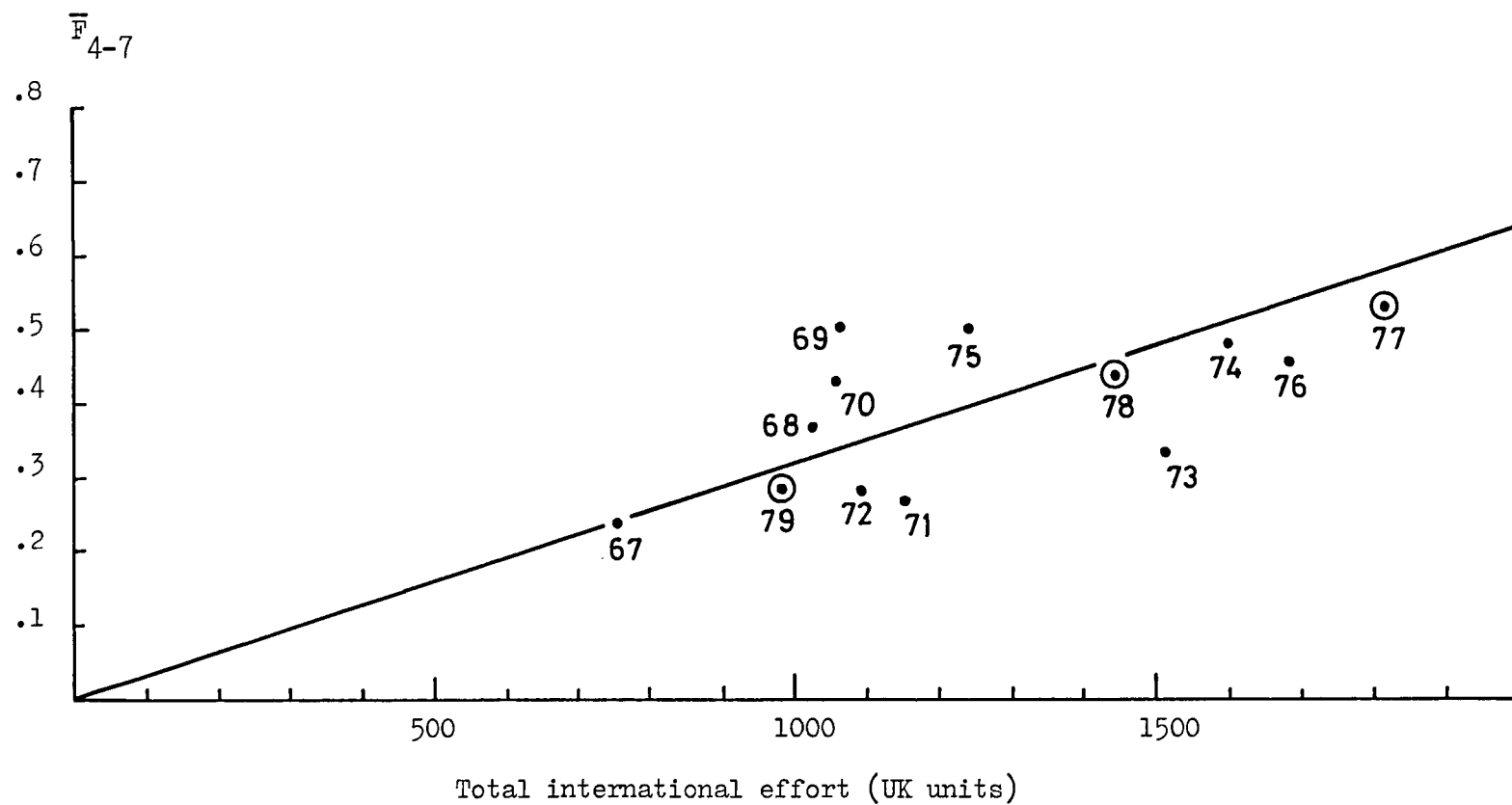
Figure 7. COD. Number of 3 year olds versus catch per unit effort of 3 year olds by UK trawlers in Sub-area I.
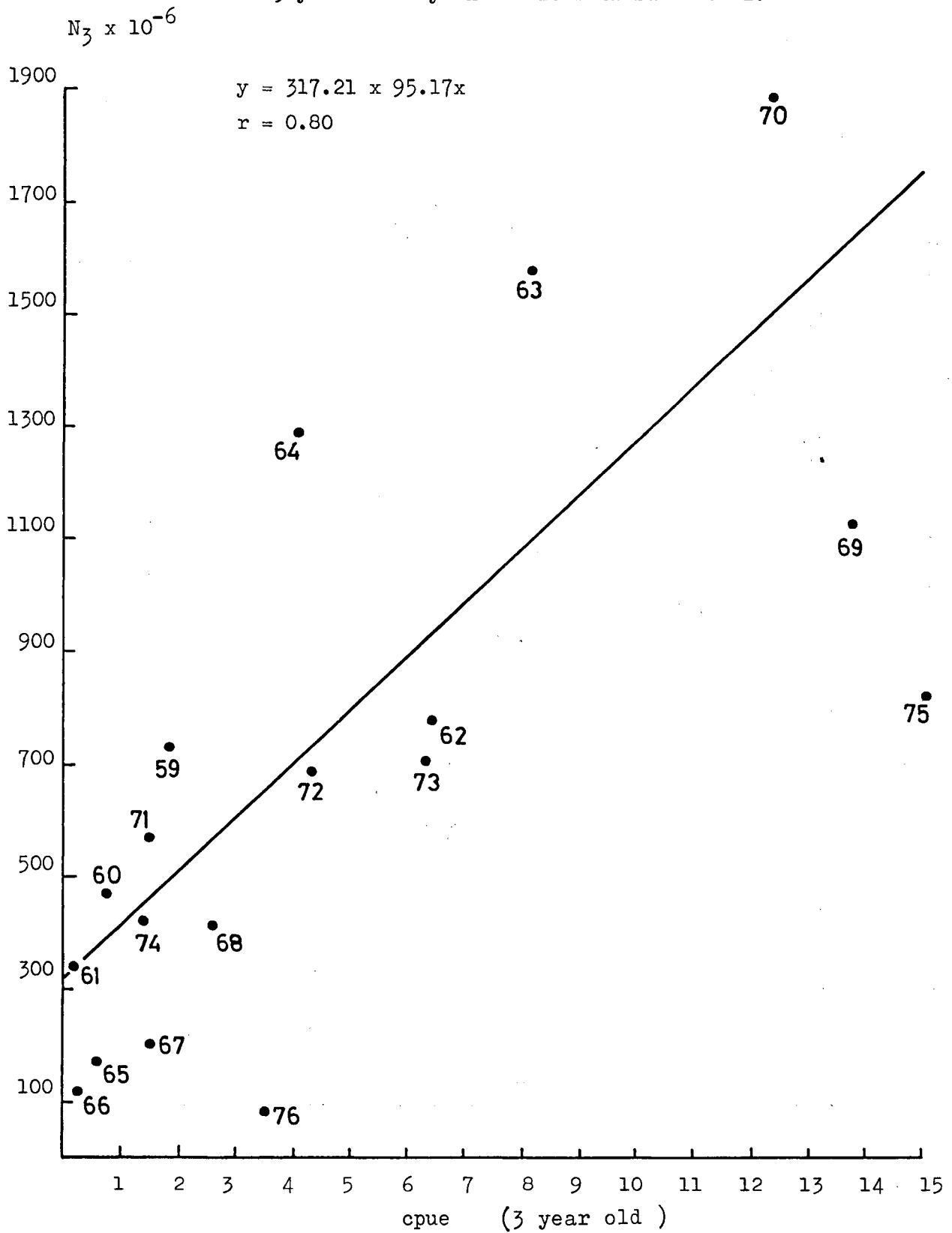
Figure 8. COD Number of 4 year olds versus catch per unit effort of 4 year olds by UK trawlers in Sub-area I.

$N_4 \times 10^{-6}$

$y = 99.79 + 40.34x$

$r = 0.95$

cpue (4 year old)
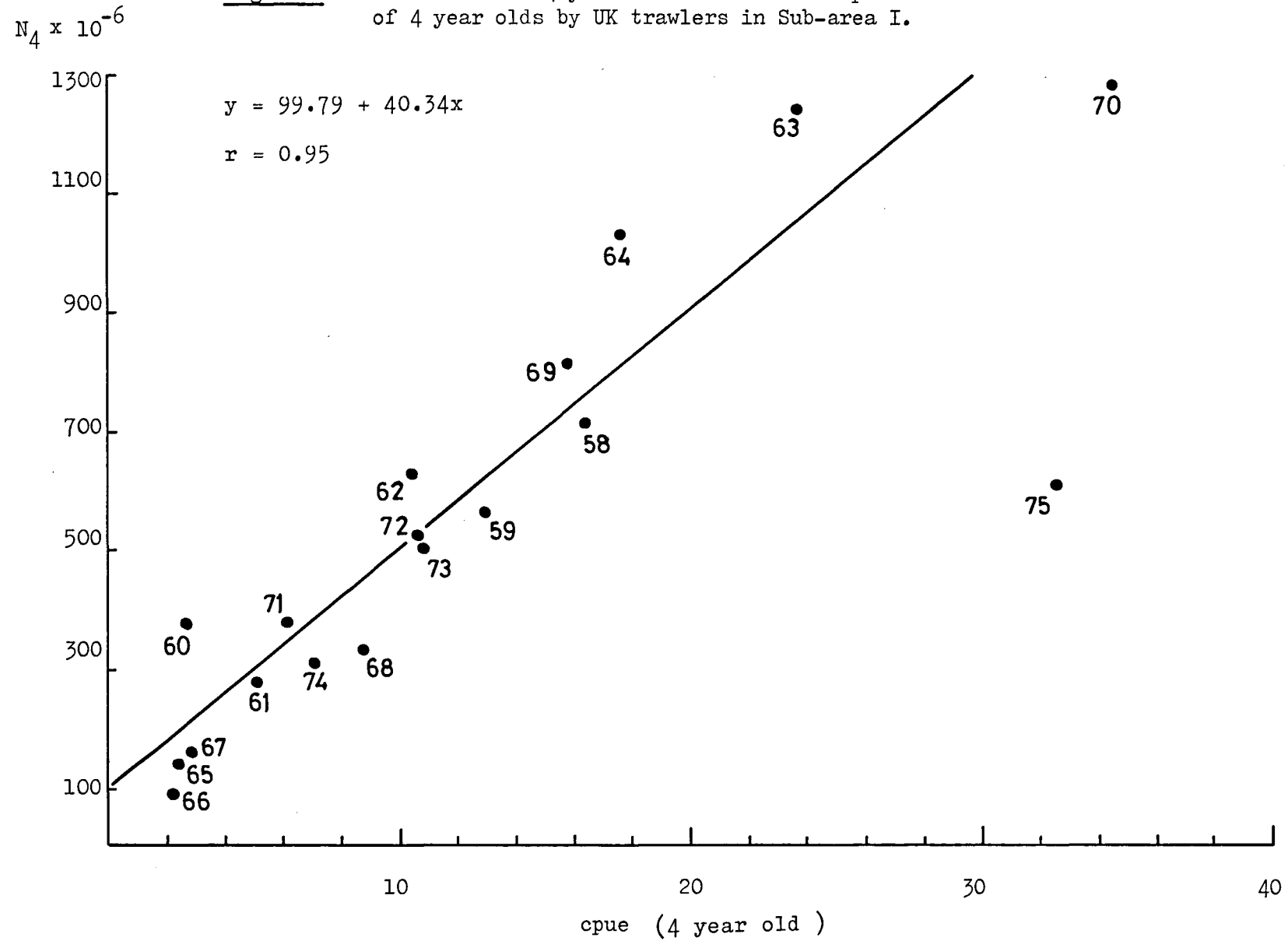
Figure 9. COD. Number of 5 year olds versus catch per unit effort of 5 year olds by UK trawlers in Sub-area I.
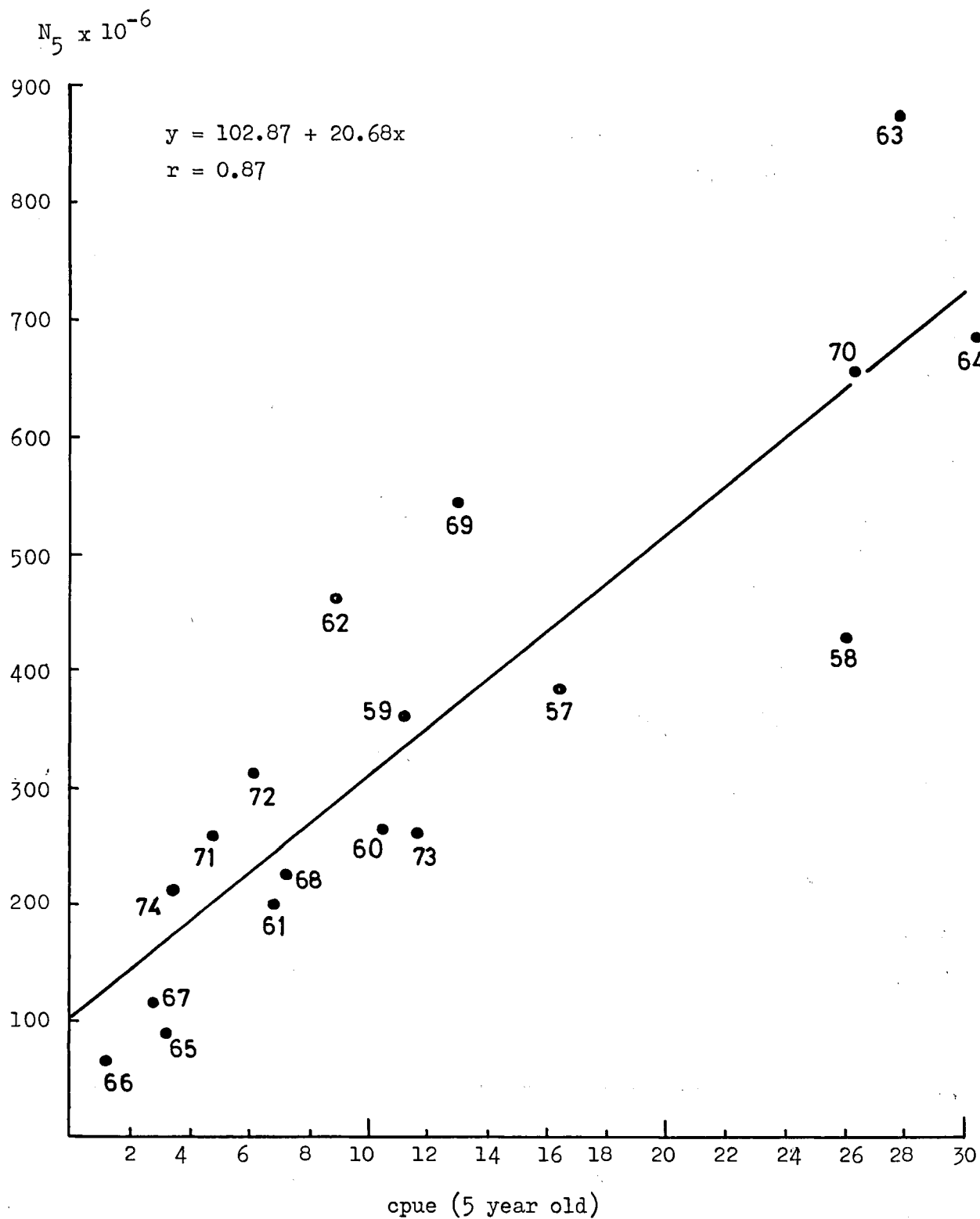
Figure 10. COD. Correlation of VPA recruitment estimates on USSR young
fish survey for 1957-1974. 1975 year class is not
included in the regression

No. of 3 year old (VPA) cod x 10^{-6}

USSR young fish survey index (age 3)
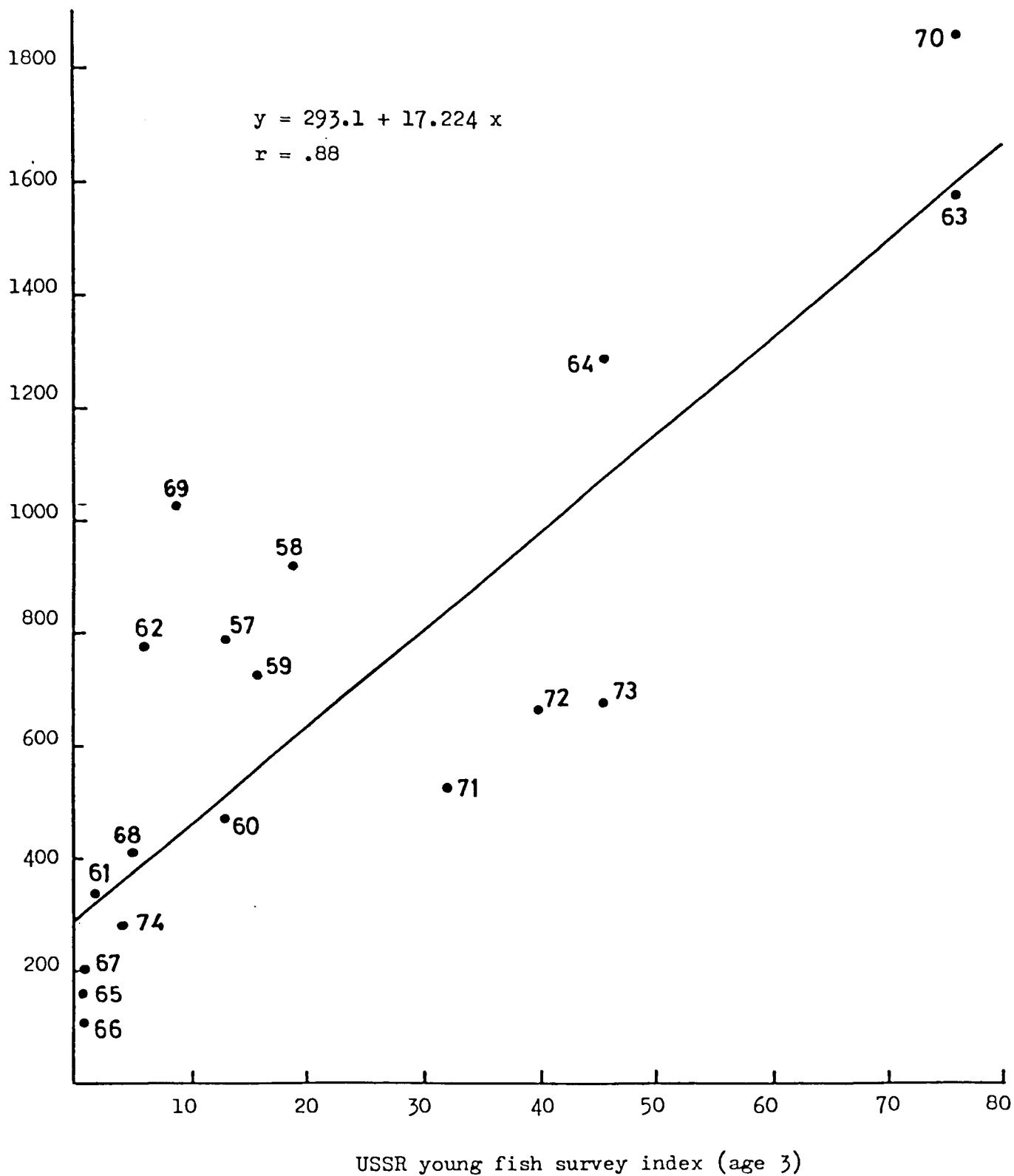
Figure 11. COD. Yield per recruit (at age 3) versus the average fishing mortality on 8 to 12 year olds

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$\overline{F}_{8-12}$
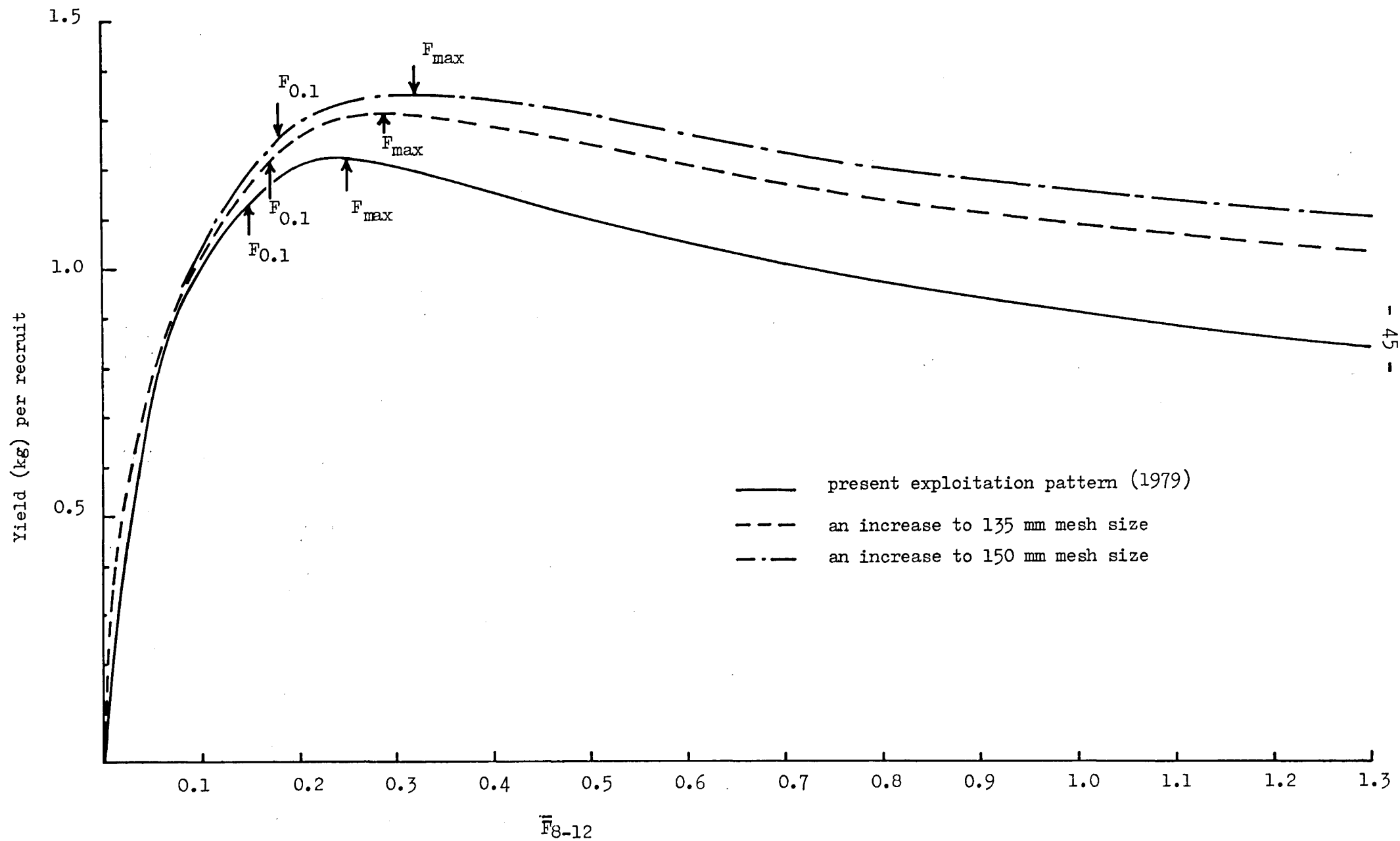
Figure 12. COD. Spawning stock biomass per recruit (at age 3) versus the average fishing mortality on 8 - 12 year olds.
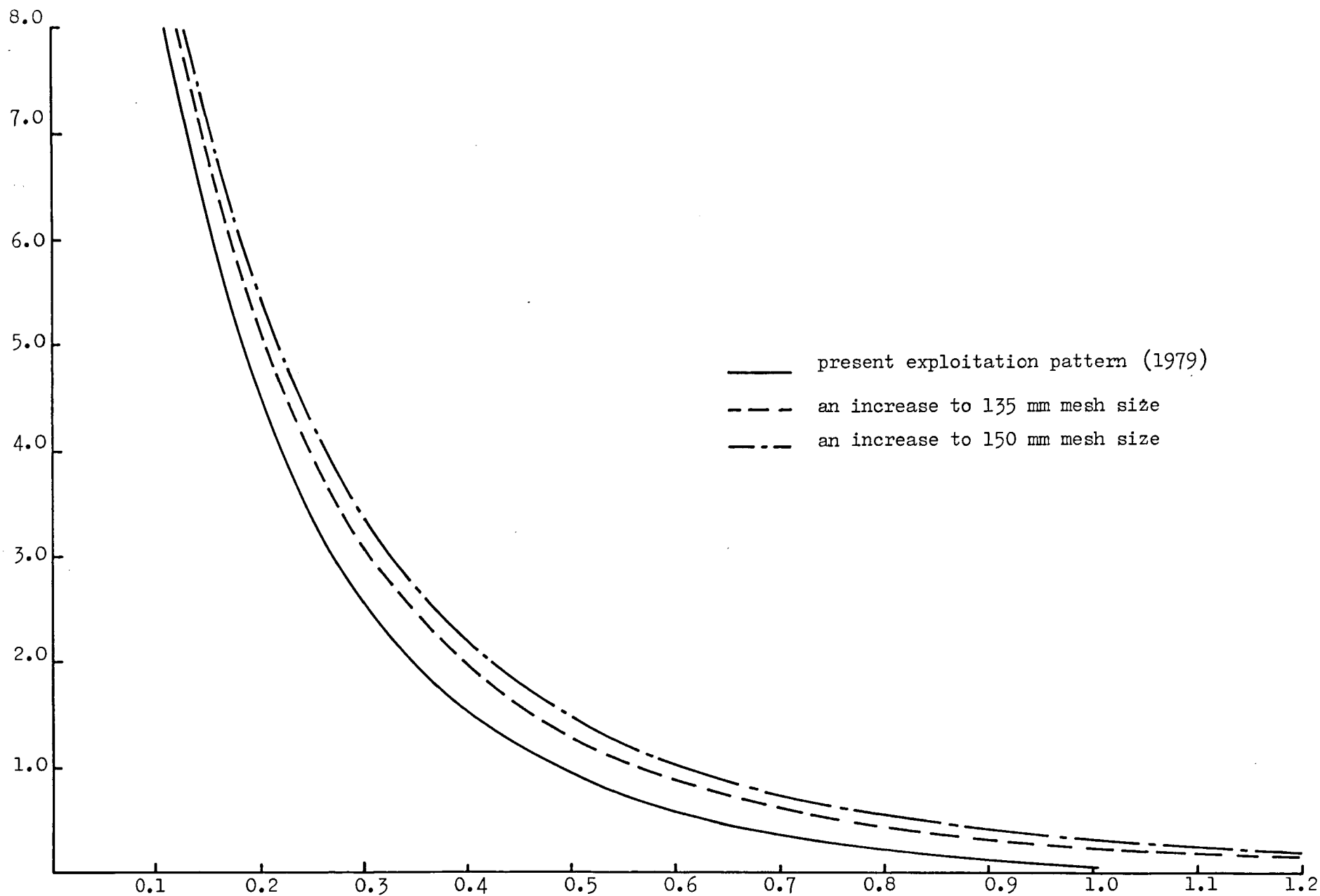
Figure 13. HADDOCK. Average fishing mortality on 3-6 year olds versus the total international effort (in UK units) from final VPA run
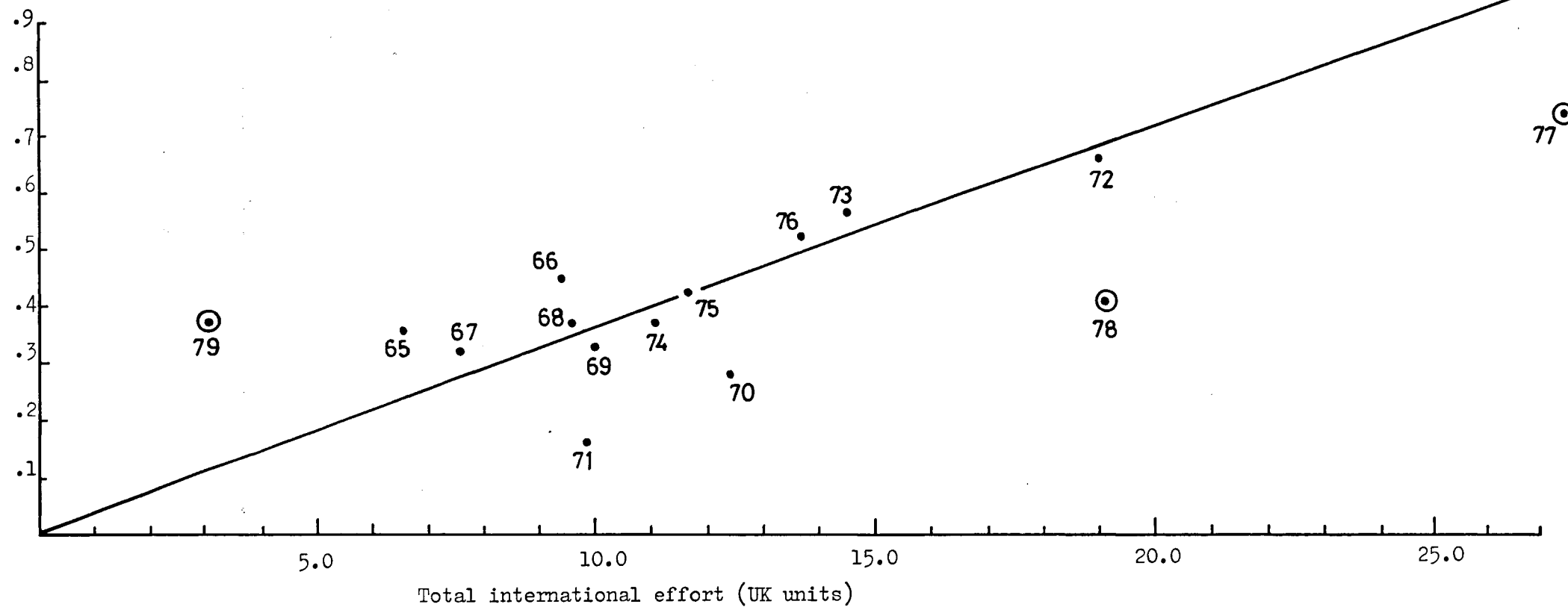
Figure 14. HADDOCK. Correlation of numbers of 3 year olds (from VPA)
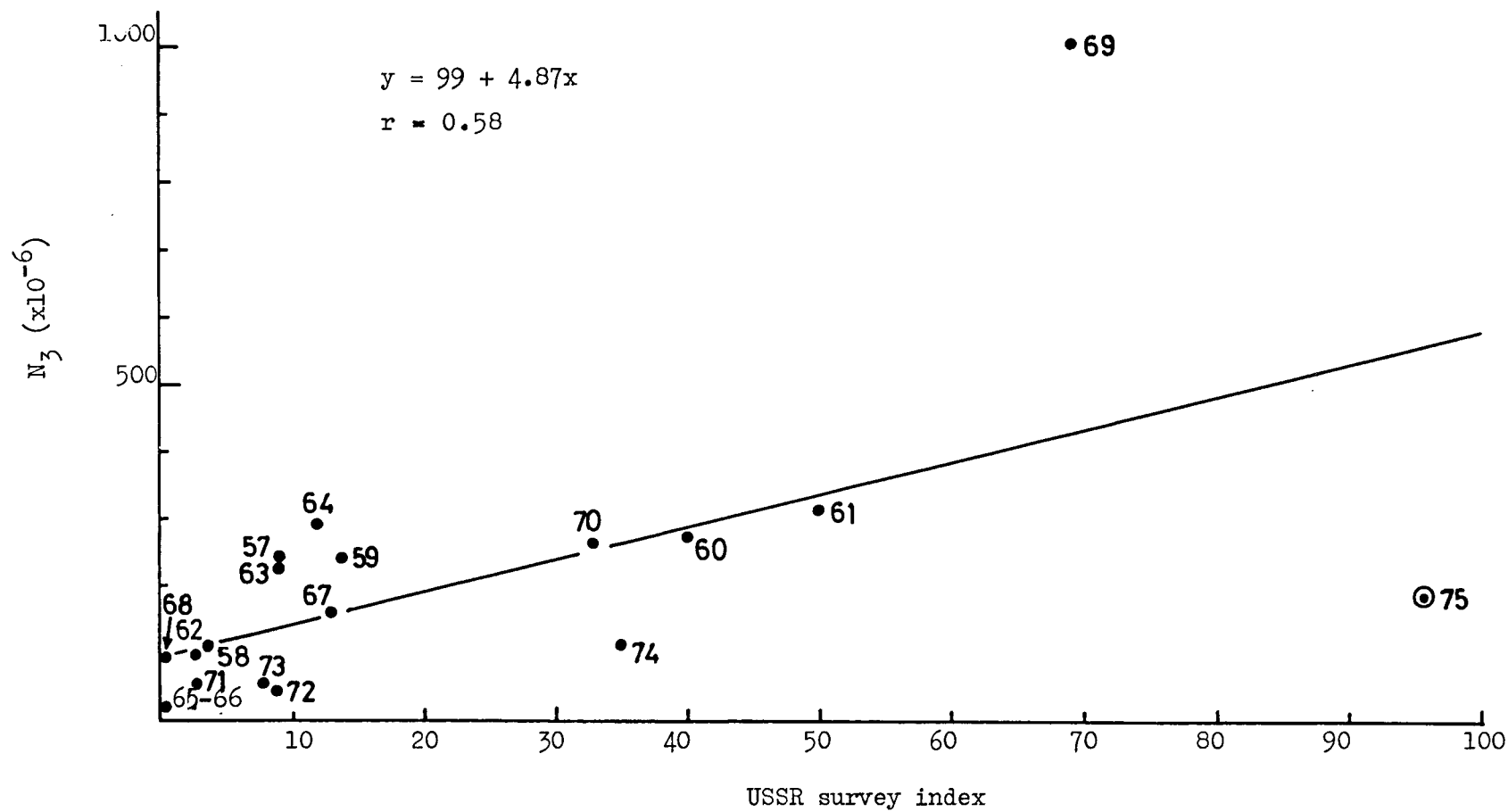and USSR young fish surveys for the year classes 1957-1974.

Figure 15. HADDOCK. Yield per recruit (at age 3) versus fishing mortality on 7 years and older fish.
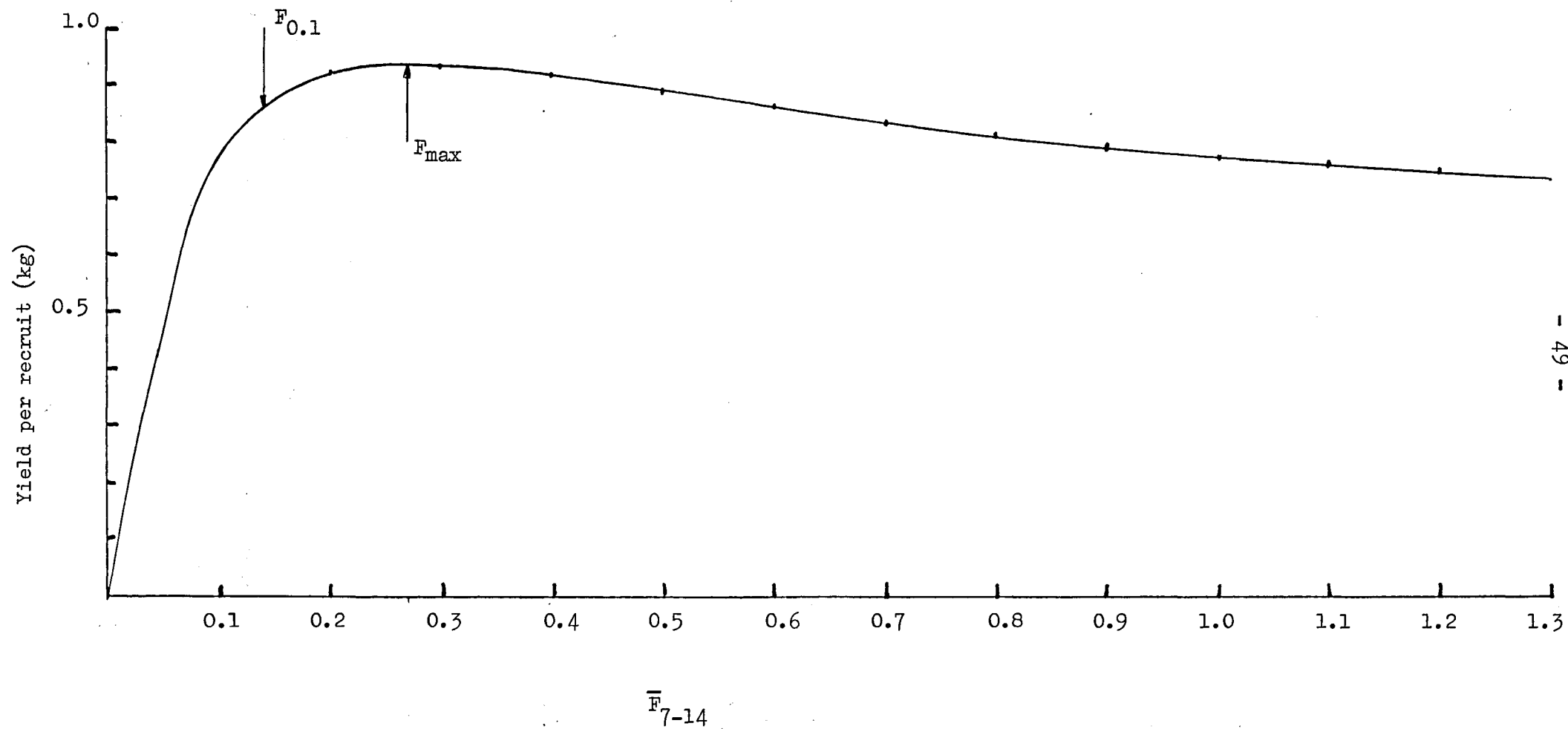
Figure 16. HADDOCK. Spawning biomass per recruit (at age 3) versus fishing mortality on 7 years and older fish.