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(distribué à Lowestoft en avril 90)

Report of the Meeting of the STCF Working Group on Improvements of the Exploitation Pattern of the North Sea Fish stocks

Lowestoft 23-27 January 1989

and

Nantes September 1989

and of the meetings of its Economics Subgroup

1. Introduction

1.1 Meetings and Participation

Meetings of the STCF Working Group on Improvements of the Exploitation pattern of the North Sea Fish stocks were held at the Directorate of Fisheries Research, Lowestoft, UK from the 23-27 January 1989 and at IFREMER, Nantes, France from 11-15 September 1989. Meetings of the Economic subgroup of this working group took place at the CEC Brussels, Belgium from 10-12 May 1989 and at IFREMER, Nantes, France from 4-8 September 1989. Participants in these meetings are listed in Appendix A. The working group was particularly pleased to welcome representatives from Norway whose participation completed the coverage of the North Sea.

1.2 Terms of Reference

To explore the quantification of the biological, economic and social effects of any technical measures that might be operated in the North Sea.

1.3 Background

The EC obviously needs to know what the consequences of adopting various fisheries management measures will be in order to take sensible decisions. In most human activities we need some sort of chart to tell us what will be the consequences if we do a certain thing. Of course the best maps are based upon direct practical experience; we all have a very clear insight of what the consequences of slamming the door on our fingers is and at least a vivid idea of what the consequences of pushing a bare wire into an electric socket might be. But, when we are faced with the problem of doing something that has not been tried before then either we must experiment or alternatively use our knowledge about how the system works to predict what the consequences of our actions will be. If the system is anything but very simple we may have to use computers to work out what outcomes stems from particular actions. Nevertheless, however complicated these computer programmes are they are really only producing maps and they are good or bad insofar only as they steer us to safe harbours or lead us onto uncharted reefs. The EC STCF Working Group (STCFWG) on technical measures was set up to chart what the consequences might be of adopting various technical measures in the North Sea.

Technical management measures such as gear restrictions and derogations, mesh changes, closed seasons, closed area or combinations of these measures are already an important part of the management of the North Sea. Mesh regulations for example being a fundamental management measure and closed areas also features with the Norway Pout box, the Shetland box, the plaice and the cod box or even the Norwegian sector being existing areas where some differences on the fishing regime to the standard North Sea conditions are in force. These technical measures affect the proportions of different sizes and species of fish caught and are thus an important consideration in managing a mixed fishery where there is a need to avoid too much fishing on the juveniles of some larger species such as cod while enabling fishing to take place on smaller species such as sole or whiting. They can also affect the profitability of different national fleets. For example the Norway Pout box is estimated to have, in effect, transferred landings worth more than £3 million per annum from industrial fishermen to human consumption fishermen. This second feature of technical measures is particularly the case with closed areas which by their nature are likely to affect fishermen who live near them the most. The same is however true but less obviously so of any technical measure. For example a mesh increase will often affect fishermen living near a small fish area such as the German Bight, the Waddensee or Northeast coast of England far more than where the fishery is based upon the older individuals of larger species such as cod or plaice. For these reasons technical measures have to be considered on a finer geographical scale than North Sea wide management measures such as TAC's. They also have to be considered in terms of their impacts on the catches of the range of species which form the basis of various fleets operations. All this requires a much more detailed biological understanding of the North Sea fisheries than is required for a management measure such as a TAC. It also requires an understanding of the economic forces which make up the profit and loss of fishing fleets. For example would a bigger catch of large cod in the future compensate a particular fleet for the loss of its whiting catch? The STCF WG therefore needs to study a considerable body of information which although often implicit in national data sets was previously only available in a much coarser form. For example catch-at-age data were available for the various North Sea species as total North Sea numbers but not as numbers caught in say the pout box by different fleets. Since a new closed area could in principle be proposed anywhere it was realised that the only viable way of organising the data was by statistical rectangle, the 0.5 degree of latitude by degree of longitude rectangles from which catches are recorded. By organising the data sets in this detail we would be able to give advice not just on some predefined area but could also give advice on any area. Certainly this is a requirement if the group is to be able to give advice not just on some predefined area, but on any area. Clearly this is a requirement if the group is to be able to give timely advice rather than have to start with a new 5 year sampling scheme every time a new proposal is made.

At the previous meeting of this working group it was decided that it was practical to develop the means of assessing the effects of technical measures in the North Sea. To be useful such assessments should be capable of giving advice on the various technical measures that could be proposed such as area and seasonal closures, mesh and gear changes or combinations of these measures. The effects of these measures should be estimated both with respect to their biological results and their effects on particular national fishing fleets both in terms of physical and economic yield.

To support these objectives suitable biological, technical and economic data sets were proposed and requirements for a suitable computer simulation model discussed. It was agreed that in the first case this model should be a single bucket (random mixing) representation of the North Sea. Refinement such as migration/distribution effects and species interactions might be included at a later date.

Getting the existing data into the required shape has however been a major undertaking because when the WG considers 10 species with up to 10 ages in 200+ rectangles being caught by 50 fishing fleets there are something like a million numbers to be estimated and stored in a usable way. The estimation is difficult because existing sampling schemes were not designed to generate data in this detail and the storage problems become quite serious even with computers.

For the same reason using the data has required the WG to develop ways of handling and condensing the data into the appropriate degree of detail. It has required us to develop computer programmes to do this and predicting what will happen if a certain technical measure such as a mesh increase in a specified area was imposed. What will happen of course requires estimates to be made of the short term effects on each fleet as well as the effects to be expected in the longer term. In short who will the measure hurt and who will it help and in what time period.

The primary objective of the current meetings was to review and expedite the construction of data sets and to use them as far as possible in a large scale example so as to test the data integrity, the means of interfacing it to the computer model and to test the computer model. While this model was made as realistic as possible to test data exclusively it should be stressed that results from it are not intended as management advice. The meeting also provided an opportunity to discuss the further development of the model and to review commissioned work on mesh selection. In the meetings so far held we have developed programmes which consider the effects on each species separately and combine these with a knowledge of how prices might react to a long and short term loses and gains account for each fleet. There are however some obvious improvements will need to be made in the future. Firstly the existing model assumes that fish are freely mixing between areas. Thus a fish not caught in the German Bight apparently becomes catchable off the Shetlands. Of course this is not correct and we will need to include our growing knowledge of how and where fish migrate into our picture of the North Sea. The problem is to do this in a way which is realistic but does not require a super computer for a year to run the programme.

We need to consider how to give advice not only of what a specific measure will do but also how to give advice in the form, "This might be a better measure than that proposed to meet the stated objectives". Equally we need to know how fishermen will react to changes. Will they stop fishing in a box with an increased mesh size and spread their effort in the remaining area. Will some of the effort disappear either to other regions or just tie up? Finally, we now know something of the interactions between the predator species such as cod and whiting and saithe and their prey. We should really include this knowledge into our North Sea picture.

All these improvements add to data requirements and the complexity of the computer programmes. The first job therefore is to get some idea of how important each is likely to be to the final results. This will be an immediate task for our next meeting.

2.1 Introduction

At the May 1988 meeting of the working group (Anon 1988a) a comprehensive data set was specified. It was hoped that this data set would prove feasible to assemble and would provide the essential factual basis for the future work of this working group. It was agreed to use a Supercalc4 format for data exchange. Standard templates were developed and circulated to members. In January 1989 a meeting of this working group was held in Lowestoft. In this meeting some of these data became available. The main purpose of that meeting was to attempt to use that data in a realistic fashion in order to pick up any missing requirement in the data specification, to pick errors in the data itself and to resolve problems with the exchange of national data and its interfacing with the model. For the September 1989 meeting in principle the same data were available as in January. In addition data for Scotland and Norway became available.

This section describes what data are currently available, what data are used in this Working Group and what should become available for the next meeting of this Working Group.

2.2 Data currently available to the Working Group

Disaggregated data on landings, age compositions, weight at age, effort and prices were available on fleet basis for several countries. No data were available for the German fleets at present.

The fleets for which data currently are available to the Working Group are described in table 2.2.1.

Table 2.2.1 Number and type of fleet disaggregated data for each country

Belgium:

4 fleets	beam trawl <300 HP
	beam trawl >300 HP
	otter trawl total
	pair trawl

Denmark:

9 fleets	Gillnetters, hooks, lines	<20 GRT
	Gillnetters, hooks, lines	<20 GRT
	Danish seines	
	Trawlers	<20 GRT
	Trawlers	>20 GRT
	Trawlers	60-150 GRT
	Trawlers	>150 GRT
	Purse seiners	
	others	

France:

11 fleets	VOT	Long distance fleet + Freezers	; Otter trawl
	H10	High sea vessels >1500 HP	; Otter trawl
	H20	" " " 1000< <1500 HP	; Otter trawl (*)
	H30	" " " <1000 HP	; Otter trawl
	CBT	Coastal vessels 15< <25 meters	; Beam trawl
	COT	" "	; Otter trawl
	CVA	" "	; Other gears(**)
	SBT	Small scale (<15 meters)	; Beam trawl
	SOT	" "	; Otter trawl
	SVA	" "	; Other gears(**)
	APT	All types of vessel	; Pelagic trawl

(*) This fleet was present in 1985 and 1986, not in 1987 and 1988

(**) Gillnet, trammel, line

Netherlands:

4 fleets	A: Beam trawl	all sizes
	B: Otter trawl	all sizes
	C: Pair trawl	all sizes
	D: Pelagic trawl	hek trawlers

Norway:

1 fleet   Otter trawl (human cons.) all sizes

UK (England and Wales):

5 gears   A: Otter trawl
             B: Pair trawl
             C: Seine
             D: Beam trawl
             E: Other gears

UK (Scotland):

5 fleets   heavy trawl
             light trawl
             demersal seine
             nephrops trawl
             pair trawl

The types of data currently available and the years for which it was available are described in table 2.2.2. A brief description of the procedures each country adopted to construct these data sets is given below.

Belgium

Catch statistics per market category for 1983 up to 1987 were available for sole, plaice, cod and whiting for each fishing rectangle including fishing effort on a rectangle and fleet basis. The prevailing age-length key was applied to the different market categories, resulting in an age distribution per rectangle and per quarter. In addition mean weight per age group and per quarter was calculated.

Four most representative Belgian fleets were separately treated, viz:

1) beam trawl fleet wish horse power over 300 HP plus the "eurokotters". This fleet fishes directly on sole with plaice as bycatch, operating mainly in the western part of IVc.

2) beam trawlers less than 300 HP (coastal fishery directed on flatfish):

3) otter trawlers fishing for cod and whiting, spread over different parts of the North Sea.

4) Pair trawlers (winter coastal fishery with small vessels)

No data on discards is available.
The information on prices is limited to the level of market categories per species and per quarter.

Similar information on the Belgian catches for 1983, 1984, 1985 and 1987 will become available by the end of June 1989.

Denmark: No comment.

FRG

The data are not available in the required formats due to software limitations. Average quarterly prices for 1981-1987 are made available to the economists.

France

The data of effort per fleet/month/rectangle are available for the period 1985-1988. The data of quantity and value per species/fleet/month/rectangle have been prepared from the data bank of the national statistics system for the same period and for all species.

The data of numbers at age, mean weight at age and mean price at age per species/fleet/quarter/rectangle are available for 1985-1988 for cod, haddock, whiting, saithe and herring. These data come from the IFREMER laboratory in charge of these North Sea stocks. They are the same which are submitted each year to the relevant ICES Working Groups.

For the period 1983-1984 the data are not available and are not expected to be.

Netherlands

Age compositions were calculated on a rectangle basis for cod, whiting, plaice, sole, herring and mackerel. These data are calculated on a quarterly basis for the years 1983-1987. The unit of the data is numbers in thousands. All data are based on estimates of the landings as provided to the ICES assessment working groups. All data refer to human consumption landings only. Information on discards is not included as these data are scarce, incomplete and not easily available in a useful format yet.

Since 1982 no national landing and effort statistics are available on a rectangle basis in the Netherlands. Therefore, for plaice, sole, cod and whiting the disaggregation of the total age compositions as provided to ICES working groups was simulated, using average distribution patterns of the catch by age group of the landings in the period 1974-1977.

The data for cod and whiting are given for 3 fleets, otter trawl, beam trawl and pair trawl. No information on the nominal landings by fleet is available since 1982. The disaggregation of the total landings between these fleet was rather arbitrary and based on earlier years and information of the development of these fleets in recent years.

The data for plaice and sole are given for beam trawl only. More than 95% of the catch of these species originate from this fleet. Unfortunately no distinction could be made between large beamers and the smaller beamers which are allowed to fish in the 12 mile zones and in the plaice box.

Weight at age data are the same to those in the ICES data base.

ALKs or ALD are available in printed form on quarterly basis for each year. Effort data were not available yet.

Price and revenue data by age group were available for all species in all years on quarterly basis.

Data on the amount of bycatch and the spatial distribution of bycatch are not available.

Norway

Catches of saithe were allocated to rectangles according to trawler journals and raised to the total catch by the fleet. A common age distribution and common weights at age were used to obtain catches by number and age. Catches of other species by this fleet are small, and have not been included.

UK (England and Wales

Data for England and Wales (E&W) have been split into 5 fleets (otter, seine, pair, beam and other) for 2 years (1986 and 1987) either by month or quarter as requested by the group. All agreed species have been covered.

The available database does not contain sufficient information to retrieve catch numbers at age by rectangle, directly. A generalised linear model was therefore used that fitted catch numbers per kilogram (for each species) to roundfish area, quarter and gear. The fitted values for each rectangle (contained in a given roundfish area) were then multiplied by rectangle catch weights to give estimated catch numbers at age by rectangle for all fleets, all species and both gears. The resulting data were consistent with UK (E&W) catch statistics except for 1 and 2 year old plaice. In this case, there were too many 1 year olds (instead of 2 year olds) estimated in the catch. No discard data was available for UK (E&W).

All effort data by rectangle, by month for each fleet and gear have been provided. For the four main fleets these data are in days at sea. For the "other" fleet the effort measure is somewhat quaint as the effort units vary between the constituent parts (eg, days at sea, metres of net, numbers of hooks).

Catch weights at age by quarter have been provided for most roundfish species for all fleets for 1987 only. No flatfish catch weights at age, by fleet, were available. Age length distributions have been provided for most roundfish species for all fleets but it has not proved possible to supply these in 1 cm groupings as requested. Cod are in 5 cm groupings and haddock, plaice and sole are in 3 cm groups. An attempt was made to smooth the distributions and to interpolate 1 cm grouping. This was not successful but does give a possible future route to providing data in the required form.

Quantity and value by age and quarter, for 1987, have been provided for limited fleets and species. This is an area that needs further work.

No by-catch data were available.

UK (Scotland)
No comment.

2.3 Data used by the Working Group this meeting

This meeting the Working Group decided for practical reasons to restrict the amount of data and to use 1987 data only for the demersal human consumption species: Cod, Whiting, Haddock, Saithe, Plaice and Sole.

2.4 Future data

It is the intention of the Working Group to build up a data base taking into account the most recent information about the developments in the fishery. Therefore the data base will have to be extended with data for recent years. The Working Group expressed preference for working up the 1988 data to the required aggregation level for the following meeting rather than older years.

Data which were not currently available to the Working Group but which countries hope to produce next year are specified in table 2.4.1. The following comments on this data were received from the various participating countries.

Belgium no comment.

Denmark

Data for the industrial fishery will be included in the database.

France

This job being now a routine job in the IFREMER laboratory in Boulogne, the data for 1989 will be prepared as soon as they will be available from the various sources.

In addition, from 1989 onwards, the data disaggregated by age for plaice and sole will be supplied from a new sampling program on the North Sea French coast.

FRG

Catches by rectangle are available for the years 1986 and 1987 for cod, haddock, whiting, plaice, sole, mackerel and herring. Age distributions, pooled over rectangles for these years exist for cod, haddock, plaice and sole (plaice only 1986) and some years further back. Five fleets are considered:

pelagic freezers
long range otter trawlers
close range otter trawlers
close range beam trawlers

Due to software limitations, these data are not available in the required format yet.

The mentioned catch data for 1987 and also for 1988 can be made as ASCII files in the agreed format until the next meeting. Prices and quantities can probably be given by size category for 1987 and 1988.

Netherlands

The data provided for 1987 can also be made available for 1988 without many technical problems in the course of the beginning of 1990. Also quarterly effort data by fleet and rectangle can be made available for 1988 from the log book statistics.

In principle ALD data, which are available in printed form, can be made available in spread sheet format.

Norway

For the species considered in the analyses of this Working Group the following fleets can be included:

1) Industrial trawlers fishing for sandeel, Norway pout and blue whiting with small bycatches of cod, saithe, whiting and haddock.

2) Purse seiners fishing for herring and mackerel.

3) "Others". We may include an "others" fleet accounting for the catches not taken by the defined fleets. The age distribution and allocation to rectangles of these catches will probably be somewhat arbitrary.

2.5 Problems with data and formats

Catch at age and effort data were provided by most countries in the required Supercalc4 format. In order to use these data in the model it was necessary firstly to transform the data in ASCII file format which was done with a country specific macro which was developed for this purpose. Secondly it was necessary to reaggregate these data into quarterly totals within and without a specified area.

There are two areas of data file quality control to be considered. Firstly, format quality control and secondly, data integrity. Format quality control should be achievable by the use of a standard, unmodified reaggregation macro distributed to, and used by, all nations. The subject of data integrity during this working group meeting that most, if not all, countries have inadvertently brought data files with some "suspect" entries. Many errors have only become obvious once the data have been reaggregated - this, however, is too far down the line in the process and for future meetings when "real" advice would be desirable, might cause time delays. Clearly, it is not easy, nor indeed appropriate, to organise an international checking procedure on national data. It must, therefore, be the responsibility of each nation to provide correct, and verified, data.

Difficulties were encountered when trying to apply a general data reaggregation to each nation's files. The difficulties were minor (but were time consuming to overcome) and were all caused by small differences between input files. Specifically much time was lost to the Working Group due to Supercalc4 files where blank entries had to be replaced with zeros. Also inconsistent use of lower and UPPER cases caused problems with the reaggregation. As the program requires data for all species in all fleets in all quarters a lot of files had to be produced with zero entries for species which are not caught by a fleet.

It is recommended that in future:

1) that all files are named in a systematical way. Kevin Stokes will work out a system which is easier to work with as the present nomenclature and inform people well in advance of the next meeting.

2) that all data will be submitted to the Working Group in ASCII format in a standard way. The macro produces such a standard format, but also programs or data bases available at national laboratory might be able to produce a standard format.

3) to present a printed directory list of the existing data

4) that back up data (.PRN files) should be brought to each meeting or send to the data handler which is responsible for reaggregating the data in advance of the meeting.

5) also to keep the Supercalc4 file (.CAL file) as corrections and charts are often more easily made from these files.

6) to get rid of all zero files. For the moment it is necessary to create all files, also for species which are not caught by a fleet

7) that the final preparation of the data and the reaggregation will be done before the meeting and sort out time consuming difficulties in advance.

2.6 Data archiving and confidentiality

The working group discussed the problems of archiving and confidentiality of the disaggregated data base. The data basically consist of catches in quantity and value, fishing effort and biological data disaggregated into ICES international rectangles. The data are given on a quarterly basis for about 5 to 10 fleets for each country.

The data reported to this working group are therefore far more disaggregated than data previously reported to ICES on the STATLANT 27B forms and they cover data on earnings and economic behaviour of each fleet component by country. A number of problems concerning the practical archiving and possible access and confidentiality of the data must therefore be dealt with.

2.6.1 Confidentiality

The national laboratories providing the data have through their annual sampling programmes spent substantial funds to collect the data. The data are collected for scientific purposes and are usually made available to ICES assessment working group in a more aggregated form.

Because of a recent tendency of the national laboratories to undertake study contracts the data are of commercial value and should therefore be protected. The data base also enables detailed analyses of the economic importance of various sectors of national fleets and it is expected that national governments will reserve their rights to approve such analysis.

The terms of reference of the working group include bioeconomic modelling of the fishery in the North Sea and this objective cannot be met unless disaggregated biological and ecological data are available to the working group. The evaluation of technical measures for certain areas (box closures and derogations) cannot be dealt with unless data are available on a disaggregated area basis. Similarly the consequences of any management measure on each fleet cannot be calculated unless data are available for each fleet component.

Data of the specified disaggregated form must therefore be available to the working group during its meeting. It is envisaged that substantial amounts of preparation in terms of development of programmes and models must take place outside the working group meetings. For this reason it is preferable that all working group members have access to a realistic data set.

In order to serve both the requirement of protection and confidentiality of the database and the obvious need for realistic test examples the working group agreed the following:

- the disaggregated national data base will be available only at the national laboratories, in an agreed standardise format.

- a complete disaggregated data base will be kept at the EC. This data base will only be used during the meetings of the working group, or before, in order to prepare the meetings. In the latter case all members of the working group will be informed in advance.

- depending on the terms of reference, the data should - if possible - be aggregated before or during the meeting.

- these compressions can be taken from the working group meetings by the numbers and be used to prepare and develop programmes and models for the working group.

- the use of aggregated data will be restricted to working papers, for the STCF and may not be published, unless agreed within STCF.

2.6.2 Archiving - Database

The Working Groups' experience with the present media and format (diskettes and SC4 spread sheets) cover both advantages and practical difficulties. The spread sheets has proven feasible to standardize and no insuperable problems arose when the "national diskettes" were processed (see sec 2.4).

The number of diskettes is however in the order of 200 in total for a year and it is expected that the final database will need 1000 (or even more) spread sheet files. It is therefore essential that a more handy procedure is considered. The working group briefly discussed two possibilities:

A: Data are kept on spread sheet files, but in addition CSV files are produced. These can be processed by SAS (or similar software) at a high speed.

B: Data can be stored in a "real database" (DBase, SAS or similar). Appropriate software will enable quick access and processing of the data.

2.7 The change of exploitation pattern caused by increase in mesh size from 85mm to 120mm

In the example studies at the Lowestoft meeting a change in mesh size was considered. To simulate such a change, the model requires estimates of selection factor and selection range.

In principle, it is necessary to specify the selectivity parameters for each species. In particular, it was assumed that all gears exhibit the same selectivity parameters for all species except cod. For cod it was assumed that the Scottish fleets exhibit different selectivity parameters to all other fleets. These assumptions are not considered to be realistic but were made to indicate and test the flexibility available to users of the model.

Selectivity parameters used in this exercise were based on data given by Wileman (1985) and are listed below.

	Selection Factor	Selection Range (L75-L25)
COD Non-Scottish fleets	3.1	0.63

COD Scottish fleets	2.5	1.06
WHITING	3.3	0.85
HADDOCK	2.7	0.90
SAITHE	3.9	1.10
SOLE	3.2	0.47
PLAICE	2.2	0.30

The proportion retained at each age was calculated from the expression...

$$P(l(a)) = \left\{ 3^{(L50-l(a))/(L50-L25)} + 1 \right\}^{-1}$$

where l(a) denotes mean fish length at age
L50 denotes 50% retention length (L50=Mesh size*Selection Factor)
L25 denotes 25% retention length (L25=L50-(0.5*Selection Range))
P(l(a)) denotes proportion retained at age a

Values of l(a) for the roundfish species were calculated from corresponding values of mean weight at age using the relationship ...

$$(w(a)/q)^{1/3}$$

where w(a) denotes mean weight at age
q denotes a known species-specific constant

For the flatfish species values of l(a) were available directly.

Fishing mortality rates at age following the mesh change were calculated by multiplying the pre-change mortality rates by the ratio ...

P(l(a):120):P(l(a):85)

where P(l(a):120) denotes proportion retained at age with 120mm mesh
P(l(a):85) " " " " " " 85mm mesh

It should be noted that the model for selectivity indicated above assumes that selectivity can be adequately specified if cod-end mesh size is known. However, recent work (Armstrong et al (1988)) has demonstrated that selectivity can be significantly altered for a net of given cod-end mesh size by (legal) alterations to other aspects of the gear design. In addition, some of the selectivity parameters quoted above are derived from work carried out some time ago. It is possible that, as a result of changes in gear design, the selectivity parameters assigned to these gears in this exercise are no longer appropriate. Work is required to establish, where necessary, appropriate selectivity models and associated parameters for gears currently in use.

2.8 Some checks run on the data base.

At the Nantes meeting it was possible to run a few checks on the data base. The first check was carried out using Belgium catch at age by rectangle data to check for differences in fleet catch patterns through time. This was done because the situation may occur that a given fleet changes its effort pattern from one year to another. This is however not expected to be a frequent phenomenon as each fleet type tend to exploit on "traditional" fishing grounds. However some external changes may have an influence and may alter the normal fishing pattern.

Some observations on this topic can be drawn:

1) The distribution of each fish species has a typical stable pattern. Any change during the same year is linked with known migration patterns (spawning, feeding grounds).

2) The general distribution pattern can be changed mainly by severe abnormal climatological changes (cold winters, hot summers) or even by pollution effects.

3) The fishery will obviously follow these seasonal (normal) or annual (abnormal) changes.

As a standard procedure however the most recent distribution pattern of each fleet type should be used in any prediction model, rather than an average pattern over a number of years. This procedure should only be abandoned in a situation where the recent pattern was heavily disturbed by abnormal conditions. Therefore it should be advised that mapping of each fleet performance should where possible be carried out for the last five years. These mappings should incorporate data on effort distribution on a quarterly basis as well as the data on the spatial species distribution of the most exploited age group of each fleet type.

Analysis of these maps will give indication of any future work based on post fishery activities. At the Nantes meeting the % distribution of the catch of 3 year old plaice caught by Belgium beam trawlers in 1985-87 were available. See figs 2.8.1-2.8.3. These indicate a very consistent distribution pattern of catches for this species in the three years.

Another possible check is to relate catch at age data from a fleet to the estimated numbers per rectangle obtained from survey results raised to the VPA population estimate for the year.

Estimates of the proportion of 2-year-old cod in each statistical rectangle of the North Sea in the first half of 1987 provided by the ICES Atlas WG from results of the International Young Fish Survey were available to the meeting. An estimate of the average number of 2-year-old cod in each statistical rectangle was obtained by multiplying the proportions by the total number of 2-year-olds in the sea at the start of the year obtainable from VPA results presented by the ICES North Sea Roundfish Working Group (1988). For the same time period it was possible to construct from the STCF data base the number of cod of age 2 caught by Scottish vessels. Division of number caught by mean population number in each statistical rectangle gives an estimate of the local fishing mortality rate by Scottish vessels (Figure 2.8.4.). Some of the values are higher than might be expected but, in general, the results are encouraging and suggest that the STCF data base is reasonably representative of actual catches and that reasonable estimates of abundance per statistical rectangle can be obtained using research vessel data.

3. The simulation model

Objectives

The program is so far a prototype designed for the immediate needs of the STCF Working Group on the Improvements of the Exploitation Patterns in the North Sea and using rather crude approximations. It will be subject to further developments when practical constraints (especially with the data) and more specific requirements are made clearer.

Basically, the model used is a multiple-species, multiple-fleets, multiple-seasons extension of conventional age-based short-term forecast models accounting for technical interactions only at this stage. The current implementation is derived from the IFREMER program MSFP which is designed to assess the effects of changes of effort in each fleet component, and/or changes in exploitation pattern for each species and fleet combination. In the first meetings of the Group, it was recognised that no appropriate software was available to evaluate the effects of box closures, and this new program MSFBOX is a first attempt towards that aim. During the course of the year, an economic module (effects of landings upon prices) has been interfaced and should form a basis for the development of a true bioeconomic model.

The regimes which can be simulated consist, for each fleet and each quarter, in varying the effort levels and/or the exploitation patterns (e.g., mesh sizes) applicable in each area. The predicted catches are expressed in weight and in value; they are given for each species in each fleet, and as totals over fleets and over species, for different time and space resolutions.

The program can handle a variable number of species and fleets depending on the memory size of the computer used, up to 4 seasons, with the fisheries broken down over 2 areas (in and out of the simulated box); the number of age groups is currently standardized at 11. The fleets can be any desired grouping of vessels having some features in common (size, gear type, mesh size, nationality, spatial and seasonal fishing pattern, or combinations thereof), depending on the scenarios submitted to simulation. Whenever relevant, landings and discards are treated as separate fleets, with a linkage of their effort multipliers.

Assumptions

A simple assumption (population numbers at age of each species in a single bucket) has been adopted for the treatment of the spatial aspects : for each age of each species in each quarter, the same overall mean number is available to all fleets, whether they fish in the box area of outside, the actual vulnerability in each area being proportional to the fleet's reference fishing mortalities in and outside at the age and in the season considered. In other words, the structure of the fishery is determined by the reference fishing mortality vectors adopted for each fleet component, and estimated by splitting total Fs at age provided by VPA in proportion to that fleet's catch in number at each age in each quarter and area. This simplistic option implies that fish surviving the fishing regime applied in each quarter redistribute themselves uniformly and immediately over the entire area (the whole North Sea in this instance). This is in contrast with the more sophisticated option in which a known proportion of the population is vulnerable to some fleets in the box, and a fraction of the survivors stay in the box while other emigrate outside at the end of each period; conversely, the rest of the population is distributed outside of the box where it is subject to different exploitation patterns and levels, and receives migrants from the box and possibly provides some fish back to the box area. Subject to the availability of quantitative migration or mapping data and to some theoretical thinking, developments along these lines are now recognised to be essential.

A rather similar assumption holds for the fleets' interaction: the effort multiplier simulated for each fleet in each quarter and area holds equally for all the species vulnerable to that fleet, in proportion to its reference fishing mortality vectors on each species; every fish of age a "saved" by the regime applicable to the fleet becomes equally available to all fleets in the following time period. As in MSFP, this implies that changes of targeting at the different species by a fleet cannot be easily dealt with, and that we cannot simulate a "metier" which has never been practised.

Although this is not inherent to the construction of this particular model, the accurate évaluation of the box will depend largely on how the assessors redistribute the effort which is subject to restrictions by the box, and the options in this regard are not only multiple, from frozen effort to full redistribution outside, but also largely speculative as determinants of fishermen's choices are essentially unclear. Just as a practical warning : due to the way in which effort is modulated, by means of effort multipliers applied to reference F arrays, the reduction of, say, 10% in the box does not mean an increase by the same percentage outside; the fraction should be recalculated on the basis of the absolute transferred and external amounts of effort. In fact, anticipating on the requirements of a true spatial model, it may be preferable to consider local catchabilities instead of fishing mortalities as the basic entity, with nominal effort distributed among areas.

Data needs

The data required by the program are basically the same as for conventional forecast software, namely, for each species (or stock component): starting stock numbers at age in first quarter, stock weights, natural mortalities and proportions mature at age in each quarter then, for each fleet component, the reference fishing mortalities, catch weights and, in principle, unit prices at age. It has been assumed that stock weights, Ms, maturities, prices and, in the present state of the model, stock numbers at age are not disaggregated by area. This disaggregation would then apply only to fishing mortalities, catch weights (if different mesh sizes apply in and out) and effort multipliers.

Due to the unavoidable multiplication of the number of parameters, the task of entering the data is formidable and error prone. In order to limit the burden, the option has been taken to read the data from ASCII files which are set up by assembling contributions from the various countries prepared under a standard format, by means of preprocessing programs or with a text editor. The structures of these files are described in appendix B.

There are 4 basic data files:

1) The "STOCK FILE" contains the actual species and seasons parameters and, for each species, a name, the first and last age and a plus-group code then the stock weights, Ms and proportions mature over the given age range, each data type being duplicated for each quarter in the same block. The data in this file do not depend on the fleets nor on the scenarios that can be simulated.

2) The "BASELINE CATCH-DATA FILE" contains the reference descriptors of the fishery: first the list of the fleet components with their effort linkages and attachment to a nation (more precisely to a market, for economic considerations); the nations are coded according to the alphabetical order:

1 = Belgium 2 = Denmark HC 3 = England 4 = France

5 = Germany FR   6 = Netherlands   7 = Norway HC 8 = Scotland

9 = Industrial   10 = Others

A code 0 is defined for discard "fleets" and should be used systematically in order to by-pass summation of landings and computation of earnings for these.

The list of fleets is followed by a series of blocks for each species; these are the population numbers at age in the first quarter of the starting year (from VPA) then, for each quarter and each fleet, when relevant, the reference Fs at age in and out, and the catch weights at age in and out the envisaged box.

3) The "ECONOMIC DATA FILE" (provisionally) contains, for each nation, the flexibility coefficients relating marginal changes of prices to marginal changes of landings of the same and other species, on the same market and from the whole study area, then the reference quarterly landings of each species in each market, and the reference quarterly prices of each species (in ECU per kg) which should ideally be defined for each fleet and for each age (or commercial category, these being ignored in the current version).

4) The "SCENARIO FILE" contains, for each simulation year, the definition of the regimes: effort multipliers in/out for each fleet and quarter then, for each species, each quarter, each fleet, the new Fs in/out and catch weights in/out if changed compared to previous year.

As for the outputs, they are currently produced in the form of 4 basic tables or results, each having catches by fleet in rows, by species in columns and the relevant marginal sums : (1) is the most detailed, giving results by quarter and area, (2) gives sums over areas in each quarter, (3) gives sums over quarters in each area and (4) gives the annual sums for the entire region. The volume of tables produced can be quite formidable also in this sort of exercise and the user can choose the degree of resolution he desires; by default, only tables of type (4) are produced and combinations of the others are optional. In future versions, it is intended to output the detailed results to an ASCII file with a standard format (still to be defined) from which they can be retrieved by post-processing programs or by spreadsheet software for comparisons with status quo options, or for graphical representations.

Extensions

Here is a list of possible developments that can be envisaged in the near future, keeping in mind that the development of a true spatial model is an urgent requirement. It should be emphasized also that several desirable features would substantially increase the demand of memory space (already quite considerable although it is restricted to the minimum so far) or would imply restrictions of the number of fleets or species, or less chances to have the program run on computers (mini-anyway) which were easily available to all WG members. The numbering of items in the wish list below does not imply any ranking of priorities.

1) The program does not incorporate yet species' interactions although this was deemed desirable. If this program is accepted as a starter, a Lowestoft made compact predator-prey subroutine might be bolted on somewhere.

2) The treatment of discards as fleets is flexible but possibly memory consuming. Maybe, special discard data matrices of smaller dimensions with

appropriate linkage to the main landing components can be envisaged although this is probably complex.

3) In a mainframe implementation, it might be envisaged to have, in addition to the main species treated in structural models, some accessory species treated in simpler models (SHOT or others); the limitation would be on how these simpler methods would accommodate changes of the exploitation patterns when the boxes are subject to special mesh sizes and not only to effort restrictions.

4) The RCODE index read from the scenario file has only 0 or 1 as valid values to tell whether recruitment is same as in previous year or changed. Other values might be used to read parameters of either Stock and Recruitment Relationships (with the problem of lag between spawning and recruitment) or stochastic recruitment about the average.

5) There is currently no consideration of the costs of fishing here or there for each fleet; if the relevant parameters (fixed, variable, proportional costs) can be made available together with the reference absolute effort for each fleet, the possibility of computing expected benefits can be envisaged. Using these and preset decision rules, an evolutionary model can be constructed in which the distribution of effort in each time period would be determined internally depending on results in the previous period or on returns from exploratory effort in the same period, instead of being input externally from the scenario file.

6) Data files might be streamlined by having only relevant data preceded by the corresponding subscripts, at the expense of tremendous difficulties in checking the data. If an agreed structure for the data files is decided upon, special audit programs should be set up which read the files and check the completeness and validity of the data, and the consistency of corresponding parameters among files, instead of augmenting the main simulation program with too many control statements.

4. A practical test of combining the data and the model

4.1 Introduction

The data sets developed by this working group are in all cases new and the spread sheet method of exchange adopted was also new. Consequently, it was considered desirable that the data sets should be tested as vigorously as possible in the time available. Moreover, such a test should also test both data assembly procedures and the new computer program MSFBOX developed to estimate the effects of technical measures associated with area closures in the North Sea. To this end a test example was devised based upon a seasonal mesh increase for human consumption fisheries in a central North Sea 'box'. It must be CLEARLY UNDERSTOOD that this measure was not investigated as a practical technical management measure but in order to FORGE A SUITABLE TOOL. The data inputs to the problem were incomplete and in some cases doubtful, and the results must therefore not be interpreted as management advice. The exercise was, however, very successful in identifying problems with data and with data handling procedures which must be solved before the group can confidently offer advice on technical measures.

4.2 The Test Problems

The Group decided to carry out a first test of the MSFBOX model by establishing a "box" in which fishing would be restricted. The box was chosen to cover the area within the following positions:

54°N 1°00'E
54°N 6°00'E
57°30'N 6°00'E
57°30'N 1°00'E

See fig 4.2.1.

It was assumed that inside the box fishing by trawl would only be allowed by using 120 mm mesh (as opposed to the 85 mm presently in use by fleets fishing for human consumption) during the first and fourth quarter of the year.

In order to simplify the evaluation of the effect of the box, two extreme conditions were to be considered:

(a) The fishing effort previously applied within the box by fleets using 85 mm mesh would be diverted to the area outside the box, ie, assuming that vessels would leave the box rather than changing to 120 mm mesh trawls. The increase in effort outside the box would be distributed in proportion to previously recorded effort in that area.

(b) The human consumption fleet would continue fishing in the box by changing to 120 mm mesh.

Industrial fleets using small meshed nets and beam trawl fleets would continue fishing as before.

The following species were considered:

cod
haddock
whiting
saithe
sole
plaice

For each of the species basic biological data were obtained from relevant ICES Working Group reports (Anon 1988b, Anon 1989). Data from the reports were supplemented by unpublished data available from Working Group files. The data included:

stock in number at 1 January
natural mortalities 1987
maturity proportions 1987
mean weights by quarter 1987
all given for age 0 to 10+.
Fishing mortalities by age

4.3 Results of the Test Problem run at Lowestoft in January 1989

Numerous difficulties were encountered when trying to reaggregate all nations' data files and input them into the MSFBOX program. These difficulties resulted in a reduced amount of time available to the group to look at the test problem. Consequently, only one assumption on effort was considered - it was assumed that all human consumption fleets would continue to fish in the box but would change to 120 mm mesh. No redistribution of effort scenario was considered.

Such problems brings into perspective, the difficulties that will be encountered if a centralised, disaggregated database is not maintained. Nevertheless, the work did permit the group to consider one scenario from inception to conclusion and to explore ways of presenting data and results.

The whole process of reaggregation and simulation revealed many shortcomings in the way that data and model have been handled. Being the first attempt at this process, many phases in the proceedings were not automated and took far longer than anticipated. Also, due to lack of automation, many errors were made - some of these were noticed, others might not have been. In future, a far greater degree of automation of all stages is both desirable and necessary if both speed and precision are to be achieved. The precise mechanics of future workings have yet to be decided.

The test problem results are presented by fleet and quarter in table 4.3.1. This table shows the percentage change in catch to each fleet in the second prediction year (1989) given a 120 mm mesh regulation enforced in quarters one and four in the box. Also shown are the percentage changes in the stock biomass and spawning stock biomasses. Results of this kind are available for all prediction years (up until 1991) but have not been included in the report. In a true management exercise, results for all, or for first and last, prediction years might be shown.

It is not particularly necessary to consider table 4.3.1 in detail. Rather it should be viewed as indicating the sorts of output that could be expected from the model. It is the case, however, that all changes in catches between fleets and in the overall SSB and biomass levels are working in the right directions and are of sensible magnitude except for some large increases in the sole landings which need to be checked.

4.4 Possibilities of presenting the results

The results by quarter and fleet shown in Table 4.3.1 are one way of summarising the effects of any management scenario. The tables show concisely who is affected and by how much in any one time period. Tables could also be shown for value in ECUs in a real scenario where the economic data was available. Similar tables summarising the effects on stocks, rather than on fleets, can also be created. Table 4.4.1 shows percentage changes in catch, biomass and spawning stock biomass for each species in each prediction year. Figure 4.4.1 shows the same results in a graphical form.

All of the above mentioned results tables could in principle be extracted directly, with minimal programming effort, whilst running MSFBOX. The current method has involved a long editing process on the main (and very large) output file created in the test run.

So far, only summary presentations have been considered. The group may often, however, need to present data on a rectangle basis. For this purpose, a spreadsheet template has been created which takes in a standard rectangle list of data (catch, effort, value or whatever) and displays the data on a chart of the North Sea. Figure 4.4.2 shows, as an example, the template with the statistical rectangle descriptors in their appropriate positions. The box definition chart (figure 4.2.1) was created using this template.

In conclusion, although the group has had to consider many large and highly disaggregated data sets, and although the total output from MSFBOX is huge, it is possible to summarise the important results into a coherent and digestible format. Much of this summarisation will be able to be automated at runtime.

4.5 Input for the ICES multispecies WG with respect to fishing for cod with 120 mm mesh

ICES has been requested to estimate the effects on landings, discards and biomass which would result from fishing for cod with 120 mm mesh, the mesh size when fishing for other species remaining at 90 mm.

An attempt to answer this question was made by members of the Roundfish Working Group in October 1987. The data base available to the Roundfish Working Group is disaggregated to the level of age compositions for various nations and also, in some cases, to fleets within nations. For each of these "fleets" it was assumed that the proportion of the total weight landed by that fleet represented by cod and saithe. (In retrospect, landings of plaice should also have been included in the calculation of the proportion adopting the larger mesh size). A recent historical F-at-age vector was calculated for each fleet and this was split into two vectors, one for the fleet which would exploit cod and the other for the remaining part of the fleet. The vector for the part of the fleet which would exploit cod was then further modified to account for the effect of the increased mesh size. Predictions of landings, discards and biomass were then made (a) assuming no change in mesh size and (b) assuming mesh changes as explained above. Comparison of the no-change scenario with that for changed mesh size permitted estimation of the effect of the mesh change.

There were several technical deficiencies in this procedure. The selectivity parameters used to estimate the effect of mesh change are probably not appropriate to many of the gears in use today. Because of this, it is probable that short-term losses and long-term gains were overestimated. The procedure described above was carried out with no attempt to account for species interactions. In principle, the Multispecies Working Group should repeat this type of calculation with species interactions included. However, it may be difficult to modify the MSVPA programs to permit these calculations ... Consideration could be given to modifying alternative, simple, multispecies programs. In addition, the quarterly data base available to the Multispecies Working Group is by no means as disaggregated as that used by the Roundfish Working Group. Unless a higher level of disaggregation of the Multispecies data base can be achieved it will be difficult, perhaps impossible, to define the proportion of the total fishery which will choose to fish for cod. Finally, it is not yet possible to adequately define appropriate selectivity parameters for many of the major fleets fishing in the North Sea.

4.6 Results from reruns of the test problem at the Nantes meeting, September 1989

At the Nantes meeting the test problem was rerun using the updated data set and with the programme altered to allow for price flexibility. Again it must be stressed that this was done as a test of the method and that the results <u>MUST NOT BE USED FOR MANAGEMENT ADVICE</u>. The data input has been refined since the Lowestoft meeting and though still many minor format errors gave rise to slow progress with loading data it ultimately proved possible to load the data and run the model in the course of the meeting. Once the data was correctly formatted the data assembly and model running were achieved rapidly. Problems to solve were therefore:

1) Format checking and Data Integrity
2) Output presentation

Results from the runs are presented in tables 4.6.1-4.6.2 as % that the 120 mm closed area run formed for the base run. The results are for the landed weight, the landed value and the discard weight for each fleet. Table 4.6.1 shows the 1988 results and Table 4.6.2 shows the 1991 results. Summary results are presented in table 4.6.3. As can be seen from these results the 120 mm mesh change was not applied to all species and fleets. In particular saithe and sole clearly experienced no change in their fishing regime.

A further problem noted was that total catch used to calculate partial F's was supplied externally from ICES Working Group results. This allows the possibility that the sum of partial F's does not equal the total F for the stock/age. In future this partitioning should be based upon the total calculated from the numbers data set.

5. Economic Models and Data

5.1 Introduction

The catching sector of the fishing industry is unusual in that it depends for its output on a renewable resource. Because of this the economic activity of the industry and the level of stocks are inextricably linked. There is nevertheless a clear separation between economic factors and the biological factors.

Biologists have for some time been modelling the levels of stocks and in doing so have been forced to use many economic variables as if they were an exogenously determined part of a biological model. In development work, and in the absence of anything better, this approach is acceptable. However, it builds mis-specification into the model and in order to more closely replicate reality it is desirable for the economic variables treated as biologically exogenous to be endogenously determined by creating one or more economic models parallel to the biological part of a general bioeconomic model.

Two matters arise from this. First, it has been necessary to remove from the biological model any attempts to estimate monetary gains and losses by the use of values rather than quantities (weights) in the model. Secondly, it is imperative that identically specified variables are used at the interface between the biological and economic sub-models of the general bioeconomic model. The two sides must be able to "talk" to each other. As an example, the biological model must produce quantities of landings by country, species, and size group to enable the economic model to estimate prices. These prices will then serve to determine the values of landings and the gains and losses by sector arising from hypothesised administrative decisions.

5.2 Problems relating to the economic input

5.2.1 A model of the economic background

The purpose of this model is to provide managers with a tool to evaluate the effects of specific management policies with reference to closed areas (boxes), mesh sizes and other technical measures. The model will enable comparison of the alternative "do nothing" situation, the effects of the various measures on the different participants (fleets) will be exposed to make it possible for managers to consider the balance and distribution of gains and losses that might arise from a proposed measure.

The economic section of the model can be regarded as consisting of an evaluation part and an evolution part. The evaluation part gives the relationship between catches, prices, and costs of fishing, and enables the calculation of total revenues and profits. In the evolution part the relationship between fishing effort and the elements influencing the effort would be specified.

The evaluation part of the model is specified by the following simplified equations:

(1):TR = P.Q
(2):P = p(Q,n)
(3):Q = q(Effort)
(4):Cost = c(Effort,size of stock,Q)
(5):VA = P + W
(6): P = TR - Cost
(7):W = a.TR

Where, TR = Total Revenue, P = price of species, Q = Quantities landed, P = profits, VA = value added, W = Wages, n = other variables.

The link between the biological model and the economic model at present stage is through equation (3), where Q will be an output of the biological model. At present, the biological model is not capable of responding to changes in costs.

The second part of the economic model, the evolution part is specified by the following equation:

(8):Effort = e(P*,other objectives,weather)

where P* is desired profit.

The objective for economic activity is often assumed to be to maximize profits. Empirical studies have indicated that this is not always so in fisheries. Therefore a more realistic aim for a model of fishermen's behaviour may be to maximize gross earnings or a combination of the goals, but this remains to be confirmed.

At some stage in the future, effort from equation (8) will be fed back to the evaluation part of the model.

In developing the model priority is given to the equations in the following order:

(3):Q = q(Effort)
(2):P = p(Q,n)
(1):TR = P.Q

and the cost function for later use in equation (6):

(4):Cost = c(Effort, size of stock, Q)

5.2.2. Deciding on the functional form of the price-quantity relation

It was agreed that the economic model was to compute prices by working with percentage change transformation.

In macroeconomic planning it is often the change in different key variables which is computed and not the absolute level of the variables. This is for a number of reasons which shall not mentioned here, but an approach where we compute *changes* in the biological system and in the economic system will be a natural choice for the model at hand though there are a number of disadvantages.

An approach where we compute by changes instead of computing by absolute values will consist of the following steps:

1 - Compute changes in the biological system; that is, changes in landings by species, age and country;

2 - Transform changes in landings to percentage change, ie (quantity minus quantity in reference period) divided by quantity in reference period;

3 - Use price flexibilities directly to compute changes in prices:

percentage change in price = price flexibility times percentage change in quantity or,

$p^* = b.q^*$; $p^* = dp/p$; $q^* = dq/p$

b = price flexibility

In computations we use the fact that:

$b = p^*/q^* = d\,Ln(p)/dLn(q)$

so that the computation is done by formulating the system in natural logarithms.

The formulation above only takes care of the own quantity effect on price but the model is generalized to include cross effects too.

4 - When change in price and change in landings are known the change in landings revenue can be computed.

5 - Independently, studies to estimate the price flexibilities used in step 3 need to be done.

This approach just mentioned will have the following consequences:

1 - Model building will be easier as no new variables except price flexibilities will be introduced in the model and the price flexibilities will be fed into the model as parameters. Therefore they can easily be changed as new knowledge about market reactions is obtained.

2 - Short and long-term behaviour can be studied by changing price flexibilities accordingly in comparative static studies.

As the model is intended only to answer questions such as "what will happen to landings revenues of different fleets if a change in regulation by technical measures is adopted, the only necessary information *for the model* is the price flexibility information of change in prices with change in quantities.

3 - To estimate the price flexibility economists will need more complex models where quantities are only one among a number of others explanatory variables such as income. These other explanatory variables are introduced to reduce effect of mis-specification bias on the estimated price flexibilities.

4 - It will not be necessary to change the North Sea Exploitation model as new knowledge of the market reactions is gained. The only new knowledge which has to be fed into the model is that on price flexibilities which can be fed in by changing the appropriate figures in the price flexibility matrix.

5 - By using the (constant) price flexibility model we have fixed the functional relationship between price and quantity. The underlying price-quantity function is of isoelastic type, that is the price elasticity is the same all along the demand curve and looks like this:

The functional form is of course simplified by excluding other variables. If they are included we will observe a cobb-douglas-like function.

This is in theory problematical because of adding-up problems, but as an approximation and as a computationally and intuitively very appealing formulation it is accepted by the group for the time being.

5.2.3. Comments on other problems

5.2.3.1. *Problem of landings in other countries*

The biological model produces catches per fleet aggregated to landings per country. These country-wise landings are basis for price determination.

In fact a part of the catches of certain fleets will be landed in other countries. So the Q (landings) of a certain species given by the biological model will not automatically represent the Q (supply) needed for price determination.

It is advisable to add to the system some parameters to direct some landings to other countries (perhaps on the basis of experience). It must be said that including total North Sea landings of the same species in the model could overcome this problem in part, but nevertheless the prediction of prices for an individual country could be affected.

5.2.3.2. *Price flexibility for individual market categories*

The total catch subdivided into age-groups will be translated into market-categories (based on age-length relations). For each market category the price in the reference period is obtained. The model then calculates the new prices of each category, taking into account total landings of that (and possibly other) species. This means that the relationship between the prices of the market categories will be constant (all prices will go up or down so many percent). In some cases, however, this relationship may vary in the course of time to a great extent. It is suspected that landings of individual market categories have much to do with this phenomenon. In this case total proceeds of a species, as calculated on the basis of total landings per species, may differ rather greatly from what will actually happen. The following example will show such a difference.

I	Reference period	Quantity	Price	Proceeds
	Category A	100	23.00	2 300
	Category B	300	12.00	3 600
	Total	400		5 900

We will assume that in the next period landings will change to 200 category A plus 250 category B, totalling 450. If the price flexibility F is -0.4 the outcome in the stated formula (disregarding other flexibilities) will be:

II	Next period (a)	Quantity	Price	Proceeds
	Category A	200	21.85	4 370
	Category B	250	11.40	2 850
	Total	450		7 220

If, making use of the same price flexibility of -0.4, each category is treated with the quantity of the category itself, the outcome will be:

III	Next period (b)	Quantity	Price	Proceeds
	Category A	200	13.80	2 760
	Category B	250	12.80	3 200
	Total	450		5 960

It is clear that this example results in two levels of total proceeds, the one 21% higher than the other. It is conceivable that method (III) is more realistic, leaving the management an overestimate by 21% if individual market category flexibilities are ignored.

If market categories are disregarded and the price flexibility is used on total landings of that species one will have:

IV	Next period(c)	Quantity	Price	Proceeds
	Category A	200	*	*
	Category B	250	*	*
	Total	450	14.01	6 306

This solution comes a lot nearer to the assumed realistic one (a difference of 6%).

Some research has to be done to ascertain whether in reality the relationship between prices of market categories is stable or not. In the case where certain categories are (mostly) used for processing purposes and others for the fresh market, these relationships can be stable within a certain range of landings (cod, plaice). However, if for instance mesh sizes have a marked effect on the relationship between quantities of market categories, it is conceivable that price relationships may change.

A problem arises in cases where a nation's catch of a species only contributes a small proportion of the total international catch of that particular species. This must be taken account of when calculating the quantity/price relationship for that nation.

5.2.4 Values

The whole economic part of the system should be valued in one denomination: ECU. Converting national currencies into ECUs is therefore necessary. For the input of the reference period the exchange rates in that period should be chosen. However, the results of the calculations, being in ECUs should perhaps be converted back into national currencies. Problems in this respect are inflation (perhaps at different rates in the individual Member States) or changing currency rates. As it is conceivable that (to a certain extent) variations in inflation rates and exchange rates will counter each other, the best solution is not to include both variations and stick to the basic ECU value and exchange rates.

5.2.5 Short and long run relationships

Just as a given technical measure may have short run and long run effects (in terms of the level and composition of catches), the economic relationships have theirs. One of the main causes is the time-lag between a change in the pattern of landings and the reaction (adaptation) of the processing industry, marketing organisation and other sectors of the industry's infrastructure.

The short run effects are generally better known and traceable than those of the long run.

Perhaps the best solution is to use the short run reactions and to adapt the model later when the development of monitoring real prices so urges.

5.3 *The economic submodel and its specification*

5.3.1 The interface between the biological model and economic submodels

It was agreed that the economic model should be constructed to calculate a set of *price modification factors*, at the full level of disaggregation recognised by the biological model, in order to maintain full flexibility of future developments, even though it is envisaged that in the immediate future the actual level of disaggregation for these factors will be substantially less (nations, species and quarter only). An early future step will be to include prices at age-size.

These modification factors are then taken by the biological model and applied to the array of *references prices*, also at the full level of disaggregation, again in order to maintain flexibility for the future.

The economic submodel is a FORTRAN subroutine linked with the biological model (MSFBOX), and called by it each quarter, after the landings have been calculated, using the statement:

```
CALL PRICES (Q,LANDINGS,PRICEMOD)
```

where Q is the index of the current quarter, LANDINGS (NFLEET,NS,NCAT) is the array of landings by fleet, species and size categories for the current quarter and PRICEMOD (NFLEET,NS,NCAT) is the array of (multiplative) price modification factor calculated, ie, the output of the submodel.

This defines the interface between the biological model and the economic submodel. Note that the economic submodel does not need to know the reference prices - these are read by the biological model and the price modification factors applied to them within the module of the biological model which calculates earnings.

Note also that the interface has been defined in terms of size categories. This implies that, when implemented, the biological model will carry out the mapping from age groups to size categories, and accumulate the landings to the disaggregation required.

5.3.2. The economic submodel

It was agreed that the economic submodel should be based on a log-log form of equation for price flexibilities, primarily so that the flexibilities should take the form of non-dimensional parameters which can be estimated easily (eg, set to zero) if they cannot be estimated formally.

After considerable discussion it was also agreed that:

1 - the calculation should be carried out quarter by quarter (ie, the model involves short-term flexibilities only);

2 - that market should be assumed to operate at the level of nations, and at the international level (not for individual fleets);

3 - that it was not feasible at this stage to allow for price flexibility within individual size categories (or between size categories of the same or other species); the landings must therefore be aggregated to total landings for each nation of each species, in order to define the supplies to the markets and thus the flexibilities.

With these decisions, the basic form for the price modification factors is:

$$D\ Ln\ P\ (fl,s,cat,q) = .\ flex_1\ (N,s^1) D\ Ln\ Landnat(N,s^1,q) + .flex_2(N,s^1) D\ Ln\ Landtot\ (s^1,q)$$

The multiplicative price modification factor required is actually the exponential of the left hand side (LHS) of this expression. Here $flex_1$ represents the flexibility due to supplies to the national market, and $flex_2$ that to supplies to the international market (ie, the summation of the nations included in the model - supplies exogenous to the model are unknown and cannot be handled at present). Suffix N identifies nations. Landnat is the array of national total landings of each species, and landtot the international total thereof. Note that:

(i) although variation with fleet (within nations) and wish size category is allowed for in the LHS, it is not actually implemented in the right hand side (RHS), so that many of the price modification factors will actually be the same, and need only be computed once,

(ii) the suffix q (for quarter) has been written on both sides of the expression, to emphasise that the calculation is carried out for each quarter; only the current landings and modification factors are needed and calculated at any one time, so the full arrays are not actually needed.

The implementation is sketched in FORTRAN - like pseudocode in the Appendix C, where a number of practical housekeeping details have been taken into account.

The main data requirements for the economic submodel are:

(i) the mapping from fleet to nations (Note: *nations* here really define markets, and it was agreed that the pseudo-nation should be defined for the industrial fishing fleets, since the market for their landings is largely independent of that for human consumption landings,

(ii) the landings in the reference period (to which the reference prices also refer), so that D in landings may be calculated,

(iii) the flexibilities, for each nation, of prices of each species in response to landings of that species and all the other, within the nation (denoted $flex_1$ above FLEXOWN in the pseudocode) and internationally ($flex_2$ and FLEXOTHER).

The flexibilities are arrays of dimension 48 x 6 each in the currently envisaged implementation, and will need to be provided by the economists. They will be set to zero (giving no influence on price) if they are not know. The tabulator format required is sketched below.

For each nation:

Two tables of the following form, one for flexibility due to national landings (domestics + imports) and one for that due to international landings (as a whole).

		Species landed		
		COD	HAD	...
Price	COD			
Affected	HAD			
	...			

The values supplied must be coefficients of log-log relationships (and will therefore usually be real numbers lying between 0 and -1. Until these are available the model may be tested using zero as a default estimate.

5.4 *A review of progress to date*

5.4.1 Specification of the model

The economic model has been specified in concept, agreement reached with the biologists on what parameters the economic submodel should provide for the biological model, and where the parameters are know, they have been provided.

The model does not require full demand equations as only the flexibilities are used in calculating the price relative to the reference prices.

The economic submodel can now enable the effect on national revenues and, therefore, gainers and losers, to be estimated.

5.4.2 Data

Data needed for the model is therefore:

1 - Reference prices per fleet per species per size for each quarter,

2 - Reference quantities corresponding to (1-) above,

3 - Flexibilities explained in section 5.3.

In accordance with the May 1989 Brussels economics subgroup meeting, data required by the economic submodel were gathered. The data required were mean prices by national market (each nation), species and quarter. Flexibilities by national market (considering the effect on prices of a change in landings by both the countries own fishermen and that of other countries' fishermen).

It is important to stress that estimation for national markets be done for the effect of the sum of the landings of the countries own and of foreign fishermen into the national market.

The flexibilities of the landings thus estimated are referenced as "flexown", but include cross species effects. In addition to the flexibilities of the landings to the national markets, the effects of landings elsewhere of the same species, caught in the North Sea, was evaluated and flexibilities were set provisionally until estimation can be done. Estimations can be done when data on landings in all countries have been gathered. It was discussed whether it was possible to secure confidentiality by aggregating data and only distribute data aggregated over all or a number of the countries involved. In the program, the effect of landings elsewhere is referenced as "flextot", but they really should be referenced as "flexother", meaning the effect of landings into foreign ports. Data on quantities in the reference year 1987 were gathered during the meeting for all species considered, except for industrial species, which were not considered in the first run. For the individual countries the following data were available as required for the meeting.

Belgium:

Belgian prices were available at the meeting as required and transformed to ECU value. Flexibilities were not estimated, but assumptions were made by the group (see section on price flexibilities). Reference quantities were not available at the meeting, but can easily be obtained.

Denmark:

Prices were available. Price flexibilities were estimated except for sole and reference quantities were available except for plaice, which will readily be available.

England:

Prices on the English-Scottish market were used. Flexibilities were set after considering the relation between the Scottish and English market. Reference landings quantities were not available, but will readily be.

France:

Prices, flexibilities and quantities were provided as required.

Germany:

Prices and quantities were available for the meeting and assumptions on flexibilities were made by comparing the market situation in Holland, Denmark and West Germany.

Netherlands:

Prices and quantities were available as required and estimates and assumptions on flexibilities were provided as well.

Norway:

Prices and quantities were available. The price subsidy marketing system for fish at first-hand was described, and assumptions on flexibilities were made for the pre-subsidy prices.

Scotland:

The prices were available from the England-Scotland market prices. Quantities will be available. Assumptions on flexibilities were made based on estimations on the British market and considerations on the relation between the English and Scottish market.

The cost figures were not considered but at the next meeting it will be discussed how costs can be measured and used in a coming model of effort redistribution.

5.4.3 Price flexibilities.

It is expected that the prices of a species in a nation are dependent on a country's own landings, foreign landings in the country, landings of substitutes and the landings in the other countries fishing in the North Sea. It was decided to use the following price model:

P(N,S) = f[(Q(N,N,S) + Q(N,F,S)),((Q(N,N,O) + Q(N,F,O)),(Q(C,N,S)), other]

O = 1,...6,0 = S
C = 1,...8
F = 1,...8,F = N

Q(N,N,S) is the landings of species S in national market N by fishermen of nation N Q(N,F,S) is landings of species S in national market N by fisherman of other countries; (Q(N,N,O) + Q(N,F,O)) is landings of other species in country N of other species and (Q(C,N,S) + Q(C,F,S) is landings in other countries.

Only a part of the flexibilities requested by the model are available on the basis of research. The remaining coefficients were estimated on the basis of the experience of the working group. In particular the flexibilities with respect to landings in other countries are not known. All flexibilities are thought to be only reliable for the short run (less than two years) predictions. Details of the price flexibilities used by species and by country are presented in paragraph 5.4.2.

When no price flexibilities were available the working group had to make estimates. These estimates were in general based on the following considerations:

- the relevancy of the species for the country in question,

- the degree to which the national market is isolated,

- does the species have obvious substitutes?

- is the national market connected to particular markets in other European countries?

- what is the relative share of the national market to the whole market?

When data on prices distributed on commercial categories are made available the flexibility will be used on each category price.

Needed for the next meeting:

To use the model for long term predictions, it will be needed to develop ideas on the impact conservation measures will have on the price level in the long run.

The predictions of the model might be improved with more accurate information on price flexibilities, in particular the flexibilities with respect to the landings in other countries.

5.5 *Future work*

5.5.1 Some considerations about the model

The model as it stands at present is not a true bio-economic model, but rather, a biological model with an economic sub-model which merely calculates price-quantity effects. Unfortunately, this limits the use of the model to simulations over the short term (two years) because there is no opportunity within the model for costs and effort to respond to price and quantities changes, or regulatory measures, except by exogenous imposition.

The model as it stands is thus a comparative static analysis of the costs to individual fleets of measures intended to conserve threatened stocks. Because it cannot yet accommodate changes in human behaviour other than in determining prices it is not suitable for use as a simulation model to calculate medium and long term gains accruing from improved stock sizes. In addition, the absence of feedback from the economic section to the biological model means that the biological model will always dominate the results produced.

Thus the future economic input to the development of the model must be directed towards a dynamic structure with immediate improvements being prepared in the cost and effort variables.

5.5.2 Converting size-quantities to age-quantities

The disaggregation of the quantities for each species into categories will improve the price modelling, taking into account the cross-price flexibilities between all categories.

The best way to introduce the categories in the regression model is to use the commercial categories which are the more relevant from an economic point of view.

The MSFBOX program uses and computes the age-quantities for each species. To transform the price-size-quantities relationship to a price-age-quantities relationship, we will need to use the conversion matrix from age-quantities to size-quantities to enable the price subroutine to convert age-quantities to size-quantities and calculate the variation of the price per size. The gross earnings will be obtained by multiplying the price per size by the size-quantities.

5.6 *For the next meeting*

1 - Estimates for each country are needed of the flexibility matrices based on estimation of:

$$n\ P = a + b \ln Q_{df} + g \ln Q_{i-df} + \quad \ln Q_{jdf}$$

where P is the real price, Q_{df} is the quantity of domestic and foreign landings, and Q_{i-df} is the quantity of all landings from the North Sea minus Q_{df}, and Q_{jdf} is the domestic and foreign landings of other species. Although specified in double-log form, if another functional form is felt more realistic, estimates from such a form would be welcome. This equation is required at present to be estimated for each species, but should, if possible, also be estimated for each species by size. It must be understood that for a thorough econometric estimation an enormous amount of work would be involved, and that at present, estimates will be rudimentary.

2 - Reference prices and quantities are needed for each country, by species, if not already provided, and if possible by size category.

6. Providing an overview of the North Sea fisheries

6.1 Introduction

The first requirement for any mathematical model is an accurate description of the system to be modelled. For the purpose of the working groups model this is the fishing activities in the North Sea. Although many publications exist on various aspects of the North Sea fisheries a general up to date overview is not available. An attempt to give a brief description of the major fishing activities was undertaken and is given in section 6.2.

A feature of all models based on a large data base is that the volume of in-and-output data is not only difficult to manage but also very difficult to interpret. To overcome this problem an attempt has been made (section 6.3) to represent the data in a pictorial form.

6.2 Fleet descriptions

The vessels exploiting the resources in the North Sea differ in many aspects. Therefore the total fleet has been subdivided into fleets which are considered to be in some way homogeneous. Ideally such a subdivision should be based on some standard definitions of the fleets. However, the available data does not allow such an approach at present. For this reason the subdivision into different fleets has been left to the national institutes. The present list of fleets chosen per country is given in Table 6.2.1 which also includes the main features such as size of the fleet, vessel size, fishing gear used, mesh sizes used, fishing grounds and target species. The subdivision for each country is in general based on the type of gear used and the target species. In some cases the size of the vessels is used to define the fleets. The present list of fleets and their descriptions must be considered as preliminary, because changes might be necessary, either because a more appropriate division will be suggested or because the relevant data for the fleets is not available.

6.3 Pictorial summaries of fleet activities (to be revised by Henning

The data set provides the possibility for producing simple pictorial descriptions of the distribution of fishing effort and catches in the North Sea together with the relative economic importance of different fishing areas according to fleets, species and time of the year.

It is possible to output for each rectangle the following main parameters:

- catch in numbers
- catch in weight
- value of catch landed
- effort in days fishing

and from these it is possible to derive further parameters such as

- catch weight/unit effort
- catch value/unit effort

These parameters can be evaluated according to

- species
- age
- fleet
- quarter
- year

or summations of these.

The following are examples of the sort of distributions by rectangle that might be produced.

- General overviews.
  Total fishing effort all fleets combined.
  Total landed value all fleets combined.

- Single species biological/technical studies
  (All fleets including discards).
  Total weight cod caught according to fishing method (trawl, beam trawl, seine and gill net).
  Cath of one + two year old cod and haddock in numbers.

- Single species bioeconomic studies
  (All fleets excluding discards).
  Relative value of whiting to total catch value.
  Distribution of sole catch value.

- Single or grouped fleet studies.
  Relative value of sole to plaice catch for Dutch and Belgium beam trawlers.
  Relative value of haddock to total catch for Scottish seiners.
  Distribution of French total catch value (all fleets combined).
  Fishing effort subdivided according to codend mesh size used.

Fig 6.3.1 give some idea of how such data could be presented but such figures could be made more comprehensible by "3D" plotting techniques.

7. REPRESENTATION OF MIGRATION IN SPATIALLY DISAGGREGATED MODELS

7.1 Introduction

It is not difficult to envisage how one might set about representing migration in spatial models, but there are a number of technical points which are worth discussion, and major difficulties in acquiring the necessary data.

7.2 Possible Solutions

In a spatial model, it is inevitable that the catches, and the fish populations abundances, will be represented as quantities within moderately sized regions (eg, rectangles). These quantities may naturally be represented in a (box) model as vectors of catches, abundances etc in each rectangle. Note that the fact that these represent a two-dimensional array (a matrix) in real space is irrelevant - mathematically they are more conveniently regarded as a one-dimensional vector.

The equations representing the fishing process (catches, deaths, changes of population) can easily be written down. These will look a bit different to the usual ones, because it would be more natural to have fishing mortality rates operating on local populations (ie, the opposite of the present MSFBOX convention), although this may not be essential. It may be neater to work with a total population abundance, and proportions in each rectangle.

These equations can be set down (see Appendix B) for any desired time-step. At the end of each time-step it will be necessary to model the movement (migration) of the population. Conceptually, this involves the application of transfer and mixing rates between all the boxes, but the end result of this is just a migration matrix. This is big (NrectxNrect), but conceptually simple - it just contains, for each rectangle, the probability that fish move during the time-step to any other rectangle. It will be difficult to get the data for this matrix, but if it could be done, there would be no real problem in applying it. The size of the matrix is not a serious difficulty, because it will be sparse (most of the cells will contain zeros), and one needs to store, for each cell, only the list of cells having non-zero probabilities, and the numbers themselves.

However, there is in fact probably no need to run the prediction with such a high spatial resolution anyway. Considering that the preliminary model, MSFBOX, works with just two regions (in the box, and outside it), one could as a minimum simply enhance the calculation to allow for migration between them - this involves only a matrix of 4 numbers (for each time step). For experimental purposes, these could simply be guessed at intermediate values (in the range 0.2 to 0.8, say). This would however be a very crude representation, and it would clearly be preferable to split the area outside the box into several sub-areas - on something like the scale of the roundfish sampling area. The mathematical formulation is identical to that of a more detailed representation (see Appendix B), but the computational and data requirements are much less. Thus one would work with the detailed spatial representation (rectangles) for data abstraction, and to permit flexible aggregation for the determination of partial fishing mortalities. For prediction, however, one would work with a modest resolution, say in the range 2 to 10 boxes, one (or possibly more) of these would obviously be the restricted area under consideration.

7.3 Data requirements

Even for a handful of boxes there is a considerable problem in determining the numbers for the migration matrix.

One possibility would be an analysis of the existing large body of tagging data. Until this is done it is impossible to know whether or not this would be a sufficient basis. It is likely that some of the necessary parameters would be well-defined, and others not.

Another possibility would be to attempt to determine the parameters from the sequences of spatial distributions available from survey data. This is an exercise in what is known as inverse modelling. However, experience with such techniques on passive chemical tracers (including temperature and salinity), shows that such problems are usually horribly ill-conditioned, and this approach on its own is not considered to be at all promising.

A third approach would be to utilise the information available from research on migratory behaviour, including that on tidal transport mechanisms (refs). It is in fact possible that the results from our existing model of selective tidal transport (Arnold, pers. comm., etc) could be used to determine the deterministic part of the transport mechanism in a fairly comprehensive way. There are also field observations which indicate the variability of transport about those predicted by the model, which might serve to determine the random ("mixing") element of the migratory process.

It is also possible that in the end it may be possible to determine the parameters by fitting to more than one of these datasets at the same time - possibly even all of them. This is in principle feasible in the inverse modelling approach, but the practicability will need to be examined at a later stage.

Whichever approach is adopted, there is no doubt that obtaining the necessary data for a sensible calculation is a major task, which will require a considerable effort over several years. The development of predictive calculations may have to proceed with poor resolution and bold approximations (cf. MSFBOX - two boxes and instantaneous mixing) for some time yet. This problem is further discussed in Appendix D.

8. INCORPORATING SPECIES INTERACTIONS IN THE MODEL

8.1 Possible solutions

The ICES multispecies W.G., Anon. 1984-88 made considerable progress in understanding predation based interactions between North Sea species. These effects have to some extent been taken into account by the single species working groups who use estimates of natural mortality based upon the multispecies W.G. estimates. However these levels are only appropriate at the current stock sizes of predator and prey fish. When fisheries management measures are proposed which may change these stock levels the predation mortality levels will change. These changes can and do change the calculated effects of some management measures. It will be important therefore when calculating the effects of technical measures to have the ability to include multispecies interactions in the calculations.

To do this however could potentially be difficult as computer programmes used to calculate multispecies effects and technical interactions are large and complex. A merger with MSFBOX might therefore be expected to be huge and very complex. There is therefore a strong argument for including the multispecies effects into the technical measures program in as simple a fashion as will capture the chief effects. A simple method developed by Shepherd 1983 may provide one possible approach. This assumes that predation mortality is generated on prey species in proportion to the biomass of predators and with the coefficient of proportionality given by prey/predator and size effects. In the past the problem with this approach has been estimating this coefficient of proportionality in such a way as to mirror reality as estimated by the multispecies working group. Recent developments Miss S Singh pers. com. however suggest that these problems could be substantially overcome using different fitting procedures. It is requested that the multispecies working group might consider such fittings as their June 1989 meeting and advise on the most suitable formulation of multispecies model that could be adopted by this working group for incorporation in the MSFBOX programme.

9. Optimisation of technical measures

9.1 Possible solutions

The procedures so far developed by this working group together with those in prospect are appropriate to answering questions of the form 'What would happen if fisheries were managed by a particular specified set of technical measures'. At present the group does not have a methodology for answering questions of the form 'What would be the best specification for technical measures to achieve stated objectives and satisfy stated constraints?' As an example, such a question might be how best can we increase the yield of cod while maintaining the yield of other species and maintaining the general equity of catch allocation of all species between countries? More simply, it might be a question such as could you find a set of technical measures which have much the same effect as those already proposed but which bear less heavily in the short or the long term on particular national fleets? It seems likely that such questions will be asked sooner or later and it would be wise to think how they could be answered in a reasonable time frame.

Several useful suggestions were made at the meeting and these should form the basis of future investigations. One suggested approach was to formulate both the objective and constraints in linearised forms so that linear programming techniques could be adopted to suggest roughly optimal solutions which could be further investigated using the standard methodology. An alternative approach suggested for closed area type measures was to rank rectangles in order of the value their closure would give to a particular subset of species. With this information it might be possible to manually select improvements to proposed measures which could be evaluated using the standard methodology.

Clearly the practicality of these or other as yet unspecified methods need to be investigated. The working group will be grateful for reports of research on these problems at its next meeting.

Appendix A. Participants

Members participating in the meetings are listed below. The working group was particularly pleased to welcome representatives from Norway which had not previously been represented on this working group and whose participation completed the coverage of the North Sea.

List of participants at the Lowestoft meeting 23-27 January 1989

R De Clerck	Belgium
J Sorgensen	Denmark
P Rodgers	UK
N A Nielsen	Denmark
F Van Beek	Netherlands
D Wileman	Denmark
W Brugge	EC
B Mesnil	France
U Damm	FRG
A Souplet	France
P Lewy	Denmark
E Bakker	Norway
Engeseacker	Norway
J Pope (Chairman)	UK
J Shepherd	UK
K Stokes	UK
R Ayers	UK
D Armstrong	UK

<u>List of Participants at the Economics Subgroup Brussels 10-12 May 1989</u>

Mr W Brugge	EC
Mr S Engesaeter	Norway
Mr H P Jorgensen	Denmark
Mr F Lantz	France

Mr B Mesnil	France
Mr P Rodgers (Chairman)	UK
Mr J Shepherd	UK
Mr W Smit	Netherlands

List of participants at the Nantes meeting 11-15 September 1989

A Souplet	France
R De Clerke	Belgium
U Damm	FRG
F Lante	France
P Rodgers	UK
P Sandberg	Norway
D Skagen	Norway
F Van Beek	Netherlands
B Mesnil	France
J Pope (Chairman)	UK
J Smit	Netherlands
K Stokes	UK
D Armstrong	UK
P Lewy	Denmark
H Sorgensen	Denmark

Appendix B STRUCTURE of the DATA FILES

As mentioned in Section 3, the structure of the files was designed to allow for hopefully convenient assembly of the data by replication or concatenation of similar blocks, although this will remain essentially a tedious task. In addition, the distribution of data items among files ensure that these keep a reasonable size, but requires that consistency of the dimensional parameters (species, age ranges, fleets, seasons, nations) be carefully controlled. For convenience, the program can read the data in free format (any number of data per record, commas or blanks as separators) but character data should each be on separate records. Also for easier control, the species and fleets names are written as headings to each relevant block of data and therefore repeated several times; since they are not actually read, they can be kept as short as possible or, subject to changes in the program, deleted from the files.

Since the format may not be definitive, the structures are presented by commenting the files which were used during the meeting in Nantes (September 1989). The comments are given after an opening square bracket [; they are not part of the files!

1) The STOCK File:

```
MSFBOX DATA - STCF WG NANTES 09/89           [general title
  6  4                                       [number of Species, of Seasons
  0.25  0.25  0.25  0.25                     [each season lasts 1/4 year
COD                       [Main Loop on SPECIES; read name of Species n° 1
  0 10 1                  [First age=0, last age=10, 1 indicates 10 is + group
0.,.250,.728,1.579,3.666,6.139,8.185,9.841,11.463,12.514,13.279  [read stock
0.,.310,.756,1.955,4.045,6.273,8.245,10.584,11.879,13.268,11.871 [weights at
0.,.404,.923,2.285,4.268,5.855,8.145,10.032,11.273,11.346,12.013 [age in
0.1,.557,1.091,2.729,4.811,7.012,9.536,10.770,12.448,12.516,14.302 [seasons
1                         [MCODE is 1, implying Ms vary with age
2.7,.800,.350,.250,.200,.200,.200,.200,.200,.200,.200 [read Ms in season 1
1                         [repeat for seasons 2-4
2.7,.800,.350,.250,.200,.200,.200,.200,.200,.200,.200
1
2.7,.800,.350,.250,.200,.200,.200,.200,.200,.200,.200
1
2.7,.800,.350,.250,.200,.200,.200,.200,.200,.200,.200
1                         [Main Spawning Season is n° 1
0.,.010,.050,.230,.620,.860,1.000,1.000,1.000,1.000,1.000 [read proportion
0.,.010,.050,.230,.620,.860,1.000,1.000,1.000,1.000,1.000 [mature at age in
0.,.010,.050,.230,.620,.860,1.000,1.000,1.000,1.000,1.000 [each season
0.,.010,.050,.230,.620,.860,1.000,1.000,1.000,1.000,1.000 [end of COD data
HADDOCK                   [read name of Species n° 2; used to label outputs
  0 10 1                  [repeat same block structure as for cod
   etc.
WHITING                   [then for Species n° 3
  0 10 1
   etc.
SAITHE                    [name of species n° 4
  1 11 1                  [age range (exception) and + group code
.151,.347,.449,1.016,2.004,2.751,3.383,4.713,5.293,6.643,7.456 [stock Ws at
.128,.394,.630,1.144,1.795,2.684,3.356,4.289,4.971,6.030,6.252 [age by
.143,.529,.792,1.327,1.893,2.841,3.594,4.954,5.041,7.187,7.359 [season
.366,.528,.715,1.161,1.913,2.900,3.650,4.712,5.214,7.123,10.967
```

```
0                         [here MCODE is 0: M is constant
.200                      [read constant M for Season 1
0                         [continue for other seasons
.200
0
.200
0
.200
1                         [Rank of Main Spawning season
.000,.000,.000,.150,.700,.900,1.000,1.000,1.000,1.000,1.000 [maturity
.000,.000,.000,.150,.700,.900,1.000,1.000,1.000,1.000,1.000 [ogives
.000,.000,.000,.150,.700,.900,1.000,1.000,1.000,1.000,1.000 [in seasons
.000,.000,.000,.150,.700,.900,1.000,1.000,1.000,1.000,1.000
PLAICE
 0 10 1
                          [continue with other species
SOLE
 0 10 1
```

2) The BASELINE CATCH File:

```
STCF WG NANTES DATA SEPT 1989          [general title again
 6  72  4  2  1988  [number of Species, Fleets, Seasons, Areas; Ref. Year
 DEN NE1 L          [start list of Fleets; read name of Fleet n° 1
 0      2           [0 means no Effort linkage; fleet lands in Nation n° 2
 DEN NE1 D          [name of Fleet n° 2; discard counterpart of n° 1
 1      0           [apply same Effort as for fleet n° 1;discards = Nation 0
 DEN NE2 L
 0      2
 DEN NE2 D
 3      0
   etc.             [continue till end of fleets' list
 ENG OG  L
 0      3           [England is Nation N° 3 for market considerations
 ENG OG  D          [last fleet is n° 72, linked with n° 71
 71     0           [and attached to nation 0 since it is discard component
 COD         [Now we start a Main Loop on SPECIES; read name of Species n° 1
 6.1300e+06  277000.0  97361.0  62856.0  2418.0 [read Stock Ns at age in 1st
  6299.0  963.0  803.0  127.0  191.0  68.0      [season of starting year
SEASON  1           [then Loop on SEASONS; read or skip comment
DEN NE1 L           [and, for each Season, on FLEETS; read or skip comment
1 1          [FCODE and WCOD]; if not-0, read corresponding data
 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.               [Ref. Fs IN Box
 0.  0.  7.12879e-03  3.81394e-02  5.97444e-02  0.112929  [Ref. Fs OUT
  0.123363  0.153050  9.22500e-02 2.81067e-02  0.         [of Box
 0.  0.  0.948  1.887  3.959  6.196  8.768        [Landings Weights at age
  9.762  11.543  13.216  0.                       [IN Box
 0.  0.  0.948  1.887  3.959  6.196  8.768        [same, OUT
  9.762  11.543  13.216  0.
DEN NE1 D    [2nd Flet for Cod in Season 1
0 0          [codes are 0 since no discard of cod; no data read
DEN NE2 L    [then continue with Fleet n° 3
1 1
  etc.
ENG OG  D    [this is the last fleet in the list
0 0          [no relevant data
SEASON  2    [now proceed to 2nd season, still for Cod
  etc.       [same structure as above is repeated over seasons
```

```
               [with inner loop on fleets
HADDOCK        [same pattern is repeated for Species n° 2
3.74420e+07  825364.0  706659.0  133423.0  19710.0  [starting Population
 22162.9  1608.0  1324.0  284.0  578.0  59.0        [numbers in Season 1
SEASON  1      [start loop on Seasons
DEN NE1 L      [then on Fleets
1 1
  etc.
SEASON 4       [we are now in last season
DEN NE1 L      [resume loop on Fleets
1 1
  etc.
ENG OG  D      [there is data this time for the last fleet; read Fs In
1 1            [and Out, followed by mean Ws at age In and Out
4.51256e-07  2.59472e-05  6.87915e-05  1.59941e-05  4.68937e-06
 4.19233e-06  3.60150e-06  0.  0.  0.  0
5.93911e-07  3.41499e-06  4.36682e-05  5.56207e-06  1.00980e-06
 5.24983e-07  3.29111e-07  0.  0.  0.  0
1.90e-02 0.162 0.312 0.556 0.738 0.923 1.139 1.346 1.651 2.153 1.548
1.90e-02 0.162 0.312 0.556 0.738 0.923 1.139 1.346 1.651 2.153 1.548
WHITING
  etc.         [continue for other Species
SAITHE
  etc.
PLAICE
  etc.
SOLE
  etc.
```

3) The ECONOMIC DATA File:

The content of this file is very provisional as yet, and would be largely augmented if commercial categories were considered and if prices were defined at lower level of resolution (i.e., age and fleet). Such changes would also imply significant amendments to the simulation program. This file currently has 4 section, each with a specific type of data:

```
STCF WG NANTES DATA SEPT 1989    [general title again
  6  72  4  9  [number of Species, of Fleets, of Seasons and of Nations
Flexown by Nation                [comment to first section
BEL             [loop on NATIONS (ordered alphabetically); name of Nation 1
-0.10  0.00  0.00  0.00  0.00  0.00   [read a (species * species) matrix of
 0.00  0.00  0.00  0.00  0.00  0.00   [coefficients relating changes of
 0.00  0.00  0.00  0.00  0.00  0.00   [prices to changes of landings,
 0.00  0.00  0.00  0.00  0.00  0.00   [BOTH in same Nation (Belgium here).
 0.00  0.00  0.00  0.00  0.00  0.00   [Use standard order of Species both
 0.00  0.00  0.00  0.00  0.00  0.00   [in rows and columns!
DK HC           [continue with Nation n° 2
  etc.          [ and others
IND             [ a pseudo-nation (n° 9) is defined for Industrial market
 0.00  0.00  0.00  0.00  0.00  0.00   [data here were all set to .
 0.00  0.00  0.00  0.00  0.00  0.00   [implying that there would be no
 0.00  0.00  0.00  0.00  0.00  0.00   [effect accounted for in this run;
 0.00  0.00  0.00  0.00  0.00  0.00   [also, industrial fleets were not
 0.00  0.00  0.00  0.00  0.00  0.00   [defined as such in this meeting
 0.00  0.00  0.00  0.00  0.00  0.00

Flextot by Nation                [comment to second section
```

```
BEL              [same structure as above, with a loop on NATIONS
-0.10  0.00  0.00  0.00  0.00  0.00   [but here coefficients relate
 0.00 -0.10  0.00  0.00  0.00  0.00   [change in Belgian prices to changes
 0.00  0.00 -0.05  0.00  0.00  0.00   [in total North Sea landings of each
 0.00  0.00  0.00 -0.10  0.00  0.00   [species; only diagonal values used
 0.00  0.00  0.00  0.00 -0.05  0.00   [here, implying no cross-effects
 0.00  0.00  0.00  0.00  0.00 -0.10   [between species
DK HC
  etc.           [continue over next Nations
Quarterly landings by Nation     [comment to third section
BEL              [loop on NATIONS again within this section
 0.0  0.0  0.0  0.0  [for each Species read ref. landings by Season;
 0.0  0.0  0.0  0.0  [each row is for a species in standard order (from
 0.0  0.0  0.0  0.0  [Cod to Sole), with 4 fields per record;
 0.0  0.0  0.0  0.0  [Here, 0.0 imply no consideration of price function
 0.0  0.0  0.0  0.0  [Data should be in TONNES if Stock Numbers are in
 0.0  0.0  0.0  0.0  [THOUSANDS and Mean Weights in KG
DK HC            [continue with Nation n° 2
9488 10399 8005 2902      [this is another example with data actually
1359 1784 3239 1878       [accounted for in computations
 276  129  3095 377
2262 6093 3860 3471
 0.0  0.0  0.0  0.0       [except for Plaice
  18  150   48   25
  etc.           [continue with other nations
Prices at landing, by species and quarter  [comment for section 4
BEL              [loop on Nations again
  etc.           [let's take another nation this time
FRA
 1.57  1.54  1.56  1.54  [format is same as for reference landings
 1.23  1.29  1.00  1.14  [with species in rows, seasons in columns;
 1.03  1.25   .80   .90  [data here are mean prices in ECU per kg.
 1.05   .61   .41   .60  [Ideally, they should be age specific
  .63   .68   .97  1.07  [and provided for each landing flet
 6.70  6.92  6.27  7.01  [instead of nation only.
GER
  etc. till end of file.
```

4) The SCENARIO File:

```
STCF WG NANTES DATA SEPT 1989       [a general title
  6  72  4  2  1988       [number of Species, Fleets, Seasons, Areas; Ref Year
1988                      [here it starts; read first simulation year
 BASELINE FORECAST - NANTES 1989   [read comment for the simulated regime
 DEN NE1 L             [First, loop on FLEETS to read Effort Multipliers
 1 1           [Effort Multipliers IN and OUT in Season 1
 1 1           [ id. in Season 2
 1 1           [ id. in Season 3
 1 1           [ id. in Season 4
 DEN NE1 D     [This fleet is linked to previous; nothing to read except name
 DEN NE2 L     [Next Fleet
 1 1
 1 1
 1 1
 1 1
  etc.
 ENG OG  L
 1 1
```

```
1 1
1 1
1 1
ENG OG  D    [last fleet in list; no data for it since linked to previous
COD          [Now loop on SPECIES for forecast year 1988
0  [RCODE is 0: recruitment 1989 same as in 1988; otherwise read Cod R 1989
SEASON  1    [then loop on SEASONS within Species
DEN NE1 L    [and on FLEETS within Seasons; read or skip comment
1 0          [FCODE is 1: read new Fs; WCODE is 0: mean weights unchanged
0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0   [new Fs IN Box
0.0  0.0  0.00713  0.03813  0.0597  0.11293  0.1234
 0.153  0.09225  0.0281  0.0  [new Fs OUT Box;
DEN NE1 D    [name of Fleet n° 2 recalled to help housekeeping
0 0          [codes are 0: data unchanged, proceed to next fleet
 etc.
ENG OG  D    [last fleet
0 0
SEASON  2    [then next Season for Cod, same structure as above
  etc.
HADDOCK      [and continue for other species

  etc.       [until last fleet for Sole in season 4

1            [INEXT is 1, meaning that following regime is for next year
1989         [read year
BASELINE FORECAST - NANTES 1989   [read comment on regime
DEN NE1 L    [loop on FLEETS to read effort multipliers IN and OUT in
1 1          [ each season
1 1
1 1
1 1
DEN NE1 D

  etc.       [then repeat same structure as for 1988

1            [INEXT=1, another year coming; if INEXT is 0 the next regime
1990         [ would apply in the same year (e.g., for option table)
```

APPENDIX C
ECONOMIC MODEL PSEUDOCODE

```
NB: use SAVE between Calls

SUBROUTINE PRICES (Q, LANDINGS, PRICEMOD)

INCLUDE PARAMETERS.DAT

      (Set Dimensions NQ, NS, NCAT, NNATION, NFLEET)

REAL LANDINGS (NFLEET, NS, NCAT)
      PRICEMOD (NFLEET, NS, NCAT)
      LANDREF (NFLEET, NS, NCAT, NQ)
      FLEXOWN (NNATION, NS, NS)
      FLEXOTHER (NNATION, NS, NS)
      LANDNAT, LANDNATREF (NNATION, NS)
      LANDTOT, LANDTOTREF (NS)

INTEGER NATION (NFLEET)

      Read NATION array from file     )
      Read FLEXOWN from file          )  First Call only
      Read FLEXOTHER from file        )
      Read LANDREF from file          )

Comment: For Q = Current value (Do Nothing)

            For each species
            For each FLEET
            For each CATegory
                  NAT = NATION (FLEET)
                  Sum Landings -- LANDNAT (NAT, S)
                  Sum Ref Landings -- LANDNATREF (NAT, S)
            Endloops

Comment: For Q = Current value

                  For each Species
                  For each NATion
                        Sum Landings -- LANDTOT (S)
                        Sum Ref Landings -- LANDTOTREF (S)
                  Endloops

Comment: For current quarter

                  For each NATION
                  For each species (S1)
                  For each secondspecies (S2)
            Sum         TEMP
                  + = FLEXOWN (NAT, S1, S2)
                  *   ALOG (LANDNAT (NAT, S2))
                              /LANDTATREF (NAT, S2))
                  +   FLEXOTHER (NAT, S1, S2)
                  *   ALOG (LANDTOT (S2)
                              /LANDTOTREF (S2))
                  PRICEMODTEMP (NAT, S1) = EXP (TEMP)
                  Endloops
```

```
For each FLEET
For each Species
For each CATEGORY
NAT = NATION (FLEET)
PRICEMOD (FLEET, S, CAT)
= PRICEMODTEMP (NAT, S)
Endloops
```

Comment: Call Differential Inflation Subroutine (etc., etc.) here, if necessary.

```
RETURN
```

In Biol Model

```
Sum Inside and Outside Landings
Map Ages onto Categories and Sum

LANDINGS (FLEET, S, CAT)
      For Current quarter

Read Reference Prices
      PRICEREF (NFLEET, NS, NCAT, NQ)

From Econ Routine: Get PRICEMOD (NFLEET, NS, CAT)
      for current quarter and apply to reference prices.
```

NB: LANDINGS and PRICEMOD are passed at full disaggregation (NFLEET, NS, NCAT) even though they are not needed that way at present, to preserve flexibility by avoiding constraining the interface.

Appendix D. Spatially disaggregated forecasts: mathematical considerations

In MSFBOX (and most peoples' minds), spatial disaggregation just means partitioning the total fishing mortality in the appropriate way. However, once one plans to model mixing and movement of the population, it is more convenient to work with the alternative representation in which the total population is disaggregated, rather than the F's. Thus one chooses to work with proper fishing mortality rates operating on (partial) local population abundance, rather than partial fishing mortality rates operating on the whole population.

Letting suffix r index spatial boxes (it's short for rectangle but would in practice probably relate to a substantial group of rectangles), the local population is denoted by product of the total population N, and the proportion (P) of the total to be found in the box, i.e.

$$N(s,a,q)\ P(r,s,a,q) \tag{B1}$$

The local catch equation becomes

$$C(r,s,a,q,f) = F(r,s,a,q,f)\ N(s,a,q)\ P(r,s,a,q) \tag{B2}$$

where the average is over the time period in question (denoted by q for quarter but actually of arbitrary length).

The area total catch is

$$SC(r,s,a,q,f) = N(s,a,q)\ SF(r,s,a,q,f)\ P(r,s,a,q) \tag{B3}$$

which by definition is equal to

$$N(s,a,q)\ F(\$s,q,f) \tag{B4}$$

where F($, etc.) is just the usual quarterly fleet partial F.

Thus, dividing (B2) by (B4),

$$F(r,s,a,q,f) = \frac{C(r,\ etc.)}{C(\$,\ etc.0} \text{È} \frac{F(\$,\ etc.)}{P(r,\ etc.)} \tag{B5}$$

Thus F(r, etc.) is of the same magnitude as F($, etc.): it is not a fraction of it, and F($, etc.) is not the area summation of F(r, etc.). F(r, etc) is in fact a true local mortality rate, operating on the local population, and proportional to the fishing effort in the 'rectangle'.

Because these local fishing mortality rates will vary spatially (being lower inside closed areas, for example), the local populations will evolve at different rates, determined by the local total mortality. This is most conveniently expressed by the evolution of the proportions of the total population each area, i.e. the final proportions P' are

$$P'(r,\ etc.) = P(r,\ etc.)\ \exp\ [-Z(r,\ etc.)]$$

where

$$Z(r,\ etc.) = F(r,\ etc.) + M(s,a,q) \tag{B6}$$

This equation is non-linear, and the new total population obtained by summing over the local ones will only be the same as that obtained from the overall Z($, etc.) if the time step is sufficiently short that the exponential function is reasonably linear - say $ZDt < 0.3$. Thus quarterly time steps are the maximum if such errors are to be avoided (monthly steps for the integration would probably be preferable).

At the end of each timestep the proportions can be renormalised to the total, if desired, to keep track of the evolution of the total stock. Also at the end of each timestep, the migration matrix should be applied to the absolute local populations (given by expression B1) (i.e. in effect, to the proportions, P) - hence the reason for keeping track of these. Note that there will be one (Nbox and NBox) migration matrix for each species. For Nbox not exceeding 10, this is only of moderate size, and there seems to be no reason by this formalism should not be implemented as an extension to MSFBOX in the future.

Table 2.4.1 Data possible available to a *meeting in 1990

	Belgium	Denmark	Fed Rep Germ	France	Netherlands	UK(England)	UK(Scotland)
Age comp.	1983-88	1986-88	1987-88	1)86,87,88	1988*	1987-88	1988,87
Discards	NE	NE	NE	NE	NE	NE	1988,87
Effort	1983-88	1987-88	?	1987-88	1987 1988	1987,8	1988,87
Weight age landings	1983-88	1987-88	87(88)	1) 87-88	1988	1987,88	1988,87
Weight age discards	NE	NE	NE	NE	NE	NE	1988,87
Age-length key	1983-88	1987-88	1987-88	1)87-1988	1983-88	1987-88	
Revenue	1983-88	1987-88	81-88	87-88	1988	1987-88 part 89	
Quantity	1983-88	1987-88	81-88	87-88	1988	1987-88 part 89	1988,87
Catch Other spec.	1988	1987-88	NA	87-88	NA	NA	
Value Other spec.	1988	1987-88	NA	87-88	NA	NA	
Remarks							

*May be NOT to September meeting but definitely next year

1) Not for plaice and sole.

Table 4.3.1 Results of test problem showing percentage changes in landings by fleet & quarter

Fleet	QUARTER 1 COD	HAD	WHI	SAI	SOLE	PLAICE
BEL BT1 L	.00	.00	.00	.00	100.00	.00
BEL BT1 D	.00	.00	.00	.00	.00	.00
BEL BT2 L	.00	.00	-2.22	.00	8.62	.00
BEL BT2 D	.00	.00	.00	.00	.00	.00
BEL OT L	1.55	.00	-14.94	.00	.00	.00
BEL OT D	.00	.00	-17.39	.00	.00	.00
BEL PT L	2.08	.00	.00	.00	.00	.00
BEL PT D	.00	.00	.00	.00	.00	.00
BEL DPT L	.00	.00	.00	.00	.00	.00
BEL DPT D	.00	.00	.00	.00	.00	.00
DAN OT1 L	-.51	.00	.00	-7.88	.00	-1.43
DAN OT1 D	.00	.00	.00	.00	.00	.00
DAN OT2 L	-.52	-12.24	.00	-14.29	.00	-.88
DAN OT2 D	.00	-20.00	.00	.00	.00	.00
DAN OT3 L	.00	-5.26	.00	-2.22	.00	-3.85
DAN OT3 D	.00	-18.18	.00	.00	.00	.00
DAN OT4 L	.00	-7.41	.00	-.39	.00	.00
DAN OT4 D	.00	-25.00	.00	.00	.00	.00
DAN GILL1	.00	-4.00	.00	.00	.00	.00
DAN GILL2	-.34	.00	.00	.00	.00	.00
DAN SEINE	-.47	.00	.00	.00	.00	.00
DAN INDUS	.00	.00	.82	.00	.00	.00
ENG BT L	-6.67	.00	.00	.00	-20.00	-1.45
ENG BT D	.00	.00	.00	.00	.00	.00
ENG OT L	-.65	-11.96	-4.64	.00	.00	-1.44
ENG OT D	.00	-25.00	-5.63	.00	.00	.00
ENG PT L	-8.80	-12.12	-25.00	.00	.00	.00
ENG PT D	.00	-20.00	-23.08	.00	.00	.00
ENG SEI L	-11.49	-26.67	-48.00	.00	.00	-4.17
ENG SEI D	.00	-37.50	-40.00	.00	.00	.00
ENG OTH L	.72	.00	.00	.00	.00	.00
ENG OTH D	.00	.00	.00	.00	.00	.00
FRA ALL L	.91	.93	1.09	.28	.00	.00
FRA ALL D	.00	.00	.54	.00	.00	.00
GER ALL L	-.83	.00	-7.14	-4.83	.00	.00
GER ALL D	.00	.00	.00	.00	.00	.00
NET BT L	-7.86	.00	-14.79	.00	-35.31	-2.13
NET BT D	.00	.00	-15.29	.00	.00	.00
NET OT L	.77	.00	-6.22	.00	.00	.00
NET OT D	.00	.00	-7.02	.00	.00	.00
NET PT L	-11.25	.00	-5.68	.00	.00	.00
NET PT D	.00	.00	-6.34	.00	.00	.00
NOR HC L	1.53	.99	.00	.75	.00	.00
NOR HC D	.00	4.76	.00	.00	.00	.00
NOR IND	.00	1.32	.00	.75	.00	.00
SCO ALL L	1.16	.97	1.12	.00	.00	.00
SCO ALL D	.00	1.64	.76	.00	.00	.00
TOTALS	-1.97	-.45	-1.78	-1.01	-28.47	-1.88
BIOMASSES						
BIOMASS Start	.47	.30	.29	.59	5.43	.20
BIOMASS Final	1.09	.39	.62	.98	8.86	.41
Final SSB	.41	1.10	.81	.20	18.35	.41

Table 4.3.1 Cont'd

Fleet	QUARTER 2 COD	HAD	WHI	SAI	SOLE	PLAICE
BEL BT1 L	.00	.00	.00	.00	12.50	.00
BEL BT1 D	.00	.00	.00	.00	.00	.00
BEL BT2 L	.00	.00	.00	.00	15.79	.00
BEL BT2 D	.00	.00	.00	.00	.00	.00
BEL OT L	3.23	.00	.00	.00	.00	.00
BEL OT D	.00	.00	.00	.00	.00	.00
BEL PT L	.00	.00	3.88	.00	.00	.00
BEL PT D	.00	.00	.00	.00	.00	.00
BEL DPT L	.00	.00	.00	.00	.00	.00
BEL DPT D	.00	.00	.00	.00	.00	.00
DAN OT1 L	1.60	.00	.00	3.13	.00	.57
DAN OT1 D	.00	.00	.00	.00	.00	.00
DAN OT2 L	2.03	2.63	.00	.63	.00	.00
DAN OT2 D	.00	.00	.00	.00	.00	.00
DAN OT3 L	2.00	.00	.00	.27	.00	.00
DAN OT3 D	.00	.00	.00	.00	.00	.00
DAN OT4 L	.00	.00	.00	.00	.00	.00
DAN OT4 D	.00	.00	.00	.00	.00	.00
DAN GILL1	.85	.00	.00	1.52	.00	.97
DAN GILL2	1.03	.00	.00	1.37	.00	.97
DAN SEINE	1.64	.00	.00	.00	.00	.00
DAN INDUS	.00	.00	.11	.00	.00	.00
ENG BT L	.00	.00	.00	.00	20.00	.00
ENG BT D	.00	.00	.00	.00	.00	.00
ENG OT L	1.84	1.19	1.10	.00	11.11	.00
ENG OT D	.00	4.00	.00	.00	.00	.00
ENG PT L	1.90	1.79	.00	.00	.00	.00
ENG PT D	.00	.00	.00	.00	.00	.00
ENG SEI L	1.54	.00	.00	.00	.00	.68
ENG SEI D	.00	.00	.00	.00	.00	.00
ENG OTH L	.86	.00	.00	.00	.00	.00
ENG OTH D	.00	.00	.00	.00	.00	.00
FRA ALL L	1.41	1.18	1.34	.60	.00	.00
FRA ALL D	.00	.00	.48	.00	.00	.00
GER ALL L	3.57	.00	.00	1.57	.00	.00
GER ALL D	.00	.00	.00	.00	.00	.00
NET BT L	1.69	.00	2.22	.00	17.95	.58
NET BT D	.00	.00	.00	.00	.00	.00
NET OT L	2.99	.00	2.22	.00	.00	.00
NET OT D	.00	.00	.00	.00	.00	.00
NET PT L	2.65	.00	1.67	.00	.00	.00
NET PT D	.00	.00	.85	.00	.00	.00
NOR HC L	1.25	2.50	.00	1.08	.00	.00
NOR HC D	.00	.00	.00	.00	.00	.00
NOR IND	.00	.00	1.67	1.08	.00	.00
SCO ALL L	1.51	1.19	1.32	1.08	.00	.00
SCO ALL D	.00	1.33	.62	.00	.00	.00
TOTALS	1.64	1.12	.78	.95	17.23	.53
BIOMASSES						
BIOMASS Start	1.09	.39	.62	.98	8.86	.41
BIOMASS Final	1.03	.32	.45	1.05	7.60	.41
Final SSB	.41	1.09	.73	.20	17.99	.41

Table 4.3.1 Cont'd

Fleet	COD	HAD	WHI	SAI	SOLE	PLAICE
			QUARTER 3			
BEL BT1 L	.00	.00	.00	.00	22.22	4.35
BEL BT1 D	.00	.00	.00	.00	.00	.00
BEL BT2 L	.00	.00	.00	.00	20.00	.46
BEL BT2 D	.00	.00	.00	.00	.00	.00
BEL OT L	6.25	.00	4.17	.00	.00	.00
BEL OT D	.00	.00	5.00	.00	.00	.00
BEL PT L	.00	.00	.00	.00	.00	.00
BEL PT D	.00	.00	.00	.00	.00	.00
BEL DPT L	.00	.00	.00	.00	.00	.00
BEL DPT D	.00	.00	.00	.00	.00	.00
DAN OT1 L	2.08	.00	.00	1.92	.00	.61
DAN OT1 D	.00	.00	.00	.00	.00	.00
DAN OT2 L	2.60	.00	.00	.93	.00	.70
DAN OT2 D	.00	12.50	.00	.00	.00	.00
DAN OT3 L	1.72	1.28	.00	1.10	.00	.00
DAN OT3 D	.00	.00	.00	.00	.00	.00
DAN OT4 L	.00	.00	.00	.81	.00	.00
DAN OT4 D	.00	.00	.00	.00	.00	.00
DAN GILL1	.00	.00	.00	1.41	.00	.00
DAN GILL2	.00	.00	.00	1.41	.00	.00
DAN SEINE	2.04	.00	.00	.00	.00	.00
DAN INDUS	.00	.50	.29	.00	.00	.00
ENG BT L	.00	.00	.00	.00	50.00	.53
ENG BT D	.00	.00	.00	.00	.00	.00
ENG OT L	2.29	.00	1.04	.00	11.11	.00
ENG OT D	.00	.00	.00	.00	.00	.00
ENG PT L	1.75	.00	.00	.00	.00	.00
ENG PT D	.00	.00	.00	.00	.00	.00
ENG SEI L	1.25	.00	.00	.00	.00	.00
ENG SEI D	.00	.00	16.67	.00	.00	.00
ENG OTH L	.00	.00	.00	.00	.00	.00
ENG OTH D	.00	.00	.00	.00	.00	.00
FRA ALL L	2.08	1.56	.99	.62	.00	.00
FRA ALL D	.00	.00	1.15	.00	.00	.00
GER ALL L	1.69	.82	.00	1.58	.00	.00
GER ALL D	.00	.00	.00	.00	.00	.00
NET BT L	1.92	.00	1.85	.00	11.11	.63
NET BT D	.00	.00	.00	.00	.00	.00
NET OT L	.00	.00	1.85	.00	.00	.00
NET OT D	.00	.00	.00	.00	.00	.00
NET PT L	1.83	.00	1.85	.00	.00	.00
NET PT D	.00	.00	.00	.00	.00	.00
NOR HC L	2.13	3.03	.00	.90	.00	.00
NOR HC D	.00	.00	.00	.00	.00	.00
NOR IND	.00	.00	.00	1.12	.00	.00
SCO ALL L	1.91	1.12	1.06	.96	.00	.00
SCO ALL D	.00	1.59	.69	.00	.00	.00
TOTALS	1.80	1.04	.88	1.06	11.88	.57
BIOMASSES						
BIOMASS Start	1.03	.32	.45	1.05	7.60	.41
BIOMASS Final	.90	.24	.35	.85	7.02	.37
Final SSB	.39	1.07	.67	.18	17.74	.38

Table 4.3.1 Cont'd

Fleet	COD	HAD	WHI	SAI	SOLE	PLAICE
	QUARTER 4					
BEL BT1 L	.00	.00	.00	.00	.00	.00
BEL BT1 D	.00	.00	.00	.00	.00	.00
BEL BT2 L	.00	.00	-12.50	.00	1.35	-.31
BEL BT2 D	.00	.00	-28.57	.00	.00	.00
BEL OT L	.00	.00	-21.88	.00	.00	.00
BEL OT D	.00	.00	-28.00	.00	.00	.00
BEL PT L	3.13	.00	.00	.00	.00	.00
BEL PT D	.00	.00	.00	.00	.00	.00
BEL DPT L	.00	.00	.00	.00	.00	.00
BEL DPT D	.00	.00	.00	.00	.00	.00
DAN OT1 L	.00	.00	.00	-5.36	.00	-3.61
DAN OT1 D	.00	.51	.00	.00	.00	.00
DAN OT2 L	.00	-8.33	.00	-6.84	.00	-3.03
DAN OT2 D	.00	-11.11	.00	.00	.00	.00
DAN OT3 L	.00	.00	.00	-5.39	.00	.00
DAN OT3 D	.00	-6.67	.00	.00	.00	.00
DAN OT4 L	.00	.00	.00	-5.03	.00	-4.35
DAN OT4 D	.00	.00	.00	.00	.00	.00
DAN GILL1	6.25	-33.33	.00	-5.49	.00	.00
DAN GILL2	.00	.00	.00	-5.49	.00	.00
DAN SEINE	.00	.00	.00	.00	.00	.00
DAN INDUS	.00	.83	.61	.00	.00	.00
ENG BT L	-12.50	-100.00	-100.00	.00	-16.67	-1.34
ENG BT D	.00	.00	.00	.00	.00	.00
ENG OT L	.00	-4.00	.00	.00	.00	-2.78
ENG OT D	.00	-5.06	-2.25	.00	.00	.00
ENG PT L	-13.40	-16.67	-41.18	-.18	.00	.00
ENG PT D	.00	-30.77	-31.25	.00	.00	.00
ENG SEI L	-17.14	-26.67	-40.00	.57	.00	-3.13
ENG SEI D	.00	-44.12	-50.00	.00	.00	.00
ENG OTH L	1.37	.00	.00	-100.00	.00	.00
ENG OTH D	.00	.00	.00	.00	.00	.00
FRA ALL L	1.52	2.15	1.05	1.00	.00	.00
FRA ALL D	.00	.00	.45	.00	.00	.00
GER ALL L	-4.23	1.43	-25.00	.00	.00	.00
GER ALL D	.00	.00	-21.21	.00	.00	.00
NET BT L	-18.97	.00	-21.21	.00	-35.92	-2.31
NET BT D	.00	.00	-22.58	.00	.00	.00
NET OT L	-15.79	.00	-24.49	.00	.00	.00
NET OT D	.00	.00	-27.14	.00	.00	.00
NET PT L	-17.24	.00	-10.13	.00	.00	.00
NET PT D	.00	.00	-15.02	.00	.00	.00
NOR HC L	1.30	.00	.00	2.89	.00	.00
NOR HC D	.00	.00	.00	.00	.00	.00
NOR IND	.00	.00	.00	1.34	.00	.00
SCO ALL L	-1.76	-3.18	1.09	3.45	.00	.00
SCO ALL D	.00	-8.43	.56	.00	.00	.00
TOTALS	-4.16	-3.72	-2.54	-2.32	-31.70	-2.07

BIOMASSES

	COD	HAD	WHI	SAI	SOLE	PLAICE
BIOMASS Start	.90	.24	.35	.85	7.02	.37
BIOMASS Final	1.11	.41	.56	1.61	13.82	.58
Final SSB	.92	1.14	.77	.68	13.82	.61

Table 4.4.1
Percentage changes in catch & biomasses through time

	1988	1989	1990	1991
COD				
SSB	.2474969	.9139466	2.011567	3.254949
CATCH	-.644363	-.539374	.0074979	.5876068
BIOMASS FIN	.4669871	1.099557	1.721788	2.244172
HAD				
SSB	.7187781	1.131042	1.505157	1.985496
CATCH	-.966584	-.449166	-1.13237	-.637608
BIOMASS FIN	.3036544	.4049129	.6814115	.9428445
WHI				
SSB	.3948992	.7639848	.9448962	.9397204
CATCH	-.895332	-.709393	-.347805	-.077157
BIOMASS FIN	.2933551	.5546448	.6734755	.6681479
SAI				
SSB	.1686016	.6750381	1.856523	3.887195
CATCH	-.889994	-.704284	.0879817	.7013070
BIOMASS FIN	.5836828	1.586271	2.359958	2.996255
PLE				
SSB	.2232276	.6065285	1.165536	1.462034
CATCH	-.444397	-.569476	-.132214	.8033531
BIOMASS FIN	.1996144	.5777886	1.165536	1.462034
SOL				
SSB	9.496256	12.14421	21.90422	28.42950
CATCH	-20.0154	-16.7187	-5.86207	8.851884
BIOMASS FIN	5.146792	12.14421	21.90422	28.42950

TABLE 4.6.1
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STCF WG NANTESDATA SEPT 1989
Regime 120mm MESH CHANGEIN Q1 & Q4

Percentage of base run 1988

Metier			COD	HAD	WHI	SAI	PLA	SOL	TOTAL
DEN	NE1	L	100	100	0	100	104	0	101
		Val	100	100	0	100	106	0	101
DEN	NE1	D	0	0	0	0	0	0	0
DEN	NE2	L	100	100	0	100	103	0	100
		Val	100	100	0	100	104	0	100
DEN	NE2	D	0	0	0	0	0	0	0
DEN	SEI	L	100	100	0	100	104	0	102
		Val	100	100	0	100	105	0	102
DEN	SEI	D	0	0	0	0	0	0	0
DEN	TR1	L	100	100	0	100	104	0	103
		Val	100	100	0	100	104	0	103
DEN	TR1	D	0	0	0	0	0	0	0
DEN	TR2	L	100	100	0	100	104	0	101
		Val	100	100	0	100	105	0	101
DEN	TR2	D	0	0	0	0	0	0	0
DEN	TR3	L	100	100	0	100	104	0	101
		Val	100	100	0	100	107	0	101
DEN	TR3	D	0	0	0	0	0	0	0
DEN	TR4	L	100	100	0	100	105	0	100
		Val	100	101	0	100	106	0	100
DEN	TR4	D	0	0	0	0	0	0	0
DEN	PUS	L	0	0	0	0	0	0	100
		Val	100	0	0	0	0	0	100
DEN	PUS	D	0	0	0	0	0	0	0
DEN	OTH	L	100	100	0	100	104	0	101
		Val	100	100	0	100	105	0	101
DEN	OTH	D	0	0	0	0	0	0	0
BEL	SBT	L	100	0	100	0	102	100	101
		Val	100	0	100	0	104	100	101
BEL	SBT	D	0	0	0	0	0	0	0
BEL	BBT	L	99	0	98	0	96	100	97
		Val	99	0	97	0	96	100	98
BEL	BBT	D	0	0	0	0	0	0	0
BEL	OT	L	100	0	91	0	0	0	98
		Val	100	0	92	0	0	0	99
BEL	OT	D	0	0	0	0	0	0	0
BEL	PT	L	101	0	100	0	0	0	101
		Val	101	0	100	0	0	0	101
BEL	PT	D	0	0	0	0	0	0	0
FRA	H10	L	101	100	100	100	0	0	100
		Val	100	100	100	100	0	0	100
FRA	H10	D	0	100	98	0	0	0	98
FRA	H30	L	100	0	96	0	0	0	97
		Val	100	0	96	0	0	0	98
FRA	H30	D	0	0	100	0	0	0	100
FRA	CBT	L	100	0	100	0	0	0	100
		Val	100	0	100	0	0	0	100
FRA	CBT	D	0	0	0	0	0	0	0
FRA	COT	L	100	100	101	0	0	0	101
		Val	101	100	101	0	0	0	100
FRA	COT	D	0	0	0	0	0	0	0
FRA	CVA	L	100	0	100	0	0	0	100
		Val	100	0	100	0	0	0	100
FRA	CVA	D	0	0	0	0	0	0	0

FRA	SBT	L	0	0	0	0	0	0	0
		Val	0	0	0	0	0	0	0
FRA	SBT	D	0	0	0	0	0	0	0
FRA	SOT	L	0	0	0	0	0	0	0
		Val	0	0	0	0	0	0	0
FRA	SOT	D	0	0	0	0	0	0	0
FRA	SVA	L	0	0	0	0	0	0	0
		Val	0	0	0	0	0	0	0
FRA	SVA	D	0	0	0	0	0	0	0
FRA	APT	L	0	0	100	0	0	0	100
		Val	100	0	100	0	0	0	111
FRA	APT	D	0	0	0	0	0	0	0
NET	BT	L	96	0	92	0	87	100	89
		Val	96	0	94	0	90	100	95
NET	BT	D	0	0	0	0	0	0	0
NET	OT	L	97	0	96	0	0	0	96
		Val	97	0	97	0	0	0	97
NET	OT	D	0	0	0	0	0	0	0
NET	PT	L	98	0	96	0	0	0	98
		Val	99	0	97	0	0	0	98
NET	PT	D	0	0	0	0	0	0	0
NOR	ST	L	0	0	0	100	0	0	100
		Val	0	0	0	100	0	0	100
NOR	ST	D	0	0	0	0	0	0	0
SCO	LTR	L	100	100	100	100	0	0	100
		Val	100	100	100	100	0	0	100
SCO	LTR	D	0	100	0	0	0	0	100
SCO	TRL	L	101	100	100	100	0	0	100
		Val	101	100	100	100	0	0	100
SCO	TRL	D	0	0	0	0	0	0	0
SCO	NTR	L	100	100	100	100	0	0	100
		Val	100	100	100	0	0	0	101
SCO	NTR	D	0	0	0	0	0	0	0
SCO	PTR	L	100	100	100	100	0	0	100
		Val	100	100	100	100	0	0	100
SCO	PTR	D	0	99	99	0	0	0	99
SCO	SEI	L	100	100	100	100	0	0	100
		Val	100	100	100	100	0	0	100
SCO	SEI	D	0	99	0	0	0	0	99
ENG	BT	L	96	100	100	0	78	98	80
		Val	97	100	100	0	78	98	84
ENG	BT	D	0	100	100	0	0	0	67
ENG	ST	L	100	99	98	100	74	100	97
		Val	100	99	98	100	76	100	97
ENG	ST	D	0	97	98	0	0	0	97
ENG	SP	L	97	96	82	100	90	0	93
		Val	96	95	83	0	88	0	92
ENG	SP	D	0	86	62	0	0	0	82
ENG	PR	L	98	97	89	100	89	0	97
		Val	98	96	89	100	100	100	97
ENG	PR	D	0	91	81	0	0	0	87
ENG	OG	L	100	100	100	50	100	100	100
		Val	100	0	100	0	100	100	100
ENG	OG	D	0	0	100	0	0	0	100

TABLE 4.6.2

1

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STCF WG NANTES DATA SEPT 1989

Regime 120mm MESH CHANGEIN Q1 & Q4

Percentage of base run 1991

Metier			COD	HAD	WHI	SAI	PLA	SOL	TOTAL
DEN	NE1	L	101	100	0	100	124	0	107
		Val	101	100	0	100	123	0	105
DEN	NE1	D	0	0	0	0	0	0	0
DEN	NE2	L	101	100	0	100	126	0	103
		Val	101	100	0	100	128	0	102
DEN	NE2	D	0	0	0	0	0	0	0
DEN	SEI	L	101	101	0	100	117	0	109
		Val	101	101	0	100	115	0	106
DEN	SEI	D	0	0	0	0	0	0	0
DEN	TR1	L	101	107	0	100	116	0	112
		Val	102	100	0	100	115	0	109
DEN	TR1	D	0	0	0	0	0	0	0
DEN	TR2	L	101	101	0	100	117	0	105
		Val	101	101	0	100	117	0	104
DEN	TR2	D	0	0	0	0	0	0	0
DEN	TR3	L	101	101	0	100	115	0	102
		Val	101	101	0	100	117	0	102
DEN	TR3	D	0	0	0	0	0	0	0
DEN	TR4	L	101	101	0	100	111	0	101
		Val	101	101	0	100	120	0	101
DEN	TR4	D	0	0	0	0	0	0	0
DEN	PUS	L	100	0	0	0	0	0	100
		Val	100	0	0	0	0	0	100
DEN	PUS	D	0	0	0	0	0	0	0
DEN	OTH	L	101	100	0	100	117	0	106
		Val	101	102	0	100	117	0	104
DEN	OTH	D	0	0	0	0	0	0	0
BEL	SBT	L	100	0	100	0	106	100	103
		Val	104	0	133	0	107	100	101
BEL	SBT	D	0	0	0	0	0	0	0
BEL	BBT	L	100	0	99	0	104	100	102
		Val	100	0	98	0	104	100	101
BEL	BBT	D	0	0	0	0	0	0	0
BEL	OT	L	101	0	93	0	0	0	98
		Val	101	0	94	0	0	0	99
BEL	OT	D	0	0	0	0	0	0	0
BEL	PT	L	102	0	100	0	0	0	102
		Val	102	0	107	0	0	0	101
BEL	PT	D	0	0	0	0	0	0	0
FRA	H10	L	102	101	101	100	0	0	100
		Val	101	101	101	100	0	0	100
FRA	H10	D	0	100	98	0	0	0	99
FRA	H30	L	105	0	97	0	0	0	99
		Val	104	0	97	0	0	0	99
FRA	H30	D	0	0	87	0	0	0	87
FRA	CBT	L	100	0	100	0	0	0	105
		Val	100	0	117	0	0	0	100
FRA	CBT	D	0	0	0	0	0	0	0
FRA	COT	L	101	100	102	0	0	0	102
		Val	101	100	102	0	0	0	101
FRA	COT	D	0	0	0	0	0	0	0
FRA	CVA	L	100	0	100	0	0	0	100

		Val	100	0	100	0	0	0	100
FRA	CVA	D	0	0	0	0	0	0	0
FRA	SBT	L	0	0	0	0	0	0	0
		Val	0	0	0	0	0	0	0
FRA	SBT	D	0	0	0	0	0	0	0
FRA	SOT	L	0	0	0	0	0	0	0
		Val	0	0	0	0	0	0	0
FRA	SOT	D	0	0	0	0	0	0	0
FRA	SVA	L	0	0	0	0	0	0	0
		Val	0	0	0	0	0	0	0
FRA	SVA	D	0	0	0	0	0	0	0
FRA	APT	L	100	0	100	0	0	0	100
		Val	100	0	107	0	0	0	106
FRA	APT	D	0	0	0	0	0	0	0
NET	BT	L	96	0	93	0	95	100	96
		Val	97	0	95	0	97	100	98
NET	BT	D	0	0	0	0	0	0	0
NET	OT	L	98	0	98	0	0	0	97
		Val	98	0	98	0	0	0	98
NET	OT	D	0	0	0	0	0	0	0
NET	PT	L	99	0	97	0	0	0	98
		Val	99	0	98	0	0	0	99
NET	PT	D	0	0	0	0	0	0	0
NOR	ST	L	0	0	0	100	0	0	100
		Val	0	0	0	100	0	0	100
NOR	ST	D	0	0	0	0	0	0	0
SCO	LTR	L	101	101	101	100	0	0	101
		Val	101	101	101	100	0	0	101
SCO	LTR	D	0	100	0	0	0	0	100
SCO	TRL	L	101	101	101	100	0	0	101
		Val	101	101	101	100	0	0	101
SCO	TRL	D	0	0	0	0	0	0	0
SCO	NTR	L	100	100	101	100	0	0	101
		Val	103	100	101	0	0	0	101
SCO	NTR	D	0	0	0	0	0	0	0
SCO	PTR	L	101	101	101	100	0	0	101
		Val	101	101	101	100	0	0	101
SCO	PTR	D	0	99	100	0	0	0	99
SCO	SEI	L	101	100	101	100	0	0	101
		Val	101	100	101	100	0	0	101
SCO	SEI	D	0	99	0	0	0	0	99
ENG	BT	L	97	100	80	0	90	100	91
		Val	95	100	50	0	90	99	92
ENG	BT	D	0	100	50	0	0	0	75
ENG	ST	L	101	99	100	100	85	100	99
		Val	101	99	100	100	86	100	99
ENG	ST	D	0	97	98	0	0	0	98
ENG	SP	L	97	97	83	100	104	0	98
		Val	97	98	85	0	100	0	97
ENG	SP	D	0	85	62	0	0	0	81
ENG	PR	L	99	98	90	100	108	0	97
		Val	99	98	91	100	100	100	98
ENG	PR	D	0	93	82	0	0	0	86
ENG	OG	L	101	100	104	100	114	100	101
		Val	101	0	100	100	125	100	101
ENG	OG	D	0	0	100	0	0	0	100

TABLE 4.6.3
5-FEB-11:28
STCF WG NANTESDATA SEPT 1989
Regime 120mm MESH CHANGEIN Q1 & Q4
Summary of
Percentage : base run 1991

1988	COD	HAD	WHI	SAI	PLA	SOL
TOTALSx1000 t.	99	100	99	100	89	100
ValUE kU	99	100	99	100	92	100
BIOMASStart	100	100	100	100	100	100
BIOMASFinal	100	100	100	100	103	100
Final Sp. St.	100	101	100	100	104	100

1989	COD	HAD	WHI	SAI	PLA	SOL
TOTALSx1000 t.	100	100	99	100	92	100
ValUE kU	100	100	99	100	95	100
BIOMASStart	100	100	100	100	103	100
BIOMASFinal	101	100	100	100	105	100
Final Sp. St.	101	101	100	100	108	100

1990	COD	HAD	WHI	SAI	PLA	SOL
TOTALSx1000 t.	100	100	99	100	95	100
ValUE kU	100	100	99	100	97	100
BIOMASStart	101	100	100	100	105	100
BIOMASFinal	101	100	100	100	107	100
Final Sp. St.	101	101	101	100	110	100

1991	COD	HAD	WHI	SAI	PLA	SOL
TOTALSx1000 t.	100	100	100	100	98	100
ValUE kU	100	101	100	100	99	100
BIOMASStart	101	100	100	100	107	100
BIOMASFinal	101	100	100	100	108	100
Final Sp. St.	101	101	101	100	112	100

Table 6.2.1 DESCRIPTION OF THE FLEETS IDENTIFIED FOR THE MODEL Belgium

Name of the fleet (computer code)	Type of vessel	Number of vessels	Engine power KV/range	Tonnage (GRT) average/range	Main ports	Main fishing area	Type of Gear	Mesh size in use (mm)	Target species	Bycatch species	Fishing
BELGIUM											
Big beam trawlers ( )	Beam trawler	± 60	294-1064	89/328	Zeebrugge Oostende	N.east coast	beam trawl	85	sole plaice	roundfish turbot,brill rays,skates	sole: all plaice: season
Small beam trawlers ( )	Beam trawler	± 55	99-20	24/121	Oostende Zeebrugge Nieuport	Belgium coast	beam trawl	75	sole	plaice,cod whiting	seasonal all spec
Otter trawler ( )	trawler	± 40	128-880	28/146	Oostende	North Sea	otter trawl	85	cod	plaice, whiting	all year
Danish pair trawlers ( )	trawler	± 20	99-220	27/75	Oostende		pair trawl	85	cod	whiting, plaice	summer

DENMARK

Gillnetters/ longliners	Gillnetter		<200	<20	Hvide Sande Thorsminde Thyboron Hanstholm Hirtshals	Danish coast	Gillnet Longline		Cod Sole, Turbot, Plaice		Whole year Summer Whole year
Gillnetters and Scottish seiners	Gillnetter Scot. seine		200-800	>20	Hvide Sande Thyboron	Whole Nth Sea	Gillnet Scot. seine	- 90	Cod,saithe Roundfish		Whole year Whole year
Danish (anchor seiners)	Danish seiner		200-300	40	Esbjerg Thyboron Hvide Sande	Danish coast Central North Sea	Danish seine	100	Cod Plaice		
Trawlers	Trawler		100-300	<20	Esbjerg Thyboron Hvide Sande Hantsholm	Danish coast	Otter trawl Otter/pair trawl Otter trawl	75 100 9/22	Plaice, sole Cod Sandeel/ sprat	 Roundfish	 Summer/rest year
Trawlers	Trawler		300-500	20-60	Esbjerg Thyboron Hvide Sande Hantsholm Hirtshals		Otter trawl Otter/pair trawl Otter/pair trawl Otter trawl Otter trawl Otter trawl	100 100 90 34 70 9/22	Plaice, sole Cod Mixed roundfish Shrimp Nephrops Sandeel/ pout	 Round and flatfish Flatfish Roundfish	 Summer/rest year
Trawlers	Trawler		500-1000	60-150	Esbjerg Thyboron Hantsholm		Otter trawl	90	Roundfish		
Trawlers	Trawler		>1000	>150	Esbjerg Thyboron Hantsholm Hirtshals Skagen	Northern North	Otter trawl	9/22	Sandeel/ pout	Roundfish	Summer/rest year
Purse seiners	Purse seine Purse seine/ trawler	8 3	1000-2200		Hirtshals	Northern North Sea	Purse seine		Herring Mackerel	None	Whole year

F.R. GERMANY

Pelagic freezers	Trawlers > 33m	3	3600-8400	1100-7500	Bremerhaven	IVb,a	Midwater trawl	?	Herring Mackerel		All year
Fresh fish trawlers	Fresh fish trawlers & large cutters > 33m	9	1000-2100	320-980	Bremerhaven Cuxhaven	IVa	Bottom trawl	100	Saithe	Cod	All year
Medium range cutters	Fresh fish cutters 24-33m	32	711	178	Bremerhaven Cuxhaven Busna	IVb,a	Single and paid bottom trawl	90	Saithe, mixed(cod haddock, plaice,sole	Whiting	All year
Close range cutters (otter trawl)	Fresh fish cutters < 24m)				All coastal harbours	IVb	Bottom trawl	90	Mixed		All year
	)	179	~ 200	~ 30							
Close range cutters (beam trawl)	Fresh fish cutters)				All coastal harbours		Beam trawl	75	Sole, plaice	Turbot, brill	quarters 2-4 mainly

FRANCE

Long distance vessels and freezers (VHF)	Trawlers	5-7	>2000	>70	Various	Northern North Sea	Otter trawl	90	Saithe, cod Haddock, Whiting,	Ling	various
							Pelagic trawl		Herring		
High Sea vessels (HF1)	Trawlers	_20	1500< <2000	55	Boulogne-Lorient	Northern	Otter trawl	90	Saithe, cod Haddock, Whiting	Various mainly Ling, blue ling and red fish	All the year except Nov-Dec
						Southern N Sea	Pelagic trawl		Herring		Nov-Dec
						Nth & Central	Pelagic trawl		Herring		All the year
High Sea vessels (HF2)	Trawlers	3 in 86 0 in 87	1000< <1500	40-50	Boulogne-Lorient	Northern-Central	Otter trawl	90	Cod, haddock saithe, whiting	Various	All the year
						Southern	Pelagic trawl		Herring		Nov-Dec
High Sea vessels (HF3)	Trawlers	1-3	700< <1000	33	Boulogne	Southern	Otter trawl	90	Whiting, Plaice, cod	Various	All the year
							Pelagic trawl		Herring		Nov-Dec
Coastal fleet (COF)	Trawlers	40-60	300< <700	15-25	Dunkerque Boulogne Dieppe	Southern	Otter trawl		Whiting, Plaice, sole cod	Various	All the year
					Dunkerque	Southern	Beam trawl		Sole, plaice	Dab, lemon sole, cod whiting	All the year
					Boulogne Dieppe	Southern	Pelagic trawl		Herring, mackerel	Horse mackerel	Various - mainly Nov-Jan
	Netters	10-20	300< <700	15-25	Boulogne	Southern					
Small scale fishery (SSF)	Trawlers	?	< 300	<15	Various along the coast, trips of < 24h	Southern N.Sea along the coast	Trammel		Sole, cod	Various	All the year
							Otter trawl		Various mainly sole and plaice	Various	All the year
							Pelagic trawl		Herring, cod whiting	Various	Nov-Jan
	Netters	?	< 300	<15	"	"					
							Shrimp trawl		Shrimp	Flatfish	All the year
							Trammel		Sole, cod	Plaice, dab lemon sole, pollack	All the year
							Gillnet		Herring		Nov-Dec

NETHERLANDS

Beam trawl	trawler	348	1475 154-4460	182 36-442	Urk Ijmuiden Stellendam Den Helder Lauwersoog Scheveningen Vlissingen	IVb IVc	Beam trawl	<90	Sole,plaice	Cod,turbot whiting, brill	year
Otter trawl	trawler	49	500 197-1415	96 40-265	Ijmuiden Den Oever	IVb IVc	Otter trawl	90	Cod	Whiting	year winter peak
Bottom pair trawl	trawler	55	615 253-1326	109 60-212	Ijmuiden Den Oever Lauwersoog	IVb IVc	Pair trawl Bottom	90	Cod	Whiting	year winter peak
Midwater pair trawl	trawler	28	1124 300-265	177 80-390	Ijmuiden	IVb IVc	Pair trawl Midwater	40	Herring Mackerel Horse mackerel		Aug-Dec
Pelagic stern trawl	stern trawler	13	4515 1300-7500	1469 475-1900	Ijmuiden Scheveningen	VII VI IVa	Pelagic trawl	40	Mackerel Herring Horse mackerel	Blue whiting Sprat	Year

NORWAY

Industrial trawlers	Trawlers	64	220	Various Southwest Norway	Sub-area IVa east	Small mesh trawl Large mesh trawl	<16 22 90	Sandeel Norway pout Saithe Cod Haddock	Silver smelt Saithe -	April-Oct All year All year
Purse seiners	Purse seiners	106	642	Various South & West Norway	Sub-area IVa, IVb	Ring net	-	Herring mackerel (sprat)	Horse mackerel	All year
Bottom trawlers	Stern trawlers	77	387	Various W Norway	Sub area IVa	Bottom trawl	90-120	Saithe	Cod, haddock	Feb-Nov
Gill netters	Various	10	150	Various W Norway	Sub area IVa	Gill nets (78%) Long line Danish seine	?	Cod, haddock Ling, tusk Saithe		
Shrimp	Trawlers	106	288	Various South west Norway	Sub-area IVa east	Shrimp trawl	35	Pandalus	Cod, haddock	All year

UNITED KINGDOM (England and Wales)

Beam trawl	603 -169 fishing	(508.1 (14-2,700	82.1 5-623	Kings Lynn Lt Newlyn Brixham	Beam trawl
Seine	52 44 fishing	(293.6 (36-1700	51.5 8-387	Grimsby Whitstable	Danish Anchor & Scottish fly
Otter trawl	766 526 fishing	(251.6 (40-2200	46.1 3-835	N Shields Scarborough Bridlington Plymouth Fleetwood	Heavy otter trawl
Other	71 67 fishing	(210.8 (85-636	41.4 18-130	Grimsby	Gill nets trammels lines (hand) dredges drift nets pots, shark, push, midwater trawl
Pair trawl	624 507 fishing	(174.5 (20-2000	29.3 2-929	Whitby Lt Plymouth Newlyn Milford Haven	Bottom pair trawl

UNITED KINGDOM (SCOTLAND)

Trawl	?	?	?	Aberdeen	Heavy otter trawl	90	Cod, haddock whiting		All year
Seine	?	?	?	Peterhead Aberdeen Fraserburgh Buckie	Danish seine	90	" "		"
Light trawl				Peterhead Aberdeen Fraserburgh Buckie	Light otter trawl	90	Cod, haddock whiting		All year
Nephrops Trawl				Peterhead Aberdeen Buckie Fraserburgh	Nephrops trawl	70	Nephrops	Cod, haddock whiting etc	"
Pair Trawl				Peterhead Aberdeen Fraserburgh Buckie	Demersal pair trawl	90	Cod, haddock whiting	-	"

Figure 2.8.1 Belgian beam trawl fleet >300 hp.
3 year old plaice - relative numbers.
1985.

Figure 2.8.2 Belgian beam trawl fleet >300 hp.
3 year old plaice - relative numbers.
1986.

Figure 2.8.3 Belgian beam trawl fleet >300 hp.
3 year old plaice - relative numbers.
1987.

Figure 2.8.4 Scotland F (at annual rate) Cod 2's 1st $^1/_2$ 1987.

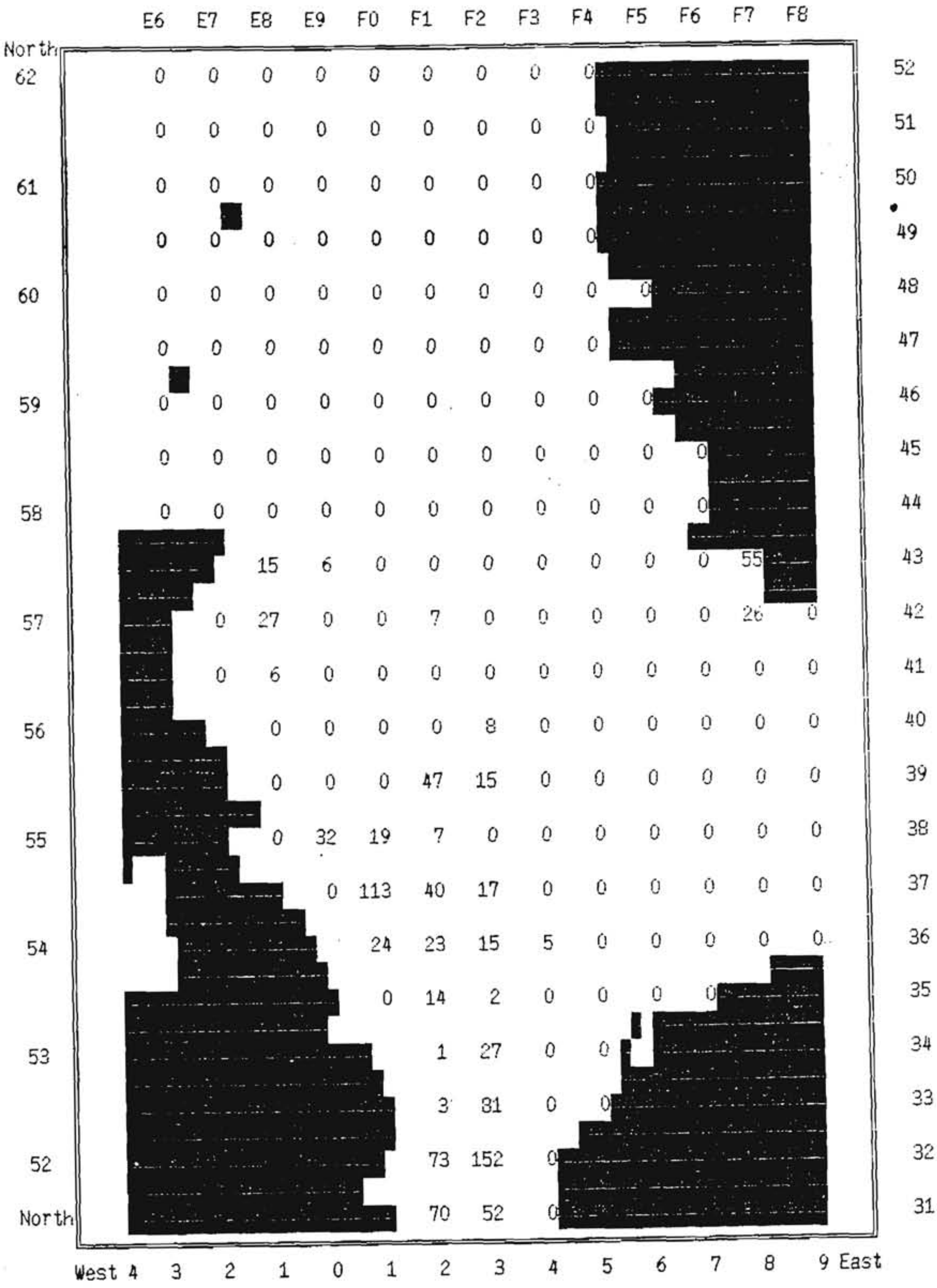
Figure 4.2.1 Outline of box adopted for test problem (Quarters 1&4)

Figure 4.4.1

Figure 4.4.2 Example of template rectangle chart with rectangle codes as data.

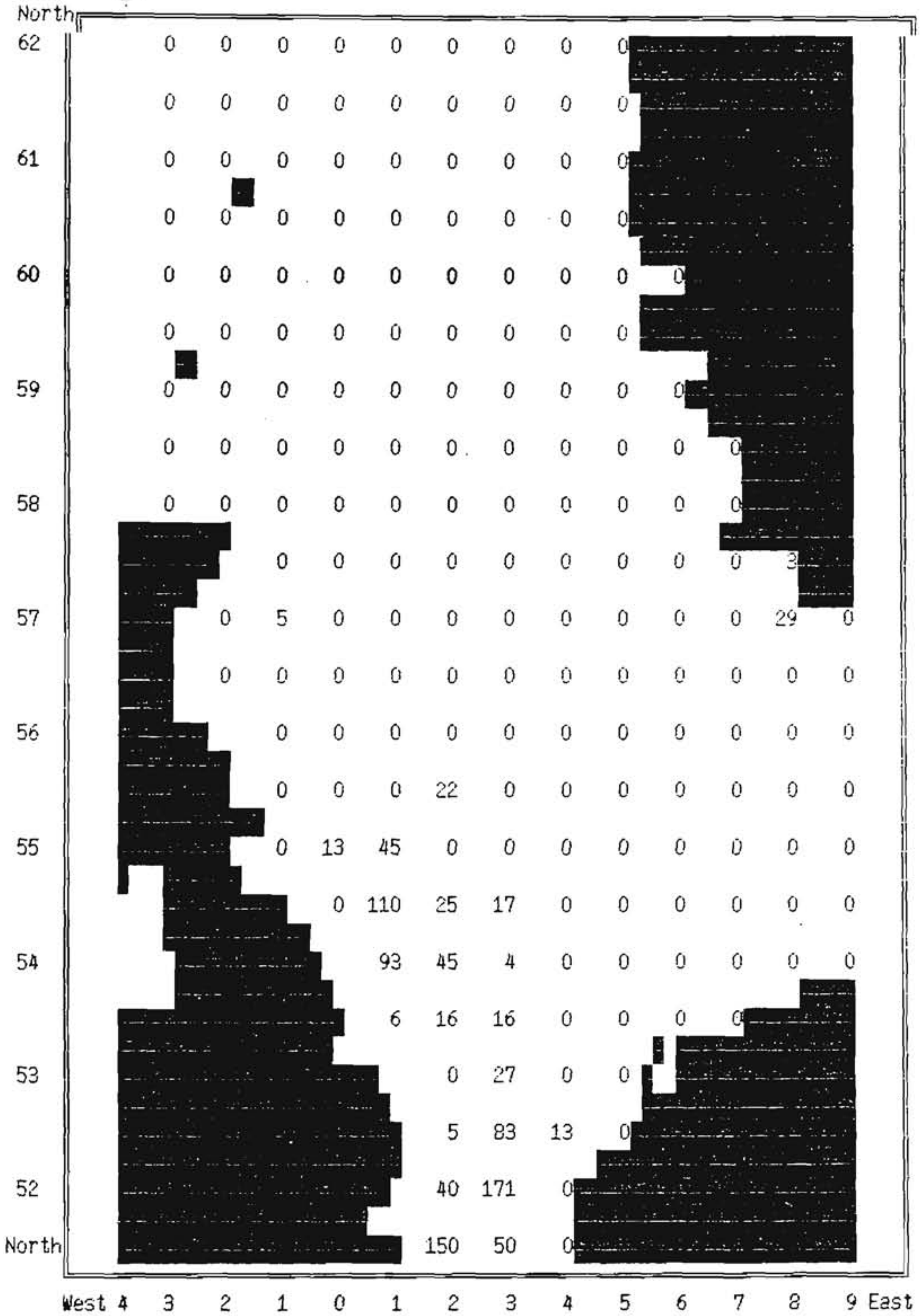
Figure 6.3.1 England beam trawl. Days at sea quarter 3 1987.

FIG 2.8.1



Belgian beamtrawl fleet > 300 hp.
3 years old plaice - relative numbers.
1985

Fig 2.8.2

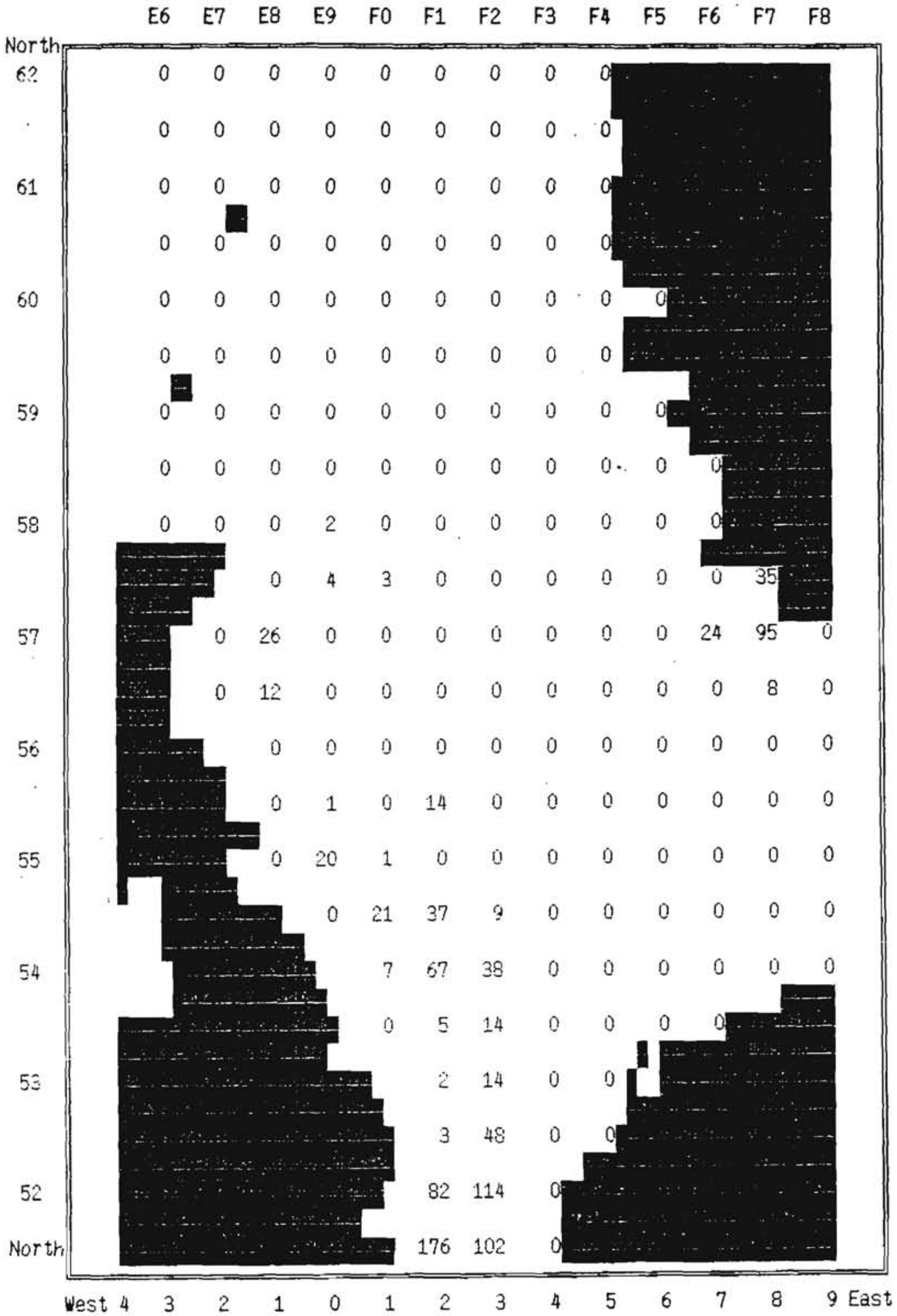


Belgian beamtrawl fleet >300 hp.

3 years old plaice - relative numbers

<u>1986</u>

FIG 2.8.3

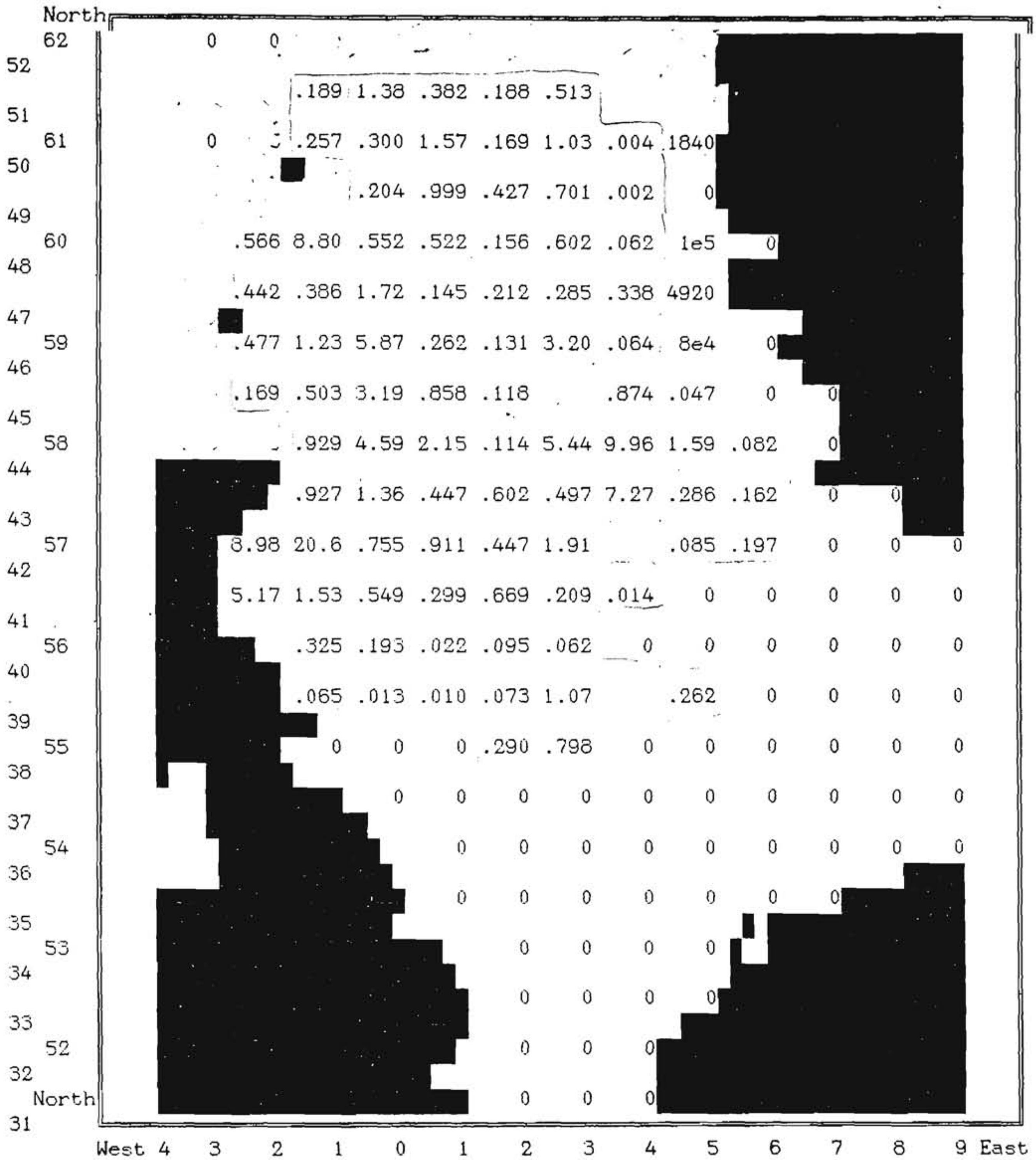


Belgian beamtrawl fleet > 300 hp.

3 years old plaice – relation numbers

1987

FIG 2.8.4



Scotland F (at annual rate)

Cod 2's 1st 1/2 1987

Fig 4.2.1
Outline of box adopted for test problem (Quarters 1&4)

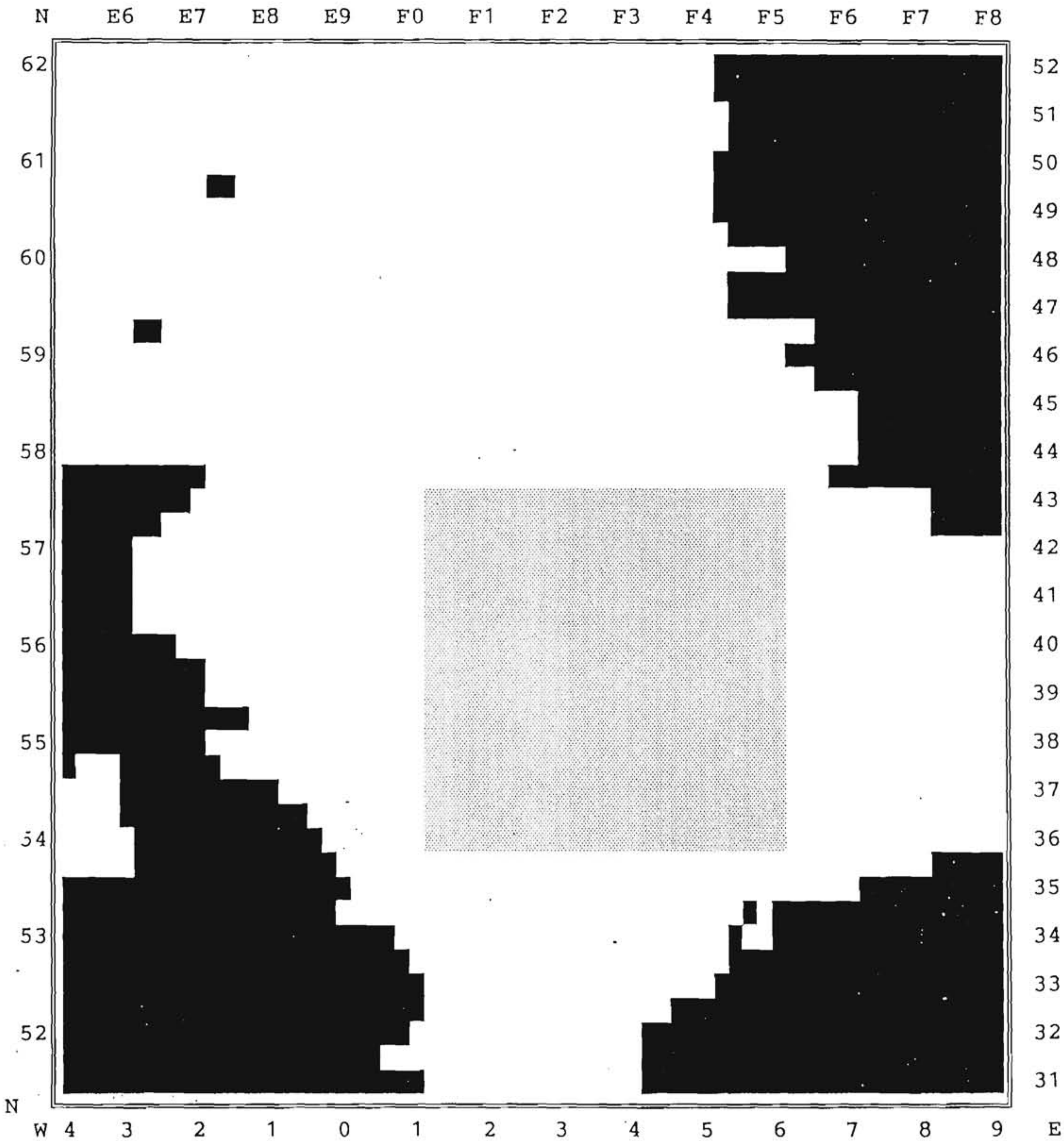
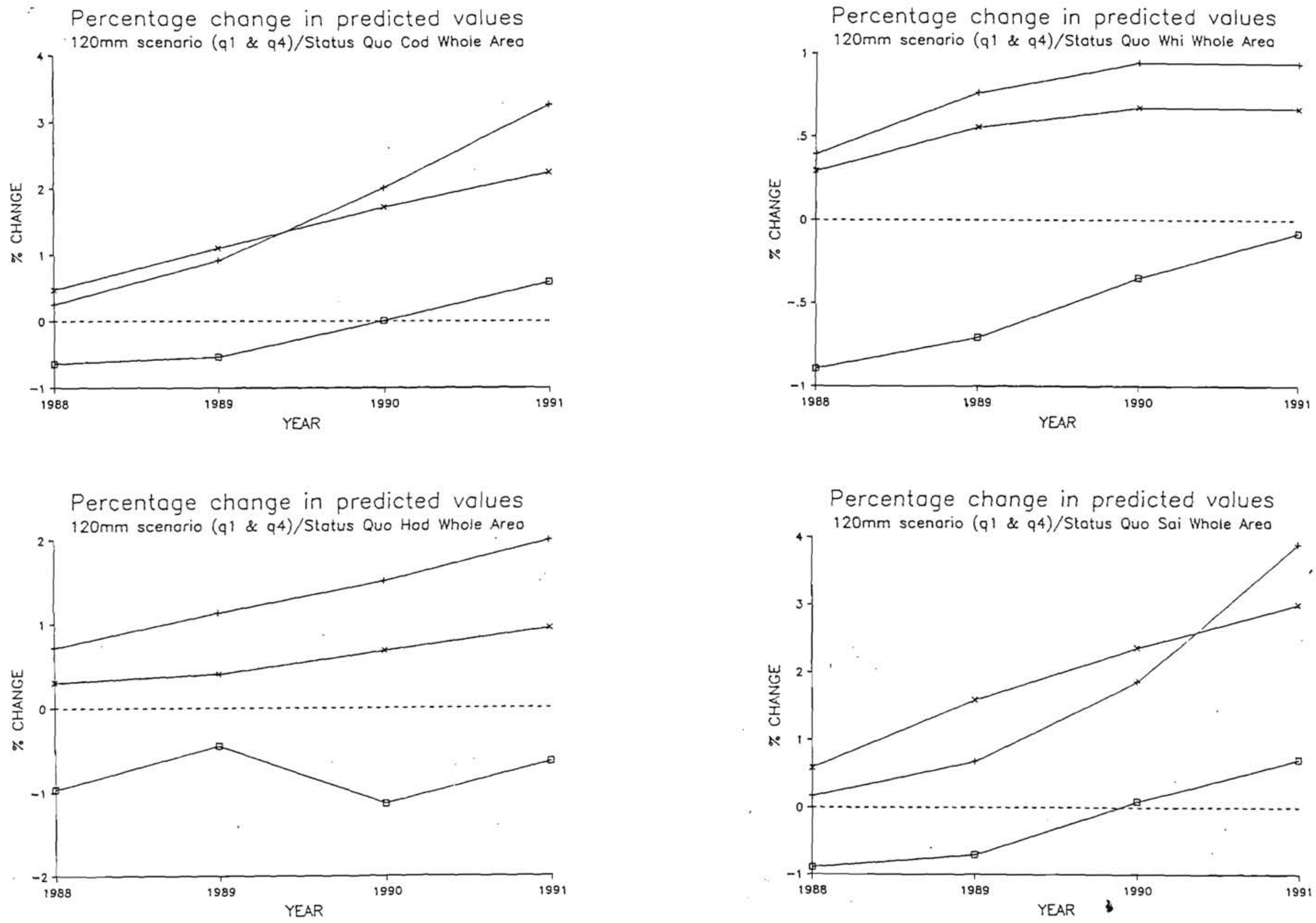
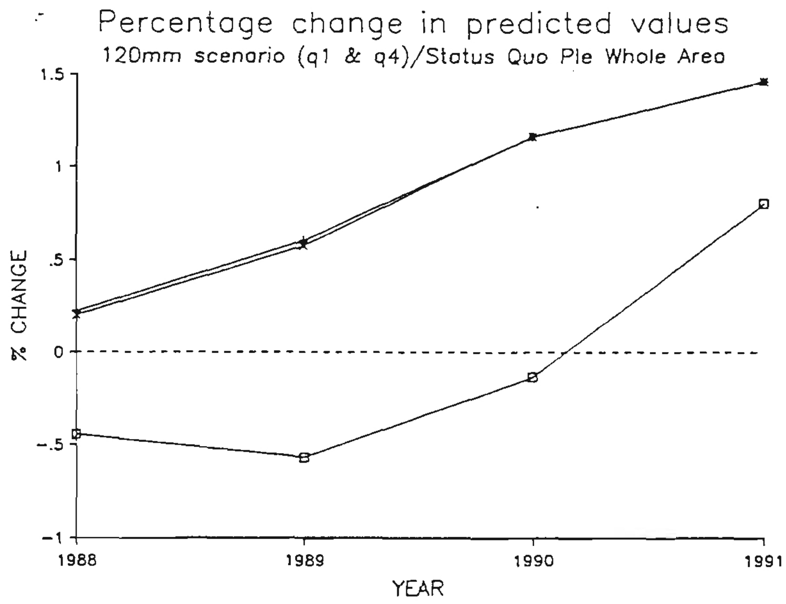


Fig 6.4.1

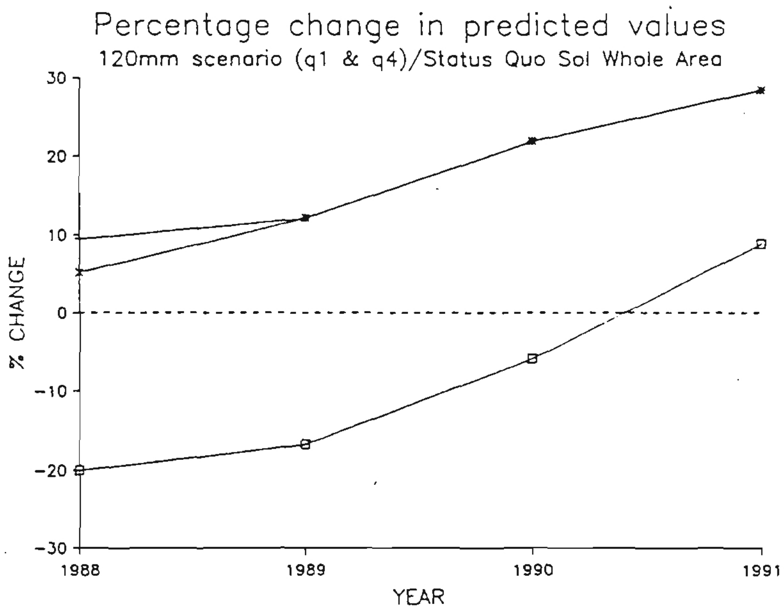


Percentage change in predicted values
120mm scenario (q1 & q4)/Status Quo Cod Whole Area
% CHANGE
YEAR
Percentage change in predicted values
120mm scenario (q1 & q4)/Status Quo Whi Whole Area
% CHANGE
YEAR
Percentage change in predicted values
120mm scenario (q1 & q4)/Status Quo Had Whole Area
% CHANGE
YEAR
Percentage change in predicted values
120mm scenario (q1 & q4)/Status Quo Sai Whole Area
% CHANGE
YEAR

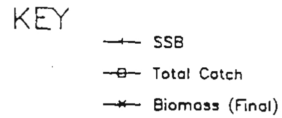
Fig 4.4.1 cont.



Percentage change in predicted values
120mm scenario (q1 & q4)/Status Quo Ple Whole Area
1.5
1
.5
0
-.5
-1
% CHANGE
1988
1989
1990
1991
YEAR



Percentage change in predicted values
120mm scenario (q1 & q4)/Status Quo Sol Whole Area
30
20
10
0
-10
-20
-30
% CHANGE
1988
1989
1990
1991
YEAR



KEY
SSB
Total Catch
Biomass (Final)

Fig 4.4.2
Example of template rectangle chart with rectangle codes as data.

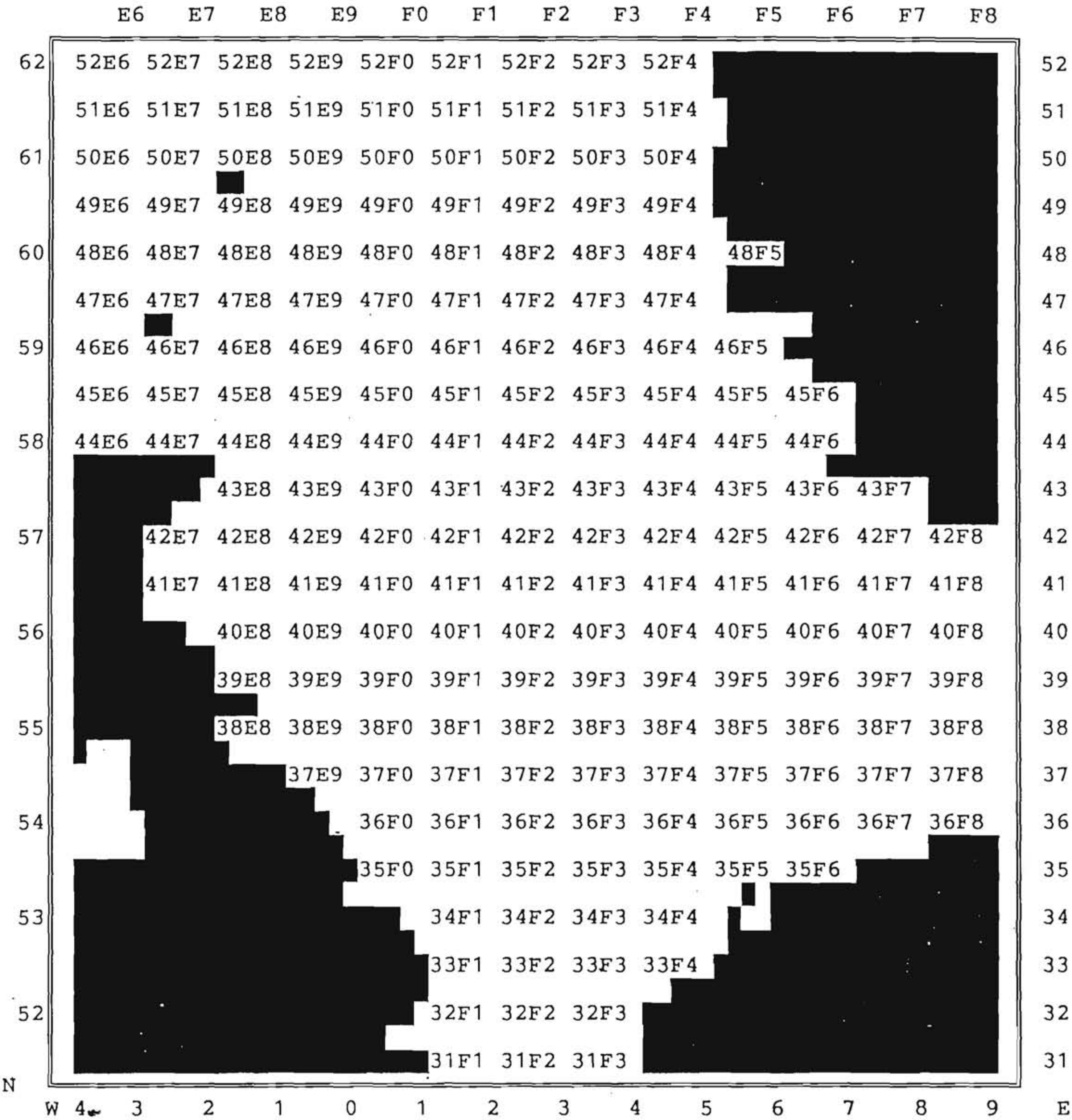


FIG. 6.3.1.

ENGLAND BEAM TRAWL
DAYS AT SEA QUARTER 3 1987

N	E6	E7	E8	E9	F0	F1	F2	F3	F4	F5	F6	F7	F8	
62	0	0	0	0	0	0	0	0	0					52
	0	0	0	0	0	0	0	0	0					51
61	0	0	0	0	0	0	0	0	0					50
	0	0	0	0	0	0	0	0	0					49
60	0	0	0	0	0	0	0	0	0	0				48
	0	0	0	0	0	0	0	0	0					47
59	0	0	0	0	0	0	0	0	0	0				46
	0	0	0	0	0	0	0	0	0	0	0			45
58	0	1	2	0	0	0	0	0	0	0	0			44
			3	0	0	0	0	0	0	0	16	0		43
57		0	34	0	1	0	0	7	1	18	3	0	0	42
		2	7	0	2	0	13	0	9	0	0	3	0	41
56			0	1	0	9	0	9	0	6	0	0	0	40
			0	2	4	37	18	2	0	1	0	0	0	39
55			0	1	2	8	4	1	0	0	0	0	0	38
				0	0	38	0	7	0	0	0	0	0	37
54					0	3	4	0	0	0	0	0	0	36
					53	0	2	0	0	0	0			35
53						0	0	0	0					34
						80	0	0	0					33
52						131	0	0						32
N						0	1	0						31
W 4	3	2	1	0	1	2	3	4	5	6	7	8	9	E