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THE SPRAT FISHERIES AND THEIR ROLE IN JUVENILE HERRING CATCHES

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PART I - INTRODUCTION

1. Background

At its meeting of 9-11 December 1988, the Council adopted the following declaration:

"The Council notes that the Commission intends to carry out a thorough examination of the situation of sprat fisheries in the North Sea and the Skagerrak and their role in juvenile herring catches, and to submit a report to the Council on foreseeable developments."(1)

In order to respond to this declaration the Commission requested Member States to provide it with any information additional to that in published documents. Only Denmark responded, forwarding to the Commission a detailed biological and socio-economic analysis of the relevant fishery in the Skagerrak and Kattegat.

The socio-economic analysis contained in this report of the Commission is necessarily based entirely on the Danish report because the data contained therein are not available in the public domain.

The other main sources of information is the latest scientific advice given in the Report of the Advisory Committee on Fisheries Management (ACFM) of the International Council for the Exploration of the Sea (ICES) for May 1989 and relevant reports of the ICES Working Groups.

The declaration of the Council clearly originates from concern about the effect on the state of the herring stocks, in particular those in the North Sea, of catches of juvenile herring taken in fisheries for which the nominal target species is sprat.

The herring stock in the North Sea (ICES subarea IV and Division VIIId) is, after its collapse in the 1970s, recovering more slowly than anticipated. ICES estimated that the spawning stock size in 1988 was only 822,000 t compared with a predicted size of 1,171,000 t. The target level for the spawning stock biomass, set as a management objective by the EC and Norway, is 2.2 million tonnes.

(1) Council Document 10269/88 Pêche 196 of 14.12.1988

Part of the reason for the slower rate of growth in the size of the stock from 1987 to 1988 has been attributed by ICES to three biological causes:

- an overestimation of the size of the 1985 year-class;
- a small overestimate of the adult stock in 1988, and
- a further decrease in the growth rate of herring.

Several fishery-related factors have also certainly contributed to this slower rate of growth, such as:

- the considerable overfishing of the TAC;
- the slipping of catches;
- the discarding of catches;
- the catches of juvenile herring caught in the directed fishery for mixed clupeoids in the Skagerrak and Kattegat (ICES Division IIIa), as a by-catch in the industrial fisheries for other species and as a by-catch in the adult herring fishery in the eastern parts of the middle North Sea (ICES Division IVb) and in Division IIIa.

The Commission is not in a position to comment in detail on all these developments, not only because it is outside the scope of the report requested by the Council, but also because the basic data to make a detailed assessment are not available.

However, it should not be overlooked that, in concentrating upon one issue concerning the rational management of the herring stocks, there may be other issues which have an equal or even much more important impact on rational management. The absence of programmes to monitor discards and slipping means that, although it may be suspected that such practices are widespread, they cannot be quantified and officially do not exist. Incidental reports suggest that the rate of discarding may be as high as 50% at certain times and in certain areas.

In this context, ACFM noted in its report for 1988 that unrecorded fishing mortality due to discards and breaking of gear had formed a considerable proportion of the total mortality on the stock of Norwegian spring-spawning herring, with the implication that this had had an adverse effect on the development of this stock.

This report, therefore, necessarily concentrates on the developments in the mixed clupeoid (herring/sprat) fishery in the Skagerrak and Kattegat and the eastern part of the North Sea.

PART II - BIOLOGICAL ASSESSMENTS

2. The biology of herring in the North Sea and the Skagerrak and Kattegat

Herring spawn in the western North Sea (Figure 1). When the eggs, which are fixed to the seabed, hatch, the larvae are carried by the currents to the eastern part of the North Sea, particularly along the west coast of mainland Denmark, and into the Skagerrak and Kattegat.

The inflow of herring into the Skagerrak and Kattegat occurs in winter when the herring are 3-5 cm long. In the following summer they grow to a size of about 10-15 cm. Until this age they are called 0-groups. During the following year they grow to a size of about 15-25 cm. They are now called 1-groups. In the autumn and winter they leave the Skagerrak-Kattegat area and migrate back to the North Sea. Thus, very few North Sea 2-groups or older North Sea herring are found in the Skagerrak-Kattegat.

The juvenile herring found off the west coast of mainland Denmark have a similar growth and migratory pattern, except that it is an offshore movement with age.

The proportion of juvenile North Sea herring which occurs in the Skagerrak and Kattegat varies from year to year; in surveys carried out in November-December 1985-88, the proportion of 0-group herring in the Skagerrak and Kattegat varied between 60-73% and of 1-group herring between 17-90%.

Herring of local Skagerrak and Kattegat and of Baltic Sea origin also occur in the Skagerrak and Kattegat but as these are not caught in the fisheries for sprat, they are not relevant to this report and are not considered further.

3. The biology of sprat in the North Sea and Skagerrak and Kattegat

The biology of sprat is not so well-documented as that of herring. The most relevant aspect in the context of this report is that the distribution of sprat partially coincides with that of herring (Figure 2). Where they overlap, the two species form schools which contain a mixture of both species of the same length and it is usually impossible to catch one species without catching the other. As sprat

reach a maximum length of 16-17 cm, and most are smaller than this, the herring within these schools always consist of juveniles.

For reasons which are not understood, the abundance of sprat in both the North Sea and the Skagerrak and Kattegat, as indicated by landings, has varied markedly between 1947 and 1986 (Table 1).

4. The origins of the problem

Historically, the fishery for sprat has always been a fishery for a mixture of varying proportions of sprat and juvenile herring, the proportion of the two species varying with time as the relative abundance of the two species fluctuated.

(In the context of this report the term "fishery for sprat" is used to mean those for sprat and juvenile herring, irrespective of the relative percentages of the two species caught, carried out using a minimum mesh size of 16 mm.)

As there has never been a large market for sprat for human consumption purposes, most of the catches of sprat, together with the associated catches of juvenile herring, have always been used for reduction to meal and oil.

While catches of herring in the directed herring fishery were high, the existence of the sprat fisheries did not present any problems. However, a series of factors changed this situation.

Firstly, catches of herring from the North Sea, which had been declining since 1965, started to fall rapidly from 1973 onwards, resulting in the effective closure of the fisheries in EC waters in 1977 by Council Regulation (EEC) N° 2115/77 (1).

This coincided with a rapid increase in the North Sea in the catches of sprat which had exceeded 100,000 t only once in the period 1947-1972 to a maximum of recorded landings of 609,748 t in 1976, after which they fell almost equally as rapidly as they had increased.

(1) O.J. N° L 247, 28.9.1977, p. 2.

In this situation catches of juvenile herring taken as a by-catch in the sprat fisheries were seen as both contributing to the decline of the stock of herring and preventing its recovery. This latter aspect was given greater emphasis when large year-classes of herring started to be spawned from 1981 onwards resulting in very high catches of juvenile herring in the fisheries for sprat, the catches from which began to consist of an increasing proportion of juvenile herring as the stock of sprat decreased and that of herring increased.

In the Skagerrak and Kattegat (the official statistics for the two areas are not distinguished), catches of herring remained relatively stable from 1970 onwards but, as in the North Sea, landings of sprat decreased, although from a later date (1980-81).

However, for both the North Sea and Skagerrak and Kattegat the official statistics of landings recorded as sprat include the unsorted by-catches of herring. Sampling of these landings to estimate the percentage of herring shows that the official statistics overestimate the true catches of sprat which, in both the North Sea and Skagerrak and Kattegat, fell rapidly from 1975 onwards (Table 2). Comparison of the official statistics with those produced by ICES Working Groups indicates that, both in the North Sea and the Skagerrak and Kattegat, catches of herring have been underestimated and those of sprat have been overestimated.

5. Management objectives

The conservation policy of the EC has as its primary objective to maximize the catches from the fisheries. To achieve this objective in respect of the stock of North Sea herring, the EC has adopted a series of regulations whose objective is to limit the catches of juvenile herring taken as by-catches in the fisheries for sprat. These regulations consist of by-catch limits and seasonal area closures. These measures have the objective of increasing the average yield from the herring fishery by permitting a higher proportion of the growth potential of the fish to be utilized. The legislation is summarized in Annex I. Although Regulation N° 2115/77 prohibits directed fishing for herring for reduction to meal and oil, the objective of this Regulation was to ban fishing for herring in EC waters. In 1977, banning fishing for purposes other than for human consumption was the only means available to the EC to achieve a total ban, fishing for herring for reduction to meal and oil being the only fishery for herring in the North Sea at that time.

Although maximizing the growth potential of each species is a primary objective of the EC conservation policy, it is an objective which is subject to social and economic considerations, as provided for by Article 1 of Council Regulation (EEC) N° 170/83 (1). This is demonstrated by the fact that the 10% by-catch limit for herring in catches of sprat caught in the Skagerrak and Kattegat has not been applied in EC legislation since 1985 because to have done so would have resulted in the total closure of the fishery for sprat. Also, from the same year and for the same area, it has been permitted to count against the EC share of the TAC all by-catches of all other species which are caught when fishing for sprat and which are landed unsorted.

Since 1986, the latter provision has formed part of the Agreed Record of the consultation on the regulation of fisheries in the Skagerrak and Kattegat between the EEC, Norway and Sweden and therefore applies to all sprat catches in the area.

The former provision was only agreed between the three parties for 1986 and since then each party has been free to fix its own measures. Norway has become increasingly critical of the lack of what it considers a rational exploitation of this fishery.

A specific management objective for the stock of North Sea herring is to achieve a spawning stock biomass of 2.2 million tonnes, as provided for in the Agreed Record of Conclusions of Fisheries Consultations between the European Economic Community and Norway, Brussels, 26-28 November 1986. The two parties agreed to manage the stock in a way designed to reach this objective but did not fix any specific management measures, except to minimize catches of juvenile herring.

(1) O.J. N° L 24, 27.1.1983, p. 1.

6. The fisheries

6.1. The North Sea

The fishery for sprat off the west coast of mainland Denmark in the North Sea is carried out by 80-200 small vessels fishing in the shallow coastal zone during part of the year. The herring caught in this fishery are mainly 0-group caught in the second half of the year and small 1-group caught in the first half of the year.

Larger 1-group together with adult herring are also taken by trawlers using nets with a minimum mesh size of 16 mm and also by trawlers using nets with a minimum mesh size of 32 mm and by purse seiners. These fisheries take place offshore and are not considered fisheries for sprat.

The distribution of the estimated herring catches in these fisheries in 1988 by age group, area and quarter are shown in Table 3.

6.2. The Skagerrak and Kattegat

The fishery for sprat is the most important industrial fishery in the Skagerrak and Kattegat although other species such as sandeel, Norway pout and blue whiting contribute significantly to the landings in some years. During the period 1975-88 the total quantities landed by the fishery for sprat have not changed significantly but the species composition has altered dramatically. In the 1970s most of the landings consisted of sprat, a situation which changed from 1979 onwards when the rapid decline of the sprat stock resulted in a predominance in the landings of herring from 1982 onwards. (Figure 3).

Although the catch composition of the trawl fisheries consists of several species, the analysis made by the Danish authorities of the target species, difference in fishing seasons and fishing areas made it possible to identify the fleet fishing for sprat. Since 1988, this fleet has consisted only of vessels less than 22 metres long, because vessels above this length can no longer obtain a licence from the Danish authorities for the fishery for sprat.

The species composition in the landings of this fleet for the three most recent years (Table 4) shows that total landings have increased to 112,000t and that herring dominates the landings.

The age composition of the herring taken in the fishery for sprat is given in Table 5 which shows that this fishery is now almost entirely based on juvenile herring.

7. The effect of catches of juvenile herring in the fisheries for sprat on catches of adult herring

The juvenile herring which occur off the west coast of mainland Denmark and in the Skagerrak belong to the North Sea stock of herring. Therefore, any catches taken in those two areas will affect recruitment to the adult population of this stock but will have no effect on the catches of adult herring in the Skagerrak-Kattegat.

The effects of fishing juvenile herring have recently been analyzed, separate analyses being made for the North Sea and Skagerrak and Kattegat.

7.1. The North Sea

For the North Sea, the effects of stopping all fishing of juvenile herring were examined by making a yield-per-recruit analysis of the effects of stopping successively catches of fish in the first year of life (0-group), first and second years of life, and first, second and third years of life. Older fish are mature. The results are shown in Table 6. In order to give figures in absolute terms, the yield-per-recruit data have been multiplied by the average recruitment for 1981-88 (54,291 million 0-group herring).

It is necessary to treat these figures with considerable caution.

Firstly, the analysis shows the effect of stopping all fishing for juvenile herring which are caught in three types of fishery:

- those for 0-group and small 1-group herring caught in shallow-water coastal fisheries by vessels using small mesh (16 mm) bottom trawls; ./.

- those for larger 1-group fish caught offshore in deeper water during the second half of the year by larger trawlers using both 32 mm and small mesh trawls, fishing herring for reduction to meal and oil;
- those for the same age-groups using purse seines.

ICES has no information concerning the rate of mortality generated by each method of fishing. However, from the description of the fisheries given above and the distribution of catches by area and age-group (Table 3) it may be concluded that the first of the three fisheries is that which is nominally a fishery for sprat in which all the 0-group fish (14,800t in 1988) and a small proportion of the 1-group fish (10,400t in 1988) are caught, while the remainder of the 1-group fish (98,900t in 1988) are caught in the other two fisheries, either in directed fisheries for juvenile herring or as catches of 1-group taken incidentally while fishing for older herring. Therefore, the analysis will overestimate the potential gains and losses.

Secondly, they are based on a fishing mortality rate on the fully-exploited age-groups of 0.33, whereas the present fishing mortality rate is of the order of 0.6. While this latter rate of fishing mortality is maintained, potential gains will be lower.

Thirdly, the calculations are very sensitive to the values of the natural mortality rate used. If those used in the calculations are less than the true values, the gains to the offshore fisheries and spawning stock biomass may be far less than calculated. In this respect it is to be noted that the ICES Multi-species Working Group uses values of the natural mortality rate for 0-6 group which are higher than those used by the ICES Working Group for Herring Assessment for the area south of 62°N.

7.2. The Skagerrak and Kattegat

Yield-per-recruit calculations similar to those for the North Sea are not available for the Skagerrak and Kattegat. For this area calculations are available to demonstrate only the gains and losses for each one million of 0- or 1-groups in each quarter as follows:

**Effect of reducing the catch of each age-group in each quarter
by one million herring**

Quarter	Age	Reduced catch of juveniles in numbers	weight in g	Reduced catch of juveniles in tonnes	Gain of 2+ -groups in tonnes	Net gain
3	0	1,000,000	10	10	17.7	7.7
4	0	1,000,000	19	19	23.7	4.7
1	1	1,000,000	16	16	33.9	17.9
2	1	1,000,000	20	20	42.7	22.7
3	1	1,000,000	36	36	57.3	21.3
4	1	1,000,000	54	54	75.8	21.8

It is assumed that prevention of a certain catch of juvenile herring will mean that these survivors will not be caught before they are 2-groups.

Using estimated catch by numbers for 1988, these represent the absolute tonnages given in the table below.

Quarter	Age	Millions caught in 1988	Reduced catch of juveniles in tonnes	Gain of 2+ groups in tonnes	Net gain in tonnes
3	0	1,305 (a)	13,050	23,100	10,050
4	0	525	9,980	12,440	2,460
1	1	1,240	19,840	42,040	22,200
2	1	2,087	41,740	89,120	47,380
3	1	1,814	65,300	103,940	38,640
4	1	651	35,150	49,350	14,200
Totals	-	-	185,060	319,990	134,930

(a) including 111 million caught in the second quarter.

The total reduced catch of 185,060t corresponds closely with the estimated catch of 183,000t, indicating that these results are of the right order.

However, all of these catches of juvenile herring are not taken in the fishery for sprat. Part is taken as a by-catch in the fisheries for other species used for reduction to meal and oil and part in the fishery for adult herring.

The economic analysis carried out by the Danish authorities has enabled the quantity landed by vessels fishing for sprat to be determined. This amounted to 97,000t in 1988 (See Table 7). Therefore, the gains shown need to be pro-rated by the factor of 97,000/185,000 to obtain the results of closing the Danish fishery for sprat. This estimate is only very approximate because it takes no account of the differences in the age distribution and mean weight at age by quarter between Danish catches and the total international catches which are give in the above text-tables.

The ICES reports do not make an estimate of the effect of these catches on the spawning stock biomass, but assuming a natural mortality rate of 0.1, a fishing mortality rate of 0.33 and that 70% of the stock biomass of herring aged 2 years and older is mature, this represents a spawning stock biomass of the order of 835,000 tonnes.

Again, these figures must be treated with caution because they are very sensitive to both the mean weights and natural mortality rates used.

7.3. Summary

Accepting the figures as they stand, the estimated effects on herring of the closure of the fisheries for sprat in the North Sea and the Skagerrak and Kattegat would be as follows:

	<u>Tonnes</u>	<u>Tonnes</u>
Losses in the North Sea fishery for sprat	75,000	
Losses in the Skagerrak and Kattegat fishery for sprat	97,000	
Total		172,000
Gains in the North Sea fisheries for adult herring:		
- from closure of N. Sea fishery	131,000	
- from closure of S+K fishery	167,800 (a)	
Total		298,800
Net gains:		
- from closure of N. Sea fishery	56,000	
- from closure of S+K fishery	70,700 (a)	
Total		126,700
Gain in spawning stock biomass:		
- from closure of N. Sea fishery	422,000	
- from closure of S+K fishery	437,800 (a)	
Total		859,800

(a) Total pro-rated 97,000/185,000

ACFM, in its report of May 1989, made the following comments on its assessments:

"The balance of gains to the human consumption fisheries and losses to the industrial fisheries depends on the expected survival of juveniles until they recruit to the adult stock. The values of natural mortality used in the calculations are still somewhat uncertain. Using currently accepted estimates of natural mortality, there would be potential gains in both yield and spawning stock biomass if 0- and 1-group catches were significantly reduced or abolished. There would also be additional gains if catches of 2- and 3-ring herring were reduced.

The magnitude of the expected gains also depends on the timing and area of any reduction in catches of juveniles. In general, the largest net gains can be expected by reducing juvenile catches in Division IIIa because juveniles there are on average smaller than in the North Sea. Within the North Sea, the largest gains come from reducing catches of 0-group and of 1-group in the first quarter of the year. Later in the year, most 1-group are caught as a by-catch in the adult fisheries and any gains are marginal.

In all cases, a proportional increase in spawning stock biomass is expected from a reduction in catches of juveniles. ACFM would also point out that the overall catch in weight of North Sea herring would consist of a higher proportion of adult herring."

PART III - The Economic analysis of the Danish mixed-clupeoid fishery in the Skagerrak and Kattegat (1)

8. Introduction

The complete prevention of catches of juvenile herring in Division IIIa is not possible because juvenile herring are also caught as a by-catch in the adult herring fishery and in the industrial fisheries other than for mixed-clupeoids. However, catches of juvenile herring in this area would be significantly reduced if the mixed-clupeoid fishery, in which the catches consist mainly of juvenile herring at present, were closed.

This section gives a socio-economic analysis of such a closure based on an analysis of the fishery for the period 1986-88.

9. The size of the fleet

The following criteria were used to identify the vessels which participate in this fishery:

- length overall of less than 22 metres (in 1988 vessels above this length were not allowed to take part in this fishery);
- landings for reduction to meal and oil include species other than sandeel;
- landings of adult herring less than 10% of the fish landed for reduction to meal and oil (excluding sandeel);
- landings of Pandalus species less than 1% of the fish landed for reduction to meal and oil (excluding sandeel);
- sales of fish caught in ICES division IIIa for reduction to meal and oil to comprise more than 5% of the total sales.

(1) It was not possible to make a similar analysis of the fishery for sprat in the North Sea because it was not possible to identify a specific fleet of vessels which primarily fishes for sprat.

In effect such a fishery is illegal because the provisions of the annual TAC and quota regulations for 1989, Articles 6(1) and 7(2) of Council Regulation (EEC) N°4194/88 (O.J. N° L369, 31.12.1988, p. 3) prohibit fishing for both herring and sprat in an area of the west coast of the mainland of Denmark during the period 1 July to 31 October. The objective of these provisions is to prevent fishing for juvenile herring.

Based on these criteria, the numbers of vessels taking part in the mixed-clupeoid fishery were 231 in 1986, 120 in 1987 and 195 in 1988.

In order to establish how many vessels depend entirely on this fishery (i.e. vessels which would have no alternative fishing opportunities if the mixed-clupeoid fishery were to be closed) two additional criteria were used:

- a minimum of 30% of total annual sales derived from the mixed clupeoid fishery;
- an annual income from all fisheries of more than 6,200 ecus (to exclude part-time fishermen) (1).

Based on these additional criteria, 91 vessels depended entirely on the mixed-clupeoid fishery in 1986, 81 in 1987 and 88 in 1988 (Table 7).

10. The value of the Danish mixed-clupeoid fishery

The gross value of the landings from the mixed-clupeoid fishery is given in Table 7.

Earlier studies estimated the direct variable cost (covering oil, ice, landing costs and wear of the gears) at approximately 20% of the gross value, resulting in the net values for the landings shown in Table 7.

11. The additional value generated by the mixed-clupeoid fishery

The additional value generated from reduction to fishmeal and oil was estimated from existing conversion factors for the raw material into fishmeal and oil and on the average world market prices for meal and oil in each year 1986 to 1988 (Table 7).

The added value generated by fish landed for human consumption was estimated based on the assumption that all fish was processed as cod in frozen blocks and sold at average market prices (Table 7).

(1) In this report all values given in the report prepared by the Danish authorities and given in Danish Kroner have been converted to ecus using a conversion rate of D.Kr. 8.1 = 1 ecu and rounded.

12. The employment in the mixed-clupeoid fishery

The numbers of crew members employed in the mixed-clupeoid fishery are given in Table 7.

These employment figures do not take into account the additional employment generated in the unloading, transporting and processing of the fish. Based on earlier analyses linking employment proportionally to the amount of fish landed, an estimate of the employment generated by the mixed-clupeoid fishery, expressed in men per year, can be made.

For the period 1986-1988 these estimates are 164, 217 and 254 men per year respectively.

13. Cost benefit analysis of the consequences of closing the mixed-clupeoid fishery

13.1. General

A cost-benefit analysis of the consequence of closing the mixed-clupeoid fishery was carried out. This analysis took into account the biological effects on the herring stock and the total yearly costs of such a closure. The cost-benefits of a closure based on three different assumptions on the end use of the additional catch of adult herring were calculated. The following assumptions were made in the analysis:

- the mixed-clupeoid fishery would be closed from 1990 onwards and all vessels taking part in this fishery would stop all these fishing activities;
- the fishing pattern in 1990 was assumed to be the same as that in 1988;
- all catches by the mixed-clupeoid fleet would cease but the fishing pattern of other fleets not involved in the mixed-clupeoid fishery would not be affected;
- constant prices in real terms;
- the potential additional catches of adult herring to be taken by the existing EC-fleet.

13.2. Biological effect

An estimate of the potential additional catches of adult herring when closing the mixed-clupeoid fishery was made using standard assessment techniques based on the age structure in the mixed-clupeoid fishery in 1988.

The effects are given in Table 8. They show that the reduction of 97,000 tonnes in catches of mainly juvenile herring from 1990 onwards would result in a gradual increase in the potential catch of adult herring (mainly in the North Sea) to approximately 190,000 tonnes in 1998. This value differs from that of 167,800 tonnes given in Section 7.2 because it is based on the actual age distribution and weight-at-age of herring caught in the Danish fishery for sprat, not on the total international catch as the value in Section 7.2.

13.3. The total annual cost of closing the fishery

An examination of the uptake of Danish quotas in the Skagerrak and Kattegat shows that there is no possibility for expansion of fishing effort into the fisheries for species used for human consumption (Table 9). As it is assumed that it would be uneconomical for this fleet to continue to fish if it is deprived of its income from fishing for sprat. Therefore, the total annual cost of closing the fishery includes the net value of catches made by the fleet when not fishing for mixed-clupeoids, which was estimated at 4.1 million ecus plus the net value of the mixed-clupeoid fishery itself, which is estimated at 13.9 ecus, a total of 18.0 million ecus.

13.4. The cost-benefits from closing the mixed-clupeoid fishery

The benefits from closing the mixed-clupeoid fishery depend critically on the assumption made about the end use of the additional herring catches. Therefore, three different scenarios were investigated.

- Scenario I: all additional catches of adult herring would be used for reduction;
- Scenario II: 50% of the additional catches of adult herring would be used for reduction and 50% for consumption as fresh, chilled fillets;

Scenario III: all additional catches of adult herring would be used for consumption as fresh, chilled fillets.

In all scenarios, the average prices for 1988 have been used. The additional value is based on the percentages derived from the additional value calculation made in sections 10 and 11. Table 10 gives the results for scenario II as an illustration.

To compare the three scenarios, the discounted net benefit of closing the mixed-clupeoid fishery has been calculated for different discount rates and are over different time periods. The results are given in Table 11.

The results show that if all the additional adult herring is used for reduction purposes, the net benefits of closing the fishery are negative. To obtain a positive net benefit it is necessary to assume that a significant part of the additional herring catches can be sold at the current market price for herring for human consumption, which under the present circumstances must be considered as very optimistic.

It must also be borne in mind that all these scenarios are based on the assumption that the additional catches will be caught by the existing EC fleets. However, under this regime, the spawning stock biomass would probably exceed 2 million tonnes, in which case Norway would obtain 32% of the increased catches.

PART IV - DISCUSSION

The management of these fisheries for sprat presents issues which are of general interest in the context of the management of the Common Fisheries Policy.

The biological analysis shows that the prevention of the fisheries which are nominally directed towards sprat but which catch predominantly juvenile herring would theoretically result in large long-term gains to the fisheries for adult herring and an increase in the spawning stock biomass, unless there were unforeseen species interactions or technical developments which resulted in the predicted increases not being realized. Preventing the fisheries would therefore meet the primary objective of the Common Fisheries Policy of maximizing the yield from the resources and also meeting the agreed management objective for the North Sea stock of herring, that is, a spawning stock biomass of 2.2 million tonnes, although there are alternative ways of achieving this objective.

Unconfirmed reports that, in the fisheries for adult herring in the North Sea, rates of discarding may be as high as 50% at certain times and in certain areas and that "slipping" of catches also frequently occurs throw serious doubt on whether the conservation benefits would be realized. Discarding occurs either because catches of large herring may contain significant quantities of small herring for which there is no human consumption market demand or the roe, if the fish are being caught for that market, are not of the required quality. The latter is the reason for "slipping".

Although it cannot be validly argued that the fishery for sprat in the Skagerrak and Kattegat should not be prevented because the objectives which this would achieve might not be realized because malpractices take place elsewhere, the conservation policy must be coherent. In particular, in this case, the socio-economic consequences of preventing the fishery would be severe. If these costs are to be incurred, the benefits must be achieved. A parallel may be drawn with the situation in the fisheries for haddock and whiting in which conservation measures have been taken to limit catches of juveniles in order to increase yields. However, much of the potential benefits of these measures has been dissipated by malpractices in the fisheries which the conservation measures were intended to benefit.

There also arises the question of the natural fluctuations of herring and sprat. There is evidence that the stocks of sprat may be rebuilding. If action were taken to stop the fisheries and decommission the vessels concerned, the situation could arise in which a legitimate fishery could be pursued but there were no vessels available. This would parallel in some respects the situation in the herring markets following the recovery of the stocks.

Another aspect of this issue is the fact that the fishermen who would incur the costs of conservation would not benefit in the long term. It has been a tacitly accepted principle that, in implementing conservation measures, compensation for short-term conservation measures should not be paid because the group of fishermen affected would benefit from the long-term gains.

In the case of these fisheries, those fishermen whose fisheries were closed would incur all the costs and the benefits, if any, would be transferred to another group of fishermen which anecdotal information suggests already have a high standard of living. As this report demonstrates, it is uncertain whether there would be any financial benefits. There would certainly be financial costs.

Closing the fisheries would have severe social and economic consequences for those fishermen which prosecute this fishery which is, within the limits of the quotas fixed for sprat in Division IIIa and the provision which applies to the uptake of that quota, legal. It is estimated that the annual loss from closing the fishing in the Skagerrak and Kattegat would be 18.0 million ecus a year and that approximately 500 men would be made unemployed in an area where the rate of unemployment is high.

A fundamental element of the Common Fisheries Policy is that "conservation of the biological resources of the sea and their balanced exploitation on a lasting basis" should take place "in appropriate economic and social conditions" (Article 1 of Council Regulation (EEC) N° 170/83 (1)). The Community, in adopting conservation measures has always sought to achieve a balance between the necessities of conservation and socio-economic factors, notably in fixing total allowable catches. In many instances the Council has not been prepared to adopt conservation measures proposed by the Commission because it considered the short-term losses unacceptably high, even though the potential long-term gains could be demonstrated. A notable example was the delay in implementing a minimum mesh size in the North Sea from 1 October 1982 to 1 January 1989.

It is therefore concluded that, if this fishery were to be closed, the closure should be phased over a period of several years and that realistic compensation should be provided for those fishermen and other persons affected. The case for this is identical to that of persons who have become unemployed as a result of restructuring the coal and steel industries.

This is an issue of general importance because there are other examples in Community waters where it would be appropriate to close fisheries in nursery areas in order that EC fishermen as a whole benefit; for example, cod, sole and plaice in the North Sea and hake in the Bay of Biscay.

The Commission therefore concludes that this is not a simple issue which can be addressed simply by implementing additional conservation measures or making control more effective. Most of the necessary conservation measures are in force; the only additional measure which might be envisaged in the phasing out of the fishery for sprat in the Skagerrak and Kattegat. Control could be made more efficient but questions of cost and effectiveness arise. It is therefore proposed that the Council debates this problem in the light of this report in order that a politically equitable solution may be reached.

(1) O.J. N° L 24, 27.1.1983, p. 1.

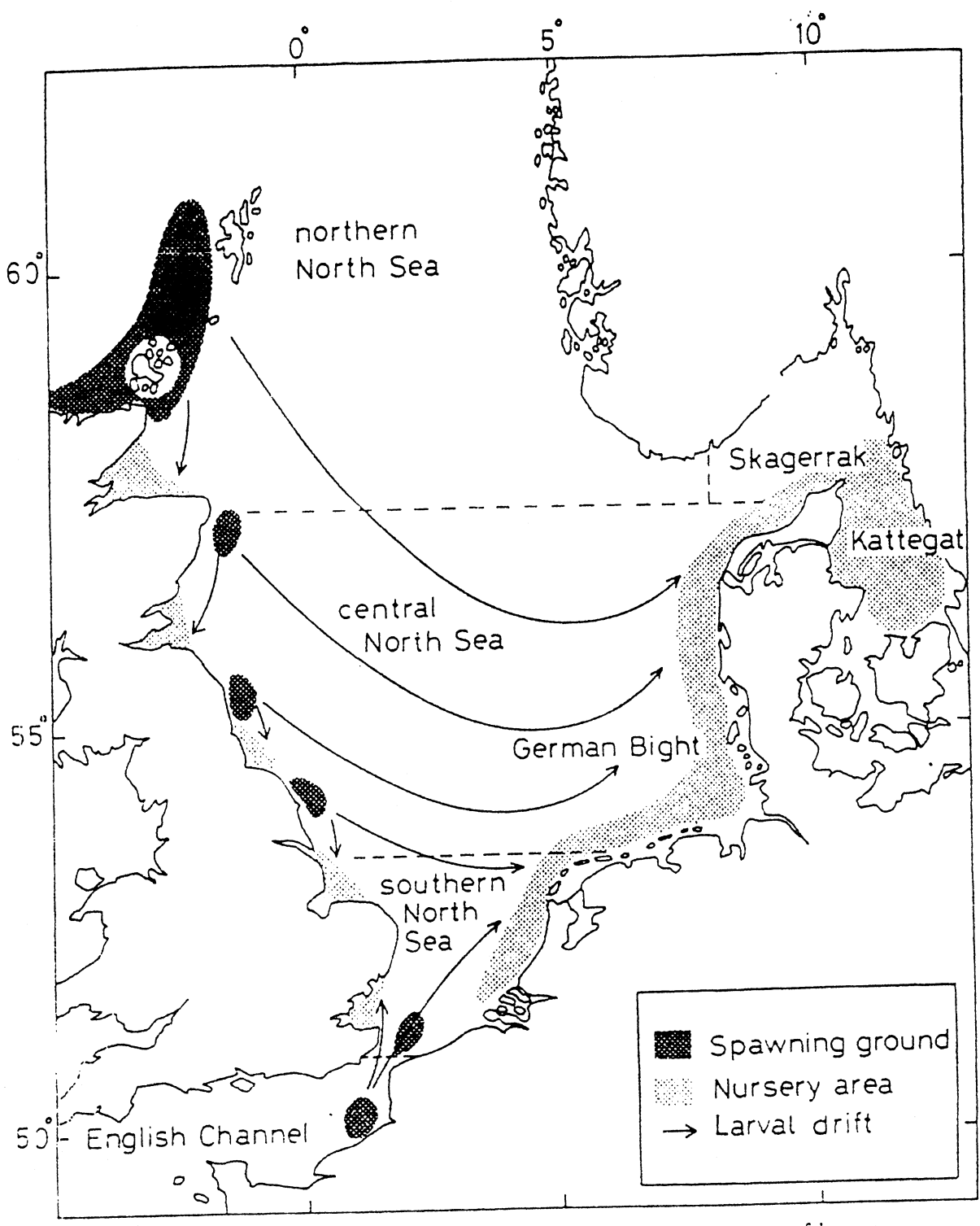


Figure 1. Herring spawning grounds, nursery areas, and drift routes of larvae.

FIGURE 3

INTERNATIONAL INDUSTRIAL CATCHES IN DIVISION IIIA

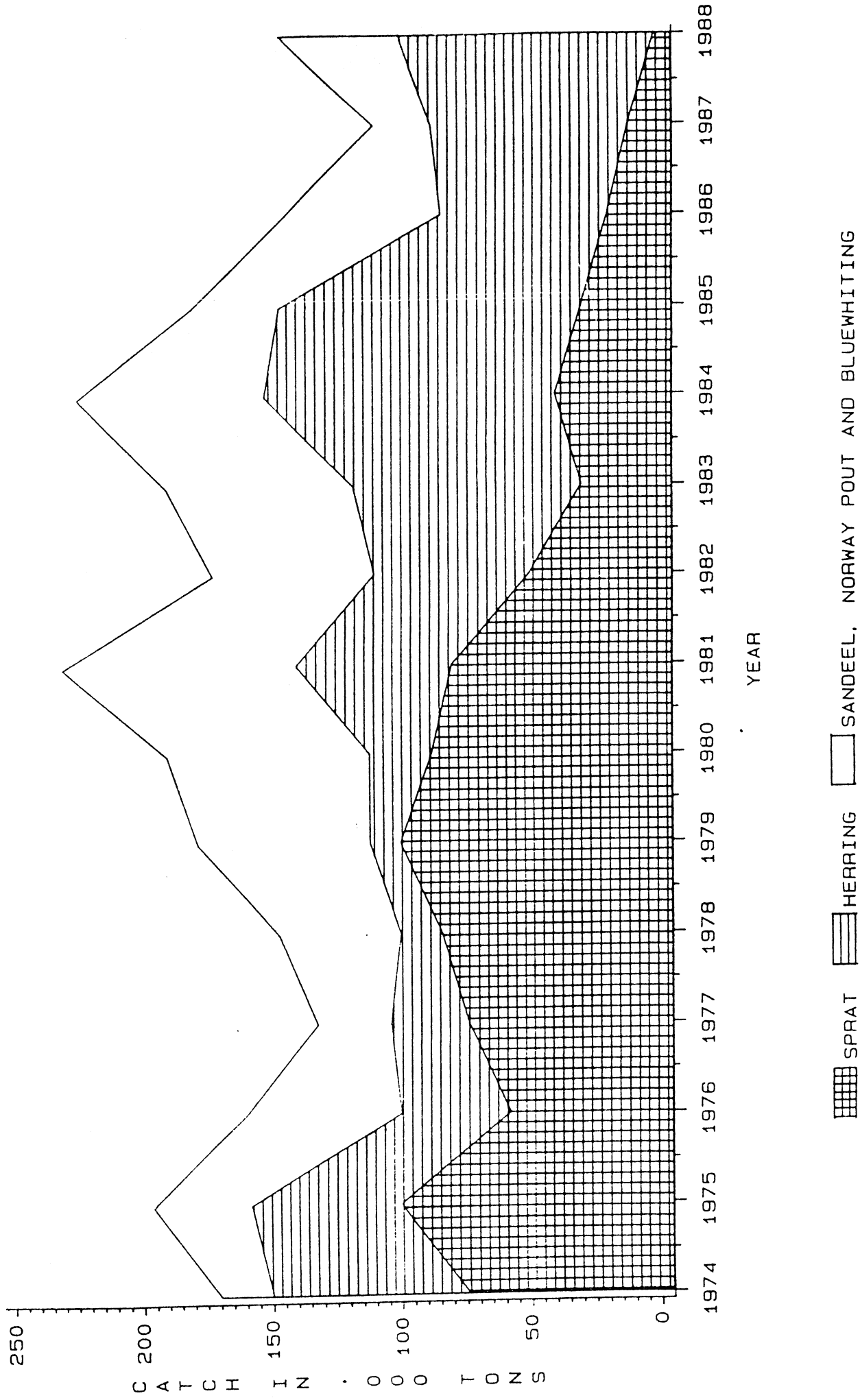


TABLE 1: Official landings of herring and sprat from the North Sea and Skagerrak and Kattegat. (In tonnes)

Year	North Sea		Skagerrak and Kattegat	
	Herring**	Sprat	Herring	Sprat
1947	989,066	8,599	40,398	12,011
1948	1,290,509	9,877	42,341	17,836
1949	1,057,246	13,176	52,365	16,142
1950	1,107,467	9,738	51,273	14,779
1951	1,220,216	11,683	46,671	13,338
1952	1,145,095	16,791	61,146	15,638
1953	1,211,390	21,491	47,940	18,471
1954	1,297,296	17,350	99,123	50,105
1955	1,411,220	23,528	108,054	44,888
1956	1,364,126	17,966	96,023	32,343
1957	1,047,834	22,396	129,985	19,116
1958	804,643	24,258	173,246	9,193
1959	903,654	32,405	152,306	14,259
1960	786,950	16,473	94,560	14,769
1961	689,778	19,694	121,901	17,781
1962*	678,515	31,312	116,771	11,988
1963*	805,301	67,668	159,988	10,168
1964*	932,046	70,812	273,603	5,683
1965*	1,230,315	76,180	238,923	3,298
1966*	1,038,851	106,577	152,449	4,376
1967*	819,324	69,496	244,698	6,339
1968*	850,127	65,437	288,987	5,030
1969*	724,853	65,294	113,086	3,306
1970*	748,750	51,002	85,675	6,622
1971*	644,385	89,153	90,274	11,056
1972*	604,808	92,371	106,822	4,445
1973	599,131	228,220	140,851	42,142
1974	326,600	326,127	100,676	50,269
1975	295,307	651,591	120,987	105,927
1976	162,531	609,748	92,211	60,346
1977	44,189	311,089	112,486	73,535
1978	6,496	401,654	101,947	75,103
1979	5,869	396,396	72,891	81,941
1980	13,795	407,616	78,422	101,372
1981	39,966	314,255	113,070	104,875
1982	47,700	298,028	106,162	82,036
1983	190,059	197,800	121,351	71,296
1984	235,335	132,658	144,455	48,469
1985	460,769	102,683	121,228	66,893
1986	462,446	60,219	145,026	61,861
1987)			
1988)	Not yet available		

SOURCE: 1947-1972 ICES, Bulletin Statistique
1973-1986 EUROSTAT, CRONOS

* For Sweden, from 1962 to 1972, herring and sprat in Skagerrak and Kattegat are included in figure for North Sea, except for sprat in 1971.

** For 1947-63, landings by Norway of spring-spawning herring which do not form part of the North Sea stock of autumn-spawning herring are included.

TABLE 2: Estimated landings of herring and sprat from the North Sea and Skagerrak and Kattegat. (In tonnes)

Year	North Sea		Skagerrak and Kattegat	
	Herring(1)	Sprat	Herring	Sprat
1975	312,789	641,200	126,113	100,600
1976	174,834	621,500	89,829	58,800
1977	46,010	304,000	115,296	67,400
1978	11,033	378,300	88,938	77,900
1979	19,158	379,600	69,195	95,600
1980	60,994	323,400	81,823	83,900
1981	140,972	209,100	171,601	76,300
1982	235,925	152,700	158,146	45,200
1983	305,954	88,200	197,996	26,500
1984	319,394(3)	77,200	232,587	36,500
1985	536,860(3)	50,200	242,485	21,900
1986	547,649(3)	16,400	212,349	18,000(2)
1987	626,294(3)	33,100	233,931	15,800(2)
1988	698,449(2)	92,000(2)	333,082(2)	8,800(2)

Source: Reports of the Advisory Committee on Fishery Management

- (1) Including ICES Division VIIId
- (2) Preliminary
- (3) Includes catches of Division IIIa spring spawners

Table 3: Catches of 0- and 1-group herring in the North Sea in 1988 by quarter and by area. (Source: ICES C.M. 1989/Assess/15).

Division	Age group	Quarter 1988				Total
		I	II	III	IV	
IVa (W of 2°E)	0	-	-	-	-	-
	1	-	0.3	+	0.9	1.2
IVa (E of 2°E)	0	-	-	0.1	0.1	0.2
	1	+	0.1	0.8	2.7	3.6
IVb	0	-	-	11.0	3.6	14.6
	1	2.2	7.8	73.7	20.4	104.1
IVc+VIId	0	-	-	-	-	-
	1	-	-	-	0.4	0.4
Total	0	-	-	11.1	3.7	14.8
	1	2.2	8.2	74.5	24.4	109.3

Weights in '000 t.
+ Less than 50 t.

Table 4: Species composition of the landings of Danish vessels fishing for sprat in the Skagerrak and Kattegat (tonnes)

Year	Herring	Sprat	Others	Total
1986	64 950	2 208	9 048	76 206
1987	72 006	2 739	12 746	87 491
1988	97 272	3 045	11 307	111 624

Table 5: Age composition in numbers of herring caught in the Danish fishery for sprat in the Skagerrak and Kattegat in 1988 ($\times 10^{-6}$)

Quarter:	1	2	3	4
0		111.11	990.62	339.73
1	1027.33	781.78	680.51	135.94
2	107.19	103.30	72.90	49.17
3	3.55	17.70	7.79	4.47
4	0.78	2.52	1.42	
5	1.20		0.37	0.91

Table 6: Effect on stopping fishing on 0-group and 0- and 1-group herring in the North Sea based on an average annual recruitment for 1981-88 of 54,291 million 0-group herring (tonnes)

Fishing pattern	Total catch	Spawning stock biomass	Gain in spawning stock biomass	Losses (a)	Gains (b)	Net gain in catch
Actual	672,500	1,927,500	-	-	-	-
No fishing on 0-group	698,000	2,096,500	169,000	26,500	52,000	25,500
No fishing on 0- and 1-group	728,500	2,349,500	422,000	75,000	131,000	56,000

(a) in all the fisheries in which juvenile herring are caught.
 (b) gains in the fishery for adult herring (2+ group).

NB: These calculations are based on a fishing mortality rate on the fully-exploited age groups of 0.33 compared with an actual rate of the order of 0.6.

Table 7: Economic statistics for the Danish mixed-clupeoid fishery in the Skagerrak and Kattegat, 1986-88

	<u>1986</u>	<u>1987</u>	<u>1988</u>
Number of vessels taking part in the fishery	231	120	195
Number of crew members	573	299	489
Number of vessels totally dependent on the fishery	91	81	88
Number of crew members	241	217	239
Employment generated (catching, transport, processing) in man-years	164	217	254
Catches (tonnes) herring	64 950	72 006	97 272
sprat	2 208	2 739	3 045
others	9 048	12 746	11 307
Sub-total	<u>76 206</u>	<u>87 491</u>	<u>111 624</u>
human consumption (a)	634	2 030	1 829
Total	<u>76 840</u>	<u>89 521</u>	<u>113 453</u>
Gross Value (million ecus)(b):			
reduction	5.0	5.4	8.8
consumption	0.9	3.1	2.5
Total	<u>5.9</u>	<u>8.5</u>	<u>11.3</u>
Net Value (million ecus)	4.7	6.8	9.0
Additional value fishmeal	2.6	2.2	3.9
Additional value human consumption (c)	0.4	1.3	1.0
Total	<u>7.7</u>	<u>10.3</u>	<u>13.9</u>

- (a) catches made in directed fishing for human consumption species weights correspond with values at (c).
- (b) excluding the value of the catches made by these vessels in other fisheries which, for 1988, was estimated at 4.1 million ecus.

Table 8: Potential additional catches of adult herring if the mixed-clupeoid fishery in the Skagerrak and Kattegat were closed from 1.1.1990 (tonnes)

The annual loss of juvenile herring is 97,000 tonnes

Effect	<u>1991</u>	<u>1992</u>	<u>1993</u>	<u>1994</u>	<u>1995</u>	<u>1996</u>	<u>1997</u>	<u>1998</u>
1990				17212	9562	3825	1912	1912
1991	61199	61199	34425	34425	17212	9562	3825	1912
1992		61199	61199	61199	34425	17212	9562	3825
1993				61199	61199	34425	17212	9562
1994					61199	61199	34425	17212
1995						61199	61199	34425
1996							61199	61199
1997								61199
Total potential additional catches	61199	122398	156823	174035	183587	187449	189361	191246



Table 9: Uptake of the Danish quota in percentages

	<u>1985</u>	<u>1986</u>	<u>1987</u>	<u>1988</u>
Herring IIIa	84	65	65	106
Herring IIIb, c, d (EC zone)	99	93	92	103
Sprat IIIa	140	100	98	101
Sprat IIIb, c, d, (EC zone)	83	79	100	91
Salmon IIIb, c, d (EC zone)	66	51	61	74
Cod IIIa Skagerrak	63	69	99	81
Cod IIIa Kattegat	97	70	103	46
Cod IIIb, c, d (EC zone)	90	102	98	103
Haddock IIIa; IIIb, c, d (EC zone)	84	42	39	32
Saithe IIa (EC zone), IIIa, IIIb, c, d (EC zone), IV	103	99	95	101
Whiting IIIa	17	3	5	3
Hake IIIa, IIIb, c, d (EC zone)	75	54	96	45
Mackerel IIa (EC zone), IIIa, IIIb, c, d (EC zone), IV	103	95	110	135
Plaice IIIa Skagerrak	105	95	103	85
Plaice IIIa Kattegat	61	51	67	43
Plaice IIIb, c, d (EC zone)	-	-	-	21
Sole IIIa, IIIb, c, d (EC zone)	76	125	101	83

Table 10 : SCENARIO II
50 pct. of potential gain in tonnes for reduction, and 50 pct. for human consumption

	1991	1992	1993	1994	1995	1996	1997	1998
A: Total potential gain in tonnes	61,199	122,398	156,823	174,035	183,587	187,449	189,361	191,246
<u>The reduction sector</u>								
B: 0.50*A Extra supply (tonnes)	30,600	61,199	78,412	87,018	91,794	93,725	94,681	95,623
C:(0.62/8.1)*B Catch-value by outlets (1,000 ECU)	2,342	4,684	6,002	6,661	7,026	7,174	7,247	7,319
D: 0.20*C Direct variable costs (1,000 ECU)	468	937	1,200	1,332	1,405	1,435	1,449	1,464
E: 0.45*C Value added (1,000 ECU)	1,054	2,108	2,701	2,997	3,161	3,228	3,261	3,294
F: C-D+E Benefits in the reduction sector (1,000 ECU)	2,928	5,855	7,503	8,326	8,782	8,967	9,059	9,149
<u>The consumption sector</u>								
G: 0.50*A Extra supply (tonnes)	30,600	61,199	78,412	87,018	91,794	93,725	94,681	95,623
H:(1.97/8.1)*G Catch-values by outlets (1,000 ECU)	7,442	14,884	19,070	21,163	22,325	22,795	23,027	23,256
I: 0.20*H Direct variable costs (1,000 ECU)	1,488	2,977	3,814	4,233	4,465	4,559	4,605	4,651
J: 0.70*H Value added (1,000 ECU)	5,209	10,419	13,349	14,814	15,627	15,956	16,119	16,279
K: H-I+J Benefits in the consumption sector (1,000 ECU)	11,163	22,326	28,605	31,744	33,487	34,192	34,541	34,884
L: F+K Total benefits (1,000 ECU)	14,091	28,181	36,108	40,070	42,269	43,159	43,600	44,033

Notes: In 1990 the benefits are 0. From 1998 onwards the benefits are constant. The costs of giving up the mixed-clupeoid fishery are for every year 18.1 million ECU.

Table 11 : Discounted net benefits (million ECU) in the different scenarios and with different combinations of time horizon and discount rate

Number of years	Discount Rate	Scenario I	Scenario II	Scenario III
5	2	- 40	24	89
5	5	- 38	20	77
5	10	- 34	14	62
10	2	- 40	130	305
10	5	- 39	106	249
10	10	- 35	73	256

Note: In scenario I the total potential gain is used for fish oil and fishmeal. In scenario III the total potential gain is used for consumption purposes. In scenario II half of the total potential gain is used in each sector.

ANNEX I: Regulations concerning the catches of juvenile herring taken as by-catches in the fisheries for sprat

	1983	1984	1985	1986	1987	1988	1989
(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
(2)	(3)	(4)	(5)	(6)	(7)	(8)	(8)
(2)	(3)	(4)	(5)	(6)	(7)	(8)	(8)
(2)	(3)	-	-	-	-	-	-
(2)	(3)	(4)	(5)	(6)	(7)	(8)	(8)
(2)	(3)	(4)	(5)	(6)	(7)	(8)	(8)
-	-	(4)	(5)	(6)	(7)	(8)	(8)
(2)	(3)	-	-	-	-	-	-

- Prohibition for a directed fishery for herring for reduction to meal and oil.
- Prohibition in Regions 1 and 2, other than the Skagerrak and Kattegat, to retain on board when fishing with nets whose mesh size is smaller than 32mm catches of herring mixed with other species unless such catches are not sorted and unless herring, if mixed with sprat only, does not exceed 10% by weight of the total weight of herring and sprat combined.
- Prohibition in Regions 1 and 2, other than the Skagerrak and Kattegat, to retain on board when fishing with nets whose mesh size is smaller than 32mm catches of herring mixed with other species unless such catches are not sorted and unless herring, if mixed with other species whether or not including sprat, does not exceed 5% by weight of the total weight of herring and other species combined.
- Prohibition in the Skagerrak and Kattegat to retain on board by-catches of herring when fishing with nets with a mesh size smaller than 32mm unless the percentage of by-catch does not exceed, if mixed with sprat, 10% by weight of the total catch of herring and sprat combined and, if mixed with other species, 5% by weight of the total catch of herring and other species combined.
- Prohibition to fish for herring and sprat from 1 July to 31 October in an area off the West coast of Denmark.
- Various seasonal prohibitions to fish for sprat in the Skagerrak and Kattegat with nets having a mesh size smaller than 32mm for various size categories of vessels.
- Permission to include in the TAC for sprat in Division IIIa all by-catches of all other species which are caught when fishing for sprat and which are landed unsorted.
- Various seasonal prohibitions to fish for herring in the Skagerrak and Kattegat.

**ANNEX I: Regulations concerning the catches of juvenile herring taken as by-catches in the fisheries for sprat
(continued)**

- (1) Council Regulation (EEC) N° L 2115/77 of 27.9.1977; O.J. L 247, 28.9.1977, page 2
- (2) Council Regulation (EEC) N° L 3624/83 of 20.12.1983; O.J. L 365, 27.12.1983, page 1
- (3) Council Regulation (EEC) N° L 320/84 of 31.1.1984; O.J. L 37, 8.2.1984, page 1
- (4) Council Regulation (EEC) N° L 1/85 of 19.12.1984; O.J. L 85, 1.1.1985, page 1
- (5) Council Regulation (EEC) N° L 3721/85 of 20.12.1985; O.J. L 361, 31.12.1985, page 5
- (6) Council Regulation (EEC) N° L 4034/86 of 22.12.1986; O.J. L 376, 31.12.1986, p. 39
- (7) Council Regulation (EEC) N° L 3977/87 of 21.12.1987, O.J. L 375, 31.12.1987, p. 1
- (8) Council Regulation (EEC) N° L 4194/88 of 21.12.1988; O.J. L 369, 31.12.1988, p. 3