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Demersal Fish Committee

ERRATA SHEET

REPORT OF THE AD HOC WORKING GROUP ON THE NORWAY POUT BOX PROBLEMS

Please note the following changes:

(1) Page 29, Table 5.2: the first figure from the top in the fourth column from the left:
delete "0", insert " -5".

(2) Page 68, Table A.3.3: in the extreme right hand column, the seventh figure from the bottom:
delete "2", insert "12".

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REPORT OF AN AD HOC WORKING GROUP ON THE NORWAY POUT BOX PROBLEM

Charlottenlund, 29 January - 2 February 1979

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Charlottenlund, 29 January - 2 February 1979

1. INTRODUCTION

1.1 Participation

D W Armstrong	United Kingdom
R S Bailey	United Kingdom
B E Brown (Chairman)	USA
A C Burd	United Kingdom
N Daan	Netherlands
K Hoydal	Faroe Islands
B W Jones	United Kingdom
H Lassen	Denmark
P Lewy	Denmark
K Popp Madsen	Denmark
C J Rørvik	Norway

Mr R Noë assisted at part of the meeting as Observer from EEC.
V Nikolaev, ICES Statistician, acted as Secretary to the ad hoc Group.

1.2 Terms of Reference

At the request of the Commission for the European Economic Communities, the Council agreed at its 66th Statutory Meeting to convene an ad hoc meeting of a Working Group to discuss a number of topics related to the Norway pout box problem. The terms of reference given to the Group were:

"to make a quantitative assessment of:

1. The effect on the yield of the industrial fishery and of the human consumption fishery on the assumption that a Norway pout Box is closed to the industrial fishery for the following areas and time periods indicated below:

1a) Areas

Box 1 is delimited to the west: 4°W longitude and United Kingdom coasts to the east: 0° longitude

Box 2 is delimited to the west: 4°W longitude and United Kingdom coasts to the east: 1°E longitude

Box 3 is delimited to the west: 4°W longitude and United Kingdom coasts to the east: 2°E longitude

in all cases between 56°N and 60°N latitude.

1b) Time Periods relating to areas

Case 1: no closure of the boxes in winter and summer.

Case 2: Box 1 closed in winter, opened in summer.

Case 3: Box 1 closed in winter and summer.

Case 4: Box 2 closed in winter and opened in summer.

Case 5: Box 2 closed in winter and Box 1 closed in summer.

Case 6: Box 2 closed in winter and summer.

Case 7: Box 3 closed in winter and opened in summer.

Case 8: Box 3 closed in winter and Box 2 closed in summer.

Case 9: Box 3 closed in winter and Box 1 closed in summer.

Case 10: Box 3 closed in winter and summer.

Explanation: winter = 1 October to 31 March
summer = 1 April to 30 September.

2. Possible effects of redistribution of fishing effort by the industrial fishery on the basis of the assumption stated in point A.1. In particular an assessment of the effects of an increase in effort outside a Norway pout box

   a) within the North Sea

   b) within EEC waters outside the North Sea

   c) within 3rd country waters.

3. The possibility of regulating fishing mortality on the Norway pout in such a way that adverse effects to the haddock and whiting stocks are significantly reduced. In particular with regard to gears selective for Norway pout, TAC regulation for Norway pout, by-catch limitations.

4. The effect on the haddock and whiting stocks of discarding in the human consumption fishery in comparison to the effect of industrial fishery on these stocks.

5. The effects on the haddock and whiting stocks of

   a) the allocation of quotas in 1978 as compared to 1977.

   b) the reduction in the permissible by-catch in the industrial fishery from 25% in 1977 10% in 1978.

   c) the closure of Norway pout boxes in previous years.

   d) the proposed increase in mesh size to 80 mm in the human consumption fisheries.

6. The effects of the industrial fishery on stocks exploited for human consumption other than haddock and whiting."

1.3 Background

A previous *ad hoc* meeting of the "Working Group on the Norway Pout Box" was held in August 1977. In the report of that meeting, the basic problem was summarised by the following statements:

> "there is no doubt that in general the human consumption fisheries would profit considerably from reduced by-catches in the industrial fisheries. .... the industrial fisheries represent, however, also an important and valuable resource usage, and in attempting to reduce the losses, one must also consider the effects of the relevant conservation measures on these fisheries."

The Working Group considered the predicted long-term gains and losses to these fisheries resulting from various area and time closures of the Norway pout fishery. The assessments carried out suggested that elimination of by-catches in the Norway pout fisheries would result in increases in yield in the human consumption fisheries which depended in a rather complex way on the extent and duration of the closures. It was stressed that this conclusion depended on the assumption of no redistribution of effort and that the predicted increases were therefore a direct result of a reduction of fishing mortality on young haddock and whiting. In addition, it was pointed out that any such increases would be at the expense of losses in yield in the industrial fisheries.

The purpose of the present meeting of the Working Group was to re-assess the likely effect on yields and stocks under several alternative patterns of closure taking into account likely redistribution of effort. The remit of the Group was also widened to consider other types of regulation on both the industrial and the human consumption fisheries with a view to identifying the most effective means of reducing fishing mortality on immature protected species.

2. BACKGROUND FISHERY INFORMATION

2.1 The Industrial Fishery for Norway Pout

Information on the distribution, biology and fishery for Norway pout in the North-East Atlantic was summarised by the Liaison Committee of ICES in Cooperative Research Report, No. 74 (1978). The brief summary below is largely taken from this report.

Basic biology and distribution

The Norway pout is a small gadoid which lives typically within a few metres of the sea-bed. Its distribution shown in Figure 2.1.1 is centered between depths of 100 and 250 m. The largest population occurs in the northern North Sea, but there are other populations in adjacent areas.

The spawning season of Norway pout in the North Sea is March-April, and the young recruit to the population on the sea-bed during the late summer. The fish first spawn at an age of 1 or 2 years and in the North Sea the normal maximum age is 4. The yield from the fishery is almost entirely composed of two age classes and annual catches are consequently very dependent on annual recruitment.

The fishery

Fishing for Norway pout in the northern North Sea using light high headline demersal trawl began in the late 1950s. Landings have since shown an increasing trend, culminating in a maximum catch of 736 000 tons in 1974. The main landings are made by vessels from Denmark, Norway, Faroes and, to a lesser extent, the United Kingdom (Scotland). The catches are mainly used for reduction to meal and oil. The distribution of the catches in the years 1972-77 inclusive is shown in Appendix 1.

As a result of the rapid increase in catches of Norway pout, ICES in 1977 set up the Working Group on Norway Pout and Sandeels in the North Sea, one aim of which was to make an assessment of the state of the Norway pout stock in the North Sea. At its meetings in both 1977 and 1978 the ICES Advisory Committee on Fishery Management found, on the basis of the reports of this Working Group, no clear need for any regulations on the exploitation of Norway pout.

As indicated in Figure 2.1.1, the distribution of Norway pout extends into other areas of the North-East Atlantic. There is a small fishery in Division VIa (the North Minch) by United Kingdom vessels, which began in 1971, and a fishery by Denmark and Faroes in the area south of the Outer Hebrides in the latter part of 1978. There is also a mixed fishery for Norway pout and blue whiting at Iceland.

By-catch

As in all trawl fisheries, the gear used in the Norway pout fishery is not able to select Norway pout and a variable proportion of other species of fish occur in the catches. Indeed in some areas the Norway pout fishery merges into industrial fisheries predominantly for other species. In the northeastern North Sea along the edge of the Norwegian Deeps, for example, catches contain a high proportion of immature blue whiting, this proportion increasing with depth of haul. In the central North Sea the industrial fishery is largely based on sprats; in shallower sandy areas of the North Sea there is an industrial fishery for sandeels, but there is little overlap in the distribution of this fishery and that for Norway pout, and indeed rather different gears are used. Other non-protected species occurring regularly, but usually in small proportions in the catches of Norway pout in the northern North Sea, are long rough dab, gurnards and silver smelts.

In addition to these other NEAFC Recommendation 2 species, the by-catch contains a proportion of protected species, that is species which can legally be caught only using large mesh nets and which have a minimum landing size. These can be divided into fish above and below the legal size. A proportion of the industrial fishing vessels pick the larger fish out of the catch and offer them for sale on human consumption markets. In general, however, the protected species of all sizes are left in the catch and form part of the industrial landing.

The only data available on that part of the by-catch extracted for the human consumption market are the Scottish data in Table 2.1. These data show that in some years a considerable part of the by-catch was extracted for human consumption markets. It is important to note, however, that the extent to which this occurs may differ markedly between individual fishing fleets.

The history of the Norway pout box

The United Kingdom Government first ratified a statutory instrument setting up an area closure of the Norway pout fishery in February 1977. The subsequent events are shown in the text table below and in Figure 2.1.2.

Dates	Extent of Box			
	Northern boundary	Eastern boundary	Southern boundary	Western boundary
21 Feb-31 Mar 77	60°N	0°	56°N	4°W
1 Apr-31 Aug 77		No closure		
1 Sep-15 Oct 77	60°N	0°	56°N	4°W
16 Oct 77-30 Sep 78	60°N	0°	56°N	3°W
1 Oct 78-present	60°N	2°E median line	56°N	3°W

2.2 Roundfish Fishery

Table 2.2 summarises the average landings by countries for the period 1973-77. The number of countries reporting roundfish catches gives an indication of the heterogeneity of the fisheries. In actual fact, the situation is still far more complicated because within individual countries a large number of different gears are in use (otter trawl, pair trawl, seine, gill nets, beam trawl, etc.). Some fisheries may be directed primarily to one species or another, but essentially they represent mixed fisheries, in which ever changing proportions of groundfish, including both roundfish and flatfish, are caught.

In Figure 2.2 is shown an index of total hours fishing summed for a variety of vessels by statistical rectangles for the United Kingdom (average 1969 to 1972) and the Netherlands (1972 to 1973) (see Doc. C.M.1975/F:5). This might be interpreted as an index of the chance of observing a fishing vessel of those countries in a particular square. Obviously, the chart is incomplete. Danish and the Federal Republic of Germany fisheries concentrate in the eastern North Sea, French and Belgian fisheries in the southern part. In general, the conclusion seems justified that the roundfish fisheries cover the entire North Sea. However, there are differences for the individual species: haddock and saithe are caught in the northern part of the North Sea, whereas the main cod fisheries are in the southern part.

In recent years, more than 50% of the whiting and 15% of the haddock were caught in the industrial fisheries. In addition an estimated 40% of the total whiting catch and 20% of the total haddock catch taken in the human consumption fisheries were discarded. The major proportion of these discards represented fish above minimum legal landing size.

This indicates that for the smallest market category of these species the market demand is limited. Therefore management measures, which result in a higher biomass of small fish, but which do not significantly change the abundance of larger fish, do not necessarily improve the economic yields of the stock. They may just result in higher discard rates.

In addition, conservation measures like TACs, which are aimed at limiting the fishing mortality, do not necessarily have that effect because few fisheries are primarily directed to these two species. When a TAC for one species in a mixed catch would be reached, the fishery would continue at a higher discard rate of that species.

For these reasons, the ICES Roundfish Working Group concluded (see Doc. C.M.1978/G:7) that TAC regulations are unlikely to have any measurable effect and to improve the yield of these stocks, unless some means, such as an increase in minimum mesh size, are found for greatly reducing the rates of discarding.

2.3 General Comments on the Effects of Box Closures in the Industrial Fishery

The effect on the industrial fisheries can only be fully assessed if the economic aspects are taken into consideration. This is outside the scope and expertise of the present Working Group which can only review the likely loss in catch due to box closures and the possible alternatives for the fishery.

The problems are somewhat different for the national fleets involved in the Norway pout fishery:

United Kingdom. Only about 20-30 vessels are taking part in the fishery and none of them are full-time engaged in industrial fisheries. In periods of Box closures their effort has partly been redistributed in Area 4 (for description of the Areas, see Section 4.1 and Figure 4.1), and partly directed onto fishing for Nephrops, sandeels and groundfish.

Norway. The Norwegian industrial fishery is mainly taking place in the northeastern part of the North Sea, and the major part of the catches of Norway pout are taken at the edge of the Norwegian Deeps together with blue whiting. It appears that Box closures even extending to 2°E longitude will not create serious problems.

The Faroes. In 1975-76 about 32 Faroese vessels were engaged in the Norway pout fisheries in the North Sea. In 1977 and 1978 respectively only 25 and 17 vessels have conducted this fishery as a result of the Box closure in those years. Their effort has mainly been redistributed in Areas 4 and 5A and southwest of the Hebrides, i.e. outside the North Sea area. The remaining vessels have taken up fishing for human consumption in their home waters and have thereby created rather severe problems for a major part of the Faroese fishing fleet due to the added fishing pressure on the restrictive catch quotas in force.

Denmark. The Danish industrial fleet is apt to suffer severe losses from an extensive closure in area and/or time. For a part of the fleet (approximately 240 vessels) the outcome is based upon fishing for Norway pout in autumn and winter and for sandeels during spring and summer. The smaller vessels concentrate in Areas 5B and 6 fishing for sprat in winter and for sandeels in summer.

2.4 Potentials for Redistribution of Effort from the Present Norway Pout Area

In case of a closure of Box 1 a major part of the effort in this area can be distributed in adjacent areas (2, 3, and 4). If Boxes 2 or 3 are closed the possible areas of redistribution become very restricted:

Area 4 is an area where the fishing grounds are restricted by the continental slope and by the shallow depth around the Shetlands. It is highly unlikely that this area can support anything like the effort hitherto exerted in Areas 1, 2, and 3. Any significant increase in fishing intensity may reduce the present high catch rates apparent in Table 4.6 to a level at which the fishery becomes unattractive.

Area 5A could be a potential area of redistribution for some of the effort. This possibility depends, however, entirely on the amount of Norway pout which Norway will allot the EEC-countries, Area 5A being essentially within Norwegian jurisdiction.

Areas 5B and 6 are not able to absorb any further effort. The sandeel fishery is already exploited by the same vessels which are engaged in the Norway pout fishery,and the sprat fishery is subject to quota regulations which necessitate a reduction of effort and certainly leave no room for increases.

Alternative fisheries

A conversion of the effort exerted in the Norway pout fishery, i.e. an industrial effort, into fisheries for human consumption is not possible in case of any of the major consumption species. In the North Sea these species are all subject to very restrictive quotas which again necessitate a decrease of effort rather than the opposite. Outside the North Sea the only major fish stocks which may be able to support additional effort are the Western mackerel stock, the horse mackerel and blue whiting. As alternatives to a Norway pout fishery in winter the value of these species is restricted by the long voyage and weather conditions. This will only allow the biggest vessels to participate, or perhaps 10% of the number deployed in the Norway pout fishery.

3. PRINCIPLES OF FISHERY MANAGEMENT RELATIVE TO MIXED INDUSTRIAL FISHERIES

3.1 General

The industrial fishery which is exploiting the Norway pout also catches juvenile components of haddock and whiting stocks of the North Sea. The NEAFC Recommendation 1 fisheries catch a significant amount of juvenile haddock and whiting which are discarded. The mortality of juveniles reduces the yield to the consumption fisheries.

A strategy to resolve this competitive situation may be either to direct each fishery towards different resources or to solve the optimality problem of finding the rational exploitation pattern taking all fisheries into account.

The problem is,therefore, that there may be losses if there are to be gains in the yield of consumption fisheries. The present report attempts to evaluate the gains and losses for the various regulatory measures proposed.

Restricting the industrial fishery may affect the overall mortality generated on the haddock and whiting stocks. The fisheries for human consumption will gain by such a measure.

A regulatory measure may affect the exploitation pattern in the industrial fishery. For example, if it were possible to completely avoid catching, say, 0-group haddock in the industrial fishery, this would result in a gain for haddock and whiting roughly equivalent to that obtainable by a reduction of 30% in the industrial fishery.

The effect of reducing fishing mortality generated by the industrial fishery on the juvenile components of the haddock and whiting stocks may be achieved by simultaneously applying several different regulatory measures. Closed area, quota and by-catch regulations are in effect in the North Sea at present. The various regulatory measures, however, affect the industrial fishery very differently. While the closed area (Norway pout Box) may cause a general decline in the fleet, by-catch regulations and quotas may not produce such a decline if the fishery has a wider range of possible adjustments to the changed situation. The loss to the industrial fishery corresponding to the gain to the fisheries for human consumption can therefore only be worked out for each regulatory measure separetely and the same gain to the human consumption fisheries can be obtained at widely different losses to the industrial fishery.

The proposed regulatory measures to achieve a gain to the fisheries for human consumption fall into three categories: closed areas (Norway pout Box), quotas and by-catch regulations and an increase in the minimum trawl mesh size applicable to the fisheries for human consumption.

3.2 Norway Pout Box

The objective of closing an area is to protect a component of the stock, in this case the juvenile component. This should achieve a change in the relative exploitation pattern which the industrial fishery is generating on the haddock and whiting stocks provided that the distribution of haddock, whiting and Norway pout stocks and their migratory behaviour is such that the proportion of the haddock and whiting stocks under exploitation will be effectively reduced.

The detrimental effects to the industrial fleet will be caused by redistribution of effort, the changed catch rate realized and the possibility of the fleet not being able to operate at all due to too low catch rates for economic survival.

3.3 Catch Quotas and By-Catch Limitations

These measures will limit the catches of protected species in the small-meshed fisheries, provided they are effectively enforced. The North Sea catch quotas of haddock and whiting alone will not necessarily restrict the industrial landings as the pay-off between industrial fishery and fishery for human consumption still has to be resolved at a national level. Combined with a catch quota on the Norway pout and a by-catch restriction, an upper bound on the catches of haddock and whiting taken in the industrial fishery might result. The effect of by-catch regulations will vary from year to year depending on the relative strength of year classes of the stocks involved.

The detrimental effects to the industrial fleet will be dependent on whether it is possible to fish with a profit under the regulations introduced.

3.4 Mesh Size Changes

Significant amounts of haddock and whiting are discarded at present. An increase in the minimum mesh size in the NEAFC Recommendation 1 fisheries will cause an immediate loss followed by a long-term gain to these fisheries.

The industrial fleet will not be adversely affected.

4. EVALUATION OF PROPOSED MANAGEMENT MEASURES

4.1 Description of Basic Available Data

Area division

National data were arranged by quarters of the year, and by the areas of the North Sea shown in Figure 4.1. Combinations of Areas 1-3 correspond to the so-called Norway pout Boxes, which have either been contemplated (see Section 1.2) or are actually in force as closed areas (see text table on p. 5) for various periods of time.

The correspondence between the Areas and the closure options is also shown on the chart in Figure 4.1 (Box 1 = Area 1, Box 2 = Areas 1+2, Box 3 = Areas 1+2+3). Area 4 is the northernmost part of the EEC-zone, while Area 5A roughly speaking comprises that part of the Norwegian fishing zone which is pertinent to the Norway pout fisheries.

The industrial fisheries in Areas 5B and 6 are almost exclusively based on sandeels and sprat.

Catch statistics

Table 4.1 shows the total catch in the industrial fisheries in 1975-78 of all species except sandeels. Tables 4.2-4.5 show the by-catch of haddock and whiting contained in the total catch figures. In case of the Faroese data no estimate of by-catch species was available and was, therefore, made by applying Danish by-catch percentages for each Area, respectively. The detailed country statistics upon which these tables are based are given in Appendix 2.

Effort and catch rate data

From Danish data on catch and effort in 1976, 1977 and the first two quarters of 1978 catch rates by Areas and quarters were calculated as shown in Table 4.6. The data comprise all catches by industrial bottom trawls except sandeel gears. By dividing the total catches in Table 4.1 by the respective catch rates in the Danish fishery, estimates of total effort were derived at and are shown in Table 4.7.

4.2 Description of Simulation of Box Closures and Evaluation of Yield per Recruit

The Working Group considered possible models to evaluate the effect of area closure of the industrial fishery. While spatial models can be developed along the lines presented in the previous (1977) Working Group report, it was impossible to obtain estimates of the exchange of fish between areas. It was then decided that a simulation based on 1976 data could be used to calculate what might have happened had various management measures been undertaken in that year. This year was selected because it was the only year for which Area catch per unit effort values were available that were not affected by regulations. The effect on the industrial fishery was evaluated by the change in catch in that fishery. The long-term effect on the consumption fishery was evaluated by estimating the change in fishing mortality rate into a yield per recruit model.

The various combinations of closed Areas suggested by the EEC were examined in the following manner: the effort (Table 4.7) based on the Danish catch/effort statistics in the closed Area and time was redistributed in adjacent areas in a manner judged likely by the Working Group. The expected catch of industrial fish was then calculated by multiplying the re-allocated effort in the new Area by the corresponding catch per unit effort for each quarter and Area (Table 4.6) and substituting the new value for that actually taken in 1976 by these displaced effort units. The expected catches of haddock and whiting were computed by multiplying the new expected industrial catch of the redistributed effort by the corresponding 1976 by-catch ratios (Tables 4.4-4.5). The values for haddock and whiting were then used to adjust the F values on these species for the industrial fishery in the yield per recruit analyses as described in Appendix 3.

The options listed below with the assumption as to distribution of effort were examined by the Working Group (winter refers to the period from October to March and summer from April to September).

1) No restriction as to area fished. Effort as occurred in 1976.

2) Closure of Box 1 in winter. Redistribution of the effort to Areas 2 and 4 in proportion to the 1976 ratio of the effort between 2 and 4.

3) Closure of Box 1 in summer and winter. Redistribution of the effort to Areas 2 and 4 in proportion to the 1976 ratio of the effort between 2 and 4.

   The above redistribution of effort was based on the general impression of the 1977 closure.

4) Closure of Box 2 in winter. Redistribution of one half of the effort in the closed period to Areas 3 and 4. The withdrawing of one half of the effort was based on the present situation in the Danish fleet under the 1978 closure. It was thought likely by the Working Group that the effort withdrawn from the fishery during the winter would stay withdrawn from the fishery the remainder of the year, in effect being the same as a complete closure which is Option 6.

5) Closure of Box 2 in winter and Box 1 in summer. This was assumed to result in a loss of one half of the winter effort for the entire year. The differential catch rates and by-catch in the areas were considered such that the catch would not be greatly different from that which would occur under Option 6, that of closing Box 2 the entire year.

6) Closure of Box 2 the entire year. One half of the effort from Box 2 was redistributed to Areas 3 and 4.

7) Box 3 closed in winter and open in summer. This was judged likely to have the same effect as Option 10, i.e. one half of the effort in Box 3 would drop out of the fishery. Therefore, it was decided to calculate only Option 10, i.e., 50% of this effort redistributed to Area 4. The difference in catch from allowing the summer effort to redistribute itself to Areas 2 as well as 4 was considered to be minimal. This is not to discount the possibility of differential costs of fishing, but that question is beyond the scope of the Working Group.

8) Box 3 closed in winter, Box 2 closed in summer. This was considered essentially equivalent to Option 10 as far as catches would be concerned.

9) Box 3 closed in winter and Box 1 in summer. This was considered essentially equivalent to Option 10 as far as catches would be concerned.

10) Closure of Box 3 in summer and winter. Redistribution of 50% of the effort to Area 4.

11) Reduction of effort equivalent to that used in Option 6 applied proportionately to the distribution of 1976 effort in Areas 1-4.

12) Reduction of effort equivalent to that used in Option 10 applied proportionately to the distribution of 1976 effort in Areas 1-4.

    The catches estimated by this simulation are given in Table 4.8.

It is realised that the redistributions of effort assumed in this report are only some of several possibilities that might actually occur. However, the Working Group decided that these were sufficient to evaluate the effect of area closures considering the available data.

The estimates of the catches of the redistributed effort assume the catch per unit effort in the area receiving the additional effort would not be reduced by the effect of the additional effort. This is, in effect, assuming that the additional effort would not reduce the abundance of the fish in that local area over time. This lack of reduction in abundance could occur by fish moving from the protected to the unprotected areas, but no estimates of the amount of movement could be made.

The relatively small amount of effort being redistributed from the closure of Box 1 would tend to mitigate the ability to measure any effect, particularly as the fishery depends on very few year classes. The re-direction of effort into Area 4 from the closure of Boxes 2 and 3 is more significant. There have been increases in catches in that Area in the period 1972 through 1976, and the 1976 catch/effort values were still higher than in Areas 1-3. However, there were reductions from 1976 to 1977 in Area 4. The extent that further effort could be placed on this Area without an effect on catch rates cannot be estimated, but it is unlikely that the present catch rate could be maintained.

4.3 Description of Input used in evaluating the Effect of Management Measures

Because no valid estimates can be obtained of transport coefficients between any system of Boxes, the Group decided that it was not possible to employ the model described in the Annex of the Norway Pout Box Working Group report of 1977, and to evaluate the long-term gains for haddock and whiting in the consumption fishery a yield per recruit approach was used. This model was also used to evaluate the effects of changes in mesh regulations in the consumption fishery. A detailed description of the model is presented in Appendix 3, with the exact input values used and the complete output for the various runs made.

This model regards Box closures simply as a means of preventing the industrial fishery catching as great a quantity of haddock and whiting as they would have caught in the absence of Box closures. The only way in which the Box effect as such is referred to by the model is in the input values of the proportion of the obtainable industrial catch of haddock and whiting which will be realised under each specified system of closure.

The model embodies a number of conceptual difficulties:

1) The model does not specify any assumptions about migration between Boxes and for this reason results obtained from a more realistic model might be expected to be considerably different to those obtained from the model used in this report, and on this basis the values of the expected gains to the consumption fishery should be treated with considerable caution.

2) It should also be remembered that these expected gains relate to an equilibrium population. In 1976, the whiting stock in particular was at a level much higher than that expected at equilibrium, mainly as a result of high recruitment in recent years. The output from the model indicates what gains might be realised if we start from a stock which is at equilibrium. In this context also, it should be remembered that any gain brought about by increasing the mesh size in the human consumption fishery implies a short-term loss in that fishery.

3) The model assumes the same proportional age distribution of haddock and whiting over the whole North Sea.

4) There is considerable uncertainty as to the value of the natural mortality rate for haddock and whiting, espceially during the first year of life. In the present case, however, the output of the model is relatively insensitive to such uncertainties, only small decreases in the estimated gains will result from very high values of mortality at age 0.

5) The model assumes that reduction of catch of haddock and whiting by the industrial fishery will result in a decrease in mortality rates of about the same percentage amount in all age groups exploited by the industrial fishery. If, for example, the real effect of a Box closure is to reduce mortality on the 0 group by a greater factor than on other age groups, then the results of the model will be altered. The effect, for example, of not changing the mortality rates on 1 year old and older fish and setting the mortality rate on 0 group fish to zero would be to decrease the expected long-term gains to consumption fishery by at most 15%.

6) The model predicts gains to the human consumption fishery, not concomitant changes as the result of losses to the industrial fishery.

Given the similarity of the results for haddock and whiting for the various options, only three runs were made: 1) Option 2, 2) the average of Options 4 and 6, and 3) Option 10.

4.4 Results of Simulation of Box Closures on the Industrial Fishery

Assuming that the actual result of a winter closure of Box 2 would be the same as a winter and summer closure, the essential effects on the industrial fishery are summarised in Table 4.9. Under a closure of Area 1 there would have been a direct loss of 69 000 tons, which would be compensated with a catch of 64 000 tons in adjacent areas resulting in an overall loss of 1%. The Working Group felt that the redirection of effort to the adjacent areas could likely compensate for the loss. A closure of Box 2 or 3 would have resulted in a direct loss of 327 000 tons and 365 000 tons, respectively. With half of the effort redirected, the corresponding compensated values would be only 177 000 tons and 218 000 tons. The higher catch when closing Box 3 is a result of the higher catch rates in Area 4, to which the effort would be diverted, compared with Area 3, which is the Area to which effort is assumed to be diverted in case of the Box 2 closure. The Working Group considered the difference in catches between these two options to be unlikely. Comparison of all options demonstrates that the effect on catches is in fact the result of effort reductions. It should be noted, however, that the actual compensations for catch from the redirected areas could well be less than calculated due to decreases in areal abundance from increased fishing effort.

4.5 Results of Simulation of Box Closures on Haddock and Whiting

The effects of the Box closure on long-term gains in haddock and whiting are presented in Table 4.9. The increase in long-term yield from a closure of Box 1 would be 3% for haddock and 7% for whiting. Such values, while potentially real, would be difficult to detect from observations on the fishery. With the closure of Box 2 the gains are 11% and 38% for haddock and whiting and with Box 3, 17% and 47%. The slightly higher by-catches in Area 3 than Area 4 result in the gains in yield per recruit being greater than the concomitant loss of effort in the industrial fishery.

However, when compared with the straight reductions in effort throughout all areas one finds that the gains in haddock and whiting yields are caused by the reduction in industrial effort resulting from the Box closures rather than a "Box" effect due to significantly differing by-catch ratios in the areas where effort could be redistributed to as compared with the entire fishing area.

5. EFFECTS ON THE HADDOCK AND WHITING STOCKS OF MESH SIZE INCREASES

5.1 Effects of the Proposed Increase in Mesh Size to 80 mm in the Human Consumption Fisheries

The options incorporated in the stock simulation model included the possibility of increases in mesh size in the human consumption fisheries to 80 mm and 90 mm as well as no change in mesh size from 75 mm now in use. Table 5.1 gives the results of the calculations in terms of the expected long-term percentage changes in yields of haddock and whiting in the industrial fisheries and in human consumption fisheries. The calculations made to obtain the results given in Table 5.1 assume that there will be no changes in the fisheries other than the indicated changes in mesh size in the human consumption fishery.

An increase of mesh size in the human consumption fishery to 80 mm will increase the long-term yields of haddock and whiting in both the industrial fishery and the human consumption fishery. For haddock the expected increases in landings are 6% and 7% for the industrial fishery and the human consumption fishery, respectively. For whiting, the corresponding increases are 17% and 10%. An increase in mesh size will also result in a reduction of the quantity of haddock and whiting discarded by the human consumption fishery. For an 80 mm mesh size, discards would be reduced by 10% for haddock and by 27% for whiting.

It will be noted that for whiting the percentage increases to the industrial fishery may cause difficulty in adhering to the by-catch regulations.

The increase to the industrial fishery is a consequence of the fact that industrial fishing mortality on whiting is greatest on age groups 2 and 3 while the greater part of discarding is of 1 and 2 group fish. Thus the benefits of the increased mesh size and reduced discarding accrue, in a large part, to the industrial fishery. For haddock, on the other hand, discarding is greatest on age groups 2 and 3 while the main industrial fishing mortality is on younger age groups.

5.2 Effects of Discarding in the Consumption Fisheries

From the results of the stock simulation model given in Table 5.1, it can be seen that under the 1976 fishing pattern situation, the discards of whiting would be expected to decrease by 65% and 33% for haddock if the mesh size was increased to 90 mm. Little of the potential gain would accrue to the consumption fishery in the case of whiting because of the relative patterns of exploitation by age group of the industrial and consumption fisheries. In contrast, a gain of 22% might be expected in haddock consumption fisheries and 18% in the industrial fishery.

The effects of reducing industrial effort while maintaining the present mesh size are illustrated in Table 5.2. It is seen that the simulation model indicates that any saving from the industrial catch would simply add to the present level of discards, to a great extent for whiting and less so for haddock.

6. EFFECTS OF REDUCING EFFORT IN THE INDUSTRIAL FISHERY

The effort reduction in the industrial fishery will result in a direct loss of yield to the processing industry while the NEAFC Recommendation 1 fisheries will gain. The result is given in the text table below:

Percentage long-term gains to the fisheries for human consumption relative to the equilibrium yield as a function of general decrease in the industrial fishery

	Total industrial landings				
	-20	-40	-60	-80	-100
Haddock	10	22	35	49	65
Whiting	25	58	100	156	228

7. EFFECTS ON THE HADDOCK AND WHITING STOCKS OF THE REDUCTION IN THE PERMISSIBLE BY-CATCH IN THE INDUSTRIAL FISHERY FROM 25% IN 1977 TO 10% IN 1978

The quantities and percentages of haddock and whiting by-catch in the landings of industrial (excluding sandeel) fisheries were as follows:

	Total industrial (all areas) Tons	Haddock		Whiting		Haddock + Whiting
		Tons	%	Tons	%	%
1977	689 071	15 862	2.3	50 611	7.3	9.7
1978 Quarters 1-3	473 206	7 958	1.7	37 150	7.9	9.5

There was no change in the percentage by-catch of haddock or whiting recorded in the first three quarters of 1978 compared with the whole of 1977. In both years the by-catch of haddock and whiting combined amounted to close to 10% of the total landings of the industrial fisheries.

The permissible by-catch levels relate not only to haddock and whiting but to the total by-catch of all protected species. If protected species other than haddock and whiting were present in the industrial fishery by-catches in 1978 to any significant extent,it is likely that the 10% by-catch level will have been exceeded in the overall average for the year. Saithe is an important component of industrial fisheries and the average annual by-catch in the period 1972-77 was 35 000 tons (ICES, Doc. C.M.1978/G:3). From 1977, saithe by-catches have been at a much lower level than in previous years. Consequently, overall by-catch levels in 1977 probably did not exceed 10%, and there was no change from this level in 1978. It is not at present possible to evaluate the effect of this by-catch regulation on the consumption fisheries because of lack of precise information on year class strength.

8. EFFECTS ON THE HADDOCK AND WHITING STOCKS OF THE CLOSURE OF NORWAY POUT BOXES IN EARLIER YEARS

During 1977 Norway pout Boxes were closed as follows:

21 Feb - 31 Mar	56°N - 60°N, 4°W - 0°
1 Sep - 15 Oct	56°N - 60°N, 4°W - 0°
16 Oct - 31 Dec	56°N - 60°N, 3°W - 0°

(See Figure 2.1.2).

The main effect of these closures would have been in the last quarter of the year when most of Area 1 was closed for the whole quarter of the year.

It is difficult to distinguish effects of the closure from stock fluctuations. However, it is clear (Tables 4.1-4.3) that catches of all species in Area 1 in the last quarter of 1977 were reduced to a very low level. However, it would appear from the text table below that the reduced industrial (all species) landings in 1977 compared with 1976 were in proportion to the reduction in estimated fishing effort. In 1977 the by-catches of haddock and whiting constituted a smaller proportion of the industrial landings than in 1976. However, for haddock the reduction in the last quarter of 1977 compared with the last quarter of 1976 was no different from the reduction from 1976 to 1977 in the first three quarters of each year and the reduced by-catch percentage of haddock cannot be shown to be associated with the closure of the Norway pout Box in the last quarter of 1977. For whiting the reduction in by-catch percentage in the last quarter of 1977 compared with the last quarter of 1976 is not as great as the reduction in the first three quarters of 1977 compared with the same period of 1976. It is not clear whether this is in any way attributable to the closure of the Norway pout Box.

	Total industrial (Areas 1-6)	Haddock		Whiting		Estimated effort hours
	Tons	Tons	%	Tons	%	
Quarters 1-3 1976	812 310	39 817	4.9	121 660	15.0	521 722
1977	483 448	13 753	2.8	37 387	7.7	350 514
RATIO 1977:1976	0.60	0.35		0.31		0.67
Quarter 4 1976	287 587	6 435	2.2	23 183	8.1	183 715
1977	205 587	2 109	1.0	13 224	6.4	129 019
RATIO 1977:1976	0.71	0.33		0.57		0.70

9. EFFECTS OF INDUSTRIAL FISHERY ON STOCKS EXPLOITED FOR HUMAN CONSUMPTION OTHER THAN HADDOCK AND WHITING

In earlier years substantial catches of saithe were taken in the industrial fisheries. Since saithe became a protected species the industrial by-catch of this species has been reduced to a low level.

10. POTENTIAL FOR USE OF GEARS SELECTIVE FOR NORWAY POUT

The Working Group was requested to consider the possibility of gear regulations for the industrial fishery which would reduce the by-catch. However, the Working Group did not have any knowledge of gear which would apply to this situation.

11. DISTRIBUTION OF NORWAY POUT, HADDOCK AND WHITING IN THE NORTHERN NORTH SEA

11.1 Distribution of Norway Pout, Haddock and Whiting in Research Vessel Cruises

11.1.1 International Young Herring Surveys

The most extensive series of independent estimates are those from the International Young Herring Surveys conducted in February/March each year. The data for the years 1975-78 have been examined in some detail. It has been said that Norway pout, and juvenile haddock and whiting are differentially distributed with respect to depth. From commercial fishery data on Norway pout and by-catches, it is not possible to examine this statement due to the rather general manner of reporting fishing positions.

For the area north of 56°N the location was plotted of every fishing position made by vessels engaged in the Young Herring Surveys in 1975-78. From the depths reported in the log sheets, depth contours were drawn at 20 m intervals. The area covered extended from 56° - 61°N and 3°W - 8°E. The research vessel catches were grouped by these 20 m depth intervals and related to day and night hauls. In 1975 very few night hauls were made as the surveys were mainly directed at herring. In later years in the northern North Sea more hauls were conducted at night aimed at juvenile haddock and whiting. In examining day and night variation, day has been defined as 1 hour after dawn to 1 hour before sunset; night is defined as 1 hour after sunset to 1 hour before dawn.

The mean catches by day and night for 1977 and 1978, for 1 and 2 group haddock and whiting and 1 and >1 group Norway pout are shown in Figure 11.1. As Norway pout was not aged in the 1976 data reports, this year could not be included. In view of the diurnal variation in catch it was decided to consider only the daylight hauls. Figure 11.2 shows the mean distribution of abundances by depth in the area north of 56°N for 1977 and 1978.

Because of the large differences between catches by USSR vessels and other countries fishing adjacent to one another in the same depths, the USSR data have been excluded from this analysis. Declining abundance indices for all ages of haddock and whiting occur in depths over 120 m, where the abundances of Norway pout are high. Peak abundances of 1 and 2 group haddock occur in depths of 80-120 m. 1 and 2 group whiting show a marked difference in distribution, the 1 group being most abundant in depths less than 90 m.

11.1.2 Norwegian acoustic survey (July/August 1978) for 0-group gadoids

Figure 11.3 shows the distribution of higher echo-integrator values recorded in a combined trawl and acoustic survey by the Norwegian research vessels "G. O. Sars" and "Johan Hjort" in July and August 1978, excluding those values attributable to blue whiting and Maurolicus. Most of the echo-recordings were found by trawling to stem from 0-group Norway pout with a proportion of 0 group haddock. The contribution from other species and from 1+ group Norway pout and haddock was negligible. During the daytime most of the 0 group Norway pout and some of the 0 group haddock were distributed close to the bottom. At night all the 0 group gadoids were found in the upper 40 m. As shown in the Figure, the major concentrations of 0 group Norway pout and haddock combined were enclosed by the 120 m depth contour.

11.1.3 Netherlands trawl survey, September 1978, and the International Young Gadoid Survey

During September 1978 a bottom trawl survey was made in daylight in the area between 2°W and 3°E between 57°30'N and 61°N. Catches were made of 0 and 1 group Norway pout, haddock and whiting. The results indicate that the 0 group Norway pout mainly occurs in the area east of the 120 m contour. In contrast, higher abundances of 1 group Norway pout occur in the areas deeper than 120 m.

The Dutch results are in good agreement with the distribution of 0 group Norway pout as given by the International Young Gadoid Survey conducted each year in June/July. The average abundance for 1974-77 are shown in Figure 11.4. These surveys are made using a fine-meshed mid-water trawl fished obliquely. The 0 group gadoids are taken in their pelagic phase before descending to the bottom.

11.1.4 Summary

From this review of the distribution of Norway pout, a general description of the area of distribution of a year class emerges. Spawning takes place in March/April, the 0 group are first taken in the Young Gadoid Survey as post-larvae as indicated in Figure 11.4. The Norwegian results in June-July by both bottom and mid-water trawls indicate a spread westwards into deeper water.

The Dutch survey in September indicates that young 1 group Norway pout have already reached the deeper waters and considerable catches of late 0 group are taken on the bottom. The same 0 group is not observed in the International Young Herring Surveys occurring in the deep water in depths below 120 m in February/March the following year.

11.2 Area of Peak Commercial Catches

Figure 11.5 presents the total catches of Norway pout by statistical rectangles summed over the years 1972-76 in relation to depth zones. The highest catches have been reported from rectangles which are hit by the 140 m depth contour.

11.3 Relative Abundance of Haddock and Whiting in the Peak Area

The differences in distribution of Norway pout and juvenile haddock and whiting in terms of depth are pertinent to the question of a rational exploitation of the Norway pout resources with minimal interference with the roundfish stocks.

By definition, the areas of main concentration of Norway pout have to be accessible in order to maintain a viable fishery. Therefore, the deep water zone has been split in 3 main compartments (see Figure 11.5). In the years 1972-76 altogether 78% of the Norway pout catches were taken in these 3 compartments, 53% in A, 7% in B and 18% in C. As a guideline for further management decisions, the potential interference of an industrial fishery in these areas with the juvenile roundfish has been assessed, using the long-term average abundance indices by rectangles from the annual Young Herring Surveys in February (Anon., 1977). The results are presented in Table 11.1 as proportions of the total year classes which are in these areas. The figures suggest that only minor proportions of the haddock and whiting year classes are available in the deep water zone, and consequently the potential impact of an industrial fishery in that area on year class strength is limited by those percentages.

This conclusion applies essentially to the winter situation, because the surveys were carried out in February. However, the summer observations that are available do not indicate that the situation is essentially different in other seasons, except for a more easterly and widespread distribution of the 0 group Norway pout.

11.4 Potential for a Norway Pout Fishing Area which would reduce By-Catch in the EEC Zone of the Northern North Sea

In the area north of 56°N there are two sets of evidence for the potential of fishing for Norway pout minimising the catch of other species, particularly whiting and haddock. Results from research surveys indicate that there are depth zone separations between these species and Norway pout. This is true to a greater extent with young whiting than with haddock. The fishery statistics indicate that the statistical squares with the greater industrial catches are also those in the deep water contrasting with the distribution of effort in the consumption fisheries (Figures 11.5 and 2.2). Examination of the plots of the distribution of Norway pout catches (see Figure 2.2) indicates that these peak areas for the industrial fishery are the areas of Norway pout concentration. These distributional data hold out the hope that an area could be found where an industrial fishery could concentrate on Norway pout while minimising the by-catch by containing itself within an area as close as feasible to depths greater than the 130 m contour.

Table 2.1. By-catch of haddock and whiting (in tons). Scottish industrial trawl landings sold on human consumption markets, compared with estimated by-catch remaining in the industrial part of the catch.

Year	Haddock		Whiting	
	Extracted for human consumption	Industr. landing	Extracted for human consumption	Industr. landing
1975	437	2 327	1 393	1 063
1976	517	482	1 601	245
1977	120	17	360	93
1978 (Jan-Oct)	39	43	227	14

Table 2.2. Average annual landings of cod, haddock, whiting and saithe (1973-1977).

Country	Cod 1)	Haddock 1)	Whiting 1)	Saithe 2)
Belgium	9 380	1 982	3 138	70
Denmark	48 118	31 451	81 769	41 431
Faroe Islands	537	420	922	435
France	8 956	5 155	19 485	31 919
German Dem.Rep.	158	20	5	4 777
Germany, Fed.Rep.of	19 967	3 537	404	23 247
Iceland	+	-	-	6
Ireland	44	15	2	-
Netherlands	24 987	2 289	11 266	9 453
Norway	2 739	3 345	3 225	21 904
Poland	2 547	1 736	570	22 643
Spain	50	62	62	133
Sweden	3 629	2 775	1 331	1 230
UK (Eng. & Wales)	40 540	14 658	5 418	4 800
UK (Scotland)	40 009	78 909	26 637	10 970
USSR	3 629	38 426	3 926	85 728
Total	205 290	184 780	158 160	258 746
Human consumption	197 562	153 881	64 589	221 873
Industrial landings	7 728 3)	30 899 4)	93 571 4)	36 873
Discards	?	34 000	43 000	?

1) Data from ICES C.M.1978/G:7.
2) Data from ICES C.M.1978/G:3.
3) Average catch in Recommendation 2 fisheries Denmark and Norway 1973 and 1974.
4) Average catch in Recommendation 2 fisheries Denmark and Norway 1973 and 1974 and Data 1975-1977 from Tables 4.2. and 4.3.

Table 4.1. Landings (tons) from North Sea industrial fisheries (all species except sandeels) and estimated quantities of Norway pout (tons) included in these landings.

Year	Quarter	Area 1	Area 2	Area 3	Area 4	Area 5A	Area 5B	Area 6	Total areas 1 - 5A	Total all areas	Norway pout
1975	I	34 006	27 665	8 092	16 304	44 243	4 676	143 043	130 310	278 029	
	II	9 344	16 305	3 978	13 188	122 173	5 819	23 458	164 988	194 265	
	III	31 140	101 738	17 688	17 914	78 465	57 086	139 555	246 945	443 586	
	IV	45 711	91 438	10 383	26 212	44 708	10 663	69 797	218 452	298 912	
	Total	120 201	237 146	40 141	73 618	289 589	78 244	375 853	760 695	1 214 792	559 700
1976	I	43 515	32 441	9 403	25 755	34 330	5 159	98 456	145 444	249 059	
	II	8 024	8 457	2 159	38 160	65 004	6 417	39 381	121 804	167 602	
	III	42 609	67 985	13 863	21 202	78 652	63 578	107 760	224 311	395 649	
	IV	53 154	70 754	12 457	15 986	20 266	23 756	91 214	172 617	287 587	
	Total	147 302	179 637	37 882	101 103	198 252	98 910	336 811	664 176	1 099 897	435 700
1977	I	26 196	22 205	14 500	25 616	36 655	4 507	63 370	125 172	193 049	
	II	10 870	671	148	5 181	35 307	4 064	20 179	52 177	76 420	
	III	36 721	39 931	4 597	12 542	44 983	16 244	58 961	138 744	213 979	
	IV	1 640	71 537	2 224	35 584	27 166	12 458	54 978	138 151	205 587	
	Total	75 427	134 344	21 469	78 923	144 111	37 273	197 488	454 274	689 035	387 400
1978	I	0	16 616	4 045	30 437	36 115	339	43 358	87 213	130 910	
	II	188	9 112	631	6 814	41 417	4 012	37 437	58 162	99 611	
	III	0	36 414	7 561	25 473	67 768	17 937	87 530	137 216	242 683	
	Total Jan-Sep	188	62 142	12 237	62 724	145 300	22 288	168 325	282 591	473 204	

Table 4.2. Quantities of haddock (tons) taken as by-catch in the North Sea industrial fisheries.

Year	Quarter	Area							Total areas 1 - 5A	Total all areas
		1	2	3	4	5A	5B	6		
1975	I	3 638	3 894	760	1 143	4 083	18	182	13 518	13 718
	II	1 550	2 186	620	1 202	2 954	160	183	8 512	8 855
	III	1 856	2 452	2 368	170	2 951	402	887	9 797	11 086
	IV	980	1 902	189	571	1 496	1 092	525	5 138	6 755
	Total	8 024	10 434	3 937	3 086	11 484	1 672	1 777	36 965	40 414
1976	I	8 372	5 660	1 667	3 105	1 030	1 117	2 409	19 834	23 360
	II	455	408	72	1 534	585	187	828	3 054	4 069
	III	964	1 679	310	548	1 669	5 563	1 655	5 170	12 388
	IV	1 952	2 550	568	518	181	449	217	5 769	6 435
	Total	11 743	10 297	2 617	5 705	3 465	7 316	5 109	33 827	46 252
1977	I	2 617	1 642	1 392	1 972	1 049	277	196	8 672	9 145
	II	948	1	3	135	161	96	131	1 248	1 475
	III	1 505	714	64	318	222	170	140	2 823	3 133
	IV	1	1 001	67	722	205	25	88	1 996	2 109
	Total	5 071	3 358	1 526	3 147	1 637	568	555	14 739	15 862
1978	I	0	1 103	152	653	719	13	101	2 627	2 741
	II	1	471	26	165	330	63	441	993	1 497
	III	0	1 105	486	1 593	457	73	6	3 641	3 720
	Total Jan-Sep	1	2 679	664	2 411	1 506	149	548	7 261	7 958

Table 4.3. Quantities of whiting (tons) taken as by-catch in the North Sea industrial fisheries.

Year	Quarter	Area 1	Area 2	Area 3	Area 4	Area 5A	Area 5B	Area 6	Total areas 1 - 5A	Total all areas
1975	I	6 375	5 773	1 444	2 003	7 389	28	1 948	22 984	24 960
	II	1 639	2 738	962	1 945	2 367	1 346	2 878	9 651	13 875
	III	444	3 001	107	438	341	1 471	6 417	4 331	12 219
	IV	8 721	13 164	2 197	3 699	465	1 093	3 199	28 246	32 538
	Total	17 179	24 676	4 710	8 085	10 562	3 938	14 442	65 212	83 592
1976	I	25 227	16 993	4 762	8 151	3 800	2 179	16 603	58 933	77 715
	II	1 847	1 035	382	4 290	1 036	852	14 534	8 590	23 976
	III	2 477	3 122	407	878	1 266	2 023	9 796	8 150	19 969
	IV	5 361	8 403	1 923	962	1 029	2 224	3 281	17 678	23 183
	Total	34 912	29 553	7 474	14 281	7 131	7 278	44 214	93 351	144 843
1977	I	3 603	2 378	1 779	2 557	3 016	519	3 255	13 333	17 107
	II	833	0	11	398	573	811	4 084	1 815	6 710
	III	2 627	827	95	183	1 004	2 326	6 508	4 736	13 570
	IV	120	3 942	128	2 768	246	2 288	3 732	7 204	13 224
	Total	7 183	7 147	2 013	5 906	4 839	5 944	17 579	27 088	50 611
1978	I	0	930	249	1 552	1 880	20	6 351	4 611	10 982
	II	2	265	0	313	676	1 268	8 099	1 256	10 623
	III	0	286	30	262	92	3 662	11 213	670	15 545
	Total Jan-Sep	2	1 481	279	2 127	2 648	4 950	25 663	6 537	37 150

Table 4.4. By-catches of haddock as percentages of total landings (all species except sandeels) from North Sea industrial fisheries.

Year	Quarter	Area 1	Area 2	Area 3	Area 4	Area 5A	Area 5B	Area 6	Total areas 1 - 5A	Total all areas
1975	I	10.7	14.1	9.4	7.0	9.2	0.4	0.0	10.4	4.9
	II	16.6	13.4	15.6	9.1	2.4	2.7	0.8	5.2	4.6
	III	6.0	2.4	13.4	0.9	3.8	0.7	0.6	4.0	2.5
	IV	2.1	2.1	1.8	2.2	3.3	10.2	0.8	2.4	2.3
		6.7	4.4	9.8	4.2	4.0	2.1	0.5	4.9	3.3
1976	I	19.2	17.4	17.7	12.1	3.0	21.7	2.4	13.6	9.4
	II	5.7	4.8	3.3	4.0	0.9	2.9	2.1	2.5	2.4
	III	2.3	2.5	2.2	2.6	2.1	8.7	1.5	2.3	3.1
	IV	3.7	3.6	4.6	3.2	0.9	1.9	0.2	3.3	2.2
		8.0	5.7	6.9	5.6	1.7	7.4	1.5	5.1	4.2
1977	I	10.0	7.4	9.6	7.7	2.9	6.1	0.3	6.9	4.7
	II	8.7	0.1	2.0	2.6	0.5	2.4	0.6	2.4	1.9
	III	4.1	1.8	1.4	2.5	0.5	1.0	0.2	2.0	1.5
	IV	0.0	1.4	3.0	2.0	0.8	0.2	0.2	1.4	1.0
		6.7	2.5	7.1	4.0	1.1	1.5	0.3	3.2	2.3
1978	I	-	6.6	3.8	2.1	2.0	3.8	0.2	3.0	2.1
	II	0.5	5.2	4.1	2.4	0.8	1.6	1.2	1.7	1.5
	III	-	3.0	6.4	6.3	0.7	0.4	0.0	2.7	1.5
	IV									
		0.5	4.3	5.4	3.8	1.0	0.7	0.3	2.6	1.7

Table 4.5. By-catches of whiting as percentages of total landings (all species except sandeels) from North Sea industrial fisheries.

Year	Quarter	Area 1	Area 2	Area 3	Area 4	Area 5A	Area 5B	Area 6	Total areas 1 - 5A	Total all areas
1975	I	18.7	20.9	17.8	12.3	16.7	0.6	1.4	17.6	9.0
	II	17.5	16.8	24.2	14.7	1.9	23.1	12.3	5.8	7.1
	III	1.4	2.9	0.6	2.4	0.4	2.6	4.6	1.8	2.8
	IV	19.1	14.4	21.2	14.1	1.0	10.3	4.6	12.9	10.9
		14.3	10.4	11.7	11.0	3.6	5.0	3.8	8.6	6.9
1976	I	57.9	52.4	50.6	31.6	11.1	42.2	16.9	40.5	31.2
	II	23.0	12.2	17.7	11.2	1.6	13.3	36.9	7.1	14.3
	III	5.8	4.6	2.9	4.1	1.6	3.2	9.1	3.6	5.0
	IV	10.3	11.9	15.4	6.0	5.1	9.4	3.6	10.2	8.1
		23.7	16.5	19.7	14.1	3.6	7.4	13.1	14.1	13.2
1977	I	13.8	10.7	12.3	9.9	8.2	11.5	5.1	10.7	8.9
	II	7.7	0.0	7.4	7.7	1.6	19.9	20.2	3.5	8.8
	III	7.2	2.1	2.1	1.5	2.2	14.3	11.0	3.4	6.3
	IV	7.3	5.5	5.8	7.8	0.9	18.4	6.8	5.2	6.4
		9.5	5.3	9.4	7.5	3.4	15.9	8.9	6.0	7.3
1978	I	-	5.6	6.2	4.4	4.6	5.9	14.6	5.3	8.4
	II	1.1	2.9	0.0	3.0	1.6	31.6	21.6	2.2	10.7
	III	-	0.8	0.4	1.0	0.1	20.4	12.8	0.5	6.4
	IV									
		1.1	2.4	2.3	3.4	1.8	22.2	15.2	2.3	7.9

Table 4.6. Average catch (all species) per hour trawling (tons) in Danish industrial fisheries (sandeel fisheries excluded).

Area / Quarter	1976				1977				1978	
	I	II	III	IV	I	II	III	IV	I	II
1	1 841	1 823	1 482	1 718	1 323	1 559	1 413	0	0	-
2	1 483	1 563	1 241	1 644	1 170	853	1 174	1 430	847	701
3	1 625	1 121	1 101	1 492	866	1 633	1 138	1 290	807	-
4	2 267	2 348	1 601	1 681	1 392	1 249	1 285	1 598	1 077	1 123
5A	1 394	1 615	1 468	1 274	1 280	2 049	1 853	1 346	1 036	1 730
5B	891	1 522	1 295	740	629	2 235	2 056	1 251	493	2 080
6	1 585	3 009	1 563	2 052	1 054	2 459	1 664	2 126	1 192	2 328

Table 4.7. Estimates of total hours trawling in industrial fisheries (excluding sandeel). (Based on Danish catch per unit effort data).

Area / Quarter	1976				1977				1978	
	I	II	III	IV	I	II	III	IV	I	II
1	23 637	4 402	28 751	30 357	19 800	6 972	25 988	?	0	?
2	21 875	5 411	54 782	43 038	18 979	787	34 013	50 026	19 617	12 999
3	5 786	1 926	12 591	8 349	16 744	91	4 040	1 724	5 012	?
4	11 361	16 252	13 243	9 510	18 402	4 148	9 760	22 268	28 261	6 068
5A	24 627	40 250	53 578	15 907	28 637	17 231	24 276	20 183	34 860	23 940
5B	5 790	4 216	49 095	32 103	7 165	1 818	7 901	9 958	688	1 929
6	62 117	13 088	68 944	44 451	60 123	8 206	35 433	25 860	36 374	16 081
Total	155 193	85 545	280 984	183 715	169 850	39 253	141 411	129 019	124 812	61 017

Table 4.8. Change in catches in the industrial fishery from simulation of options described in Section 4.2.

Option	Catch (all species) of industrial fishery in tons Areas 1 - 5A	% change from baseline	By-catch of whiting in tons All areas	% change from baseline	By-catch of haddock in tons All areas	% change from baseline
1) No closure	664 176	-	144 843	-	46 252	-
2) Closure Box 1, winter	659 007	-1%	137 558	-5%	43 913	-5%
3) Closure Box 1, all year	655 540	-1%	135 978	-6%	43 852	-5%
4) Closure Box 2, winter	569 361	-14%	111 903	-23%	36 592	-21%
6) Closure Box 2, all year	509 762	-23%	106 465	-26%	35 112	-24%
10) Closure Box 3, all year	516 927	-22%	100 056	-31%	33 380	-28%
11) Reduction of effort equivalent to closure of Box 2 all year	464 923	-30%	116 837	-19%	36 103	-22%
12) Reduction of effort equivalent to closure of Box 3 all year	438 856	-34%	113 103	-22%	34 953	-24%

Table 4.9. Results of simulation study of industrial fishery with 1976 as baseline.

Option	Direct loss to industrial fishery in tons (% of total)	Compensation tons (% of total) (Area)	Total loss in industrial fishery in tons (% of total) Areas 1 - 5A (baseline = 664 000 t)	Percent reduction in industrial fishery effort Areas 1 - 5A	In equilibrium situation, current mesh size	
					Haddock long-term % gain in yield per recruit	Whiting long-term % gain in yield per recruit
Closure Box 1 in winter	69 000 (10%)	64 000 (10%) (all effort into Areas 2 + 4)	5 000 -1%	0%	3%	7%
Closure Box 2 all year	327 000 (49%)	177 000 (27%) (½ effort into Areas 3 + 4)	150 000 -23%	-25%	11%	38%
Closure Box 3 all year	365 000 (55%)	218 000 (33%) (½ effort into Area 4)	147 000 -22% direct from above due to higher catch in Area 4	-28%	17%	47%
Reduction of effort in the industrial fishery by 30%	200 000 (30%)	-	200 000 -30%	-30%	20%	50%

Table 5.1. Long-term percentage changes of haddock and whiting in the North Sea fisheries as estimated by the stock simulation model for mesh sizes in the human consumption fisheries of 80 and 90 mm relative to the 75 mm mesh size.

Mesh size (mm)	Fishery	Haddock % change	Whiting % change
80	Industrial	+6	+17
	Human consumption landings	+7	+10
	Human consumption discards	-10	-27
90	Industrial	+18	+43
	Human consumption landings	+22	+19
	Human consumption discards	-33	-65

Table 5.2. Expected changes in by-catch and discard levels at current exploitation pattern (75 mm mesh) from effort reductions.

Effort reduction equivalent to Box closure	Whiting		Haddock	
	Percentage change in:			
	By-catch	Discards	By-catch	Discards
1	-5	+4	0	+2
2	-25	+19	-20	+8
3	-30	+23	-30	+12

Table 11.1. Percentage abundance of age groups I and II of haddock, whiting and Norway pout in deep water areas A, B and C (cf. Figure 13) according to the long-term average abundance indices per statistical square from Young Herring Surveys (Anon., 1977).

Species / Area	A	B	C	Total
Haddock I-group	13.0	7.9	3.2	24.1
II-group	6.0	5.1	1.4	12.5
Whiting I-group	1.3	0.2	0.4	1.9
II-group	9.3	1.3	0.9	11.5
Norway pout I-group	23.1	10.8	22.6	56.5
II-group	40.2	29.3	6.7	76.2

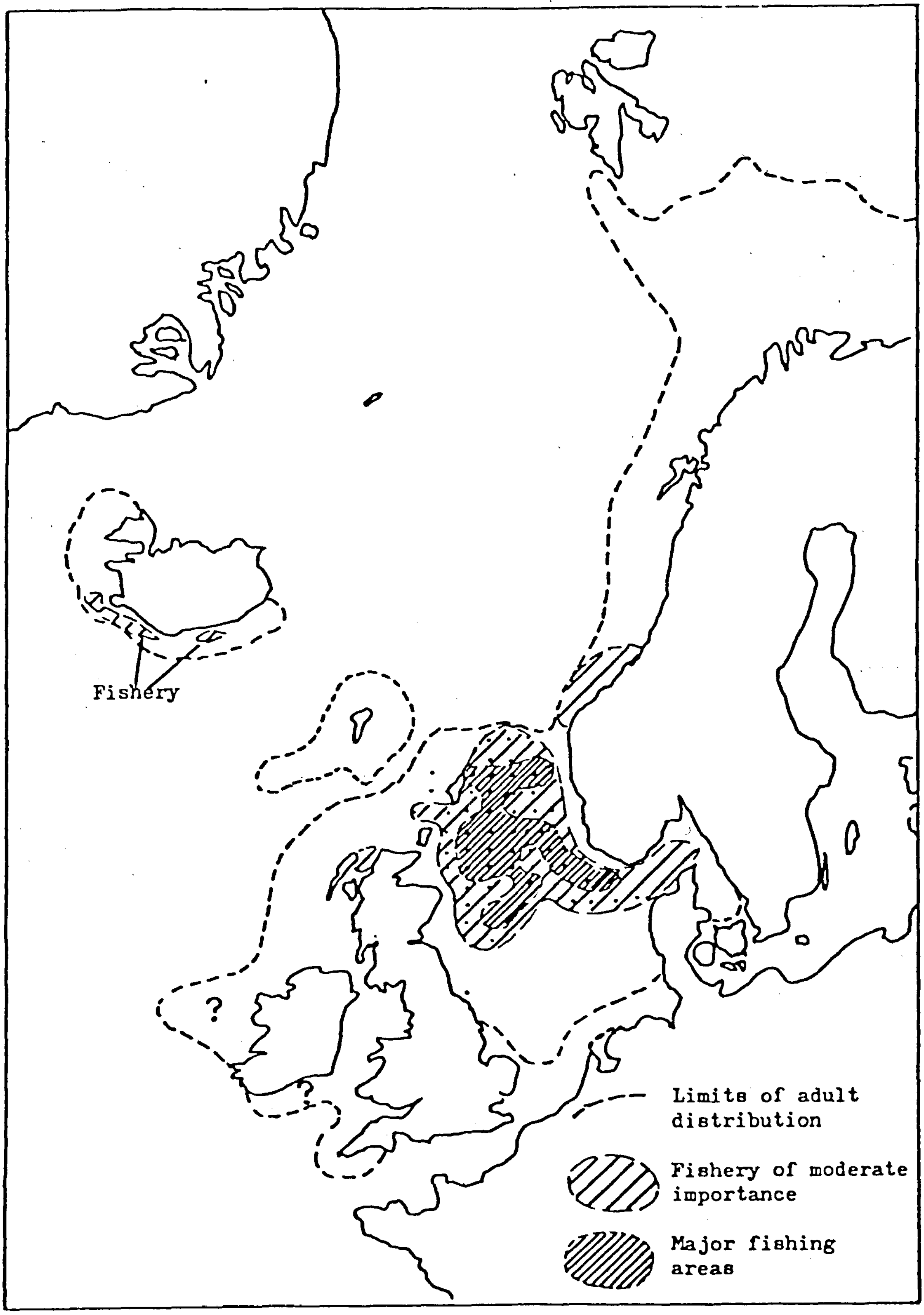


Figure 2.1.1 The distribution of adult Norway pout and known fishing areas.
Source: data supplied by national laboratories Coop.Res.Rep., No.74 (1978).

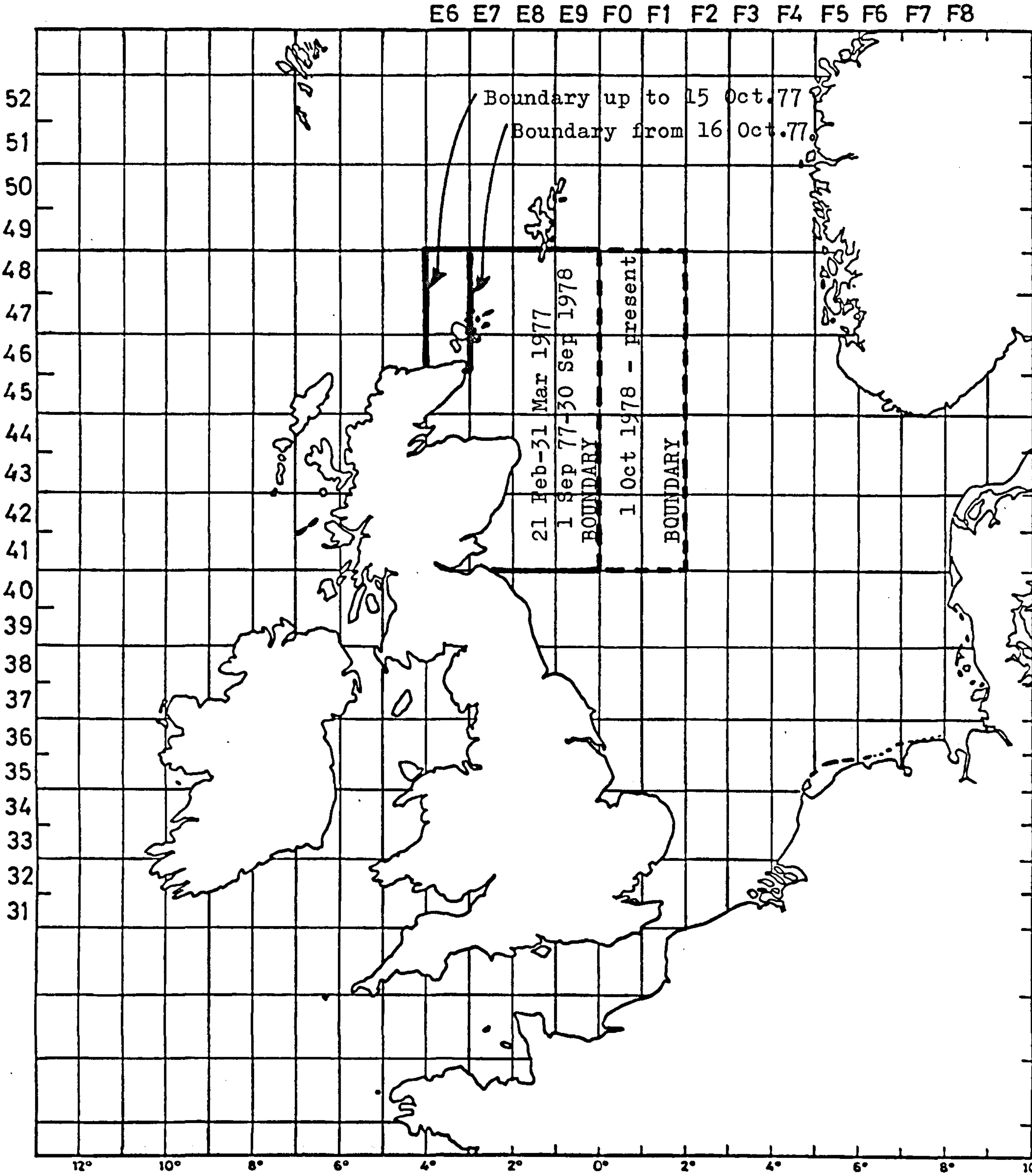


Figure 2.1.2 Extent of area closures of the Norway pout Box, 1977-79.

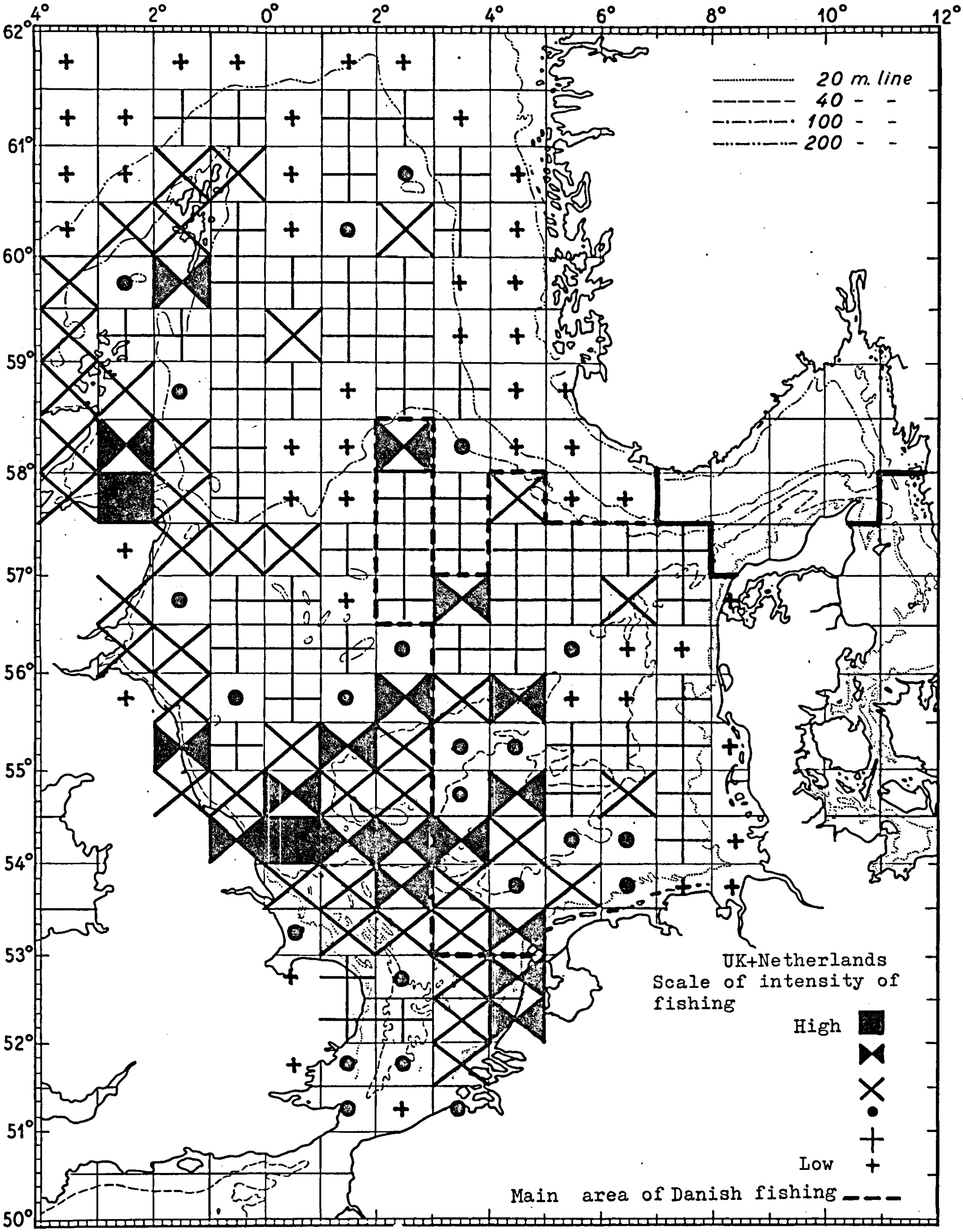


Figure 2.2 Distribution of fishing effort by United Kingdom, Netherlands and Danish vessels fishing for demersal species for human consumption.

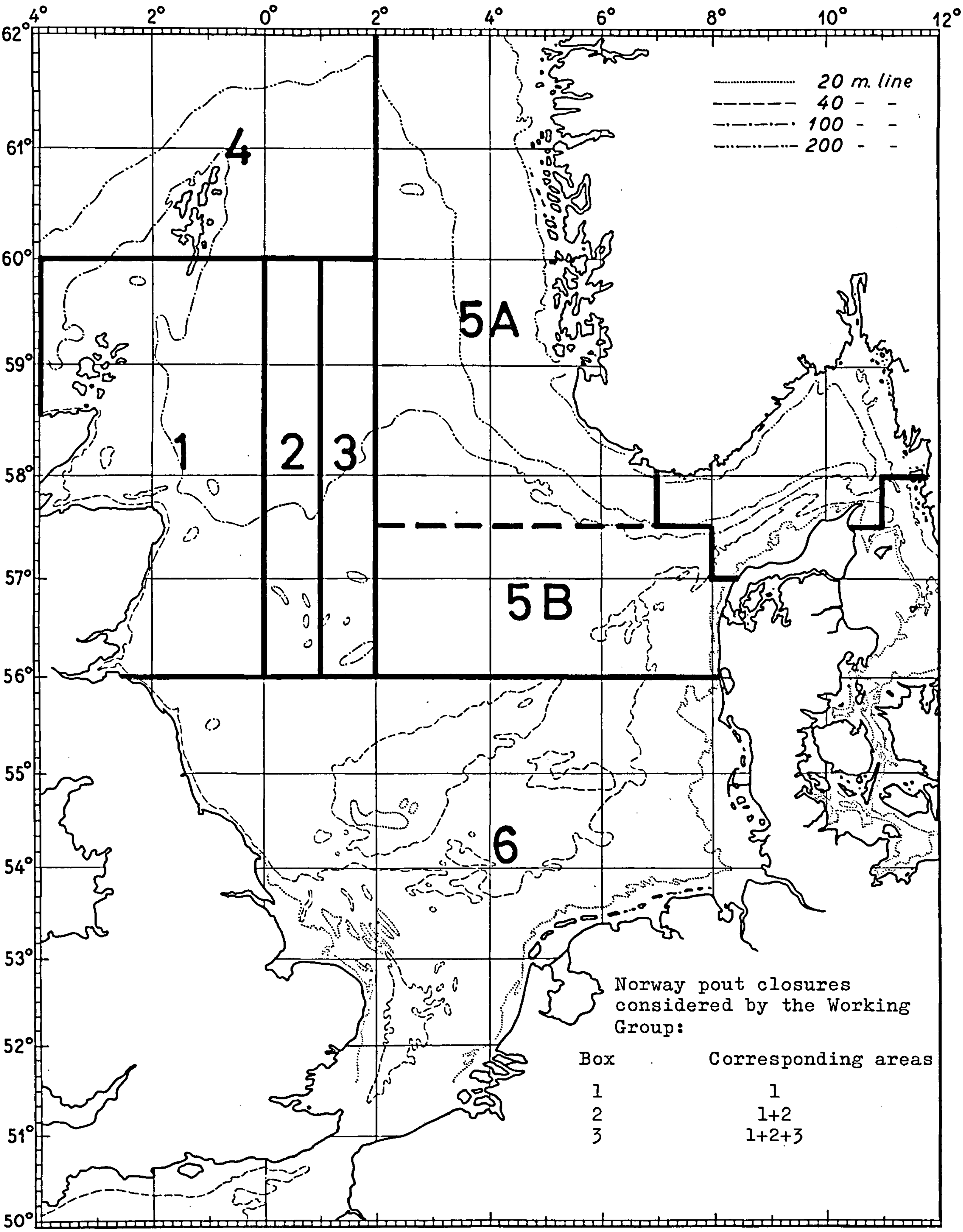


Figure 4.1 Chart of fishing areas adopted by the Working Group.

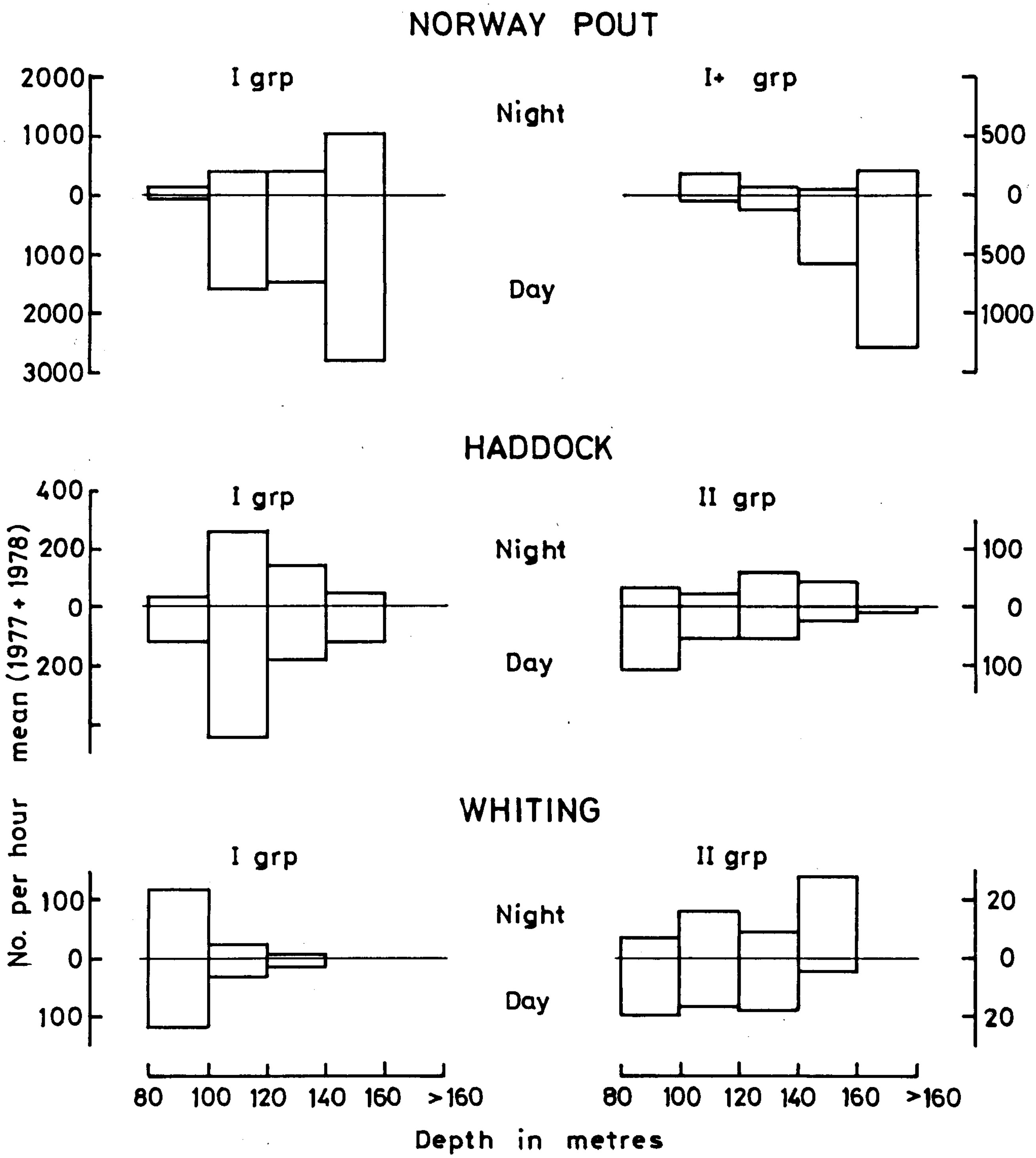
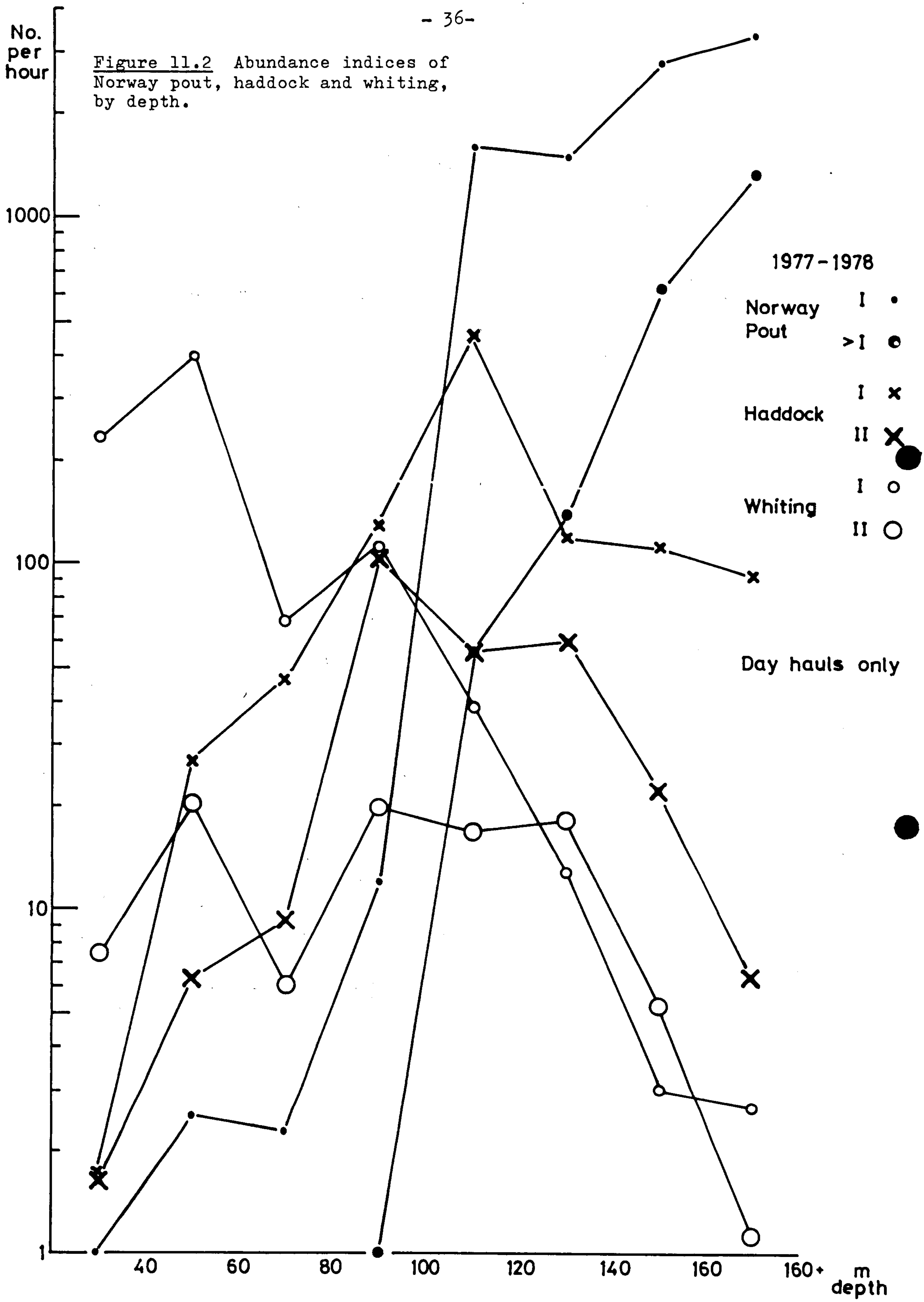


Figure 11.1 Diurnal variation in catches of Norway pout, haddock and whiting.

Figure 11.2 Abundance indices of Norway pout, haddock and whiting, by depth.



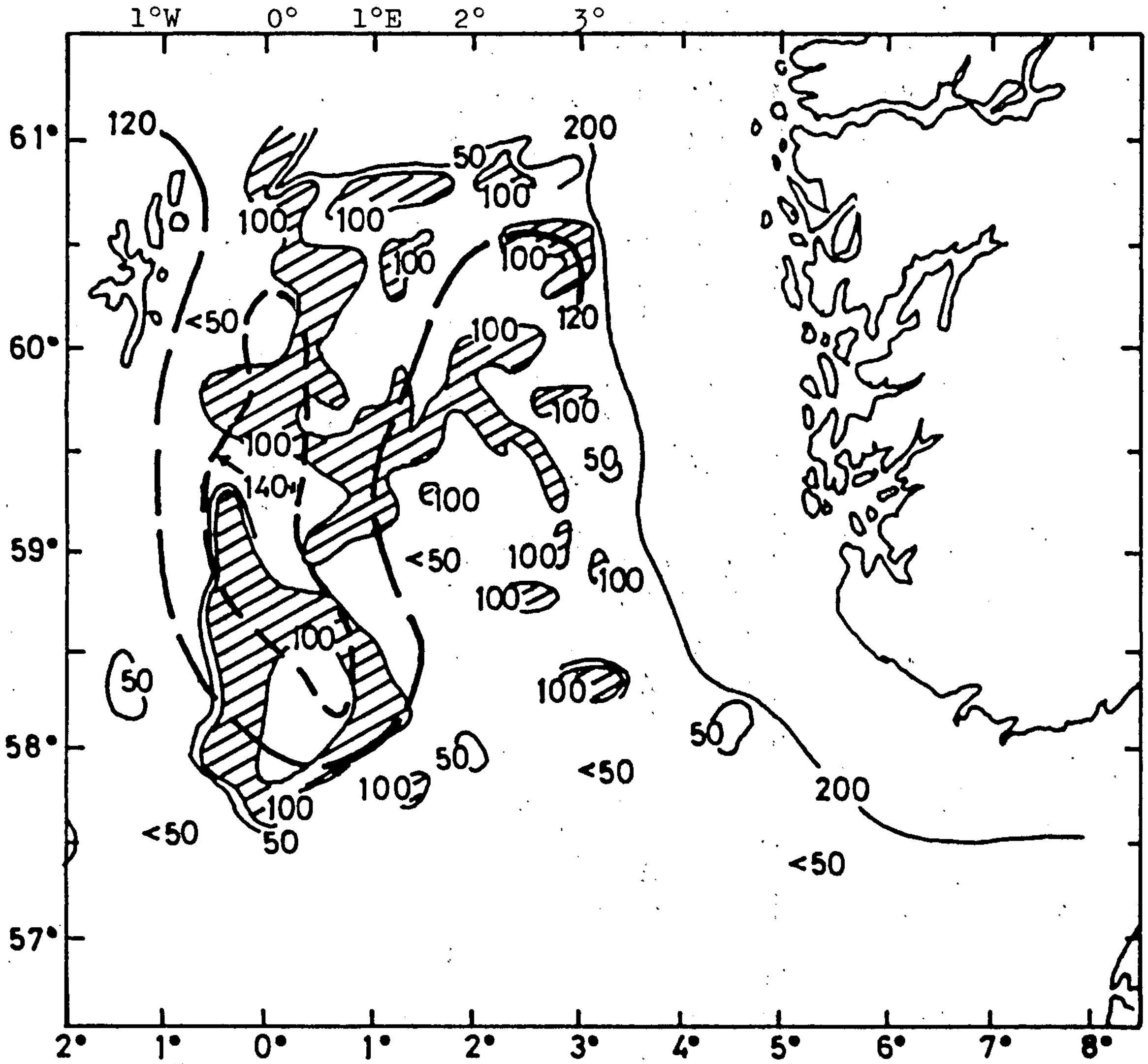


Figure 11.3 Distribution of total intergrator units greater than 100, in relation to 120 and 140 m depth contour, July/August 1978.

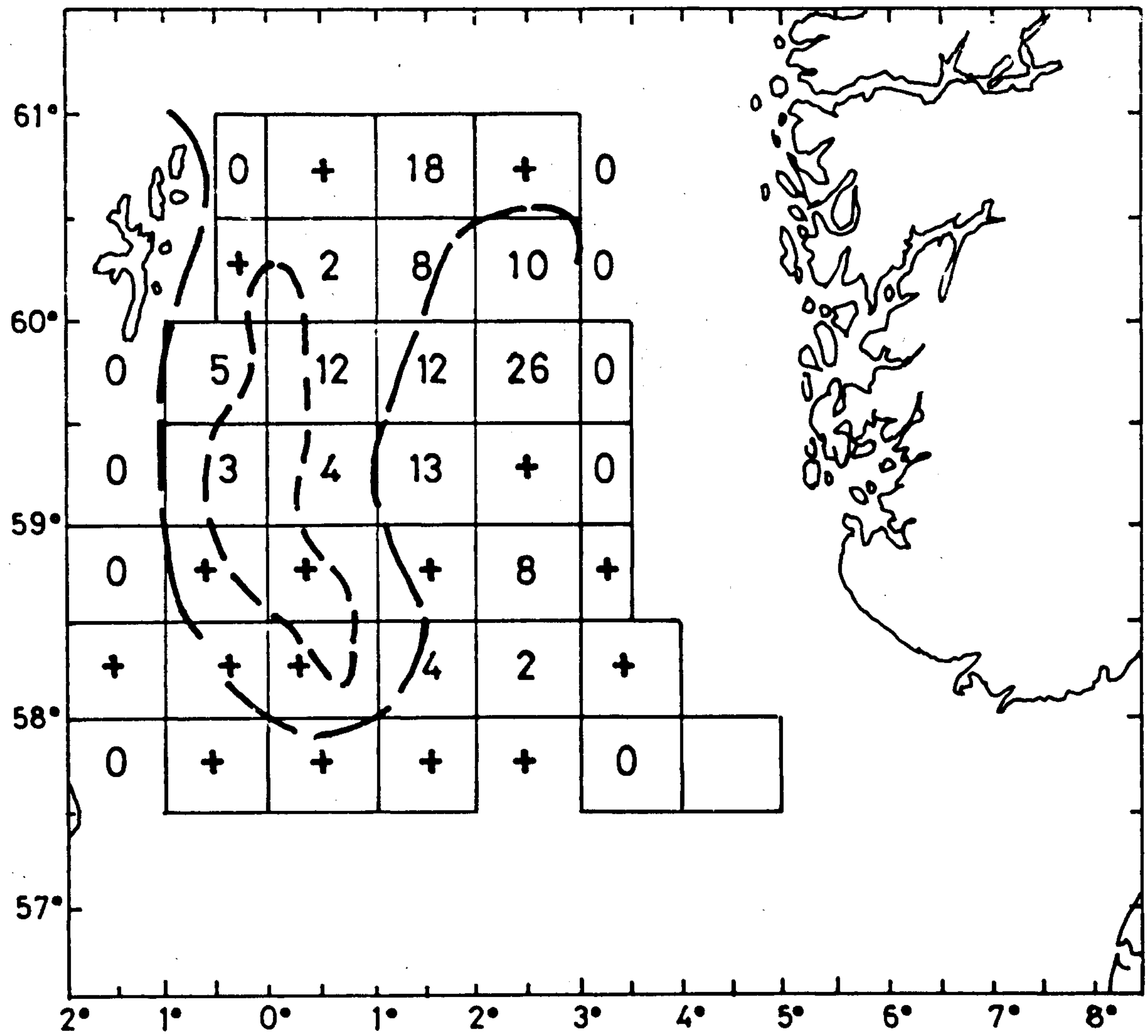


Figure 11.4 Average abundance indices of 0-group Norway pout in June/July. Young Gadoid Survey.

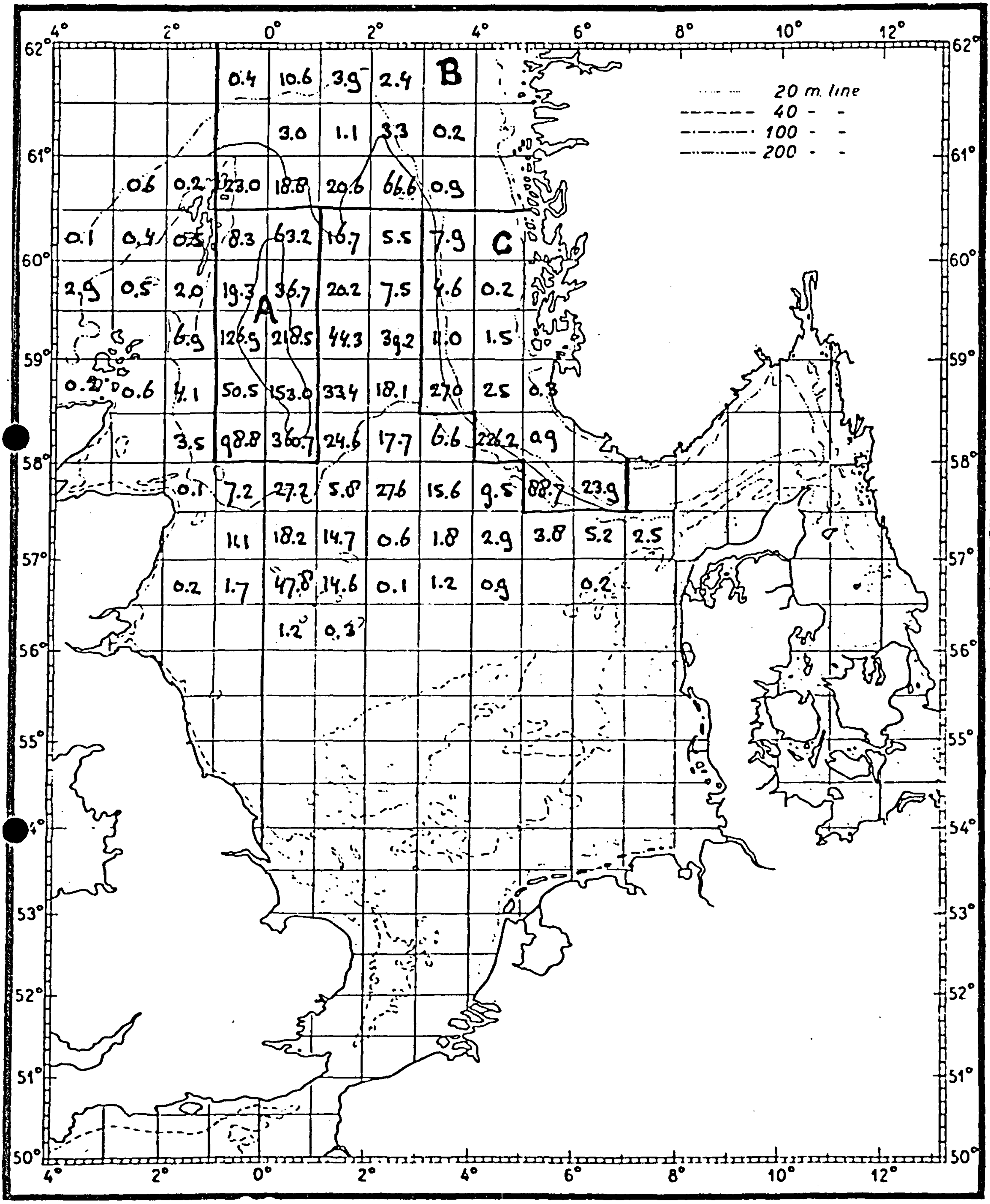


Figure 11.5 Summed catches of Norway pout 1972-76 ('000 tons) with an indication of deep water areas used in Section 11.3.

APPENDIX 1

to the Report of an *ad hoc* Working Group on the Norway Pout Box Problem

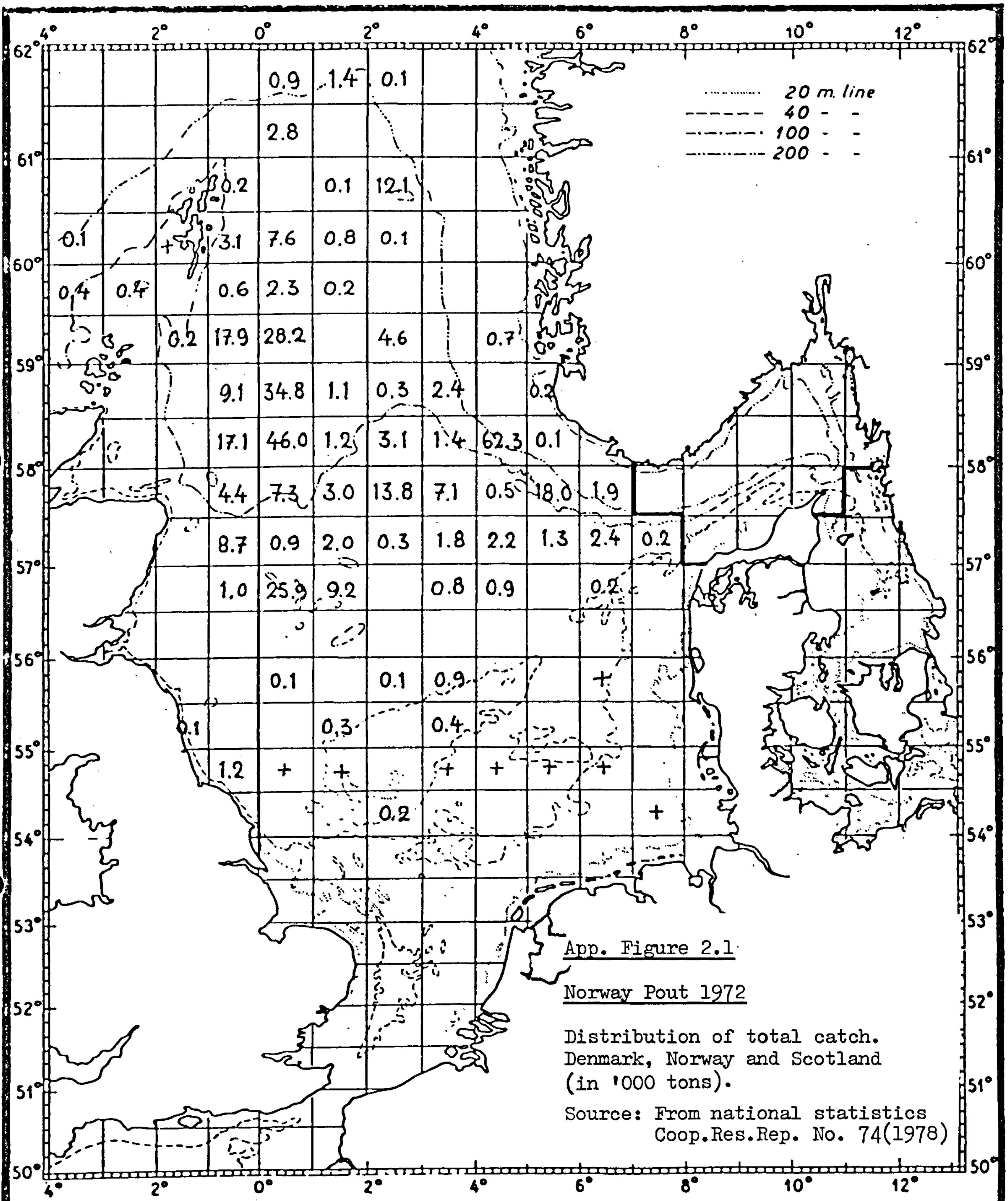
(Charlottenlund, 29 Jan. - 2 Feb. 1979)

1. Distribution by statistical rectangle of total Norway pout catches taken by Denmark, Norway, and Scotland in 1972 - 1977, in thousand tons.

   - Appendix Figures 2.1 - 2.6

2. Combined 1977 Norway pout catches by Denmark, Norway, and Scotland by month and statistical rectangle, in tons.

   - Appendix Figures 2.7 - 2.18

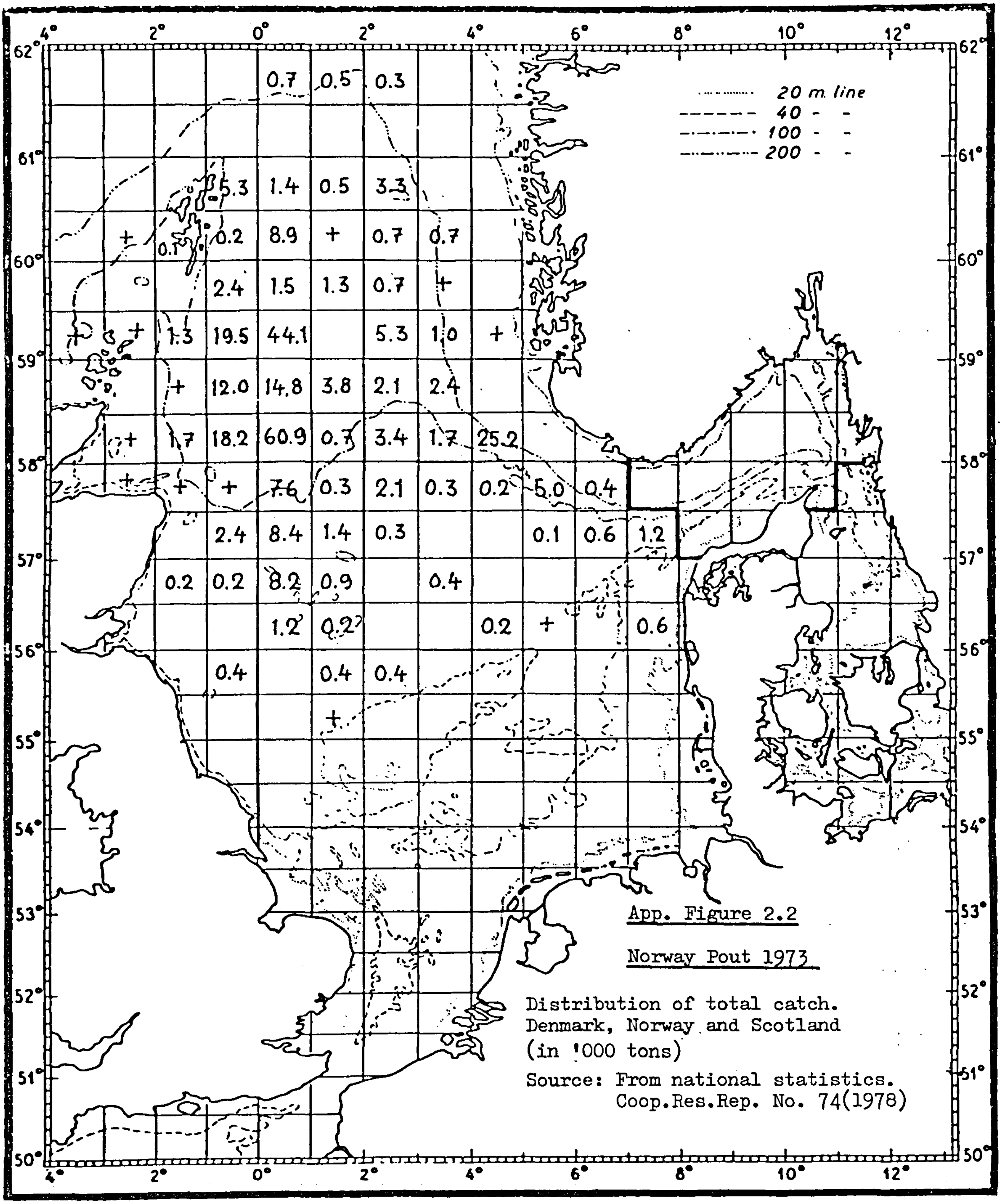


App. Figure 2.1

Norway Pout 1972

Distribution of total catch.
Denmark, Norway and Scotland
(in '000 tons).

Source: From national statistics
Coop.Res.Rep. No. 74(1978)

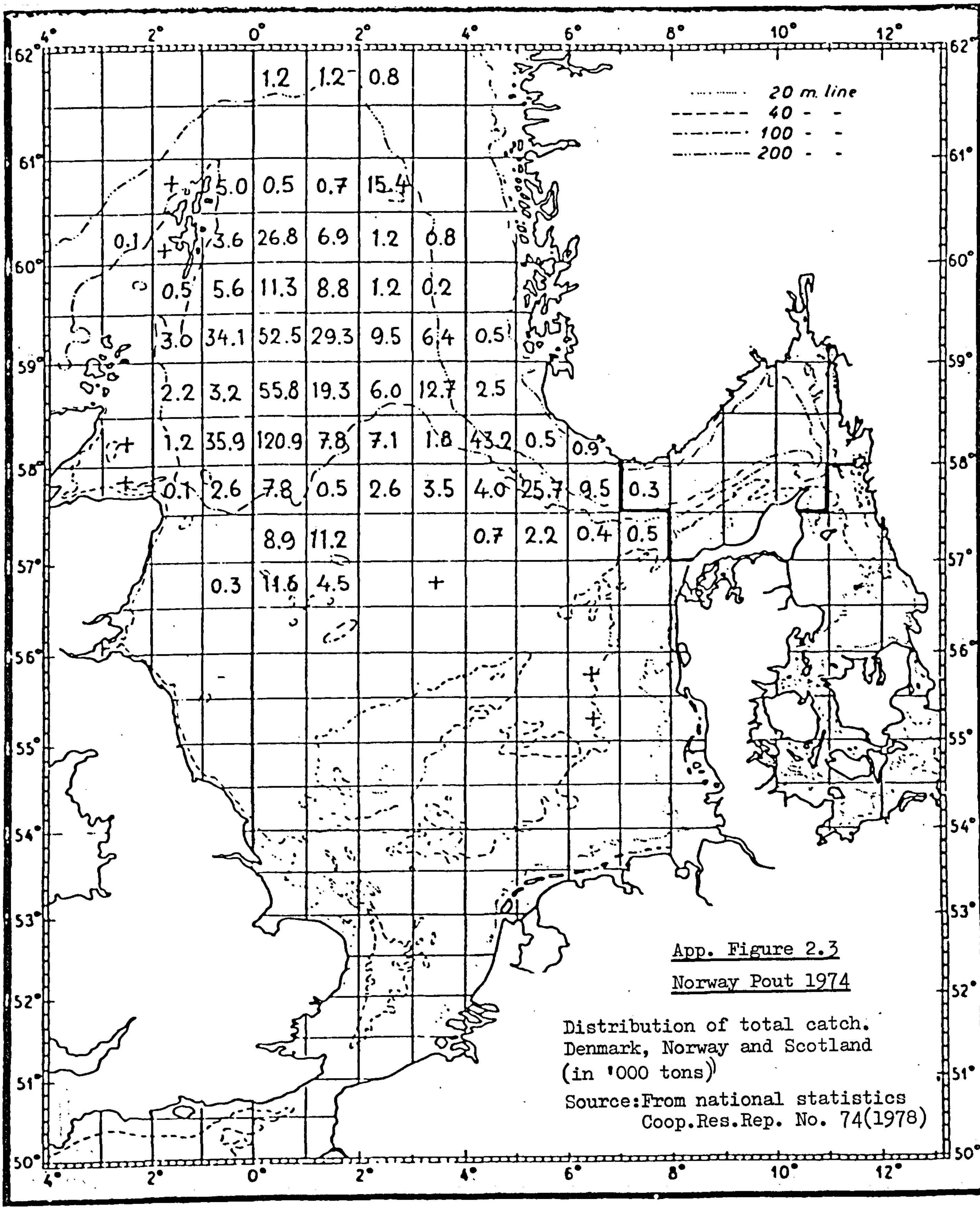


App. Figure 2.2

Norway Pout 1973

Distribution of total catch.
Denmark, Norway and Scotland
(in '000 tons)

Source: From national statistics.
Coop.Res.Rep. No. 74(1978)

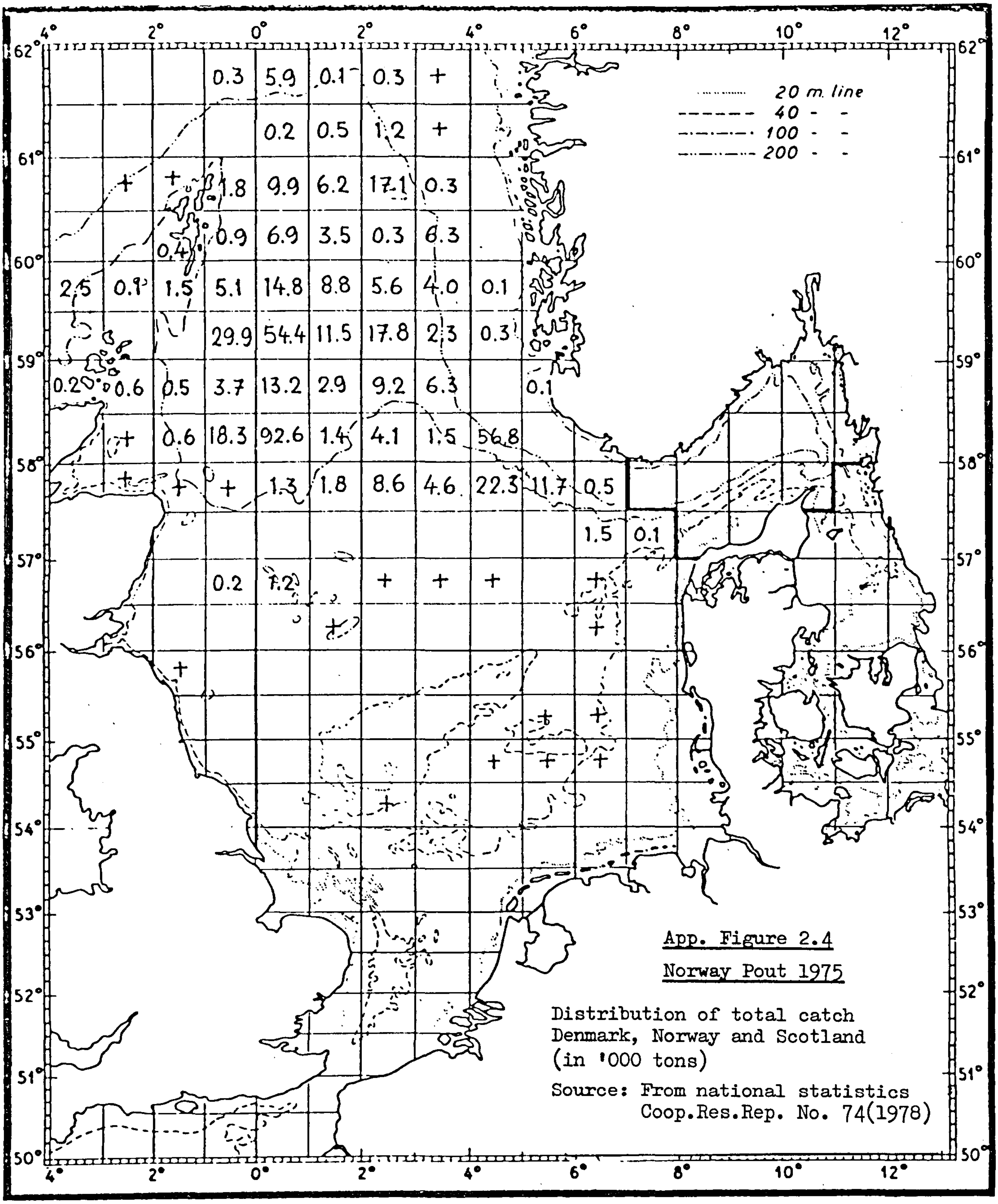


App. Figure 2.3

Norway Pout 1974

Distribution of total catch. Denmark, Norway and Scotland (in '000 tons)

Source: From national statistics Coop.Res.Rep. No. 74(1978)

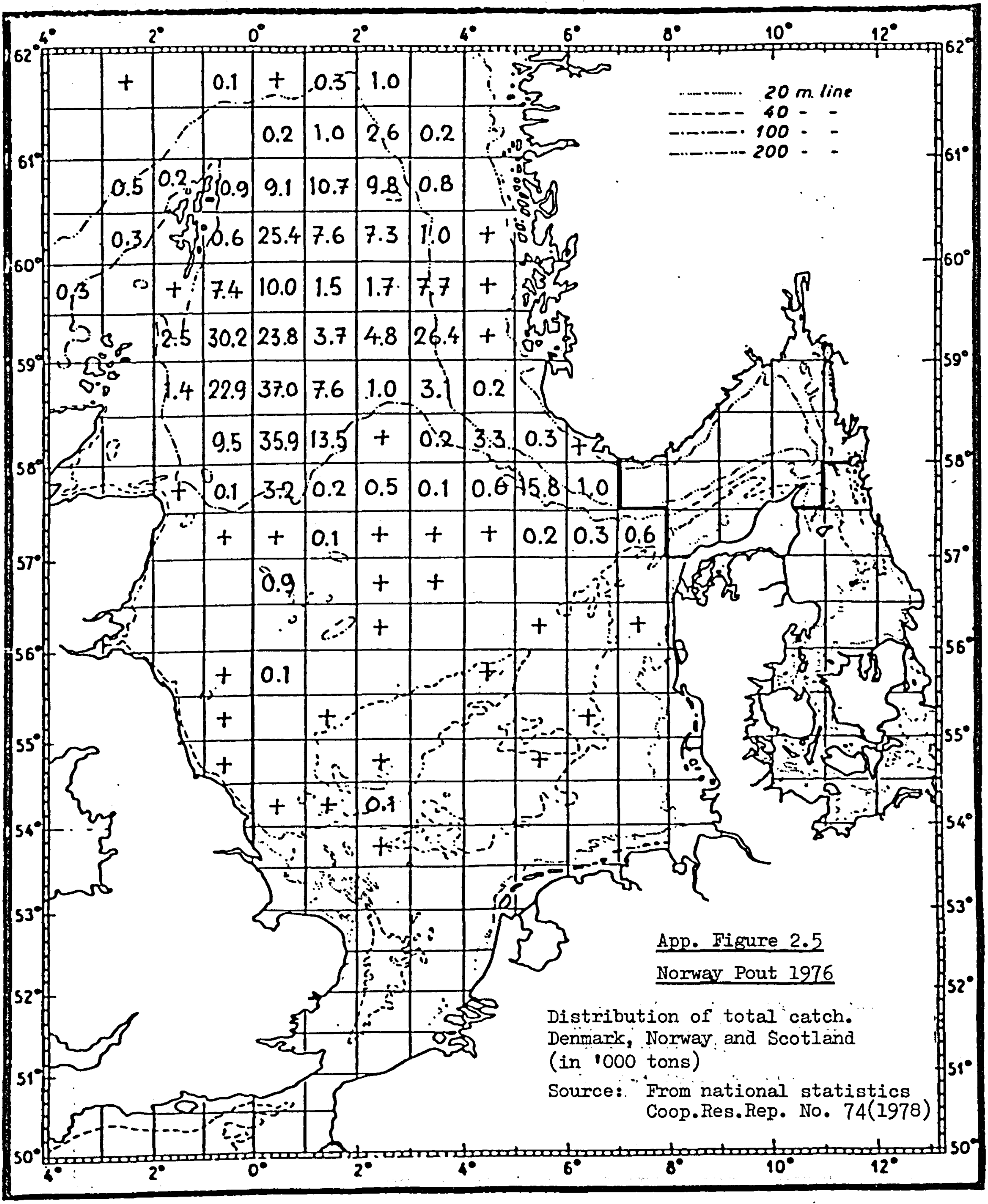


App. Figure 2.4

Norway Pout 1975

Distribution of total catch Denmark, Norway and Scotland (in '000 tons)

Source: From national statistics Coop.Res.Rep. No. 74(1978)

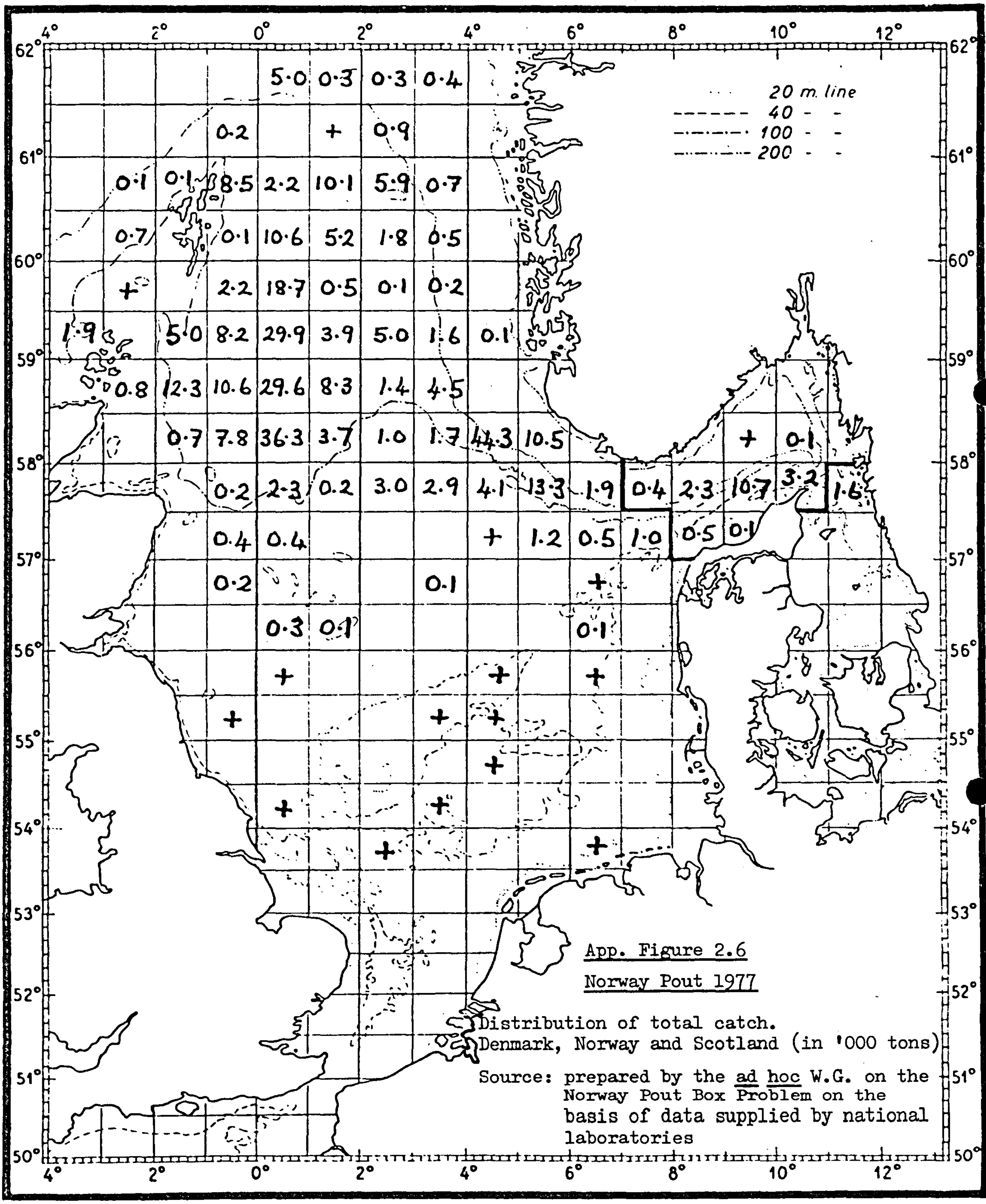


App. Figure 2.5

Norway Pout 1976

Distribution of total catch.
Denmark, Norway and Scotland
(in '000 tons)

Source: From national statistics
Coop.Res.Rep. No. 74(1978)

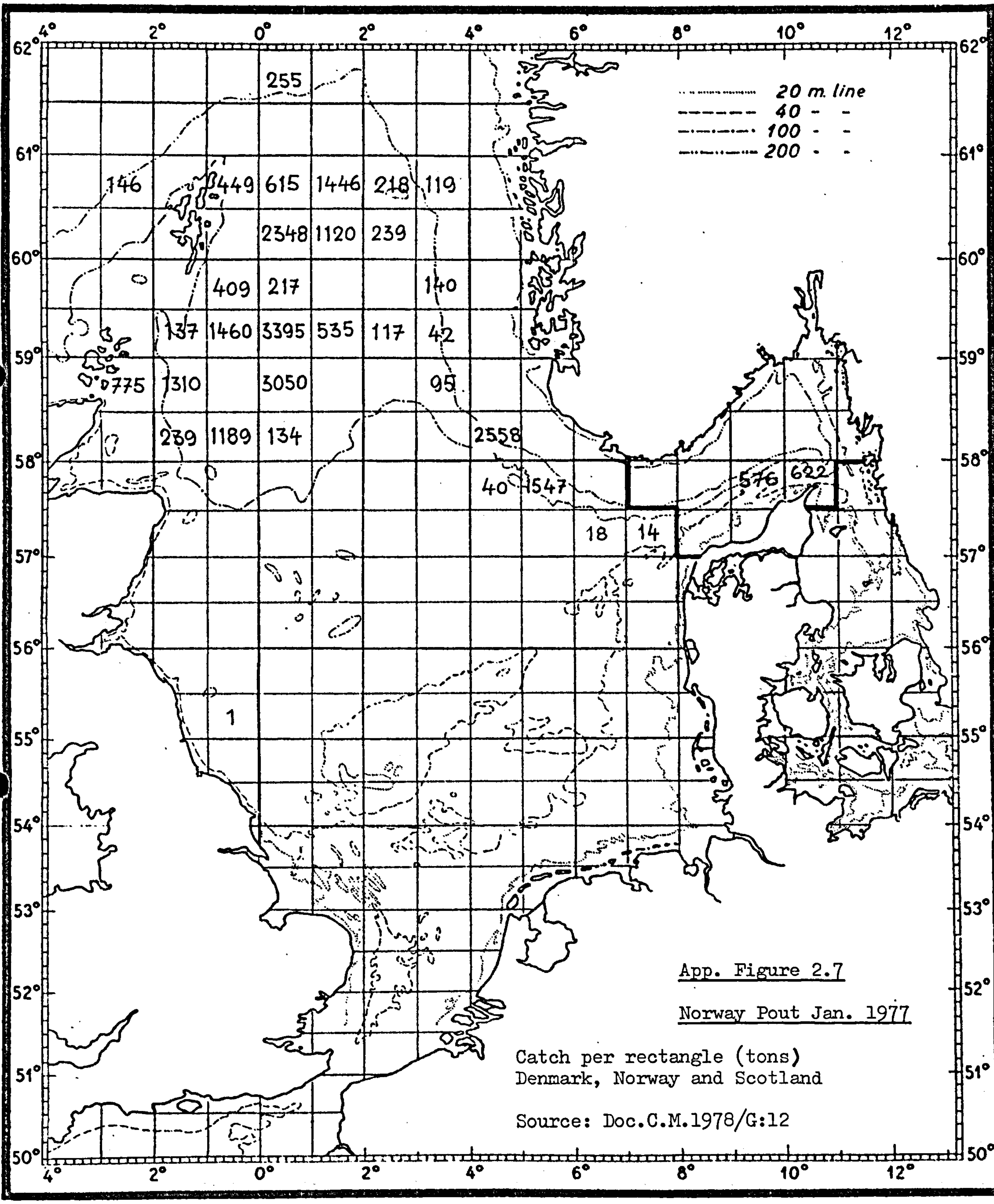


App. Figure 2.6

Norway Pout 1977

Distribution of total catch.
Denmark, Norway and Scotland (in '000 tons)

Source: prepared by the ad hoc W.G. on the Norway Pout Box Problem on the basis of data supplied by national laboratories

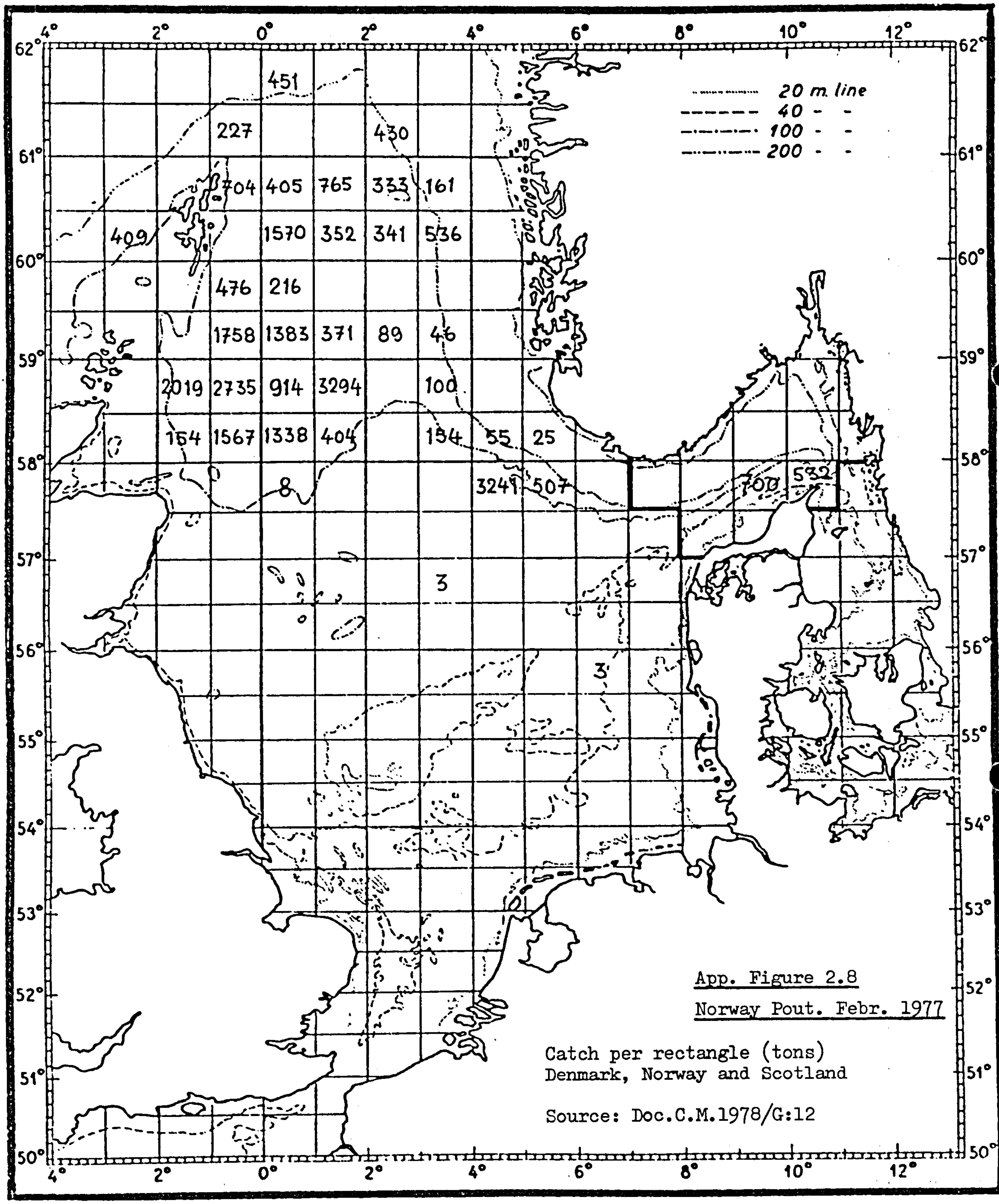


App. Figure 2.7

Norway Pout Jan. 1977

Catch per rectangle (tons)
Denmark, Norway and Scotland

Source: Doc.C.M.1978/G:12

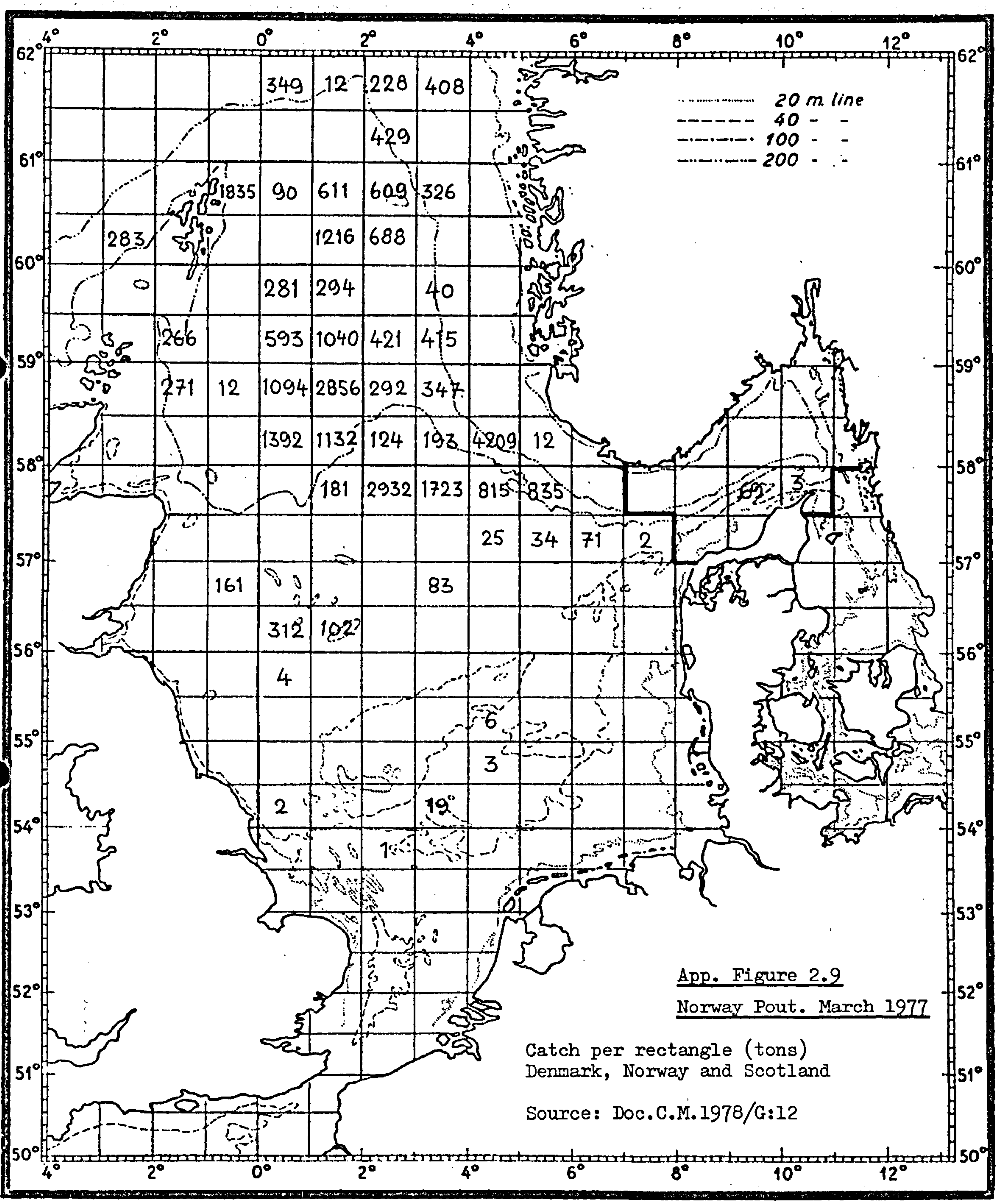


App. Figure 2.8

Norway Pout. Febr. 1977

Catch per rectangle (tons)
Denmark, Norway and Scotland

Source: Doc.C.M.1978/G:12

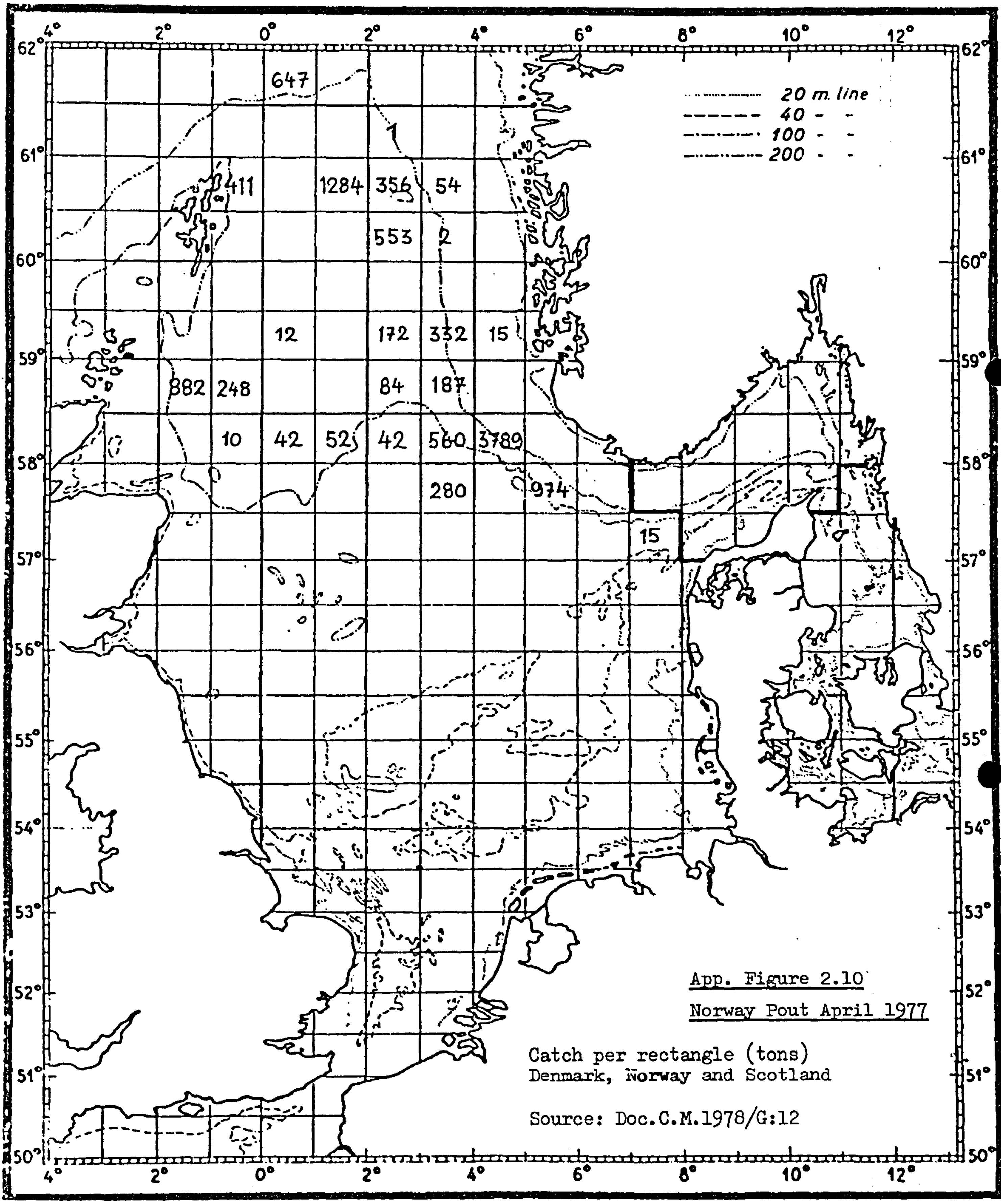


App. Figure 2.9

Norway Pout. March 1977

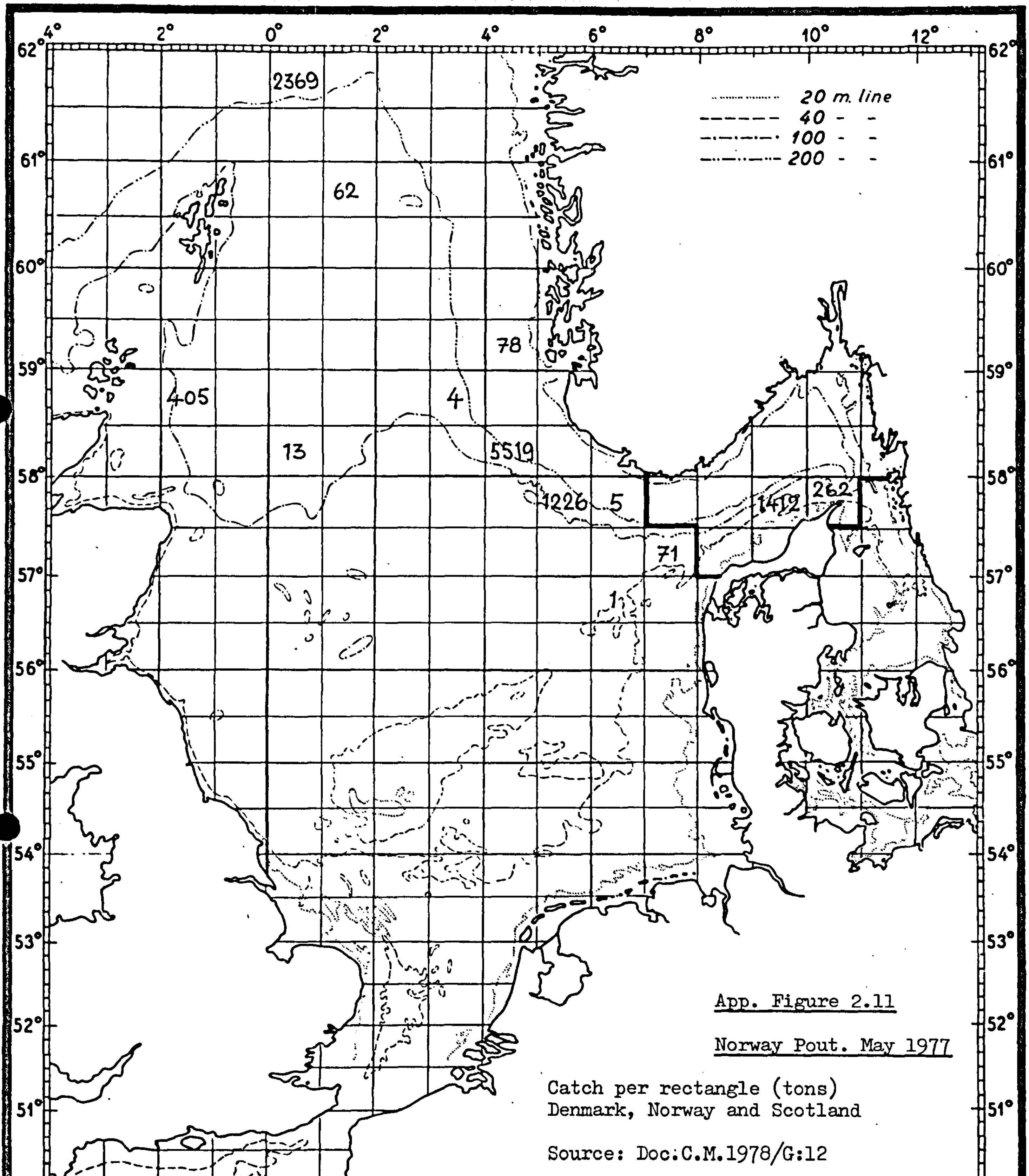
Catch per rectangle (tons)
Denmark, Norway and Scotland

Source: Doc.C.M.1978/G:12



App. Figure 2.10

Norway Pout April 1977

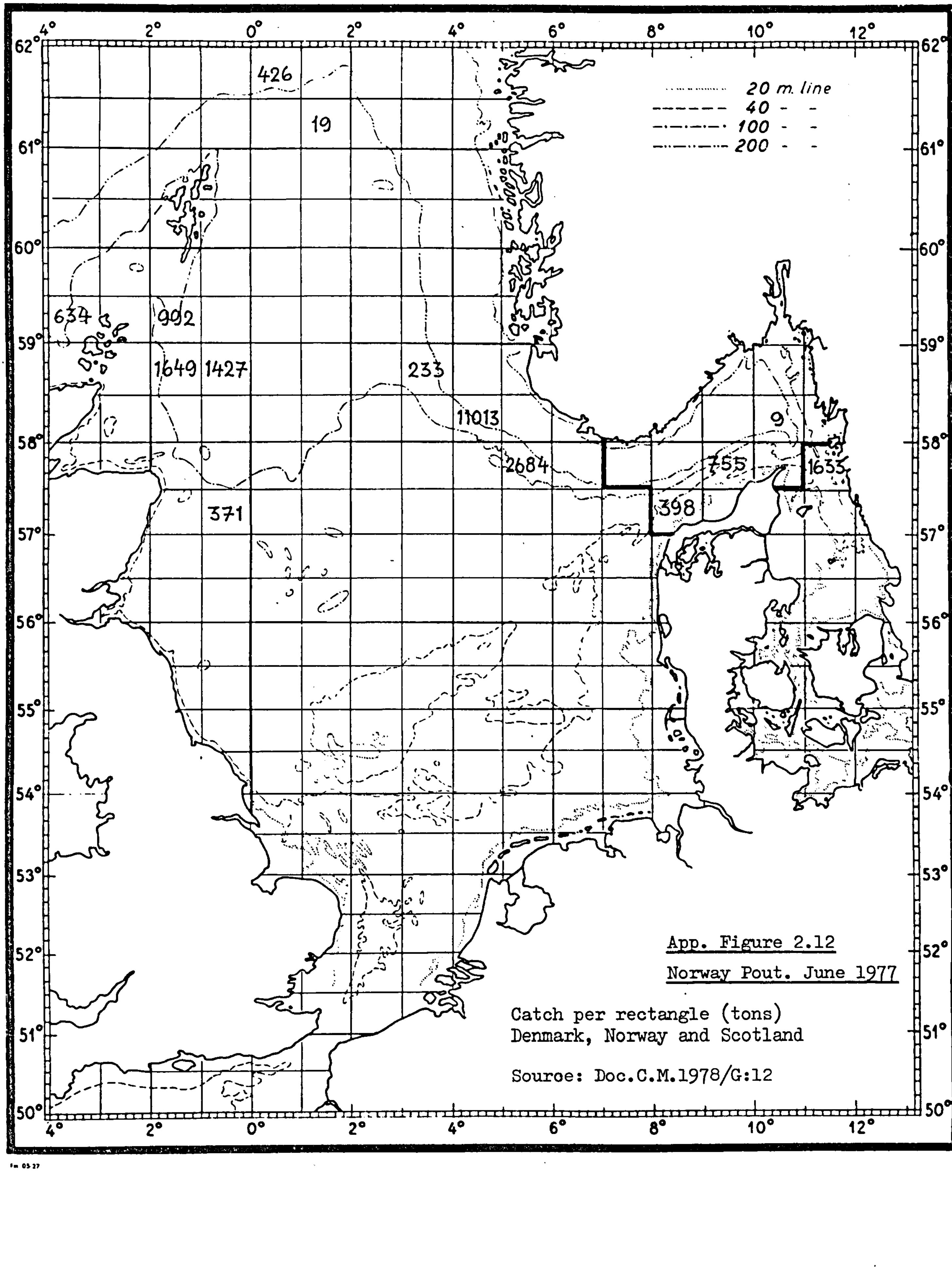


App. Figure 2.11

Norway Pout. May 1977

Catch per rectangle (tons)
Denmark, Norway and Scotland

Source: Doc.C.M.1978/G:12

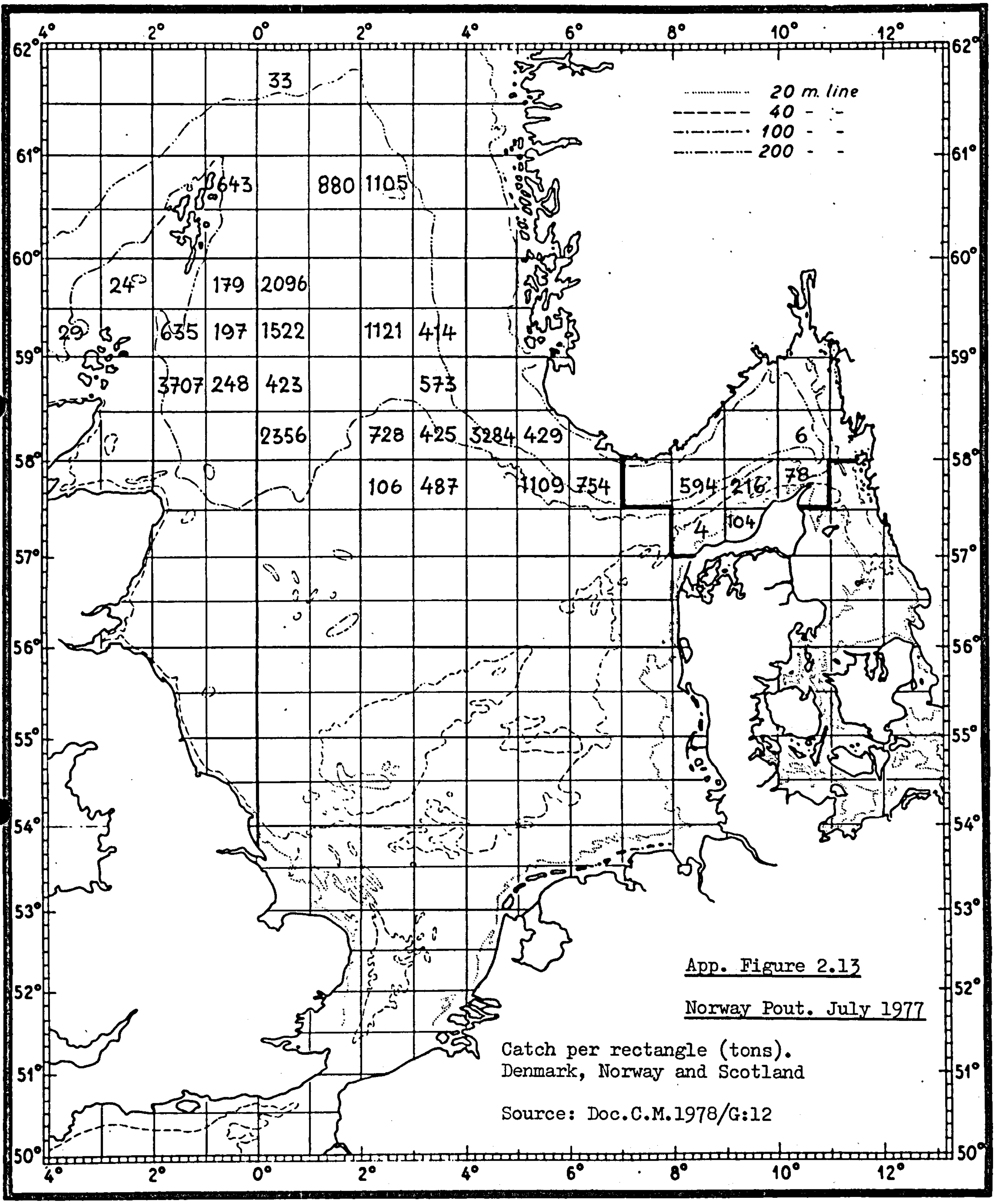


App. Figure 2.12

Norway Pout. June 1977

Catch per rectangle (tons)
Denmark, Norway and Scotland

Source: Doc.C.M.1978/G:12

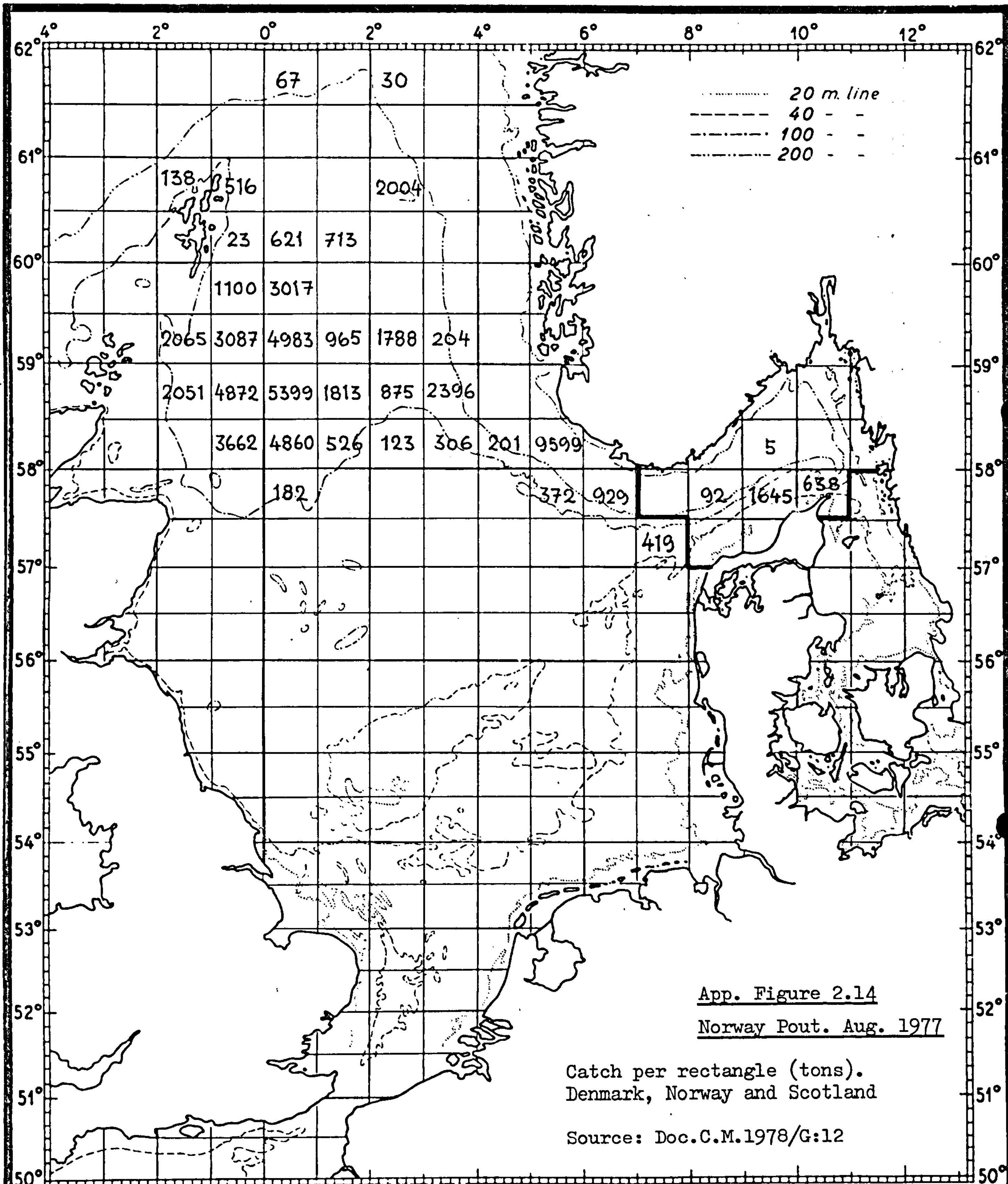


App. Figure 2.13

Norway Pout. July 1977

Catch per rectangle (tons).
Denmark, Norway and Scotland

Source: Doc.C.M.1978/G:12

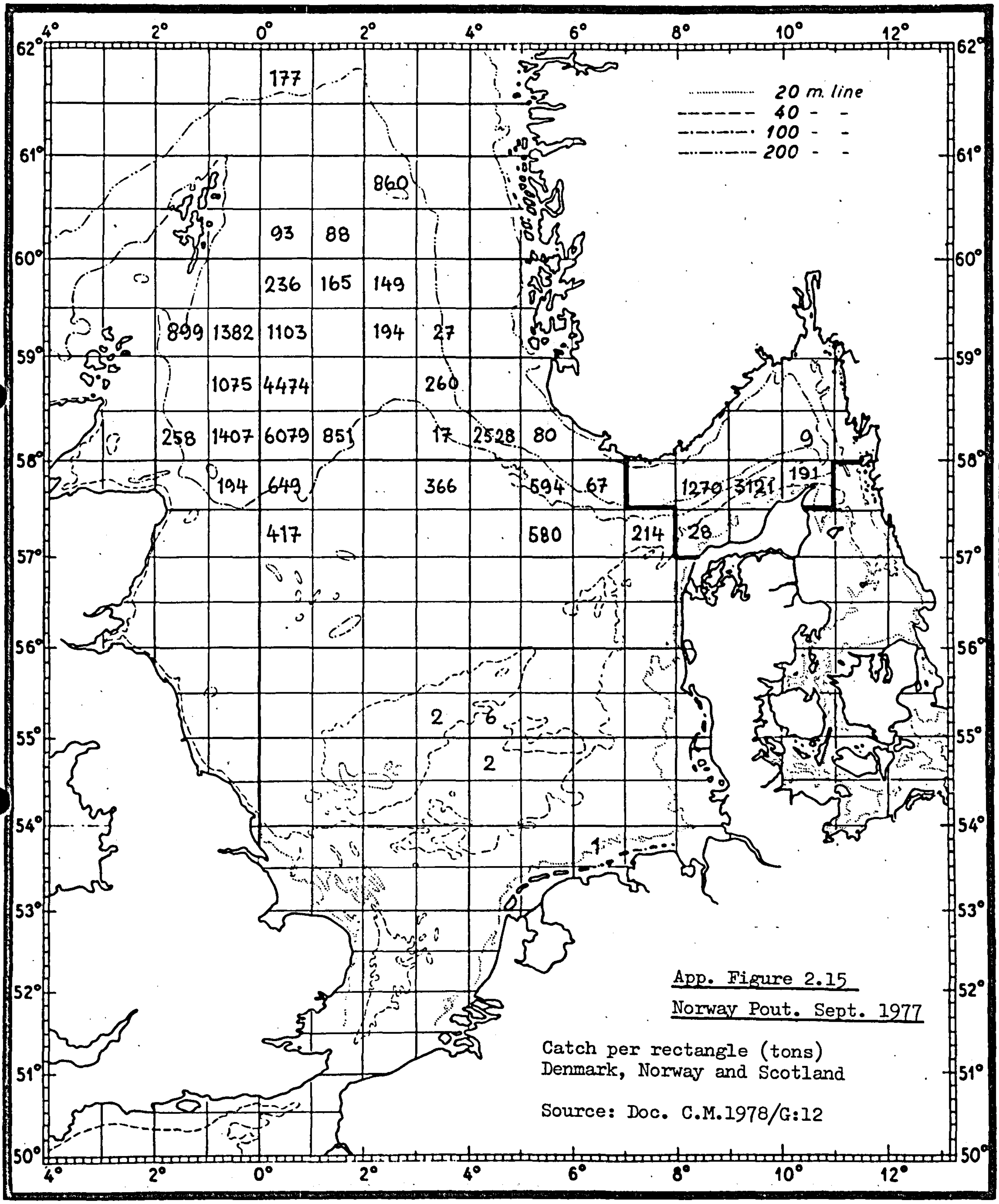


App. Figure 2.14

Norway Pout. Aug. 1977

Catch per rectangle (tons).
Denmark, Norway and Scotland

Source: Doc.C.M.1978/G:12

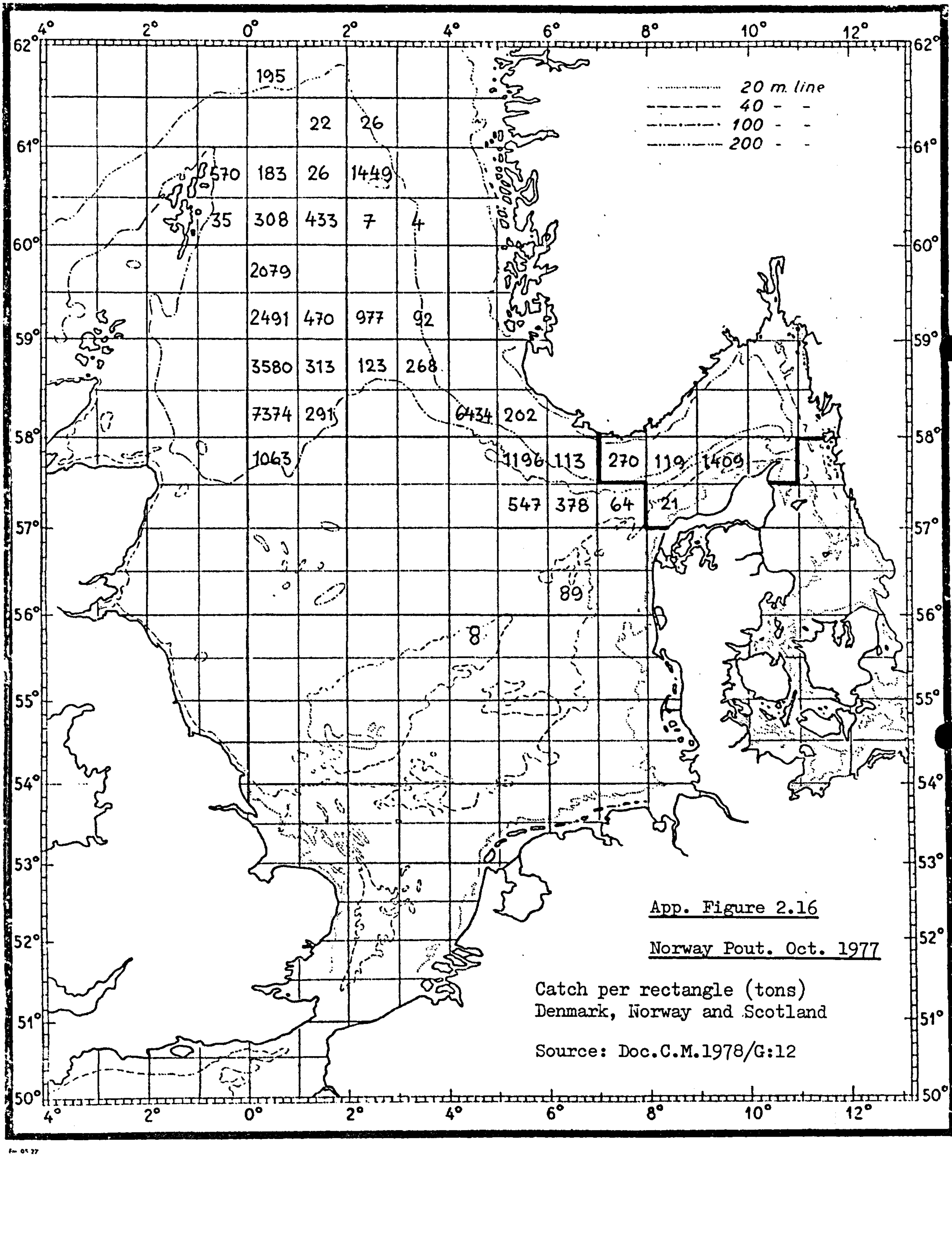


App. Figure 2.15

Norway Pout. Sept. 1977

Catch per rectangle (tons)
Denmark, Norway and Scotland

Source: Doc. C.M.1978/G:12

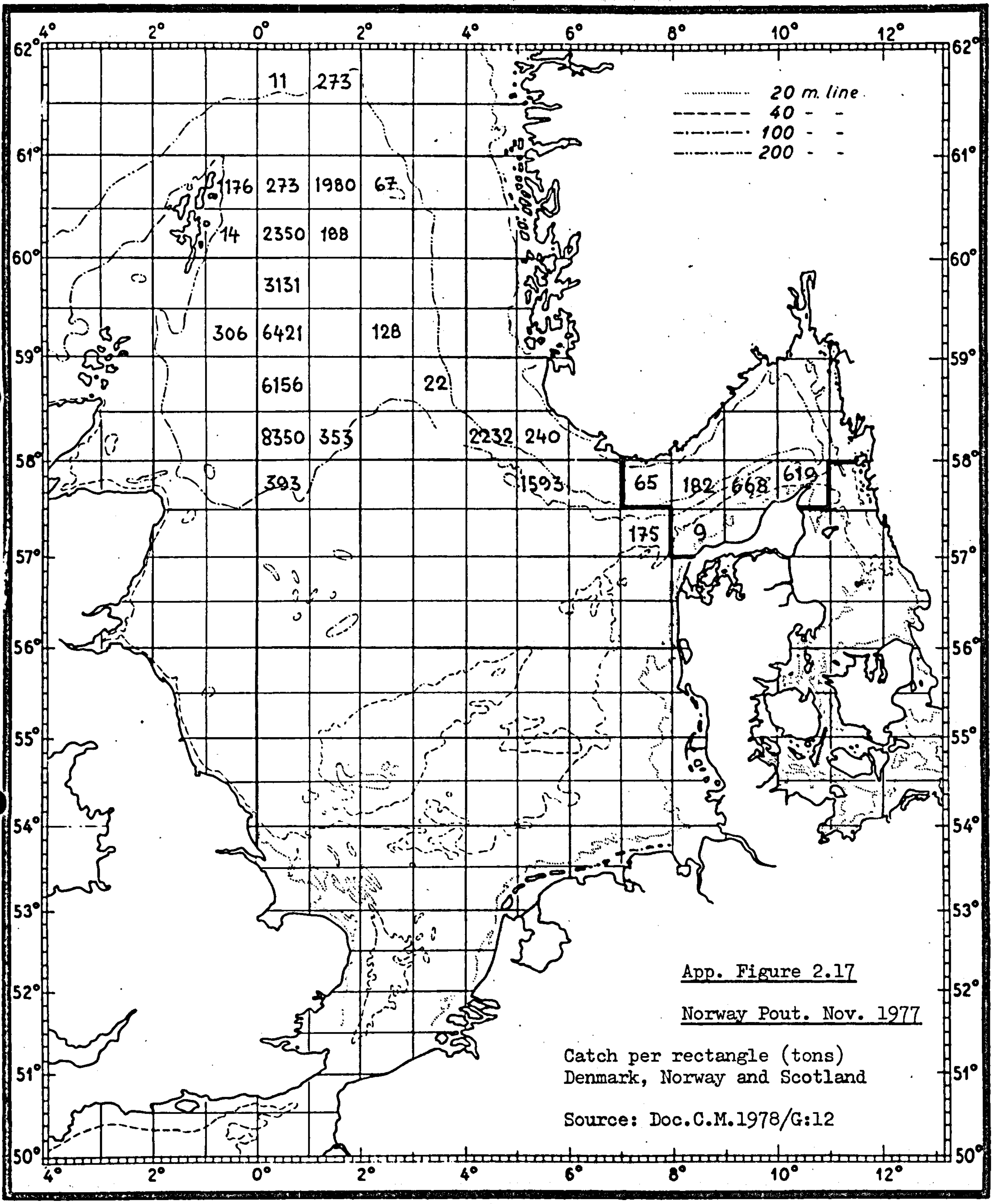


App. Figure 2.16

Norway Pout. Oct. 1977

Catch per rectangle (tons)
Denmark, Norway and Scotland

Source: Doc.C.M.1978/G:12

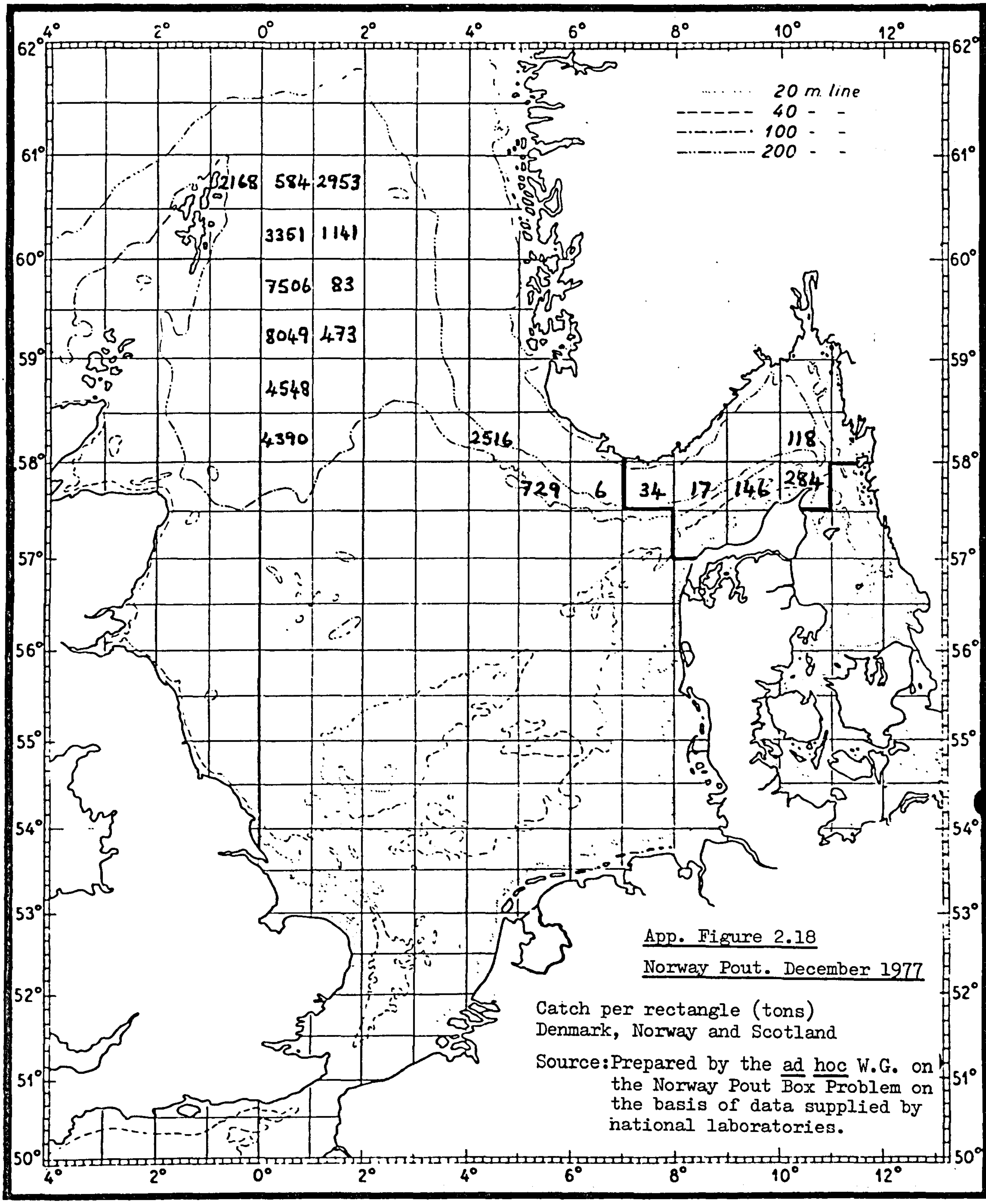


App. Figure 2.17

Norway Pout. Nov. 1977

Catch per rectangle (tons)
Denmark, Norway and Scotland

Source: Doc.C.M.1978/G:12



App. Figure 2.18

Norway Pout. December 1977

Catch per rectangle (tons)
Denmark, Norway and Scotland

Source: Prepared by the ad hoc W.G. on the Norway Pout Box Problem on the basis of data supplied by national laboratories.

APPENDIX 2

to the Report of an ad hoc Working Group on
the Norway Pout Box Problem

(Charlottenlund, 29 Jan. - 2 Feb. 1979)

Appendix 2, Tables 1 - 4

Total industrial catches (excluding sandeel fisheries) in tons by countries, and the estimated by-catches of haddock and whiting 1975-1978. The data are grouped by quarters and the areas as given in Figure 4.1.

Appendix 2, Table 1. Total industrial catches (excluding sandeel fisheries) in tons by countries, and the estimated by-catches of haddock and whiting for 1975. The data are grouped by quarters and the areas as given in Figure 4.1.

Area	*)	Quarter I			Quarter II			Quarter III			Quarter IV		
		Total indust.	Haddock	Whiting	Total indust.	Haddock	Whiting	Total indust.	Haddock	Whiting	Total indust.	Haddock	Whiting
1	D	27 765	2 996	5 692	856	123	198	9 278	325	63	33 133	549	6 459
	N	229	29	45	15	0	0	659	10	8	2 362	115	366
	S	2 966	284	14	2 255	534	3	5 145	958	264	4 065	214	697
	F	3 046	329	624	6 218	893	1 438	16 058	563	109	6 151	102	1 199
	T	34 006	3 638	6 375	9 344	1 550	1 639	31 140	1 856	444	45 711	980	8 721
2	D	19 384	2 298	3 971	4 735	1 538	2 171	38 246	1 357	416	60 190	1 288	10 867
	N	6 588	1 395	1 456	10 226	223	0	59 231	852	2 510	28 054	546	1 720
	S	5	1	0	108	24	0	713	117	36	0	0	0
	F	1 688	200	346	1 236	401	567	3 548	126	39	3 194	68	577
	T	27 665	3 894	5 773	16 305	2 186	2 738	101 738	2 452	3 001	91 438	1 902	13 164
3	D	7 856	738	1 402	3 283	558	883	17 688	2 368	107	9 953	174	2 166
	N	0	0	0	425	16	6	0	0	0	430	15	31
	S	0	0	0	0	0	0	0	0	0	0	0	0
	F	236	22	42	270	46	73	0	–	–	0	–	–
	T	8 092	760	1 444	3 978	620	962	17 688	2 368	107	10 383	189	2 197
4	D	5 336	590	1 064	1 601	327	472	6 839	51	173	9 675	182	1 804
	N	2 012	54	110	8 889	382	768	1 289	38	64	3 777	120	252
	S	5 037	66	48	306	4	0	1 842	22	0	3 953	103	1
	F	3 919	433	781	2 392	489	705	7 944	59	201	8 807	166	1 642
	T	16 304	1 143	2 003	13 188	1 202	1 945	17 914	170	438	26 212	571	3 699
5A	D	18 732	2 986	4 369	49 075	1 789	909	44 103	2 763	131	4 718	142	66
	N	25 511	1 097	3 020	72 120	1 127	1 440	34 132	174	209	39 362	1 335	390
	S	0	0	0	0	0	0	0	0	0	0	0	0
	F	0	–	–	978	36	18	230	14	1	628	19	9
	T	44 243	4 083	7 389	122 173	2 954	2 367	78 465	2 951	341	44 708	1 496	465
5B	D	4 676	18	28	4 383	121	1 034	57 086	402	1 471	10 663	1 092	1 093
	N	0	0	0	113	2	0	0	0	0	0	0	0
	S	0	0	0	0	0	0	0	0	0	0	0	0
	F	0	–	–	1 323	37	312	0	–	–	0	–	–
	T	4 676	18	28	5 819	160	1 346	57 086	402	1 471	10 663	1 092	1 093
6	D	142 540	181	1 941	21 999	172	2 701	139 555	887	6 417	69 797	525	3 199
	N	0	0	0	0	0	0	0	0	0	0	0	0
	S	0	0	0	18	0	0	0	0	0	0	0	0
	F	503	1	7	1 441	11	177	0	–	–	0	–	–
	T	143 043	182	1 948	23 458	183	2 878	139 555	887	6 417	69 797	525	3 199

*) D = Denmark, N = Norway, S = Scotland, F = Faroe Islands, T = Total.

Appendix 2, Table 2. Total industrial cat[illegible]es (excluding sandeel fisheries) in [illegible]ns by countries, and the estimated by-catches of haddock and whiting for 1976. The data are grouped by quarters and the areas as given in Figure 4.1.

Area	*)	Quarter I			Quarter II			Quarter III			Quarter IV		
		Total indust.	Haddock	Whiting	Total indust.	Haddock	Whiting	Total indust.	Haddock	Whiting	Total indust.	Haddock	Whiting
1	D	34 355	6 718	20 237	2 791	170	690	27 699	656	1 732	41 399	1 591	4 478
	N	0	0	0	0	0	0	228	4	2	139	1	18
	S	960	51	160	553	0	0	2 807	23	0	2 747	58	14
	F	8 200	1 603	4 830	4 680	285	1 157	11 875	281	743	7 869	302	851
	T	43 515	8 372	25 227	8 024	455	1 847	42 609	964	2 477	52 154	1 952	5 361
2	D	30 205	5 292	15 893	3 559	282	560	49 792	1 424	3 029	54 917	2 286	5 665
	N	111	4	5	4 204	77	377	16 570	231	69	15 119	258	2 738
	S	69	4	13	74	0	0	1 224	13	0	718	6	0
	F	2 056	360	1 082	620	49	98	399	11	24	0	–	–
	T	32 441	5 660	16 993	8 457	408	1 035	67 985	1 679	3 122	70 754	2 550	8 403
3	D	9 403	1 667	4 762	2 121	71	382	13 863	310	407	12 344	563	1 912
	N	0	0	0	29	1	0	0	0	0	46	2	11
	S	0	0	0	9	0	0	0	0	0	67	3	0
	F	0	–	–	0	–	–	0	–	–	0	–	–
	T	9 403	1 667	4 762	2 159	72	382	13 863	310	407	12 457	568	1 923
4	D	13 535	1 953	5 219	26 422	1 144	3 477	10 791	288	521	5 967	163	421
	N	824	10	9	4 993	100	186	2 847	53	53	1 483	27	249
	S	3 967	70	58	56	0	0	1 266	39	0	4 403	215	0
	F	7 429	1 072	2 865	6 689	290	627	6 298	168	304	4 133	113	292
	T	25 755	3 105	8 151	38 160	1 534	4 290	21 202	548	878	15 986	518	962
5A	D	11 308	345	1 228	19 090	325	796	27 622	1 169	220	1 537	29	40
	N	22 061	656	2 468	45 657	256	229	51 030	500	1 046	18 729	152	989
	S	0	0	0	0	0	0	0	0	0	0	0	0
	F	961	29	104	257	4	11	0	–	–	0	–	–
	T	34 330	1 030	3 800	65 004	585	1 036	78 652	1 669	1 266	20 266	181	1 029
5B	D	5 159	1 117	2 179	6 417	187	852	63 578	5 563	2 023	23 756	449	2 224
	N	0	0	0	0	0	0	0	0	0	0	0	0
	S	0	0	0	0	0	0	0	0	0	0	0	0
	F	0	–	–	0	–	–	0	–	–	0	–	–
	T	5 159	1 117	2 179	6 417	187	852	63 578	5 563	2 023	23 756	449	2 224
6	D	98 456	2 409	16 603	39 294	828	14 534	107 760	1 655	9 796	91 214	217	3 281
	N	0	0	0	87	0	0	0	0	0	0	0	0
	S	0	0	0	0	0	0	0	0	0	0	0	0
	F	0	–	–	0	–	–	0	–	–	0	–	–
	T	98 456	2 409	16 603	39 381	828	14 534	107 760	1 655	9 796	91 214	217	3 281

*) D = Denmark, N = Norway, S = Scotland, F = Faroe Islands, T = Total.

Appendix 2, Table 3. Total industrial catches (excluding sandeel fisheries) in tons by countries, and the estimated by-catches of haddock and whiting for 1977. The data are grouped by quarters and the areas as given in Figure 4.1.

Area	*)	Quarter I			Quarter II			Quarter III			Quarter IV		
		Total indust.	Haddock	Whiting	Total indust.	Haddock	Whiting	Total indust.	Haddock	Whiting	Total indust.	Haddock	Whiting
1	D	21 076	2 158	2 981	7 953	694	610	32 378	1 329	2 322	1 640	1	120
	N	0	0	0	0	0	0	21	0	0	0	0	0
	S	721	9	0	10	0	0	68	1	0	0	0	0
	F	4 399	450	622	2 907	254	223	4 254	175	305	0	-	-
	T	26 196	2 617	3 603	10 870	948	833	36 721	1 505	2 627	1 640	1	120
2	D	20 158	1 563	2 266	64	0	0	36 138	677	824	66 945	831	3 942
	N	843	0	0	31	1	0	3 591	33	0	4 592	170	0
	S	209	2	0	0	0	0	52	1	0	0	0	0
	F	995	77	112	576	-	-	150	3	3	0	-	-
	T	22 205	1 642	2 378	671	1	0	39 931	714	827	71 537	1 001	3 942
3	D	14 500	1 392	1 779	148	3	11	4 597	64	95	2 224	67	128
	N	0	0	0	0	0	0	0	0	0	0	0	0
	S	0	0	0	0	0	0	0	0	0	0	0	0
	F	0	-	-	0	-	-	0	-	-	0	-	-
	T	14 500	1 392	1 779	148	3	11	4 597	64	95	2 224	67	128
4	D	18 046	1 562	2 260	1 987	53	156	3 385	89	53	16 437	373	1 456
	N	1 543	6	116	106	0	0	856	11	0	2 200	1	0
	S	1 423	5	93	0	0	0	23	0	0	2 130	12	0
	F	4 604	399	88	3 088	82	242	8 278	218	130	14 817	336	1 312
	T	25 616	1 972	2 557	5 181	135	398	12 542	318	183	35 584	722	2 768
5A	D	19 920	962	1 862	6 937	73	206	14 281	156	962	3 325	101	64
	N	15 181	75	1 009	28 281	87	364	30 702	66	42	21 205	24	131
	S	0	0	0	0	0	0	0	0	0	0	0	0
	F	1 554	12	145	89	1	3	0	-	-	2 636	80	51
	T	36 655	1 049	3 016	35 307	161	573	44 983	222	1 004	27 166	205	246
5B	D	4 507	277	519	4 064	96	811	16 244	170	2 326	12 458	25	2 288
	N	0	0	0	0	0	0	0	0	0	0	0	0
	S	0	0	0	0	0	0	0	0	0	0	0	0
	F	0	-	-	0	-	-	0	-	-	0	-	-
	T	4 507	277	519	4 064	96	811	16 244	170	2 326	12 458	25	2 288
6	D	63 370	196	3 255	20 179	131	4 084	58 961	140	6 508	54 978	88	3 732
	N	0	0	0	0	0	0	0	0	0	0	0	0
	S	0	0	0	0	0	0	0	0	0	0	0	0
	F	0	-	-	0	-	-	0	-	-	0	-	-
	T	63 370	196	3 255	20 179	131	4 084	58 961	140	6 508	54 978	88	3 732

*) D = Denmark, N = Norway, S = Scotland, F = Faroe Islands, T = Total.

Appendix 2, Table 4. Total industrial catches (excluding sandeel fisheries) in tons by countries, and the estimated by-catches of haddock and whiting for 1978. The data are grouped by quarters and the areas as given in Figure 4.1.

Area	*)	Quarter I			Quarter II			Quarter III			Quarter IV		
		Total indust.	Haddock	Whiting	Total indust.	Haddock	Whiting	Total indust.	Haddock	Whiting	Total indust.	Haddock	Whiting
1	D	0	0	0	0	0	0	0	0	0			
	N	0	0	0	188	1	2	0	0	0	0	0	0
	S	0	0	0	0	0	0	0	0	0	0	0	0
	F	0	–	–	0	–	–	0	–	–	0	–	–
	T	0	0	0	188	1	2	0	0	0			
2	D	16 616	1 103	930	7 867	465	238	35 357	1 087	286			
	N	0	0	0	1 245	6	27	1 057	18	0	0	0	0
	S	0	0	0	0	0	0	0	0	0	0	0	0
	F	0	–	–	0	–	–	0	–	–	0	–	–
	T	16 616	1 103	930	9 112	471	265	36 414	1 105	286			
3	D	4 045	152	249	362	26	0	7 469	484	30			
	N	0	0	0	269	0	0	92	2	0	0	0	0
	S	0	0	0	0	0	0	0	0	0	0	0	0
	F	0	–	–	0	–	–	0	–	–	0	–	–
	T	4 045	152	249	631	26	0	7 561	486	30			
4	D	23 306	531	1 302	3 602	100	199	21 533	1 543	255			
	N	257	5	13	1 179	9	4	3 940	50	7	2 523	24	6
	S	2 874	26	14	33	0	0	0	0	0	985	17	0
	F	4 000	91	223	2 000	56	110	0	–	–	2 000	–	–
	T	30 437	653	1 552	6 814	165	313	25 473	1 593	262			
5A	D	20 612	437	1 024	3 020	34	306	17 679	203	51			
	N	11 203	191	642	38 397	296	370	50 089	254	41	25 556	97	116
	S	0	0	0	0	0	0	0	0	0	0	0	0
	F	4 300	91	214	0	–	–	0	–	–	1 000	–	–
	T	36 115	719	1 880	41 417	330	676	67 768	457	92			
5B	D	339	13	20	4 012	63	1 268	17 937	73	3 662			
	N	0	0	0	0	0	0	0	0	0	0	0	0
	S	0	0	0	0	0	0	0	0	0	0	0	0
	F	0	–	–	0	–	–	0	–	–	0	–	–
	T	339	13	20	4 012	63	1 268	17 937	73	3 662			
6	D	43 358	101	6 351	37 437	441	8 099	87 530	6	11 213			
	N	0	0	0	0	0	0	0	0	0	0	0	0
	S	0	0	0	0	0	0	0	0	0	0	0	0
	F	0	–	–	0	–	–	0	–	–	0	–	–
	T	43 358	101	6 351	37 437	441	8 099	87 530	6	11 213			

*) D = Denmark, N = Norway, S = Scotland, F = Faroe Islands, T = Total.

APPENDIX 3

ESTIMATES OF LONG-TERM GAINS TO THE HUMAN CONSUMPTION FISHERIES AS A RESULT OF CLOSURE OF NORWAY POUT BOXES

Input Parameters for the Model

1) For haddock and whiting respectively and for each combination of closures specified by the Commission of the EEC a value of the amount of fish which would be caught as compared to the no closure situation was evaluated in the manner described in Section 4 of this Report.

   It was evident that the values obtained for either species in the cases of involving no closure in summer were not greatly changed by involving considerations of summer closures. For this reason, a series of simulations was run for Option 2, the average of Options 4 and 6 and Option 10 (see Section 4.2). Input values appropriate to these simulations are shown in Table 4.8.

2) An array of values of F at age which the industrial fishery would generate in the absence of any restraint on that fishery was evaluated. It was decided that these values should be based on the industrial F at age array for 1976. In the case of haddock the values of F at age for 1976 were slightly modified before being used as input to the model as a result of discussions within the Working Group. The major difference was to change F at age 0 from 0.25 to 0.14, i.e. the average of 1974 to 1977. No modification was made to the industrial F at age array on whiting.

3) The arrays of F at age generated by the consumption fishery in 1977 were used as typifying that fishery in terms of fishing mortality.

4) Values of mean weight at age in the industrial and consumption fisheries were taken from the 1977 Roundfish Working Group Report for haddock and from the 1978 Roundfish Working Group Report for whiting.

5) Mean numbers of haddock and whiting in the sea at age 0 were taken from the 1978 Roundfish Working Group Report.

6) It was assumed that M = 0.2 at all ages.

The input values referred to above are summarised in Tables A.3.1 and A.3.2 for haddock and whiting, respectively.

Calculations

1) An equilibrium stock in numbers was generated from the average recruits by applying the input F and M values.

2) The catch in numbers at age was obtained for this equilibrium stock for the industrial fishery, consumption landings fishery and for discards. Corresponding values of total weight caught were evaluated by applying the mean weight at age data to the appropriate catch at age array. The values thus calculated were stored as baseline statistics.

3) To assess the effect of a box closure on the industrial catch of haddock and whiting the values of catch at age in the industrial fishery as evaluated in 2) above were reduced by the amount appropriate to that closure as shown in the Tables of input parameters.

4) The value of F at age in the industrial fishery corresponding to the reduced values of catch at age was then evaluated. This resulted in a new array of F at age for all fisheries combined.

5) A new catch at age array of consumption landings and discards was then evaluated on the basis of this new F at age array. Total weight caught under the new conditions was evaluated by applying the appropriate mean weight at age arrays to the revised catch at age arrays.

6) If the effects of a mesh change in the consumption fishery were also being investigated, the values of F at age in that fishery were adjusted in the following way:

   The mean lengths at age in the consumption fishery were evaluated from the corresponding mean weight data by means of an appropriate weight/length relationship given in the Tables of input values. The proportion retained by the existing mesh (75 mm) was worked out using a logistic function. The proportions retained using a new mesh size (80 or 90 mm) were similarly evaluated. The values of F at age were then adjusted by the ratio S2/S1 where, S1 = proportion retained by old mesh, and S2 = proportion retained by new mesh.

Simulations

A simulation appropriate to each closure specified by the Commission of the EEC was run for mesh sizes 75, 80 and 90 mm respectively for haddock and whiting. The results of these simulations are summarised in Tables A.3.3 and A.3.4.

Table A.3.1 Haddock.
Input data for pout box assessments.

M = 0.2 all ages. Recruits at age 0 = 611 x 10^6.

Age	Industrial		Consumption		Discards	
	F	$\overline{W}$	F	$\overline{W}$	F	$\overline{W}$
0	.14	.025	.00	-	.00	.041
1	.14	.064	.01	.230	.10	.108
2	.14	.157	.11	.280	.24	.185
3	.14	.324	.64	.410	.24	.246
4	.01	.423	1.00	.580	.02	.253
5	.01	.556	1.07	.710	.00	-
6	.01	.666	1.08	.940	.00	-
7	.00	-	1.10	1.210	.00	-
8	.00	-	1.10	1.440	.00	-
9	.00	-	1.10	1.500	.00	-
10	.00	-	1.10	1.600	.00	-

Proportion of obtainable
industrial catch realised
after closure

Closure			
None	1W or 1W+1S	2W or 2W+1S or 2W+2S	3W or 3W+1S or 3W+2S or 3W+3S
1.00	0.95	0.80	0.70

Data for mesh changes

Mesh size	75	80	90
Selection range	2.1	2.3	2.5

Selection factor 3.4

$W = 0.008 L^3$

Table A.3.2 Whiting.
Input data for pout box assessments.

M = 0.2 all ages. Recruits at age 0 = 1643 x 10^6.

Age	Industrial		Consumption		Discards	
	F	$\overline{W}$	F	$\overline{W}$	F	$\overline{W}$
0	.20	.020	.00	-	.00	.034
1	.35	.063	.01	.187	.20	.121
2	.50	.195	.18	.228	.45	.148
3	.46	.269	.53	.269	.17	.193
4	.09	.322	.58	.322	.04	.194
5	.02	.380	.78	.380	.03	.233
6	.01	.468	.88	.468	.01	.233
7	.01	.620	.81	.620	.00	-
8	.01	.765	.80	.765	.00	-

Proportion of obtainable industrial catch realised after closure

Closure			
None	1W or 1W+1S	2W or 2W+1S or 2W+2S	3W or 3W+1S or 3W+2S or 3W+3S
1.00	.95	.75	.70

Data for mesh changes

Mesh size	75	80	90
Selection range	2.6	2.9	3.3

Selection factor 3.8

$W = 0.0093\ L^{2.9456}$

Table A.3.3 Long-term effect of box closures on Haddock catches.

		Closures			
		None	1W[2] or 1W+1S	2W or 2W+1S or 2W+2S	3W or 3W+1S or 3W+2S or 3W+3S
Proportion of obtainable industrial catch realised after closure		1.00	.95	.80	.70
Mesh size	Fishery	Δ %[1]	Δ %	Δ %	Δ %
75 mm	Industrial landings	0	-5	-20	-30
	Consumption landings	0	3	11	17
	Consumption discards	0	2	8	2
80 mm	Industrial landings	6	1	-15	-26
	Consumption landings	7	10	19	25
	Consumption discards	-10	-8	-3	1
90 mm	Industrial landings	18	12	-6	-17
	Consumption landings	22	25	36	43
	Consumption discards	-33	-32	-27	-25

1) Δ % = % change in catch in weight as compared to the values obtained for no closure and 75 mm mesh.

2) 1W means Box 1 closed in winter.

2W+1S means Box 2 closed in winter, Box 1 closed in summer, etc.

Table A.3.4 Long-term effect of box closures on Whiting catches.

		Closures			
		None	1W[2] or 1W+1S	2W or 2W+1S or 2W+2S	3W or 3W+1S or 3W+2S or 3W+3S
Proportion of obtainable industrial catch realised after closure		1.00	.95	.75	.70
Mesh size	Fishery	Δ %[1]	Δ %	Δ %	Δ %
75 mm	Industrial landings	0	-5	-25	-30
	Consumption landings	0	7	38	47
	Consumption discards	0	4	19	23
80 mm	Industrial landings	17	11	-12	-18
	Consumption landings	10	18	57	68
	Consumption discards	-27	-24	-12	-8
90 mm	Industrial landings	43	36	8	0
	Consumption landings	19	30	79	93
	Consumption discards	-65	-63	-56	-54

1) Δ % = % change in catch in weight as compared to values obtained for no closure and 75 mm mesh.

2) 1W means Box 1 closed in winter.

2W+1S means Box 2 closed in winter, Box 1 closed in summer, etc.

APPENDIX 4

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