COMMISSION
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MEASUREMENT OF ECONOMIC IMPACTS OF FISHERY MANAGEMENT DECISIONS

- MODEL-BASED APPROACHES IN SPECIFIC FLEET SECTORS -

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Summary

A simulation model has been developed for measuring the economic impacts of fishery management decisions. This project, largely funded by the EU FAIR programme, was a co-operation of research institutes from three countries: Germany, the Netherlands and Spain.

Based on detailed investigations of costs & earnings, operational (activity) data from logbook records and other databases (e.g. price statistics) in the participating countries, this model-based approach enables political institutions and fishing industries to assess the economic consequences of political and individual measures concerning quotas, time restrictions, closure of fishing areas, decreasing catch rates, prices, etc. on the economic results of particular fleet segments.

The study can be classified as an empirical investigation, analysing and calculating the impacts of specific decisions (measures) in quantitative terms. The scope of the project is restricted to a selection of so-called “standard vessels” representing important fleet segments of the fishing fleets in Germany, the Netherlands and Spain (Mediterranean Sea). But the extension to other types of vessels and fisheries will not pose a great problem to knowledgeable experts.

In general, the selection of fleet segments in this study was determined by and depending on the importance of the fleet sector within the national fishery, the necessity of fairly homogeneous groups and the availability of data. According to these criteria in Germany two groups - Baltic cutters (located in Saßnitz/Ruegen) and North Sea cutters (situated in Cuxhaven) - were selected, while in the Netherlands the segment of the 300 HP beamers (so-called “Eurocutters”) and 2000 HP beamers were chosen for this investigation. In Spain, the selection was focussed on two important Mediterranean ports, Barcelona and Castelló where different fleet segments (trawlers and purse seiners) have been investigated.

As the model was meant not only to estimate changes in costs and earnings but also to simulate changes in operational behaviour, very detailed data were required as inputs. The evaluation of existing databases, the collection and/or updating of necessary data and data comparison, harmonisation and preparation for model use

were very time-consuming tasks. The data records were amplified by personal communications of fishermen, managers of producer organisations and accountants, together with scientific knowledge based on special investigations and experiences. For the project, the year 1995 (or 1996) has been chosen as the basic year according to the availability of a full set of data.

The data set on fishing activities is resulting from concrete operating figures recorded in the logbooks in detail (Germany and the Netherlands) or from enquiries in Spain and includes the time spent for fishing activities and the catch quantities by species on the different fishing grounds.

Fishing boats generally change their fishing grounds seasonally and sometimes even from trip to trip according to the available fish stocks and the expected catch rates. So for an adequate simulation of operational behaviour, data on the short-term evolution of fish stocks and catchabilities by fishing grounds are required. Such data are generally not available, so we had to construct them ourselves, putting a lot of effort in the process.

Monthly average catch rates per hour by fishing ground were derived from the logbook data of the sampled vessels in the German and Dutch cases and from the landings statistics in the Spanish case. The resulting data sets proved to be quite useful, although they were certainly not flawless. For some grounds very small numbers of trips made the resulting catch rates unreliable; in the Dutch case, time on the grounds had to be estimated by reducing trip duration by estimated steaming times, and similarly in the Spanish case.

Another important task was the preparation of fleet activities with respect to time input. A distinction is made between active and inactive time. The active time contains the steaming time from port to grounds and back, the so-called effort time for fishing and searching on the fishing grounds and some additional time which is directly combined with fishing activities like unloading, reparation, holidays and bad weather days.

These operating (activity) data were confronted with the (variable) cost data in such a way that cost allocations and calculations of cost units were possible which form a crucial part of the data inputs for the model.

For measurement of economic impacts an interim result, the so-called “gross margin” has been selected, representing the surplus of proceeds minus variable costs. The selected term “gross margin” only contains operating costs which are depending on fishing activities so that impacts of the introduction of alternatives and modifications of existent management measures and strategies (regulatory and individual) can be quantified. The resulting “gross margin” will not disclose the economic performance of the selected fleet segment in total, because fixed costs and depreciation are not taken into account.

The simulation model developed and applied in this project is a Mixed Integer Programming optimisation model maximising the gross margin. The model is a deterministic approach, containing deterministic data without uncertainties, developed with GAMS. Except from this deterministic character of the model, most of the limitations of the present model structure can be overcome with further development.

Based on an accurate allocation of variable costs to fishing activities and on a model configuration reflecting the economic interrelations in a proper way, first simulation runs and a great number of feasibility tests (including adjustments) were carried out. As main criteria for testing the feasibility of the model configuration and the plausibility of the model solution, specific outputs (e.g. catches, proceeds, number and length of trips, days at sea, gross margin) were considered and compared with the empirical results observed in practice.

In general, the differences between the model solutions and results in reality may be caused by deficiencies of data and by the behaviour of fishermen, not always being directed to maximising the economic result, and only to a small extent by model-inherent reasons. After extensive tuning and implementation of several reasonable and useful adaptations a set of so-called “BASIC solutions” was produced that simulates the reality acceptably well. These “BASIC solutions” are considered as the standards of comparison for all simulation procedures.

Finally, the application of the developed simulation model is demonstrated by simulating different scenarios dealing with different regulatory measures (e.g. quotas, reduction of time at sea) and changing economic and biological parameters (e.g. prices, costs, catch rates). Furthermore, some individual management strategies (additional target species and fishing areas, different fish prices in landing ports, landings only in homeports, temporary lay ups, etc.) have been considered.

In the majority of the simulated examples, the above mentioned measures and parameters have been introduced separately in the model; but in some cases several factors were simulated simultaneously with regard to their impact on the gross margin. The presented model applications were quite successful and demonstrate that the model is well able to measure the impacts of various planning decisions of the vessel owners as well as to assess future political measures on the national and EU level. However, a limitation of the model is that fish stock dynamics are not endogenous, but have to be generated exogenously and entered into the model through varying catch rates. This entails that the model does not allow to assess over how many years longer term beneficial effects of management measures will compensate for short term losses of the corresponding restrictions.

Apart from this centre topic, the research work on this EU sponsored project led to a better understanding of the specific situation of the fisheries in the participating countries, has supported the pooling and exchange of the profound expertise and scientific knowledge available in the partner institutes and represents the beginning of friendly relations between the members of the project team Laura Romeo, Eugenia Pascual, Ramón Franquesa, Jan Willem de Wilde, Wilfried Thiele, Hans Jürgen Kuhlmann, Rainer Klepper and Rolf Lasch.

"In many OECD countries there has been limited monitoring of economic conditions for fisheries and even more limited monitoring of the effects of specific fishing management measures."
John Sutinen in: Study on the Economic Aspects of the Management of Marine Living Resources. OECD, Paris 1996.

MEASUREMENT OF ECONOMIC IMPACTS OF FISHERY MANAGEMENT DECISIONS

- MODEL-BASED APPROACHES IN SPECIFIC FLEET SECTORS –

The study has been carried out with financial support from the Commission of the European Communities, Agriculture and Fisheries (FAIR) specific RTD Programme, CT 96 – 1454, "Measurement of Economic Impacts of Fishery Management Decisions – Model-based Approaches in Specific Fleet Sectors". It does not necessarily reflect its views and in no way anticipates the Commission's future policy in this area.

1 Introduction

The importance of fishing has to be seen not merely in terms of its contribution to the gross domestic product, but above all in terms of its geographical concentration and the importance of the activities linked to it. In coastal regions and at local economy level, the socio-economic importance of fishing increases substantially, even if there is a restriction to essential activities. Other induced activities (product processing and connected activities), multiplier effects and spin-off activities, such as tourism, are of great importance, too.

A key hypothesis to be considered is that proper fishery management methods which imply greater emphasis on economic efficiency, will become more attractive with economic development resulting in improvement of the efficiency of public administration and in more economic and social security for the working population.

In this context it is necessary to evaluate the effects of decreasing quotas, remote fishing grounds, varying catch rates, modification of days at sea, changing cost structures, sales prices, etc. on the economic results. This kind of information should be of great interest for the policy formation process within the European Common Fishery Policy (CFP) context.

2 Objectives of the study

The overall objective of this study is to identify the likely consequences of different management decisions within the scope of the European Common Fishery Policy (CFP) by developing a **computer-based simulation model for the measurement of the economic impacts in specific fleet sectors from the North Sea, Baltic and Mediterranean Sea.**

Such a sectoral fleet model for the analysis of management decisions will enable political institutions and fishing industries to assess the economic effects of individual and political decisions concerning quotas, fishing grounds, catch rates and prices on the costs and the gross margin of particular fleet segments.

Based on detailed cost accounts in Germany, the Netherlands and Spain and other technical and statistical data about catch effort by means of this model it is possible to identify consequences of policy instruments under various conditions, especially on effort and overcapacity, in economic terms.

The study can be classified as an empirical investigation, which analyses the effects of specific instruments in specific fleet sectors (regions), and is formulated in concrete rather than abstract terms. Apart from evaluation of existing policies, emphasis is on the likely effects of changes in policy. The participants' contribution will attempt to identify the effects implied by the choice of different management systems. These effects will be calculated in quantitative terms.

The scope of the project is restricted to a selection of a 'standard vessel' representing segments of the participants' national fishing fleets. But by exploring and laying down the principles for this measuring device, the extension to other types of vessels and fisheries should not pose great problems to knowledgeable experts.

In particular, the basic issues that have to be covered in this project are:

1. the elaboration of a comprehensive data basis by collecting and analysing costs and earnings (financial data), operational data (e.g. data from logbooks) and technical parameters of selected fleet segments in Germany, the Netherlands and Spain, and the generation of a better knowledge of economic and operational mechanisms of different fleet activities and management strategies as a basis for the development of sectoral fleet models,
2. the development of an appropriate computer-based economic simulation model placing particular emphasis on the economic effects of alternative management options, and
3. the quantitative assessment and measurement of impacts of operational behaviour and public policies, including allocation of fishing quotas etc. on the profitability (gross margin) in different fleet segments.

The project can be considered as a continuation of the EU study on "Costs and earnings ..." (Davidse *et al.*) and an extension of the EU study on "Profitability of ..." (GERECCO). At the same time, the suggestions of Scientific, Technical and Economic Committee on Fisheries (STECF) were followed not to develop yet another highly complex, in practice not applicable, model, but to choose a relatively simple model formulation, taking into account the availability of data and with a view on the applicability in the administrative and fishing practice.

In this sense, the objective is not to solve all measurement problems with the help of a model, but it should be a first step ("approach") in this direction. In the proposal it says: "The approach is seen as a stepping stone towards sophisticated sectoral fleet models ".

Furthermore, any comparison between the included fleet segments is not planned, as the structure (type and size) and the fishing conditions (target species, fishing areas and distances from home ports, restricted time and areas, traditions, etc.) are completely different for the various segments.

The selection of this large variety of fleet segments is rather meant to demonstrate the wide applicability of the model by the examples studied.

3 Project management and description of tasks

The project is a concerted investigation of four research institutions from three different EU-Member States in the course of which the data collection will mostly be organised on a national level. The relationship between the four teams is structured as equal partners, each carrying out complementary parts of the work in order to meet the objectives of this project. However, the Institute of Agricultural Market Research (IFLM) acts as co-ordinator and team leader. Furthermore, the scientific co-ordination is in the responsibility of the co-ordinator, but each participant of the countries involved is responsible for collecting and updating of the particular data basis in the required form.

Whereas the German and Dutch participants had extensive data sources at their disposal, it has to be noted that the Spanish partner had to collect on the spot the required financial data (costs & earnings) as well as operational and catch data of representative vessels of the fleet segments chosen. For this task the Spanish participant had engaged two sub-contractors, the Instituto de Estudios Oceanográficos (IEO) and the Institut de Ciencies del Mar (ICM).

In order to guarantee that the different experiences of the partners from the three involved countries could be taken into consideration, the harmonisation and preparation of data as well as the development, examination and application of the developed model configuration was designed as a joint research action with the participants operating very closely.

The participants have organised several project meetings (Palma, Barcelona, The Hague, Binz/Ruegen, Braunschweig, Lisbon, Tromsoe) – partly with dissemination of interim results – and in addition two bilateral meetings for model demonstration in Barcelona and The Hague. Each participating institute has prepared a national contribution of the relevant chapter, whereas the co-ordinator has integrated the different national texts into the progress and the final report.

As the national fisheries involved in this investigation have specific peculiarities with regard to the administrative fishing regimes but also to traditions, each chapter will contain separate descriptions of the specific situations and conditions in the participating countries Germany, the Netherlands and Spain. Thereby, this approach can demonstrate the applicability of the simulation model to different national circumstances.

The work programme, which was part of the project proposal has been the major guideline in carrying out the study. The overall research objective covers a number of tasks (and sub-tasks) in order to include all relevant aspects and objectives of the project.

- **Analysis of data basis in selected fleet segments**
  (Selection of specific fleet segments ("standard vessels") and evaluation of existing databases, collecting and/or updating of operational, financial and technical data and data comparison, harmonisation and preparation for model use)

- **Building of an economic Computer-Based Simulation Model (CBSModel)**
  (Analysis of economic and operational mechanisms, testing data frame work by using table calculations, designing a computer-based simulation model

(CBSModel) and experimental calculations and feasibility tests with the designed CBSModel)

- **Application of the CBSModel to a variety of management decisions conceivable in the framework of the Common Fisheries Policy**

  (Model calculations of different scenarios by using different variables in selected segments and assessment of impacts of various management measures including decisions on dissemination)

The methods applied for the three areas of investigation are a combination of

- Desk and field research
- Planning cost accounting ("standard costing")
- Table calculations organised in EXCEL- worksheets
- Construction of a comparative-static economic model
- Application of a simulation model approach.

The methodology is well proven by the four participants as far as desk and field research and EXCEL-worksheets are concerned. Standard costing as a basis for planning purposes in the management theory is also well known, but only in few cases applied in fisheries economics. The comparative-static models, including simulation approaches, have been used in agricultural research and were found very useful in the assessment of impacts of political decisions.

4 Selection of fleet segments

One of the most important aspects for modelling purposes is to establish an adequate segmentation of the fleet. In general, the selection of fleet segments in this study is determined by and depending on

- the importance of the fleet segment within the national fishery or coastal region,
- the necessity of fairly homogeneous groups and
- the availability of data.

Firstly, some background is given in explaining the structure and fishing activities of the fleet in each of the three participating countries. As criteria for selection and classification differ in the participating countries, secondly, a detailed description of the selection method is included in the national contributions.

Anyway, it should be clear, that the chosen groups of boats for instance do not represent fleet segments in the sense of the Multi-Annual-Guidance-Programmes (MAGPs) of the Common Fishery Policy (CFP) of the European Union (EU) . They are just groups of fishing vessels specially chosen for this exercise ("case studies"), applying the selection criteria mentioned above.

Germany

At the end of the year 1996 the German fishery fleet included 2 324 vessels in total. The German fishing fleet is composed of two main branches, the coastal and the distant water vessels. Within the latter group there are on the one hand only few freezer trawlers owned by foreign influenced companies and mainly landing their catches in foreign ports. On the other hand, a great number of bottom trawling cutters – owned by individual fishermen – exists which are by far the most important part of the German fresh fish fleet, being the backbone of the German regional fishing industry.

German Fishing Fleet 1996

	No.	GRT	average/ vessel	kW	average/ vessel
Coastal waters					
Shrimp cutter	271	10 045	37	42 585	157
Flatfish cutter (beam)	40	2 499	63	7 749	194
Gillnets and pot boats	1 841	4 530	3	30 926	17
Total (coastal)	**2 152**	**17 074**		**81 260**	
Distant waters					
Flatfish cutter	7	1 731	169	6 948	695
Cutter (bottom trawling)	136	10 374	76	31 977	235
Longline cutter	7	1 439	206	2 856	408
Cutter (pelagic trawling)	7	915	131	2 643	378
Freezer trawler (pelagic)	4	18 264	4 566	11 749	2 937
Freezer/Fresh fish trawler (demersal)	11	24 024	1 848	30 944	2 380
Total (distant)	**172**	**53 080**		**84 748**	
Total	**2 324**	**70 154**		**161 883**	

Source: Annual Report on German Fisheries 1997, BMELF.

Within this fleet segment one can distinguish vessels mainly fishing in the Baltic and those mainly operating in the North Sea. While the Baltic cutters are targeting to a great extent on (Baltic) cod, the North Sea vessels are mainly targeting on saithe (pollack). Taking into account these different activities, the study will focus on Baltic cutters and North Sea vessels.

With regard to homogeneity and data availability the groups selected for modelling purposes in the present study are situated in two different ports:

- The Baltic cutters are located in Sassnitz/Ruegen
- The North Sea vessels are situated in Cuxhaven

Cutters Investigated							
	No.	**%**	**GRT**	**%**	**average**	**kW**	**average**
Baltic bottom trawler	8	6	1 072	10	134	1 616	202
North Sea bottom trawler	8	6	1 540	15	193	4 443	555
Total	**16**	**12**	**2 612**	**25**		**6 059**	

According to the total of the German bottom trawling cutters in 1996, the selected Baltic vessels focussed in this study represent 6% of the number, 10% of the tonnage and an estimated 8% of total cod landings (or 11% of Baltic cod landings). The selected North Sea cutters have a portion of 6% of the numbers of vessels, 15% of tonnage and estimated more than 50% of total saithe landings.

In addition to that, there are data concerning temporary activities of Baltic cutters in the North Sea and similar activities of North Sea vessels in the Baltic which can be used for simultaneous calculations in alternative operational areas.

The capacity of the cutters in the study is shown in the following tables:

Selected Baltic Cutters			
	average	**minimum**	**maximum**
Length (m)	26.5	26.5	26.5
Tonnage (GRT)	134	134	134
Engine power (kW)	202	184	221

Selected North Sea Cutters			
	average	**minimum**	**maximum**
Length (m)	31.6	28.3	35.1
Tonnage (GRT)	193	102	326
Engine power (kW)	555	422	735

While the Baltic cutters investigated in the study are very similar, the selected North Sea vessels show a wider range with regard to length, tonnage and engine power.

The Netherlands

The Dutch sea fishing fleet is composed of two main branches, generally called the 'Freezer stern trawlers' and the 'Cutters'.

The freezer stern trawler fleet counts little more than a dozen very large vessels, owned by 4 companies. The boats are specialised in pelagic trawling for herring, mackerel and horse mackerel in the Northeast Atlantic waters, and have found some additional fishing opportunities in African waters. No costs and earnings data are available of this fleet.

The cutter fleet is by far the most important branch of the Dutch sea and coastal fisheries. At the end of 1995 it consisted of around 450 boats, having an aggregate gross tonnage of 93 250 G(R)T and an aggregate main engine power of 358 000 kW. In that year, it contributed about two-thirds to the total sea and coastal fisheries turnover of nearly 450 million ECU (Smit et al., 1997).

As a result of international and national fisheries regulations and restrictions the cutter fleet is gradually gravitating towards two sizes (Smit et al., 1986 - 1997):

- 300 HP (221 kW) multi-purpose 'Eurocutters'
- 2000 HP (1471 kW) beam trawlers

Together, cutters around these sizes account for close to 50% of the total cutter fleet in numbers (see table below). Therefore, these types of vessels are the logical choice as standard vessels for the Economic Impacts Measurement project.

Composition of Dutch Cutter Fleet (1995)					
HP-group	Number	Total HP	Average HP	Total G(R)T	Average G(R)T
1 - 260 HP	109	21 341	196	3 746	34
261 - 300 HP	134	39 981	298	10 469	78
301 - 1500 HP	43	42 484	988	8 561	199
1501 - 2000 HP	102	194 486	1 907	39 052	383
> 2000 HP	69	191 254	2 772	31 862	462
Total	457	489 546	1 071	93 690	205
Source: LEI, Fisheries Directorate					

300 HP Eurocutter

300 HP or 221 kW has been a limit on engine power for obtaining a shrimping licence for the Dutch coastal zone for a long time. In the mid-seventies, vessels having main engines of more than 300 HP were excluded from beam trawling within the national 12-mile zone. European subsidies in the late seventies and the early eighties supported the development of a new, powerful and versatile vessel type, with relatively long endurance, which soon got the nickname 'Eurocutter'. The development was further enhanced by the adoption in the CFP of the 221 kW beam trawling restriction in the 12-mile zone along the (eastern) coast of the North Sea, and later on by the expansion of the privileged area with the plaice box.

Over the years, the size of the Eurocutters has been growing. Originally, the restriction on beam trawling in the Dutch 12-mile zone was for vessels of 50 GRT and more. With the development of the subsidised Eurocutters, the limit was raised to 70 GRT and this was also the original limit in the CFP regulations. It soon became clear that GRT was a rather ambiguous measure for the size of vessels. The gradual changeover in the early eighties towards the new (and more precise) convention on measuring vessel size in GT showed that even the early Eurocutters already measured around 80 GT. To put an end to ambiguity, the GRT limit was lifted and replaced by a length overall limit of 24 m. This allowed designers and builders to develop ever bigger vessels within the restrictions: early examples after the introduction of the 24 m limit measured about 115 GT; more recent additions to the fleet are about 160 GT.

The increasing size of the Eurocutters has raised suspicions about their engine power. Rumours had it, the actual power installed was double or even treble the allowed 300 HP. Control actions at sea have indeed proven on a number of occasions, that more than 300 HP could be delivered by the main engine, but never to the extent indicated by the rumours. Apart from the main engine, these modern large vessels have installed a couple of auxiliary engines with nearly the same power as their main engine. The main engine is used solely for propulsion, and over the last decade, the size of the propellers of these vessels has increased considerably, resulting in higher efficiency and greater pulling power. This may (partly) explain the better performance of the Eurocutters compared to older 300 HP boats.

<u>2000 HP beamers</u>

The number of beam trawlers having a main engine of (close to) 2000 HP or 1471 kW has increased since the introduction by the Dutch Government of a 2000 HP limit for new built beam trawlers in 1987. Also, on transfer of a licence of more than 2000 HP its 'size' is reduced to 2000 HP (De Wilde, 1993).

Similar to the Eurocutters, these vessels are evolving towards bigger, more powerful boats than the older ones of the same engine power. The earlier tendency to take off auxiliary power from the main engine has been reversed, and propellers now have lower revolutions and increased diameters for higher efficiency and increased pulling power. In fact their fishing power is comparable to that of the older 2700 - 3000 HP boats.

Spain

In the Mediterranean part of Spain there are 87 harbours. We have made a selection of two of those with two criteria: the landings relevance and the warranty of the data quality.

- Landings relevance

The artisanal fleet produce only about the 10% of the captures in the Spanish part of the Mediterranean Sea. That's why we will aim our study in the *industrial* fishing of the Mediterranean Sea. In this Sea the industrial concept differs from the one in the Atlantic. In fact, there are basically two kind of gears: Trawl (Pelagic and Demersal) and Purse seine. There are also other high sea fisheries (basically on tuna and swordfish stocks). In the Spanish case the Pelagic Trawl is not allowed and the high sea fleets play a secondary role in the Mediterranean.

- Warranty of the data quality

The chosen harbours have consolidated relations with the biological research institutes: Barcelona (Institut de Ciències del Mar), and Castelló (Instituto Español de Oceanografía). The description of these harbours in terms of the number of vessels, the volume of the captures and their value as well as the effort of the chosen harbours is presented in the following tables.

Taking into account the number of vessels, the most important harbour is Castelló. This is because in Castelló there are more vessels dedicated to artisanal gears than in Barcelona. That means that the size of the ships is very small. Castelló has also a higher volume as well as a higher value of catches.

Harbour	Vessels No.	% vessels of the Spanish Mediterranean fleet (Total: 1 926)	% vessels of the Mediterranean fleet (Total: 12 364)
Barcelona[1]	99	5,14	0,80
Castelló[2]	123	6,38	0,99

Harbour	Catches kg	% the volume of the Mediterranean captures in Spain (Total: 132 336 000)	% the volume of the Mediterranean captures (Total: 1 670 000 000)
Barcelona	7 124 738	5,38	0,42
Castelló	12 529 000	9,40	0,75

[1] From now, Barcelona can be noted as BCN.
[2] From now, Castelló can be noted as CST.

Harbour	Catches Values PTSs	% of the value of the Mediterranean captures in Spain (Total: 39 542 000 000)
Barcelona	1 653 933 539	4,18
Castelló	2 480 000 000	6,27

Harbour	HP	GRT
Barcelona	19 205	2 451
Castelló	33 060	4 757

We have studied two main gears in the Mediterranean fleet: purse seine and trawler, and in the case of the Castelló harbour we have studied another gear: the pelagic trawler. In the Castelló case, the evidence of the data shows that part of the trawler fleet is specialised in the pelagic resources: sardine and anchovy.

Within them, we have sub-divided the gears into segments depending on their length between perpendiculars (EPP). Those groups in the trawler segment, are:

- TRI less than 15 m
- TRII between 15 and 20 m
- TRIII more than 20 m

For the pelagic trawler gear we can find:

- PTRII between 15 and 20 m
- PTRIII more than 20 m

Finally, for the purse seine fleet the categories are:

- PSI less that 15 m
- PSII more than 15 m

The selection method for the Barcelona and Castelló fleets is developed below for each harbour separately.

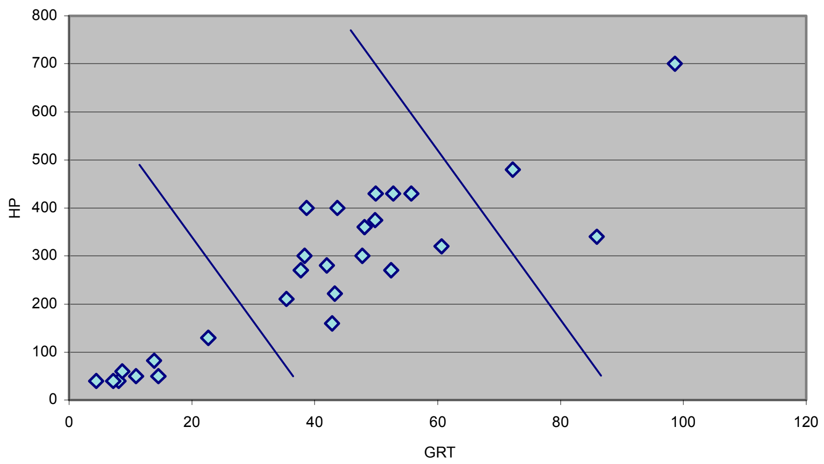
Barcelona

Taking the vessels that landed in 1995 in Barcelona we obtain the following fleet structure[3]:

Fleet Structure (Barcelona 1995)	
Fleet segment	**Number of vessels**
Purse seiner	40
Trawler	28
Artisanal fleet	19

In order to establish homogeneous groups in the fleet, we have analysed the relation between tonnage (GRT) and potency (HP).

Relation HP-GRT

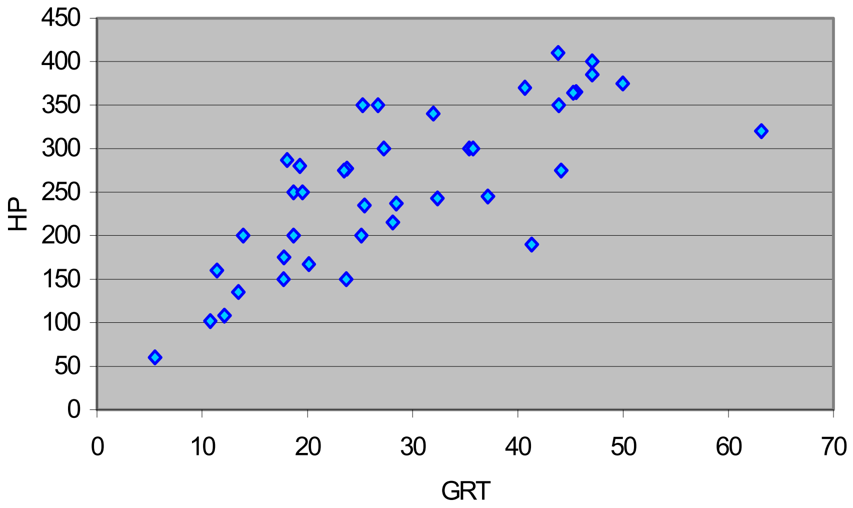


The trawler fleet has the following relation:

[3] Vessels with home port Barcelona.

It is important to notice that probably there is a bias in the data about the potency. It is allowed to have only 500 HP, but most of the vessels with high tonnage declaring potency near 500 HP have much more than they are declaring.

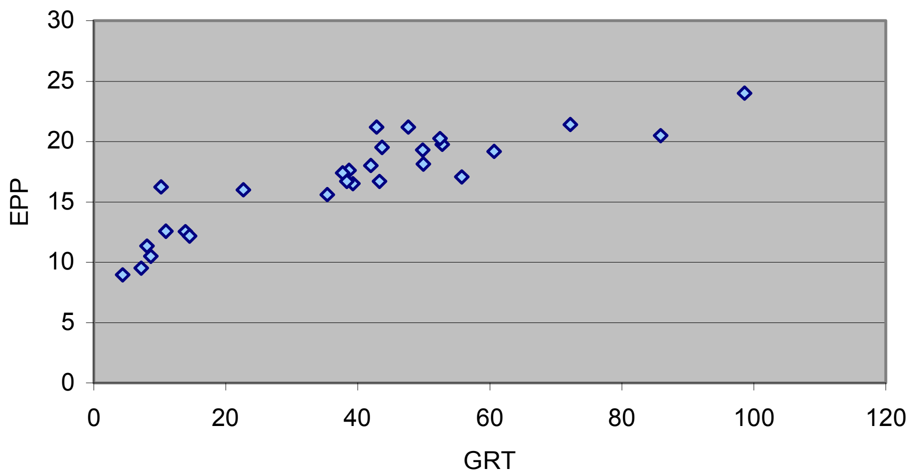
Relation HP-GRT



From the relation between HP and GRT in the purse seine fleet we can not establish so easily different groups. Therefore, we are using another way to establish homogeneous groups, by analysing the relation between the length (EPP) and the GRT of the vessel.

In the trawler fleet we obtain the following results:
The fleet can be divided in three groups taking into account the length in the way we show in the graphic.

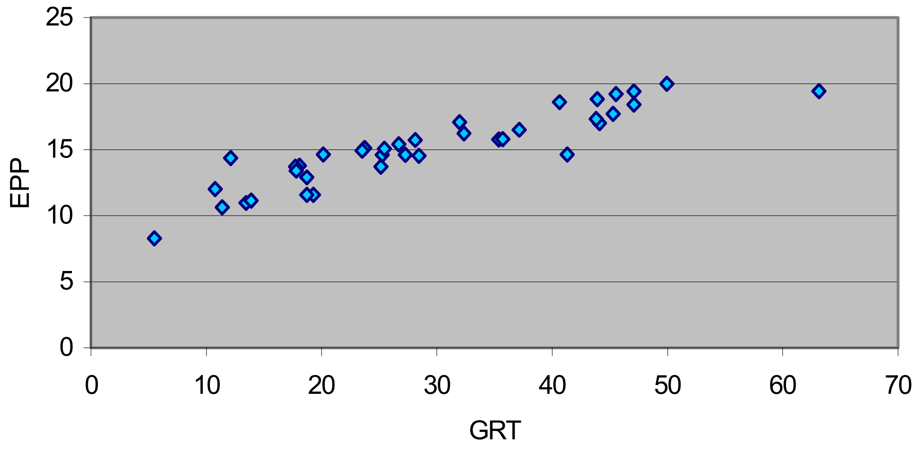
Relation GRT- EPP



- One first group with less than 15 m (TRI).
- Another group with EPP between 15 and 20 m (TRII).
- And one more group with more than 20 m (TRIII).

In the purse seine fleet the relation between length (EPP) and GRT is the following one:

Relation GRT-EPP



The definition of homogeneous groups in this case is not so clear as in the case of the trawler fleet, but we can take the following two groups:

- Vessels with less than 15 m (PSI).
- Vessels with more than 15 m (PSII).

In the first classification (HP-GRT) we have got the problem with the HP data, but this problem doesn't exist in the case of the length and the GRT because is not easy to falsify this data. We will use the length classification to define the definitive groups.

These groups will help us in the task of obtaining the operational data of the vessels. This data has to be obtained by enquiring the owners of the vessels. If we establish homogeneous groups, by asking to few owners we can extrapolate the results to the rest of the group. In this way we avoid the hard and difficult task of asking vessel per vessel the operational costs.

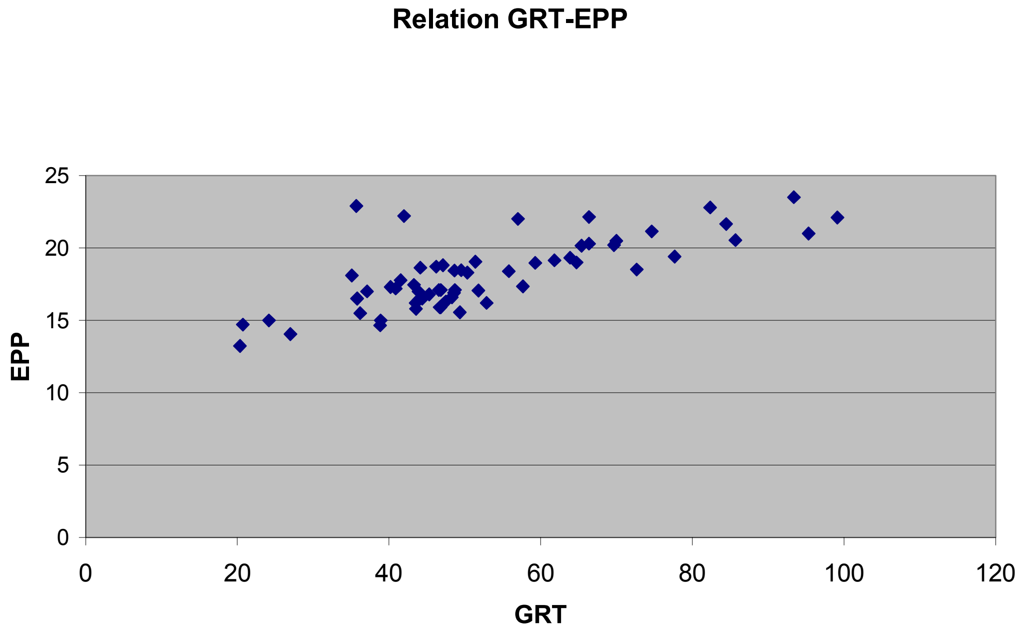
The fleet structure in 1995 in Castelló was the following one (Llorca Sellés *et al.*,1985-1996):

Fleet Structure (Castelló 1995)	
Fleet segment	**Number of vessels**
Purse seiner	31
Trawler	42
Artisanal fleet	45

As well as in Barcelona an important part of the fleet is dedicated to purse seine and trawling, but in Castelló there is a higher number of vessels using artisanal gears.

A classification of the fleet can been established taking into account the same variables as with the fleet of Barcelona.

In the trawling fleet the relation between the length (EPP) and the GRT is:

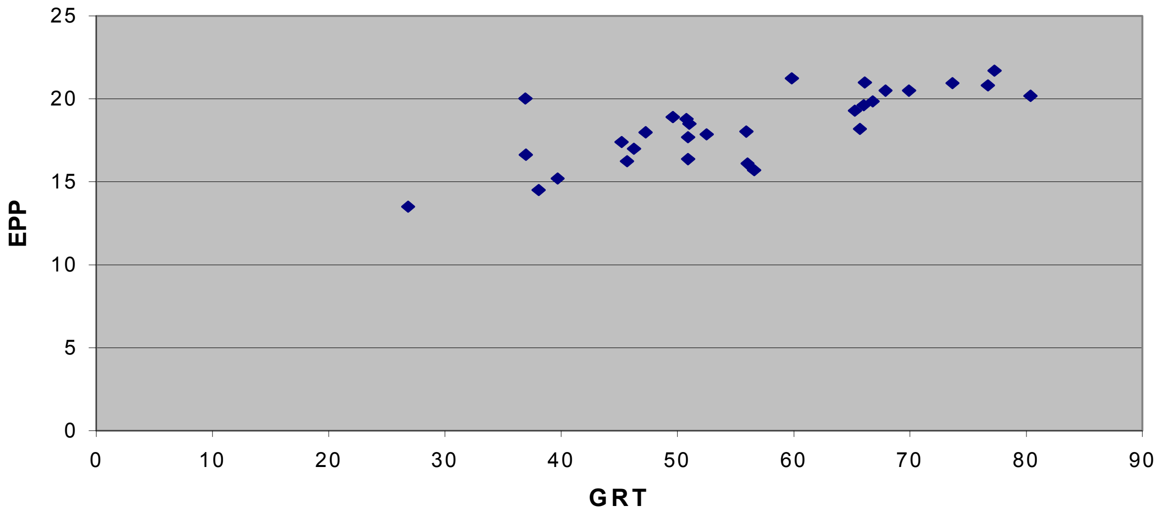


From this relation we can distinguish the three trawler groups:

- Vessels with less than 20 m (TRI)
- Vessels with length between 15 and 20 m (TRII**)**
- Vessels with more than 20 m (TRIII**)**

The purse seine fleet of Castelló is more homogeneous than the one of Barcelona. Analysing the relation between length and GRT in this fleet, we can see that we can include all the fleet in the same group.

Relation GRT-EPP



All the vessels belong to the group:

- Vessels with more than 15 m (PSII)

There is only one vessel not included in this group and this vessel is considered as an irregular vessel, so we will not include it in our analysis.

5 Data set of "standard vessels"

5.1 Origin of data

There are different data sources regarding fisheries activities in the participating countries. In Germany and the Netherlands the main data bases are:

- the logbook data,
- statistics of prices and
- national investigations in costs & earnings.

For the Spanish Mediterranean fisheries no logbook data exist and only little information about costs and earnings and prices is available.

Germany

The Federal Office for Food and Agriculture (BLE) collects the logbook data of each German vessel that is obliged to keep a record of catches. This data basis is essential with regard to operating figures, containing detailed information about fishing activities like port and time of departure and landing, time of hauls within each trip, fishing areas (statistical rectangles) and catches by species and quantities. Based on these records, necessary calculations of steaming, effort and harbour time for modelling purposes are possible trip by trip, as well as catch rates per hour for different fish species on the relevant fishing grounds.

These operating (activity) data in form of averages for the different “standard cutters” are allocated to the different variable cost items. Then it is possible to calculate the costs of the different activities like fuel cost per hour steaming time or gear costs per hour effort time.

For calculating the earnings and at least the gross margins available national/regional fish price statistics are used.

Furthermore, the different data records are amplified by personal communications of fishermen, managers of producer organisations and tax accountants together with scientific knowledge based on special investigations and experiences.

The Netherlands

Data on the activities and on costs and earnings of the standard vessels are available in three databases:

- DAFIST (DAtabase for FIshery STatistics), the result of an EC sponsored project to make logbook data in the Ministry owned database VIRIS more easily accessible. The database can be consulted with standard queries by means of a Windows application. The database holds data per vessel on times and ports of departure and arrival, on the statistical rectangles visited and on the catch declarations made in the logbooks on the most important species under quota, plus shrimps. For this project, a special data file has been made, comprising only the vessels that are of interest for the project (Van Beek et al., 1998; Dol, 1996).

- VDL (Visserij Databank Landbouw-Economisch Instituut), comprising the summarised financial data necessary to make the annual reports on the economic results of the individual vessels. For this database, a Windows application for standard queries is available as well. This enables to produce standard reports on economic results of single vessels and of the standard Landbouw-Economisch Instituut (LEI) HP-groups, but also of self-defined HP-groups. Apart from that, groups composed of a number of self-chosen vessels can be defined and stored for repeated use. This facility has been used for the standard vessel groups of this project.
- The book keeping records of the individual vessels in the LEI costs and earnings panel of the Dutch fishing fleet. This database holds detailed per vessel financial data, where possible connected to trips and/or types of fishery (Davidse et al., 1993). This includes e.g. a specification of the most important species of fish sold per trip, all single fill-ups of fuel by quantity and value and connected to a week (= approximately a trip in the Dutch cutter fisheries), full specification of auction costs and levies on a per trip basis, fishing gear expenses connected to type of fishery etc.. Trip data included in these records have been checked against the logbook data.

For the project, 1995 has been chosen as the basic year, as at the start of the project a full set of data was available for that year.

Spain

All the actual data have their origin in the auctions at the fishing ports (Lonjas). They have been accumulated in bill forms by the producer organisations (Cofradías) of the selected Mediterranean ports. These Cofradías de Pescadores are corporations of public law. In these corporations boat owners and workers are associated. They have very important roles in the fishing sector:

- They control the implementation of the rules of the different administrations. They play the decisive role of the sector regulation.
- They collaborate with the administration on issues of public interest and referring to the catch activity and the trade process.
- They assume the administrative tasks of the associated fishing firms, due to the complicated rules of accountability and taxes.
- They establish the time of leaving in the area of their activity.

Each Cofradía has a Lonja where the catches are sold. When the vessels arrive from fishing, they land all their catches in the Lonja, where the auction takes place. At the end of this process, each owner gets a bill with the quantity of catches sold, and the price of each species. That is why the Cofradías are very important for obtaining information about the fishing activity in the area.

This last role of the Cofradías is very important for us, in the sense that we can obtain all the information of the chosen ports by asking for the bills of the auction. The Institut de Ciències del Mar (ICM) and the Instituto Español de Oceanografía (IEO) process these bills, because they have a close relation with the Cofradías of the selected harbours from long time ago. This close relation is very useful in order to obtain information from the Cofradías.

Unfortunately the Cofradías have no cost data on the vessels. The Cofradía does not follow the accounts of the vessels. Usually the owners have an agent to manage these aspects for them. Sometimes the wife keeps the accounts.

The only way to have cost data is by enquiring the owners who have the costs of the vessel in their minds. This is not an easy task because they usually refuse to speak with people that they do not know. So, first a way must be found how to get to know them. The main problem is that they do not have good relations with the administration, nor with the Cofradía, and neither with the Institut de Ciències del Mar, so there are some problems to find a contact person. Once there is a chance to speak with one of them, it must be clarified that the project has completely no relation with taxes, and questions about catches can not be asked. The enquiry has been designed trying to obtain the necessary data, but also trying to make the questions as simple as possible for the owners. The used enquiry is presented in the Annex, with the number **ESP- 1**.

5.2 Basic data ("standard vessel" characteristics)

The vessels taken into account in the different segments are not "samples" in mathematical-statistical sense. The data on the so-called "standard vessel" used further on are the arithmetic means of the investigated vessels. Because the number of vessels is relatively small (Germany 6 resp. 8 vessels, The Netherlands 17 resp. 16), a mathematical presentation of the statistical distribution is therefore not meaningful, and the representativity of the so-called "standard vessel" for the selected segments can be recognised at first sight.

In the Spanish case no bookkeeping data on costs and earnings are available. "Standard vessels" for the various fleet segments in both selected ports were defined with accessory data regarding to landings and prices by the project co-operators and own calculations, based on enquiries carried out.

The following data contain the most important attributes of the theoretically formulated "standard vessel" representing the average data of the selected vessels.

Germany

The "standard vessel" of the selected Baltic and North Sea groups – located at Sassnitz/Ruegen and Cuxhaven – can be characterised by the following data frame work:

Basic Data of German "Standard Vessels"		
	Baltic	**North Sea**
Home port	Sassnitz	Cuxhaven
Length (m)	26.5	31.6
Gear	Bottom trawl	Bottom trawl
Tonnage (GRT)	134	193
Engine power (kW)	202	555
Speed (kn)	9.5	12.5
Catch (t)	332.9	1 351.9
Proceeds (1000 DM)	584.9	1 729.0
Crew number	4	6
Trips/year	35	22

The Netherlands

Eurocutters

In its panel of fishing companies where LEI collects the accounts, 32 boats are in the 261-300 HP group. This group includes a variety of vessels, ranging in size from 39 GT to 160 GT and in age from 3 to 50 years (in 1995), the older and smaller ones often being dedicated shrimpers, the modern larger ones being multi-purpose vessels, with the accent on beam trawling for flatfish. As we are aiming at the latter for our standard vessel, 17 vessels have been selected out of the total of 32 in the group, on the basis of the following criteria:

- more than 75 GT;
- maximum 15 years old (about 60% of the economic life span), or
- recently renovated and having a multiple fisheries operation.

The group of 17 boats selected to represent the standard vessel comes from a variety of homeports. There is an equal split between the northern and the southern ports (the dividing line lying between Katwijk and Scheveningen), with the northern boats mainly coming from the ports of Wieringen (WR) and Den Helder (HD) and the southern group having its main home port in Stellendam (SL, but also GO).

2000 HP beamers

The LEI panel includes 38 boats in the 1800 - 2400 HP range. Out of these, 16 were selected, having main engines close to 1471 kW.

The group of 16 selected vessels is composed of 10 boats from northern homeports and 6 from the South. As with the Eurocutters, the boats mainly come from the Stellendam area in the South (5 of the boats being registered under GO) and the Den Helder area in the North (with 8 of the boats registered under HD or TX).

The average characteristics of both groups of boats are to represent the Dutch standard vessels and are given in the following table.

Vessel Characteristics of the Dutch "Standard Vessels"			
		Eurocutter	2000 HP beamer
Length over all	(m)	23.61	41.48
Beam	(m)	6.19	8.59
Depth	(m)	2.94	4.95
Gross Tonnage	(GT)	102	455
Main engine power	(kW)	221	1471
Steaming speed	(kn)	9.5	12.5
Landings	(t)	178.3	469.2
Proceeds	(1000 NLG)	972.6	2 940.4
Average crew size		3.75	7.3
Number of trips		75	47
Days at sea		171	208

Spain

The theoretically formulated so-called "standard vessels" have the following attributes. They have been obtained by the enquiries average.

Characteristics of Spanish Mediterranean "Standard Vessels"													
	Barcelona					Roses		Castelló					
	TRI	TRII	TRIII	PSI	PSII	PSI	PSII	TRI	TRII	TRIII	PSII	PTII	PTIII
Potency (HP)	78	322	506	211	327	211	327	97	353	480	369	353	480
Tonnage (GRT)	14	46	85	19	42	19	42	23	48	82	56	48	82
Length (m)	12	18	21	13	17	13	17	14	18	21	18	18	21
Crew Number	3	6	7	16	18	16	18	3	5	7	16	5	7
Proceeds (mPTS)	16 072	44 882	50 234	31 050	45 100	2 206	3 025	11 271	18 159	28 060	42 022	36 445	36 784
Catches (kg)	23 031	54 051	67 204	212 838	276 230	14 109	54 903	19 192	36 671	55 487	300 883	314 493	300 330
Gross Margin (mPTS)	3 116	8 694	8 329	6 855	10 425	341	447	2 329	3 697	6 632	13 656	11 587	10 517
Trips per year	197	237	233	148	139	15	17	188	190	193	145	107	109

5.3 Regulatory fishery management regime

Existing regulations governing fishing activities in EU waters are formulated at both national and EU levels. Total Allowable Catches (TACs) and associated Member State shares form the core of fisheries management in the Baltic and North Sea and govern how much of each stock Member States are permitted to catch. Most species of economic importance are subject to TACs that are formulated annually on the basis of scientific advice.

Additionally, a diversity of technical measures is currently in force to support the TAC-based management regime (mesh sizes, closed/restricted areas, etc.). Furthermore, all boats fishing commercially are required to hold a fishing licence.

The EU’s Common fisheries policy does not specify how national quotas should be distributed within each member state. As a result, there is a wide range of management systems within the Community and vessels from different countries are often fishing the same stocks with quite different use rights.

Germany

The most important fish species for German fisheries are managed in the CFP quota system. The quotas are fixed annually by the Fisheries Council of the European Union. The Federal Ministry of Food, Agriculture and Forestry (BML) is responsible for negotiations at the Fisheries Council level in matters regarding quotas and for later quota swaps with other Member states. The Federal Office for Food and Agriculture (BLE) distributes the quotas within Germany and has an expensive monitoring and enforcement system that ensures the compliance with overall total allowable catch limits.

The distribution of quotas is not uniform. For quotas that are not expected to be fully used, access to these stocks is open to all German fishing vessels. Quotas that are subject to economic pressure are distributed carefully between the interest groups who receive fishing permits. There are collective permits for deep-sea fishing companies and producer organisations as well as vessel-related individual fishing permits.

In the deep-sea fisheries in which Germany is involved, fishing quota are allocated to fishing companies. The larger vessels in the cutter fleet tend to target saithe and individual saithe quotas are issued to each vessel. However, for the remainder of the cutter fleet in the North Sea fishing for cod and other roundfish there is no formal system of quota management and as a result, vessels are entitled to fish against general quota.

Apart from international quota swaps executed by the Government, German fishermen may also swap quotas; but they may not be bought and sold. This restriction is intended to give all fishermen equal opportunities irrespective of their financial situation.

The full utilisation of quotas depends upon the economic returns from harvesting the species concerned. The utilisation rate of the total of all quotas is under 50 percent. But quotas of numerous valuable species – saithe, plaice, mackerel, North Sea herring, ocean perch, etc. – are always fully, or almost fully, utilised.

In connection with the present study, mainly the quota of (Baltic) cod and to a lesser extent those of sprat, flounder and herring in the Baltic are relevant for the Baltic cutters located in Sassnitz/Ruegen. While the Baltic cod quota is allocated to the Producer Organisations (POs), which in turn allocate catch quotas for cod individually to the vessels of their members, the quotas (TACs) of sprat, flounder and herring are common quotas accessible to all German cutters.

The sampled North Sea vessels are mainly targeting saithe, the quotas of which are individually allocated to vessels whereas the quotas (TACs) of cod and haddock in the North Sea are common quotas (TACs), the access to which is open to all German cutters. In the past, these common quotas (TACs) have been utilised only to a small extent.

The Netherlands

The Dutch fisheries have a rather complex system of rules and regulations for the implementation of the general fisheries restrictions of the CFP. It has been described by De Wilde (1993) and also in a case study on the North Sea flatfish fishery (Salz et al., 1996). The following is an extract from the latter report:

A complex system of national regulations has been introduced in The Netherlands in order to regulate the fisheries, in particular that for flatfish. Since 1985 licenses on engine power restrict the capacity of the fleet. The licenses are transferable, but are reduced in size by 10 % on transfer since 1994. At the start of 1995 a total of 565 licenses were 'active', i.e. had been issued to vessels, having an aggregate engine power of 429 000 kW. The size of the actual flatfish fleet has been given in 3.1: 294 licensed vessels having an aggregate engine power of 327 700 kW.

The catches of plaice and sole are regulated basically with a system of individual transferable quotas. These were introduced in 1976, shortly after the inception of the North East Atlantic Fishery Committee (NEAFC) quota management. Originally the Individual Transferable Quotas (ITQs) were allocated on the basis of track records in the same reference years as the national quota allocation had been based upon: 1972-1974. The ITQs are expressed in kg per year and annually adapted in proportion to the changes in the national quotas, so in effect the ITQs are shares in the national quotas. Transfer of quota's is restricted in time and in relation to the extent of exhaustion of the relevant quota of both letter / seller and hirer / buyer.

Very strict rules on and control of landings were introduced during the eighties in order to curb illegal fishing and landing practices. Landing of fish is only allowed in fifteen ports, at designated quays, between certain hours. The inspection service has to be notified of the intention to land 8 hours beforehand (on trips lasting more than one day), and unloading of the catch is not allowed without the consent of the inspection service. All fish on board has to be unloaded in one uninterrupted action.

In order to support the enforcement of national quotas, restrictions on effort were introduced. From 1987 onwards, vessels having ITQs of plaice and sole were allowed to spend a certain number of days at sea. Vessels having more quotas than could be caught in the standard number of days were given derogation. Since 1992 these derogations are based on a combination of ITQs and fishing (=engine) power.

The basic number of days at sea is now reduced to 100 days, and virtually all flatfish cutters have a derogation, so in fact this is equivalent to an individual days at sea regulation. (Some vessels with very ample quotas in relation to their engine power could stay at sea the year round.)

In 1993 the management and control of ITQs and days at sea was to a certain extent transferred to PO groups. In the groups ITQs and days at sea are pooled and can be transferred more freely than outside the groups, subject to the rules of the group. Group members are obliged to sell all fish landed

through an auction. All flatfish fishermen have joined one of the eight groups that have been formed and signed a contract to abide by the rules set by the group.

The pooling of quotas and days at sea in PO-groups has had a positive effect on the freedom of operation of the companies, combined with a better compliance with the rules. In fact, it has relieved the days at sea restrictions to an extent that they are virtually non-existent. (This situation has reversed since 1998 under EC pressure to comply with MAGP IV.)

Fishing for roundfish has the same set of restrictions, with individual quotas for the dedicated fisheries (otter trawling and pair trawling) and a by-catch regulation for the other fisheries (also as a small individual allowance, available to all boats having a HP-licence).

Fishing for shrimp in the Dutch coastal zone is only allowed with a shrimping licence, with extra restrictions for shrimping in the Waddensea area.

This complex set of fishery restrictions has a major effect on the operational behaviour of the fishermen and is therefore of primary importance for the model. The average ITQs of target species for both standard boat types are given in the following table. These ITQs are basically also used as restrictions in the model.

Average ITQs of Target Species for Dutch "Standard Vessels" in 1995 (kg)

	Plaice	Sole	Cod	Whiting
Eurocutter	74 400	28 595	13 810	6 110
2000 HP beamer	125 330	259 870	-	-

Spain

In the Spanish Mediterranean Area TAC restrictions are not used. Instead of that, the management regulations are based on administrative limitations of the number of licenses and on time restrictions. This kind of regulation is because of the multi-species fisheries of the area.

As in this area there is an over-exploitation situation, the administration tries to control the effort of the fleet on the resource. This control is based on forbidding an increase of the fishing effort (number of vessels, ...) and at the same time trying to reduce the effort (retiring vessels, closed seasons, ...). In this sense, new vessels are not allowed to fish in the area if they do not have an active license. As the number of licenses cannot grow, the only way to get a license is by getting an old one or more from one or more vessels that have been retired from the fishing activity. The capacity of the new coming vessel can not be higher than the retired capacity.

The time restrictions can be in the form of a limitation in the allowed timetable, the active hours of fishing, the allowed active days of the week, or finally the establishment of closed seasons.

The smallest management unit is the Cofradia, with respect to the global legal framework. The rules established by the Cofradia can vary quite a lot from one port to another and usually depend on the point of view of the fishermen themselves. An operative vessel, with an active license can go fishing following the dispositions established by the Cofradía of the harbour census. They can reduce the fishing days and the time table if they consider that this will help the recovery of the resource, or make it as wide as possible within the general administrative rules.

5.4 Bio-economic framework

5.4.1 Target species

Germany

The Baltic vessels – registered in Sassnitz/Ruegen - are directed mainly on (Baltic) cod, contributing more than 89% to the total catch. Cod is the target species whereas other fish like flounder, sprat and turbot play a minor role (11%). But the catch of flounders and perhaps that of sprat and herring may be alternatives in the future if stocks of presently fished target species are decreasing.

Landings and Proceeds of German "Standard Vessels"				
1996	**Baltic**		**North Sea**	
Landings		332 944 kg		1 656 500 kg
	Cod %	89	*Saithe %*	74
	Others %	11	*Others %*	26
Proceeds[1)]		519 190 DM		1 729 042 DM
	Cod %	95	*Saithe %*	84
	Others %	5	*Others %*	16
Price	*Cod*	1.66 DM/kg	*Saithe/pollack*	1.30 DM/kg

[1)] Own calculations

The activities of the vessels located in Cuxhaven and mainly fishing in the North Sea (including off Norway) are mainly targeted on saithe (74%), but cod as well as haddock, whiting and ling are important species (26%) within the catches of this fleet segment.

The Netherlands

Eurocutters

Eurocutters rarely restrict their activities to one type of fishery. Most of them practice at least two fisheries: beam trawling for flatfish (sole and plaice) and shrimping (also with beam trawls, but lighter ones with small mesh nets). Other fisheries frequently practised besides these main two are otter trawling and pair trawling for roundfish (cod and whiting). The average compositions of landings from these various fisheries in 1995 are given in the Annexes table NL-1. For each fishery, the target species are specified separately. By-catches, that are non-target species, have been aggregated into two items: (other) flatfish and other by-catch. A summary of these data is given below.

2000 HP beamers

The large beam trawlers are specialised in beam trawling for plaice and sole, the latter bringing the largest contribution to gross proceeds. As a consequence of individual quota restrictions (ITQs), the importance of by-catches of species not under quota has increased considerably over recent years. Particularly other flatfish, like turbot, brill and dab, contribute substantially to the proceeds of many large cutters. The composition of average landings and proceeds of 2000 HP beamers in 1995 is given in the Annexes table NL-2. Here, by-catches are partly specified in individual species, as far as available from LEI panel data.

The table below gives a summary of landings, proceeds and average prices for both standard vessels.

Landings and Proceeds of Dutch "Standard Vessels"						
1995	**Eurocutter**			**2000 HP beamer**		
Landings		178 306	kg		469 242	kg
	Plaice %	*17.1*		*Plaice %*	*46.6*	
	Sole %	*14.9*		*Sole %*	*26.4*	
	Cod %	*10.8*		*Others %*	*27.1*	
	Shrimp %	*25.9*				
	Others %	*31.3*				
Proceeds		972 577	NLG		2 940 377	NLG
	Plaice %	*10.5*		*Plaice %*	*24.0*	
	Sole %	*37.7*		*Sole %*	*58.3*	
	Cod %	*6.1*		*Others %*	*17.7*	
	Shrimp %	*29.5*				
	Others %	*16.2*				
Prices	*Plaice*	3.35	NLG/kg	*Plaice*	3.22	NLG/kg
	Sole	13.75	"	*Sole*	13.86	"
	Cod	3.09	"			

Spain

The Mediterranean fishery has many target species. As an example, we can show the different ones caught in Barcelona during 1995:

Species	Kg	PTAs	Gears
Garfish	377	28 078	2
Round Sardinella	8 145	244 125	2
Common Eel	21	11 105	2.3
Blackspot	36 683	9 549 095	1.2
Bogue	40 594	1 503 987	2
Bonito	107 048	44 021 468	2
Forkbeard	22 249	12 238 879	1
Small Forkbeards	6 700	1 446 733	1
Meagrim	315	279 843	1
Goby	5 313	1 673 434	1
Small Gobies	80	30 398	1
European Squid	7 272	11 383 903	1.2
Black Spot Sea Bream	28 986	2 975 747	1.2
European Flying Squid	3 332	783 275	1
Sea Snail	268	40 992	3
Purple Dry Murex	396	672 521	1,2,3
Forbe's Squid	1 111	1 629 076	1
Small Locust Lobster	3 972	7 710 412	1
Red Bandfish	4 951	1 214 383	1
Clam	2 655	2 019 632	3
Conger Eel	15 990	2 936 619	1,2,3
Meagre	76	41 435	2.3
Crab	19 239	3 824 518	1
Currucos	3 566	208 556	3
Common Dentex	388	469 921	1,2,3
Several Species	18	3 009	1
Norway Lobster	10 178	38 757 162	1
Sea Cucumber	30	204 560	1
Annular Seabream	13 336	2 025 850	1,2,3
Barracuda	3 325	634 349	1,2,3
Mantis Shrimp	2 577	1 798 756	1.3
Red Shrimp	29 441	130 323 806	1
Small Red Shrimps	11 367	17 589 545	1
Smallspotted Catfish	1 121	337 734	1
Lechas	24 620	16 518 051	2
Big-Toothed Pompano	29 981	5 613 291	1,2,3
Common Spiny Lobster	164	828 465	1.3
Triple-grooved Shrimp	51	288 815	1,2,3
European Lobster	150	522 301	1.3
Common Sole	5 241	11 658 275	1,2,3
Transparent Goby	42	142 440	3
Grey Mullet	151 014	9 355 506	1,2,3
Seabass	5 100	10 467 866	1,2,3
Gurnard	1 148	486 486	1.3
Hake, Lobster	667	1 084 981	1
Hake, Shrimp	1 944	2 972 569	1
European Hake	39 385	51 314 437	1
Small European Hakes	6 684	7 546 272	1
Striped Seabream	11 608	7 714 085	2.3
Small Blue Whiting	52 708	8 444 307	1.2
Blue Whiting	70 185	23 920 304	1
Bullet Tuna	7 688	1 614 094	2.3
Moixina	2 681	976 372	1
Capelan	613	346 551	1
Mullet	42 346	27 154 944	1
Small Mullets	551	407 155	1
Small Fish/Several Species	11 258	1 468 315	1,2,3
Atherine	312	24 078	1
Swimming Crab	330	465 539	3
Negrites	2 954	736 161	2
Gilthead Seabream	6 968	10 299 874	1,2,3
Common Pandora	5 423	6 823 698	1.2
Spotted Flounder	1 737	1 215 330	1.3
Small Spotted Flounders	4 840	1 533 948	1.3
Rock Fish-blue Mouth	108	51 991	1
Swordfish	1 622	1 759 166	1.2
Soup Fish	46 059	18 724 735	1
Brown Venus Shell	13 369	2 629 595	3
Large-scaled Scorpionfish	133	122 490	1,2,3
Octopus	46 823	11 021 244	1.3
Small Octopus	7 233	18 730 416	1
Several Species	69 838	80 046 435	1
Ray	2 816	1 349 314	1.3
Angler Fish	16 500	15 976 664	1
Angler Fish, Forkbeard	23	18 420	1
Turbot	299	612 114	1.3
Striped Venus	25 977	13 463 193	3
Salema	7 470	695 616	1.3
White Seabream	10 832	5 848 768	1,2,3
European Pilchard	3 159 501	253 824 949	2
Scorpion Fish	488	321 401	1.3
European Anchovy	1 282 217	294 074 331	2
Ross' cuttlefish	786	1 044 265	1
Common Cuttlefish	14 352	13 323 429	1,2,3
Horse Mackerel	171 595	18 437 559	2
Coquina Clam	16 369	12 651 615	3
Bluefin Tuna	735	375 877	2.3
Atlantic Mackerel	72 553	5 720 180	1.2
Vigaros	966	518 245	3
Chub Mackerel	258 937	13 980 074	2
Blotched Picarel	10 357	403 761	2

Key: Trawl = 1 Purse Seine = 2 Artisanal Gears = 3

To be able to work with the Mediterranean target species, we have made a selection by their value. That selection has resulted in four groups of species: one per gear and per port.

Barcelona:

The species have been selected from a group of about one hundred, landed in the Barcelona harbour during 1995, according to their value. The selected species for the purse seine and the trawler are:

Chosen Species for Purse Seine		
Species	**% kg**	**% PTS**
European Anchovy	23.40	41.26
European Pilchard	57.68	35.61
Bonito	1.95	6.18
Horse Mackerel	3.13	2.59
Lechas	0.45	2.32
Other Species	13.40	12.05

Chosen Species for Trawl		
Species	**% kg**	**% PTS**
Red Shrimp	4.12	22.67
Several Species	9.78	13.92
European Hake	5.51	8.93
Norway Lobster	1.43	6.74
Mullet	5.93	4.72
Blue Whiting	9.83	4.16
Small Octopus	1.01	3.26
Soup Fish	6.45	3.26
Angler Fish	2.31	2.78
Other Species	52.03	26.51

Castelló:

A selection of the most important species by value is the following:

Chosen Species for Purse Seine and Pelagic		
Species	**% kg**	**% PTS**
European Anchovy	23.34	48.88
European Pilchard	72.66	47.12
Horse Mackerel	0.22	0.20
Mackerel	0.49	0.79
Round Sardinella	2.92	0.90
Other Species	0.37	2.12

Chosen Species for Demersal Trawl		
Species	**% kg**	**% PTS**
Mullet	18.40	11.05
European Hake	14.65	8.61
Octopus	9.66	17.46
European Squid	7.50	2.79
Morralla[4]	6.71	16.61
Common Cuttlefish	6.52	4.61
Soup Fish[5]	6.41	7.79
Angler Fish	4.14	4.35
Mantis Shrimp	4.12	3.74
Other Species	21.88	22.99

Because of the legal framework, the pelagic resources are caught basically by purse seiners, and a little part by artisanal fleets. But in some cases, trawlers are active on

[4]This cathegory is considered as a different one not for biological reasons but for economical ones. The crew wages include, traditionally, a payment in kind, so-called: Morralla. This Morralla is not only composed by non-commercial species or only by one or two concrete species, but it changes day by day and it is not registered by the Lonjas.

[5] This cathegory includes more than one biological spcies but they can be settled by its economical purpose: they are sold as very tasty litle fish, very appreciated for making soups, and they has a commom price per kg.

the pelagic resources. A part of the Castelló trawler fleet is specialised in the pelagic resources: sardine and anchovy.

The data on catches in the report only deal with the landing data. By-catches are not registered.

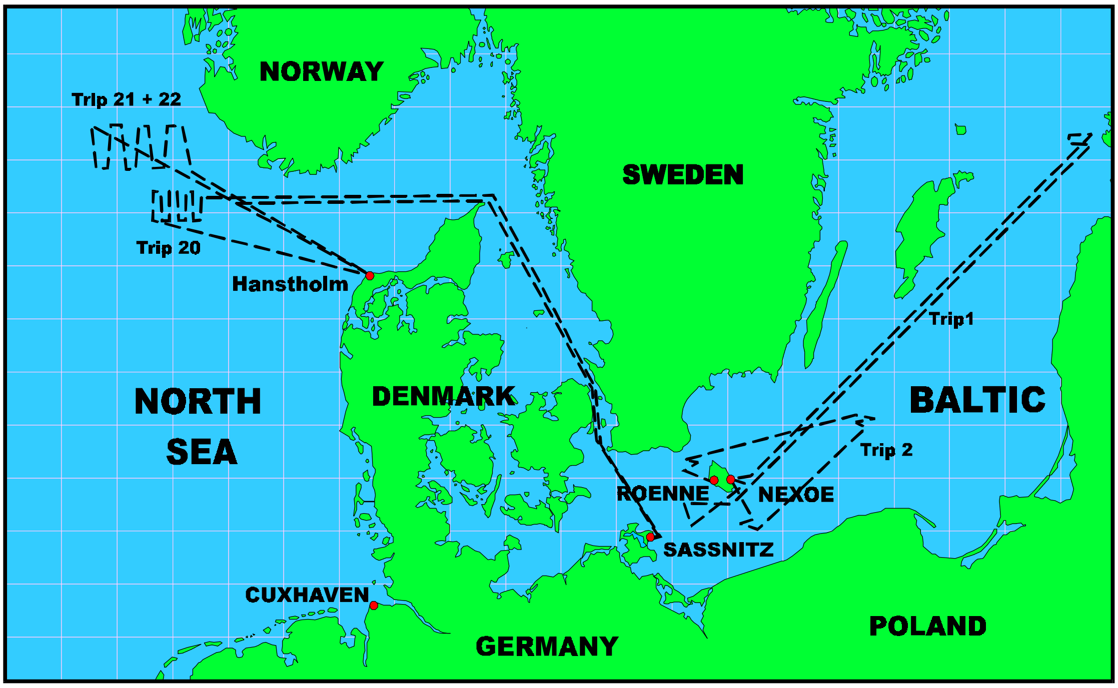
5.4.2 Fishing areas

Germany

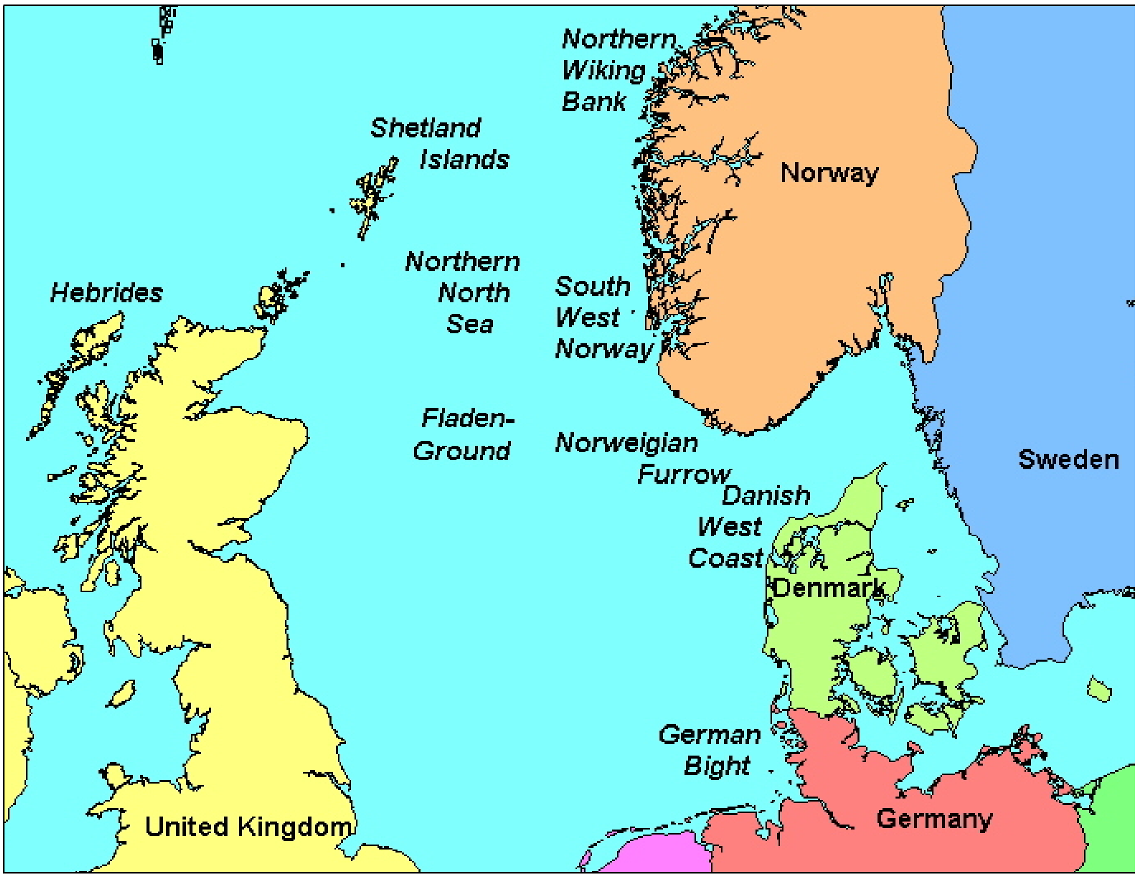
The areas in which the sampled vessels fished are accurately recorded in the logbooks in detail. There is very detailed information of the relevant fishing areas identified by so-called statistical rectangles.

According to these records, the sample of Baltic cutters – situated in Sassnitz/Ruegen - concentrate their activities on the fishing grounds of the Baltic whereas the bigger North Sea vessels – located in Cuxhaven – are predominantly fishing in the North Sea.

For model purpose the numerous rectangles had to be combined resulting in various fishing areas in the Baltic and North Sea. Thereby, some smaller fishing areas are determined in the Baltic for the vessels of Sassnitz whereas e.g. for the North Sea cutters only one fishing ground is designed around the Danish isle of Bornholm.



Definition of Fishing Grounds by ICES[1)] Rectangles Baltic cutters	
Fishing area	**ICES rectangles**
Baltic	
Arcona Sea	37G4, 38G3
Western Baltic	38G2, 39G3
Bornholm West	38G4, 39G4
Bornholm East	38G5, 39G5, 39G6, 40G5, 40G6
Eastern Baltic	40G8, 40G9, 40H0, 41G8, 41G9, 42G8, 43H0, 45H0
North Sea	
Danish West Coast	42F6, 42F7
1) International Council for Exploration of the Sea.	



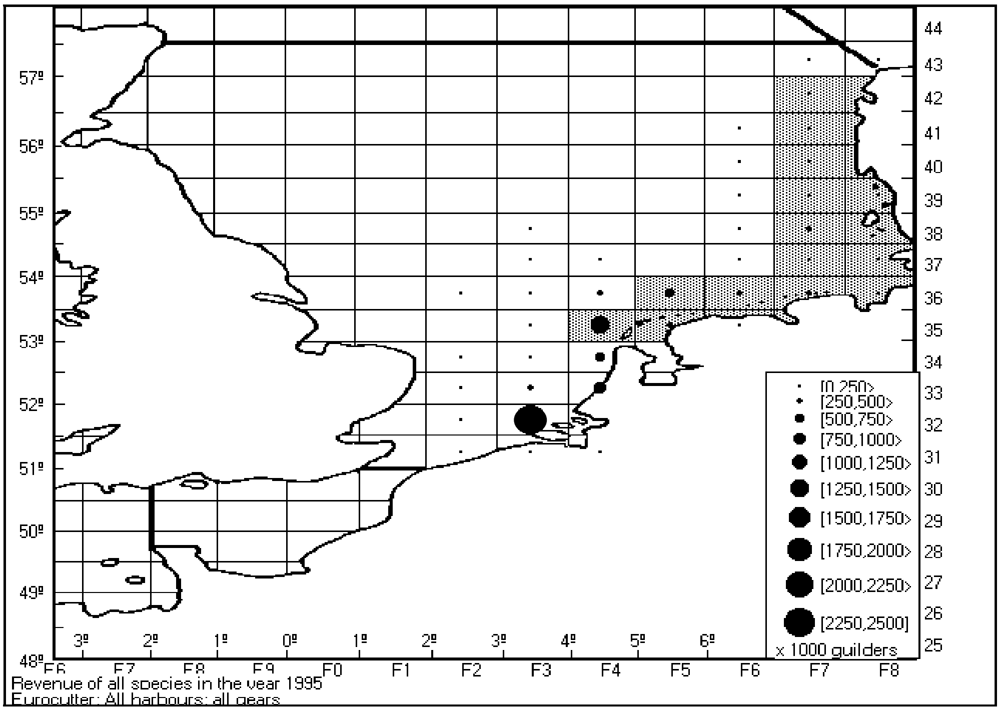
Definition of Fishing Grounds by ICES Rectangles North Sea cutters	
Fishing area	**ICES rectangles**
North Sea	
German Bight	36F6, 37F6, 37F7, 37F8, 39F4, 39F6, 39F7
Danish West Coast	41F5, 41F6, 41F7, 42F5, 42F6, 42F7, 43F6, 43F7, 43F8, 44F7, 44F8, 44F9
Northern North Sea/ Fladenground	43F1, 43F2, 44F1, 45F0, 45F1, 45F2, 46F1, 46F2, 47F0, 47F1, 47F2, 48F1, 48F2, 49F2
South West Norway/ Norwegian Furrow	44F3, 44F4, 44F5, 44F6, 45F3, 45F5, 45F6, 46F3, 46F4, 47F3, 48F3, 49F3, 50F3
Hebrides	44E6, 46E2, 46E3, 47E2, 47E3, 47E4
Shetlands Islands	49E6, 49F0, 49F1, 50E8, 50E9, 50F0, 50F1, 50F2, 51E7, 51E8, 51E9, 51F0, 51F1, 51F2, 52E8, 52E9, 52F0, 52F1, 52F2
Northern Wiking Bank	53F0, 53F1, 53F3, 53F4, 54F0, 54F2, 54F3, 54F4
Baltic	37G3, 38G5, 39G4, 39G5, 39G6, 40G4, 40G5, 40G6, 40G9, 41G8

The Netherlands

Eurocutters

The 12-mile zone along the Belgian, Dutch, German and Danish coasts comprises the main fishing grounds of the Eurocutters for all types of fisheries. In addition to that, their power and seaworthiness enable these boats to operate further offshore as well. This potential is used in particular for the roundfish fisheries and to a lesser extent for beam trawling for flatfish. An impression of the general distribution of the Eurocutter fishing activities as derived from logbook data is given in the following figure. The size of the dots indicates the relative contribution of the various ICES rectangles to the gross proceeds.

Shrimping is restricted to the 12-mile zone, with a special fishing ground near the German island Sylt.

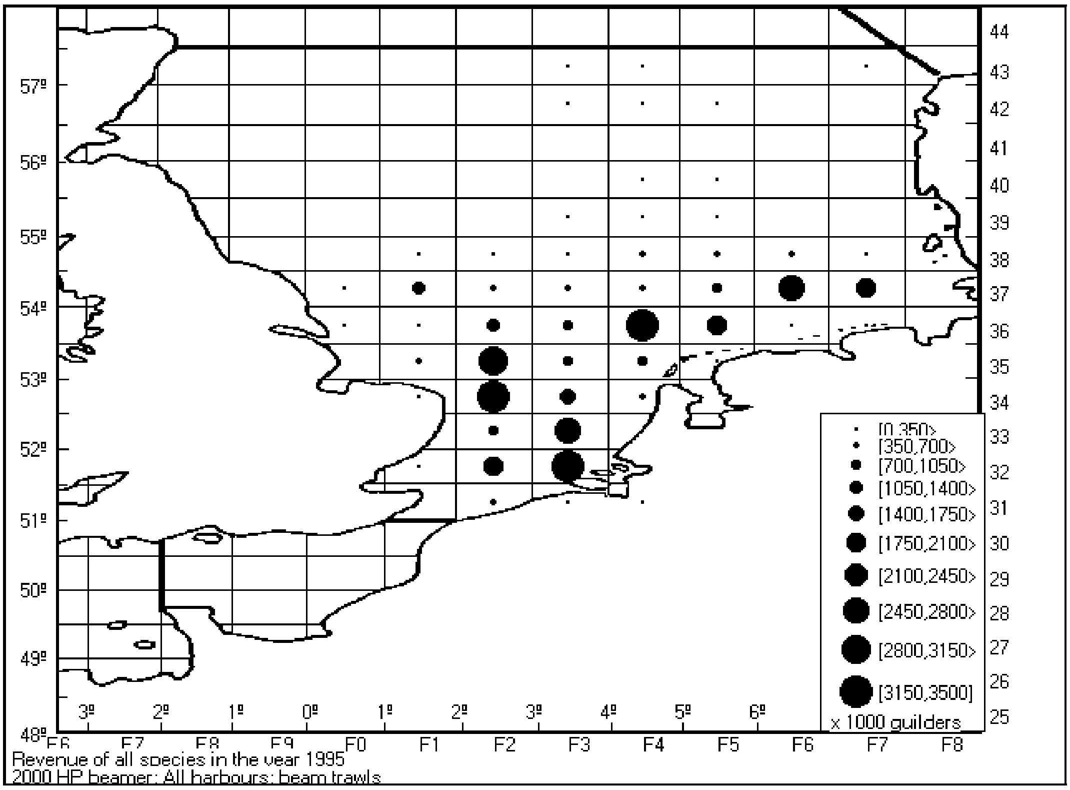


Fishing grounds of the Eurocutters

2000 HP beamers

The fishing grounds of the Dutch large beam trawlers are roughly spread throughout the south-eastern North Sea, ranging from the Belgian coast to Flamborough Head in the West and the Holman Ground in the Northeast. Concentration areas are the Leman Grounds, North of Texel and the Borkum Reef for the northern boats and West of Zeeland and South Holland for the southern ones. Additional grounds for fishing for plaice are found around the southern border of the Norwegian Exclusive Economic Zone (see below).

Generally plaice and sole are caught together, in varying ratios, but north of 55° N sole is very scarce if not absent. This is taken into account in the mesh size rules: basically the minimum mesh size for trawling in the North Sea is 10 cm, but using 8 cm meshes is allowed south of 55° N if the catch composition has more than 5% sole (and less than 10% cod). In practice, skippers can switch fishing grounds and change the catch composition in order to bring it in line with their production planning, based on the available ITQs of plaice and sole.



Fishing grounds of the 2000 HP beamers

General

For the purpose of the model, a set of fishing grounds or areas has been defined as combinations of ICES rectangles. Although the set better fits the large beamers, it is used for the Eurocutters as well. The names of the various grounds and the ICES rectangles they include, are given in the following table. (The rectangles can be found in the figures above.)

Definition of Fishing Grounds by ICES Rectangles Dutch Eurocutters and 2000 HP beamers	
Fishing area	**ICES rectangles**
Northern North Sea	42F3, 42F4, 42F5, 42F6, 43F3, 43F4, 43F5, 43F6, 43F7
Danish coast	39F6, 39F7, 39F8, 40F6, 40F7, 41F6, 41F7, 42F7, 43F8
Mid North Sea	37F2, 37F3, 38F2, 38F3, 38F4, 38F5, 39F2, 39F3, 39F4, 39F5, 40F3, 40F4, 40F5
German Bight	36F7, 36F8, 37F6, 37F7, 37F8, 38F6, 38F7, 38F8
Offshore England	31F1, 32F1, 33F1, 33F2, 34F1, 34F2, 35F0, 35F1, 35F2, 36F0, 36F1, 36F2, 37F0, 37F1, 38F0, 38F1
Friesian grounds	35F5, 35F6, 36F5, 36F6, 37F4, 37F5
North coast	34F3, 34F4, 35F3, 35F4, 36F3, 36F4
South coast	31F2, 31F3, 32F2, 32F3, 32F4, 33F3, 33F4

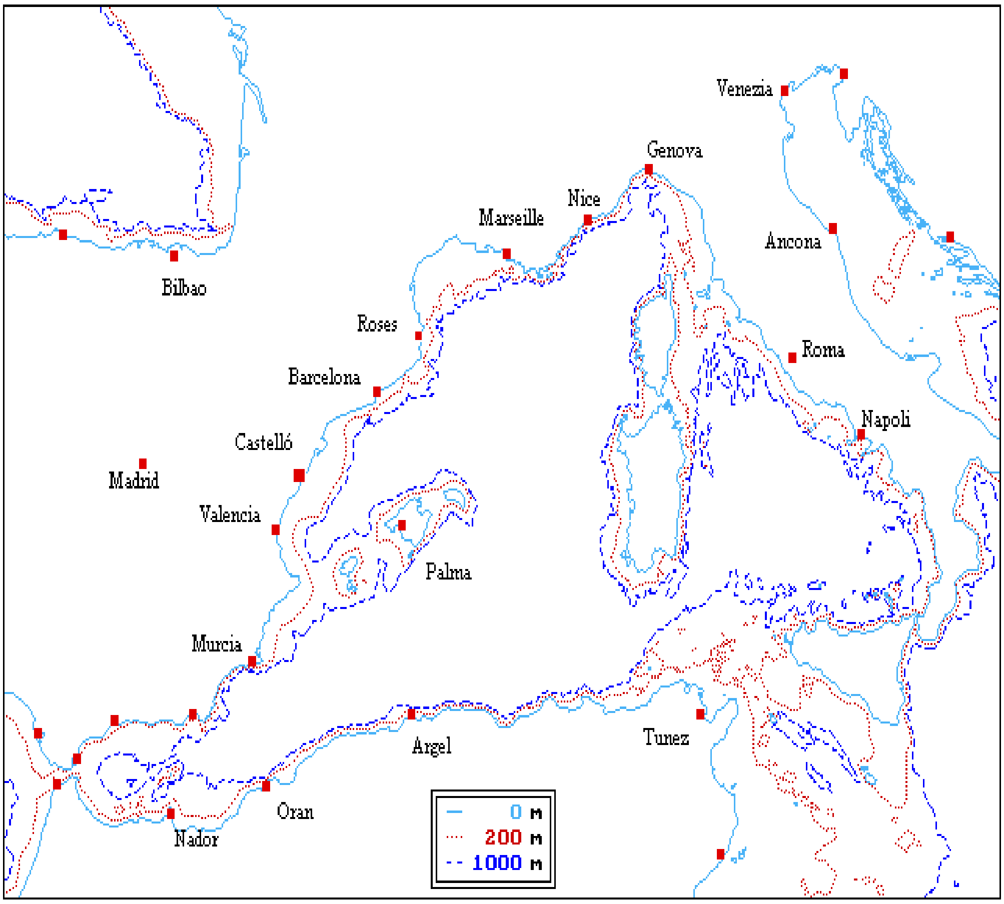
Spain

In the Mediterranean area, for the gears studied, we cannot distinguish several fishing ground as in the other cases. The vessels go fishing near to their harbours, from 3 to 30 miles. The fishing area of each harbour is limited by

- activities from other harbours and
- the continental platform.

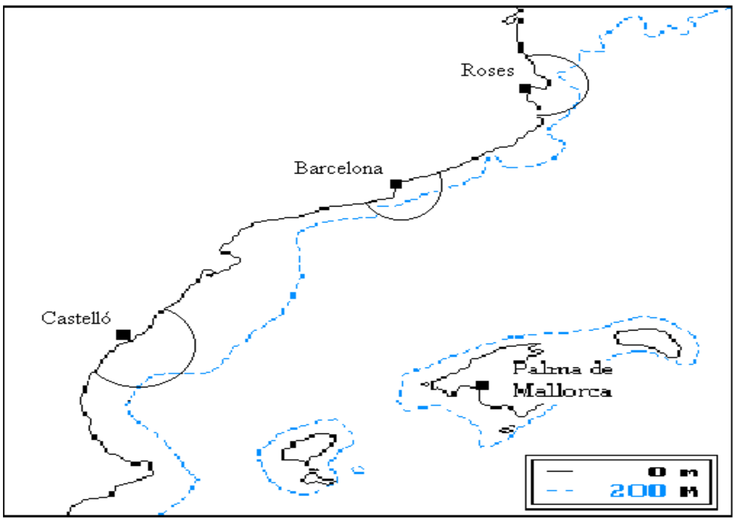
As an exception, in some months (May to October) the Barcelona purse seiners go fishing to the Gulf of Lion, but the rest of the year they never go far from their homeport.

In the following figure it is possible to have a global view to the Spanish Mediterranean area and a part of the West Mediterranean, with the most important harbours in North Africa, the French Riviera and Italy.



Main ports and continental platforms of the Mediterranean Sea

The next figure, shows the studied ports and the fishing areas, within the continental platform. No fishing activity is registered outside these limits, but in exceptional cases.

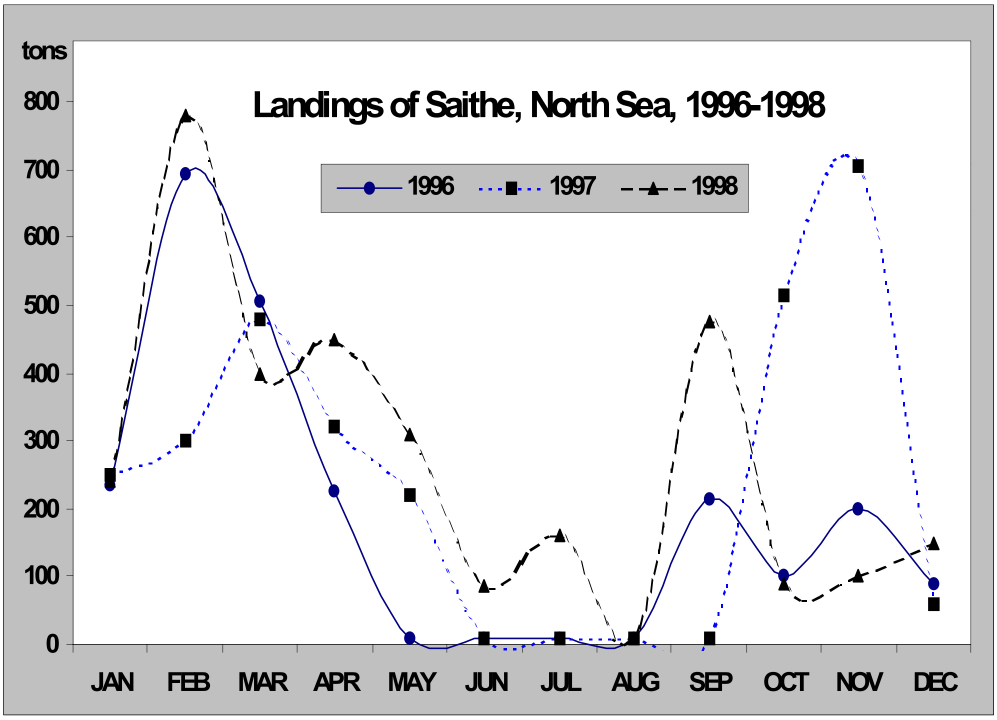


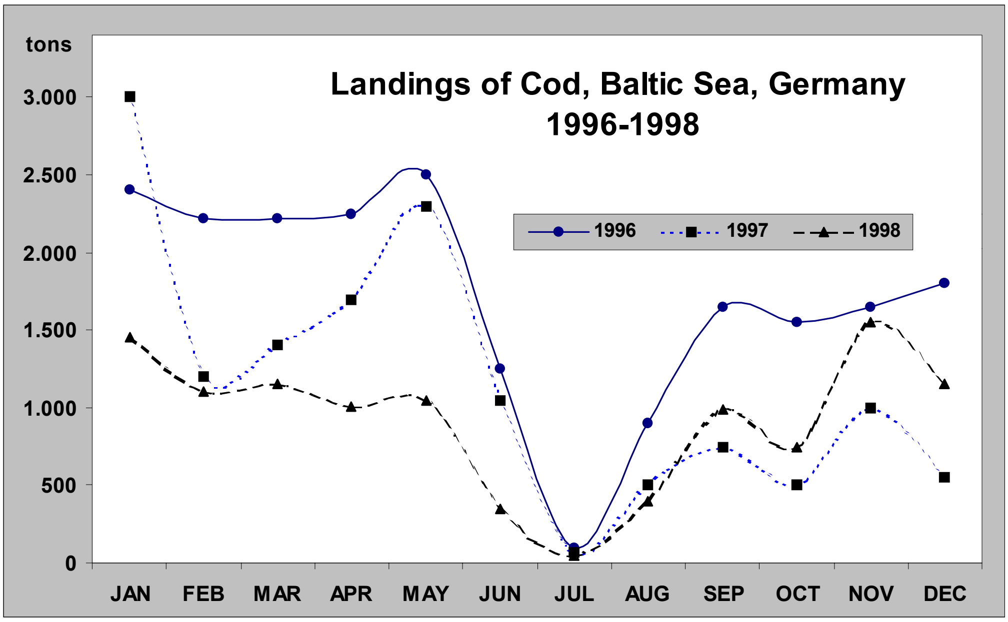
Selected ports with fishing areas

5.4.3 Catch rates and fishing seasons

Within the logbooks all catches are recorded in detail by quantities, species, time and fishing ground. Long-term observations on fish stocks concerning catch rates are not available, but stock levels can be expected to vary with the area fished but also with the year and the month. According to the catch possibilities within the year, the fishing activities in the different areas vary considerably. Corresponding to the existing fish stocks on the fishing grounds under consideration, the fishing activities of the cutters in our samples show a seasonal change of fishing areas, i.e. during the course of the year, and sometimes also from trip to trip.

The following tables demonstrate the development of monthly landings of Baltic cod and saithe of the German fishing fleet corresponding with the catch possibilities.





Source: Bundesamt für Landwirtschaft und Ernährung (BLE). Hamburg

For realistic solutions it is not possible to disregard this fact. In this context, it was evident that realistic assessments of alternatives need short-term data instead of annual figures, in order to demonstrate the varying seasonal stock abundance on the different fishing grounds and fluctuating prices. Monthly data could remedy this problem to a great extent, as these figures could show sufficiently the varying stock abundance of different species on the corresponding fishing areas.

Therefore, it was necessary to collect monthly data instead of annual figures in order to be able to include the seasonality of catches on the different fishing grounds. While in general the German and Dutch participants dispose of such information in their data records, the Spanish project partner had to invest additional work for collecting such monthly figures.

Furthermore, it is important to make reference to the fact that the catch data are sample averages based on average stock conditions in the relevant month, sometimes only representing averages of a small number of observations. Therefore, in some cases these calculated average catch data might be extreme figures not well demonstrating the realistic catch possibilities on the different fishing grounds.

For simulation purposes of alternatives, up-to-date estimations of (monthly) catch rates on the most important fishing grounds and additional information (data) from long-term (multi-annual) catch records as well as from biological research are urgently required. For the development of bio-economic models, this is an important field of future research work.

Germany

The catch rates presented in the following tables are averages and have been derived from the logbooks of the investigated vessels.

Baltic cutters:	Catch Rates by Months and Fishing Grounds kg/hour[1)]											
(Baltic) Cod	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Baltic												
Arcona Sea	86	116	-	134	125	1	6	65	86	77	63	68
Western Baltic	-	-	88	-	-	-	-	-	-	46	34	57
Bornholm West	80	234	120	53	81	94	-	104	83	68	62	72
Bornholm East	51	164	116	104	165	117	5	31	56	69	-	-
Eastern Baltic	87	249	117	93	256	-	-	133	242	-	18	-
North Sea [2)]												
Danish West Coast	208	93	199	-	455	-	-	-	-	-	58	-

[1)] Effort time.- [2)] Cod.

As was to be expected the highest catch rates for the target specie cod are from February to May around the isle of Bornholm. Furthermore good catch rates of cod had been observed in the Eastern Baltic but depend on access and additional quotas within the waters of the Baltic states.

Baltic cutters:	Catch Rates by Months and Fishing Grounds kg/hour[1)]											
Flounder	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Baltic												
Arcona Sea	97	11	-	-	-	3	18	14	46	21	28	32
Western Baltic											5	10
Bornholm West	148	73	51	26	-	17		17	15	34	49	99
Bornholm East	57	127	128	7	-	2	25	1	14	61	-	-
Eastern Baltic	4	12	108	38	-	-	-	-	-	-	-	-
North Sea												
Danish West Coast	97	-	-	-	-	-	-	-	-	-	-	-

[1)] Effort time.

The catch rates of flounder are also reported as a basis for simulating additionally catch opportunities for the Baltic cutters. The recorded catch rates of flounder are averages in the year 1996; but it is safe to assume that the catch rates will be higher when the fleet is partially directed to flounder instead of cod.

North Sea cutters:	Catch Rates by Months and Fishing Grounds kg/hour[1)]											
Saithe	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
North Sea												
German Bight/ Danish West Coast	343	343	-	393	826	-	133	-	235	126	126	272
Northern North Sea/ Fladenground	893	893	30	20	87	184	225	454	111	180	152	771
South West Norway/ Norwegian Furrow/ Fisher Bank	80	80	257	84	68	33	184	154	76	107	130	244
Hebrides/ Shetland Islands	215	215	172	90	148	152	51	110	698	200	125	261
Northern Wiking Bank	-	-	165	191	112	-	-	421	483	705	260	360

[1)] Effort time.

The highest catch rates of saithe – the target specie of the North Sea cutters – had been recorded from December to February (and May) in the Northern North Sea/ Fladenground and in autumn (September/October) on the fishing grounds of the Hebrides and the Shetlands and the Northern Wiking Bank.

North Sea cutters: Catch Rates by Months and Fishing Grounds kg/hour[1)]												
Cod	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
North Sea												
German Bight/ Danish West Coast	166	201	271	1015	597	-	24	15	74	67	667	65
Northern North Sea/ Fladenground	173	13	13	6	84	58	13	89	73	79	232	9
South West Norway/ Norwegian Furrow/ Fisher Bank	26	28	145	22	47	5	9	43	23	33	16	11
Hebrides/ Shetland Islands	32	206	48	11	14	23	26	27	87	46	40	11
Northern Wiking Bank	-	-	2	4	11	-	-	-	-	16	-	-
Baltic [2)]	99	414	144	169	158	205	-	-	-	-	-	-

[1)] Effort time.- [2)] Baltic cod.

North Sea cutters: Catch Rates by Months and Fishing Grounds kg/hour[1)]												
Haddock	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
North Sea												
German Bight/ Danish West Coast	10	10	4	111	143	-	15	8	42	115	3	9
Northern North Sea/ Fladenground	5	5	12	455	260	267	12	77	63	132	130	17
South West Norway/ Norwegian Furrow/ Fisher Bank	10	10	165	70	34	11	4	36	47	74	30	7
Hebrides/ Shetland Islands	52	52	42	5	13	27	15	11	122	82	26	5
Northern Wiking Bank	-	-	-	-	-	-	-	-	-	-	-	-

[1)] Effort time.

Cod as well as haddock are important species for the North Sea cutters investigated in this study but not the target species.

The Netherlands

The shrimp fishery has a distinctly seasonal character, with low catches from January to August and high catches during the fall. Only in the Sylt area, shrimping can be attractive in the early part of the year.

The other fisheries of the Eurocutters have a seasonal character as well, but this is far less pronounced than that of shrimps. A typical succession of fisheries during the year could be: fishing for roundfish during the first quarter; then beam trawling for flatfish during the next five months; and shrimping during the last four months. But evidently, the choice and duration of fisheries will highly depend on the fishing opportunities that occur or are expected in a particular year. Although the boats are very versatile, switching from one fishery to another generally takes some time for changing gear and deck equipment. Only switching from shrimping to otter trawling and vice versa is frequently practised within a trip.

Sole and plaice, the target species for the large beamers, have a more or less marked seasonal fluctuation of catches. Plaice catches are relatively high in the first two or three months of the year, when the fish is concentrated in spawning areas. This is the time of high landings of large spent plaice, fetching low prices, not only as a result of the big supply, but also because of the poor quality of these fish. The high catch rates, however, generally compensate for this. Attempts by POs, supported by the processors, to reduce fishing during this season have been in vain in most years. After the spawning season, the fishery is spread rather evenly over the year.

Sole also has a spawning run, starting late March and ending early May (depending on weather conditions and water temperatures), moving from Southwest to Northeast. The intensity of this season depends on the size of the stock and may vary regionally from year to year. A second season occurs in late summer and early fall, in years when a strong year-class enters the fishery. This yields small sized fish, fetching low prices, while at the same time the larger varieties may maintain a high price (if sufficiently scarce).

Fisherman can and do take these seasonal variations into account in their production planning.

Average catch rates on the various fishing grounds have been derived from logbook data of the vessel types concerned in 1995. For a good reliability, not only the data of the vessels selected from the LEI-panel as a basis for the standard vessels were used, but also those of all similar boats in the Dutch fleet. The Windows application for DAFIST proved to be a very good tool for this.

In the Dutch logbook database VIRIS, the fishing time is only rarely and then most of the time inaccurately registered. To arrive at useful data for the model, estimates of steaming times from port to fishing ground and v.v. have been made and these were subtracted from trip duration . The resulting times spent on the grounds were used to estimate catch rates in kg/hr of the target species per fishing ground per month. In the end, data resulting from very low numbers of observations / trips were skipped.

A special data set was developed for the Eurocutters in order to obtain useful data on shrimp fishing. In the DAFIST data base, shrimp trawling and beam trawling for flatfish are both coded as TBB. Although this may be technically justified, it gives rise to grave misunderstandings, e.g. in relation to the fishing effort in the 12-mile zone and in the 'plaice box'. The 1995 DAFIST Eurocutter data were transformed by taking multiple records of a trip to the same rectangle together and re-coding the fishing gear if shrimp had been caught on that trip.

Until recently, by-catches were not well specified in the logbooks of the Dutch fishing fleet. Therefore catch rates have been derived from the average landings of the boats representing the standard vessels in the LEI-panel, using the total estimated fishing time of the standard vessel per type of fishing. For the Eurocutter, this resulted in constant catch rates over time and grounds of flatfish by-catches and of 'other fish' for each type of fishery, as follows:

Catch Rates of By-catches Eurocutter (kg/hour)			
	Beam trawl	Shrimp trawl	Pair trawl
Flatfish by-catch	6.0	1.5	2.0
Other fish	15.4	7.7	6.5

For the 2000 HP beamer, extra effort was put into deriving variations of by-catches over time. In addition, variations of by-catch rates of other flatfish by fishing ground were roughly estimated on the basis of by-catch levels and fishing patterns of the individual boats in the standard vessel group. These by-catch rates are included in the following tables, giving for both standard vessel types a survey of the catch rates of the target species for each type of fishery by month and by fishing ground. (As otter trawling by Eurocutters has been left out of consideration in the testing of the model, no data of this fishery are included here.)

Eurocutters:	Catch Rates by Months and Fishing Grounds kg/hour											
Beamtrawl	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Plaice												
Danish Coast	-	-	-	-	85	94	90	80	226	-	-	-
Mid North Sea	-	-	-	-	-	-	7	-	4	4	-	-
German Bight	59	38	26	-	47	9	9	10	72	84	80	49
Offshore England	-	26	-	-	9	6	3	-	-	-	-	-
Friesian Grounds	13	25	5	8	13	15	11	8	21	44	28	14
North Coast	11	13	5	5	8	9	11	9	11	24	23	19
South Coast	32	15	8	8	9	5	6	6	16	32	23	18
Sole												
Danish Coast	-	-	-	6	11	3	2	2	2	-	-	-
Mid North Sea	-	-	-	-	-	-	0	-	1	1	-	-
German Bight	2	1	0		31	24	13	9	6	2	0	1
Offshore England	-	10	-	-	24	17	12	-	-	-	-	-
Friesian Grounds	15	7	19	29	25	14	12	15	14	13	13	10
North Coast	9	11	15	19	14	10	8	8	8	10	8	9
South Coast	11	13	24	22	20	13	12	13	14	12	10	8
Shrimp trawl	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Shrimp												
Danish Coast	39	34	31	41	41	38	26	22	-	-	-	-
German Bight	28	21	29	33	37	31	20	35	40	-	117	-
Friesian Grounds	29	21	22	15	74	20	23	44	70	120	102	56
North Coast	34	18	15	19	24	28	23	37	80	125	59	35
South Coast	20	17	20	15	52	30	21	49	96	133	58	36
Pair trawl	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cod												
Danish Coast	-	-	-	-	-	488	233	-	-	-	-	-
Mid North Sea	-	-	-	-	-	97	-	-	-	123	-	-
German Bight	-	-	-	75	249	246	653	-	-	-	-	-
Offshore England	-	-	-	-	-	79	81	172	86	-	-	-
North Coast	69	96	90	-	-	45	55	112	50	67	81	66
South Coast	37	14	-	-	-	-	-	166	118	-	81	104
Whiting												
Danish Coast	-	-	-	-	-	1	1	-	-	-	-	-
Mid North Sea	-	-	-	-	-	7	-	-	-	4	-	-
German Bight	-	-	-	1	1	1	1	-	-	-	-	-
Offshore England	-	-	-	-	-	5	7	6	5	-	-	-
North Coast	3	1	-	-	-	15	4	2	2	23	28	8
South Coast	16	11	-	-	-	-	-	-	-	-	30	20

2000 HP Beamer:	Catch Rates by Months and Fishing Grounds kg/hour											
Beam trawl	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Plaice												
Northern North Sea	112	125	135	109	98	101	128	130	250	163	145	161
Danish Coast	207	207	143	116	153	148	116	151	137	135	108	110
Mid North Sea	141	146	83	82	108	97	70	51	82	74	64	75
German Bight	151	135	66	33	19	26	32	42	56	90	81	75
Offshore England	101	107	59	55	57	32	33	37	37	45	55	59
Friesian Grounds	124	131	83	47	20	20	28	31	56	77	85	62
North Coast	77	87	43	34	29	29	23	27	40	51	52	62
South Coast	117	86	34	31	30	31	27	34	45	56	58	73
Sole												
Northern North Sea	5	3	1	0	0	1	2	0	3	0	1	6
Danish Coast	16	23	33	27	2	2	16	26	14	21	33	42
Mid North Sea	31	29	24	12	2	2	26	28	27	26	28	30
German Bight	33	24	29	35	38	31	30	37	45	47	34	38
Offshore England	30	34	29	30	21	26	25	29	39	41	38	34
Friesian Grounds	34	26	22	24	37	30	28	38	43	39	35	39
North Coast	30	26	26	25	21	20	23	29	30	38	31	37
South Coast	25	28	32	31	26	20	23	23	30	39	36	32
Flatfish by-catch												
Northern North Sea	11	15	16	23	17	15	15	17	16	17	15	13
Danish Coast	9	11	11	15	10	10	11	13	12	13	12	10
Mid North Sea	11	14	13	16	11	11	13	15	17	23	18	13
German Bight	9	11	11	15	10	10	11	13	12	13	12	10
Offshore England	14	18	19	23	16	16	20	23	25	30	25	19
Friesian Grounds	11	14	13	16	11	11	13	15	17	20	18	13
North Coast	11	14	13	16	11	11	13	15	17	20	18	13
South Coast	9	11	11	13	9	9	10	12	12	13	12	10
Other by-catch												
All grounds	22	25	13	11	19	17	12	11	15	22	17	12

Spain

The catch rates have been calculated for those months in which there is fishing activity. In the following table the fishing seasons in the different areas are presented:

Active Months for the Studied Segments												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Barcelona												
Trawler	■	■	■	■	■	■	■	■	■	■	■	■
Purse Seine	■	■	■	■	■	■	■	■	■	■	■	■
Roses												
Purse Seine I					■	■	■	■	■			
Purse Seine II					■	■	■	■	■	■		
Castelló												
Trawler	■	■	■	■	■			■	■	■	■	
Purse Seine	★	■	■	■	■	■	■	■	■	■	■	★
Pelagic Trawler	★	■	■	■	■	■	■	■	■	■	■	★

■ Active Month

★ Closed Season

The way we have calculated the catch rates is as follows:

- First of all, we have established the catches per day and species, by dividing the total monthly catches of one species by the number of days with fishing activity. With that we have obtained the catchability per day and species for each month.
- After that, we have divided this by the hours of fishing per day.

In the table we can see an example of the calculation of the shrimp catchability in June, in the Barcelona Trawl III segment:

Data:
16.41 kg of shrimp in June
17 fishing days in June
8 hours a day in June
Catchability of shrimp in June: 0.12 kg/h

Calculations:

Shrimp catches per day in June = Total shrimp catches in June – Days of fishing in June

Shrimp catches per day in June = 16.41 kg/17 days = 0.96 kg/day

Shrimp catchability in June (kg/h) = shrimp catches per day in June / hours of fishing in a day

Shrimp catchability in June = 0.96 kg/day / 8 hours a fishing day = 0.12 kg/h

With this kind of calculations we have obtained one catchability rates table for each segment and harbour studied. Below we present two of these tables. The other ones, for all the considered segments and harbours are in the Annex of this study, tables from **ESP-2** to **ESP-12**.

Barcelona

Catch Rates by Months kg/hour										
BCN TR1	*Shrimp*	*Several Species*	*European Hake*	*Norway Lobster*	*Mullet*	*Small Blue Whiting*	*Small Octopus*	*Soup Fish*	*Angler Fish*	*Others*
Jan	0.0	1.8	0.1	0.0	2.9	0.0	0.0	0.0	0.2	9.5
Feb	0.0	1.5	0.0	0.1	0.7	0.2	0.0	1.7	0.4	8.5
Mar	0.2	1.4	0.1	0.2	1.0	1.3	0.2	1.4	0.5	9.1
Apr	0.0	1.2	0.1	0.3	0.4	0.7	0.7	0.9	0.5	5.3
May	0.0	1.2	0.0	0.0	5.4	0.0	1.6	1.2	0.3	6.4
Jun	0.0	1.3	0.1	0.0	0.8	0.1	2.0	1.4	0.5	6.6
Jul	0.0	1.2	0.1	0.1	0.4	0.3	2.0	0.8	0.6	6.8
Aug	0.0	1.7	0.1	0.0	1.2	0.0	1.4	1.2	0.2	6.2
Sep	0.0	1.2	0.4	0.0	1.0	0.0	1.0	1.1	1.3	9.5
Oct	0.1	1.3	0.1	0.1	2.9	0.0	0.3	1.2	3.5	11.1
Nov	0.0	1.2	0.0	0.0	3.4	0.0	0.0	1.0	0.1	9.5
Dec	0.0	1.4	0.2	0.0	2.8	0.0	0.1	2.1	0.7	10.2

Catch Rates by Months kg/hour						
BCN PS1	*European Anchovy*	*European Pilchard*	*Atlantic Bonito*	*Atlantic Horse Mackerel*	*Round Sardinella*	*Other species*
Jan	3.5	199.8	28.1	2.8	18.0	48.9
Feb	8.9	70.2	15.2	11.7	6.0	45.2
Mar	5.3	226.1	11.0	4.1	1.4	31.7
Apr	39.8	183.0	5.0	11.1	0.3	19.4
May	89.1	120.3	8.2	8.1	0.1	7.9
Jun	140.1	130.7	0.2	11.0	0.0	21.4
Jul	14.7	59.6	1.3	14.3	0.4	43.1
Aug	84.7	25.1	0.4	6.5	1.1	23.7
Sep	62.8	33.0	3.2	4.9	0.8	34.0
Oct	51.2	4.4	12.2	5.0	1.5	57.3
Nov	49.9	26.7	11.4	3.4	4.6	27.1
Dec	21.1	98.3	3.7	4.8	1.5	24.7

5.4.4 Home ports, landing ports and distances to the fishing grounds

Germany

Apart from their home ports Sassnitz/Ruegen and Cuxhaven, all sampled vessels are landing their catches in different harbours, mainly near to the fishing grounds in order to save steaming time.

While the Baltic cutters prefer – besides Sassnitz – Nexoe and Roenne, situated at the Danish isle of Bornholm, the North Sea vessels land the great majority of their catches in Hanstholm (West coast of Denmark) and in harbours of the Faeroe Island (mainly Runavik). Due to the remote fishing grounds, only a small part of the catches is landed in the home port of Cuxhaven.

The following table shows the distances (hours steaming time) from the various ports to the designed fishing areas. In general, the cutters use the harbours near to the fishing grounds so that some figures stated in the table are theoretical and only for the sake of completeness.

Baltic cutters:	One Way Average Steaming Time from Port to Fishing Ground hours					
Fishing area / *Port*	Arcona Sea	Western Baltic	Bornholm West	Bornholm East	Eastern Baltic	Danish West Coast
Sassnitz	6	8	10	18	36	54
Nexoe/Roenne	13	14	9	8	24	49
Hanstholm	42	41	41	49	66	7

North Sea cutters:	One Way Average Steaming Time from Port to Fishing Ground hours						
Fishing area / *Port*	German Bight	Danish West Coast	Northern North Sea / Fladenground	Hebrides	SW Norway / Norwegian Furrow	Shetland Islands	Northern Wiking Bank
Cuxhaven	89	89	118	160	101	160	219
Hanstholm	17	17	84	118	51	118	168
Runavik	168	185	101	59	135	59	34

The Netherlands

The Dutch fishing fleet generally lands its catches in one of the many ports along the Dutch coast, most of the time their homeport. Only occasionally fish is landed in foreign ports and in such cases, as a rule the fish is put on a lorry for transport to be sold in a Dutch auction, again most of the time in the homeport.

The shrimp fishery, however, shows regular exceptions to this general pattern. Here the fleet often lands the catch in the port closest to the fishing grounds at the time, with a view on the highly perishable nature of the product. A special case is the seasonal shrimp fishery near Sylt in the German Bight, when most of the catches are landed in Havneby on the Danish isle of Rømø to be sold directly to Dutch traders having an establishment there for the purpose.

In view of this situation, for the model it is assumed that IJmuiden, one of the major fishing ports and auctions in the middle of the Holland coast, is the homeport for both standard vessels, where all catches are landed. Only for shrimping the exception is made that fishing can take place from Havneby and that catches can be landed there.

The average steaming times from port to the various fishing grounds defined above are given in the following table. For Havneby only the nearby German Bight and Danish Coast are considered to be relevant. The Eurocutters are supposed to have an average steaming speed of 9.5 knots, the 2000HP beamers are supposed to steam at 12.5 knots.

One Way Average Steaming Time from Port to Fishing ground
hours

	Northern North Sea	Danish Coast	Mid North Sea	German Bight	Offshore England	Friesian Grounds	North Coast	South Coast
Eurocutter								
IJM(uiden)	29	25	17	16	12	10	6	6
HAV(neby)	-	8	-	8	-	-	-	-
2000 HP beamer								
IJM(uiden)	22	19	13	12	9	8	5	5

Spain

In the Spanish Mediterranean area there are 87 harbours. We have selected two of them because of the their relevance. We have chosen to study three segments in those ports according to their weight in the fishing activity: trawl, purse seine and pelagic trawl. The fishing area for all of them is within the continental platform, 3 to 30 miles far from landing ports, where most of the fishing grounds are located.

Home ports and landing ports most of the times match. There is an important and double incentive to this:

- Tradition and
- economy

The Mediterranean Spanish area still works as a quite traditional world. It can be observed in the payment method or the big number of Cofradías all along the coast. Sometimes the way people used to do things is an enough important reason to continue doings things like this. What is supposed to happen is that a vessel lands the fish in the port from where the crew is.

However, tradition can be broken down when there are strong and persistent economical reasons against what is working. So in the case of the coincidence between homeports and landing ports, although tradition plays an important role, economical reasons support that behaviour. If ship owners decide to sell the goods in the homeports is because it is economically profitable.

5.4.5 Days per trip

Germany

The length of a trip depends on several factors, but is predominantly limited by the freshness of the fish caught. To avoid shortcomings of quality and price deductions in fish marketing a maximum of seven days between catch and landing should not be exceeded. Therefore, this fact must be considered when calculating the maximum length of a trip (including steaming, effort (fishing) and harbour time) .

Furthermore, basically the duration of a trip also depends on the quantities which can be fished and the storage capacity of the vessel. Apart from very few exceptions, the catches of demersal fish normally are not so abundant that the capacity of the vessel is not sufficient.

The Netherlands

The fishing trips of Dutch cutters basically have a weekly pattern; at least the Sundays are spent in port. This certainly goes for the smaller boats, like Eurocutters, that regularly are back in port already on Thursdays or early Friday mornings. The large beamers usually make five-day trips, alternately landing their fish for the Friday or for the Monday market, by returning to port early or late on Friday. To take this traditional pattern into account in the model, for the Eurocutters 8 days are taken as fixed days in port each month and for the 2000 HP beamers 4 days. In line with this, the maximum trip length, according to the definition in the model with harbour time included, is for the Eurocutter set at 5 days and for the 2000 HP beamer at 6 days. As we will see, later on extra restrictions had to be introduced, particularly for the Eurocutter.

Spain

The time of fishing is restricted due to technical reasons, like the weather and the success in catching, but also (and basically) it depends on institutional and cultural reasons. The local and administration regulations are based on a single workday. Only exceptionally the trip lasts more than one day.

Moreover, there is another very important factor to take into account: the fish price. A crucial factor determining the product price is the freshness of fish. In order to sell the fresh fish it is necessary to reduce as much as possible the time between catching and selling, because in the Spanish Mediterranean area fish is usually not frozen.

As a further approach to the time of fishing of a Mediterranean vessel, we present a timetable for a standard purse seine vessel and a trawler one.

Purse Seine:

The timetable of the purse seine fleet is different in the summer and winter. During the summer the vessel leaves at about eleven o'clock in the night, and in the winter at about ten o'clock in the night.

The crew arrives half an hour before sailing of the vessel. The travelling time till the fishing ground is about one hour, and the effort time depends on the day, but as a maximum a vessel fishes during six hours. The time to come back to the landing port depends also on how the catches have been, but the vessels usually arrive at seven or at eight o'clock in the morning, and half an hour later the crew usually can go home.

They go fishing during the night because of the way the gear works: fish is attracted to the sea surface with the shining of a big light that a little auxiliary boat carries, in order to catch the fish. This makes it necessary to work during nights when all is dark. If there is a full moon it is not possible to go fishing. This gear also needs a calm sea to be able to fish. That brings about that in some winter days it is not possible for purse seiners is not possible to go fishing because of the bad weather: strong wind and high waves.

Trawl:

The timetable for this gear changes from one port to another, but it is basically the same. The changes can be detected by comparing the summer timetable with the winter one. About 6:45 AM the crew arrive at the vessel in order to prepare the nets, the ropes, etc. After nearly 45 minutes of those preparing works they leave the port (about 7:30 AM). The vessels usually return nearly all together at about 16:30 PM. It is important not to arrive much later, because a delay in the presence in the auction can affect the fish price. The time they spent in landing and selling the fish is more or less an hour, so nearly 17:30 PM they leave the port and go home.

5.4.6 Fish prices

Germany

The stated fish prices represent monthly first-sale prices of various species in Germany. There is no price information of specific grading in order to consider differences with regard to the size of the fishes.

Average Monthly Landing Prices of Different Fish Species

Pfg. 1) /kg

1996	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(Baltic) Cod	174	198	218	230	212	193	274	299	234	257	227	245
Flounder	74	81	66	94	58	162	136	88	111	83	106	69
Herring	183	69	41	40	41	52	200	153	93	181	142	139
Turbot	601	592	601	640	619	576	556	596	643	634	580	625
Saithe	141	146	155	132	139	161	143	125	142	168	154	141
(North Sea) Cod	161	152	210	243	172	169	226	238	193	353	287	305
Haddock	168	90	75	175	175	225	130	117	166	164	141	149
Ocean Perch	399	269	196	240	234	185	225	225	289	278	284	369
Ling	215	190	175	167	145	134	130	130	130	130	130	130
Whiting	98	99	110	127	205	100	100	100	145	140	183	198
Plaice	205	219	165	267	199	175	184	155	212	217	229	240
Others	99	99	99	99	99	99	99	99	99	99	99	99

1) 100 Pfg. = 1 DM

Source: BLE, Hamburg.

Furthermore, no price-quantity elasticity is included in the model calculations. To include these fields of research in this study would go far beyond the framework of this project.

In general, for the majority of fish species a North European price level exists and the relatively small quantities of catches of the selected fleet segments are not able to influence this level. Nevertheless, there exist specific and limited markets, i.g. for flounders (marketed as smoked fish) where huge catches can lead to a substantial decline of prices. This fact must be taken into consideration when simulating alternative scenarios with flounders, herring and other fishes as target species.

Netherlands

The average landing prices over the year 1995 for the standard vessels are given in the landings specifications in the Annexes tables **NL-1 and NL-2**.

In the model, monthly average prices are used. For the Eurocutter, these are the monthly average prices of the target species on Dutch auctions in 1995. For the by-catches, annual average prices were derived from the landings specification in the Annex table **NL-1**.

For the 2000 HP beamer, monthly average prices are used. These could be derived relatively easily from the specifications of landings in the book keeping records of this group of vessels (together with monthly variations in by-catches).

It should be clear, that these prices apply to the landed weight of the catches that is generally lower than the catch weight that is recorded in the logbook data. Internationally a fixed set of reduction factors by species and form of processing is applied to arrive from one weight to the other.

Average Monthly Landing Prices of Different Fish Species
NLG/kg

1995	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eurocutter:												
Plaice	3,00	2,64	3,17	3,44	3,42	3,60	3,50	3,55	3,18	3,39	3,51	3,28
Sole	14,73	13,74	13,58	12,44	12,74	14,56	15,04	13,62	14,30	13,67	13,46	13,74
Shrimp	6,08	6,64	7,87	6,73	5,77	6,19	6,79	6,38	6,46	5,27	5,58	6,87
Cod	3,39	3,02	2,99	2,91	2,23	2,87	2,80	2,66	3,01	2,87	2,44	2,37
Whiting	2,04	2,01	2,24	1,96	1,74	1,76	1,53	2,05	2,11	1,46	1,00	1,21
2000 HP beamer:												
Plaice	2,99	2,63	3,17	3,44	3,45	3,76	3,54	3,64	3,34	3,38	3,54	3,21
Sole	14,82	13,85	13,62	12,44	13,25	14,88	15,08	13,65	14,43	13,51	13,48	14,12
By-catches:												
Flatfish	8,12	6,29	5,65	4,59	5,88	6,50	6,56	6,39	6,69	6,89	6,48	7,32
Others	2,06	1,88	2,40	2,47	2,25	2,46	1,86	2,48	2,46	2,28	2,36	2,06

Spain

Like we have done with catch rates, we have built tables with monthly fish prices for all fleet segments and harbours. Here, we only give two of them as an example and the other ones are in the Annex , tables **ESP-13** to **ESP-23**.

Average Monthly Landing Prices of Different Fish Species

1995 PTS/kg

BCN TRI	Shrimp	Several Species	European Hake	Norway Lobster	Mullet	Small Blue Whiting	Small Octopus	Soup Fish	Angler Fish	Others
Jan	0	998	1 335	0	583	0	1 000	475	1 106	549
Feb	0	1 000	1 207	4 262	781	355	1 155	416	1 002	445
Mar	2 427	1 068	1 117	4 101	809	404	7 144	495	1 034	479
Apr	0	1 055	1 161	4 393	989	216	5 642	433	925	342
May	2 400	1 006	1 250	2 900	976	0	3 097	440	903	321
Jun	0	1 141	1 435	3 500	1 054	460	2 443	429	1 125	421
Jul	2 900	1 211	1 380	2 923	1 267	477	2 099	339	899	356
Aug	0	1 142	1 301	0	1 202	0	1 939	241	687	512
Sep	0	1 068	1 095	0	418	0	1 556	288	883	427
Oct	4 000	986	1 121	4 567	437	0	1 129	280	920	430
Nov	0	947	1 341	0	388	0	850	354	1 176	529
Dec	4 100	1 023	1 244	6 500	476	0	1 206	378	954	416

Average Monthly Landing Prices of Different Fish Species

1995 PTS/kg

BCN PSI	European Anchovy	European Pilchard	Atlantic Bonito	Atlantic Horse Mackerel	Round Sardinella	Other species
Jan	377	105	418	226	798	83
Feb	453	92	425	102	908	114
Mar	441	83	568	172	1 031	179
Apr	384	50	426	62	790	351
May	191	49	355	119	758	169
Jun	207	81	739	138	925	167
Jul	407	112	788	121	805	152
Aug	402	63	426	152	465	162
Sep	308	68	375	88	639	76
Oct	159	85	320	137	397	63
Nov	213	102	401	208	474	120
Dec	222	100	436	84	527	139

The study of species prices has shown a certain variety in the prices behaviour during the different months of the year and the days of the week. Fish is bought and consumed fresh and has an irregular consumption, which is higher in certain periods of the year: holidays, Christmas, etc.

The weekly analysis has also shown certain trends in demand, which are analysed in chapter 10 (Box: Weekly cycles).

In this study we have considered monthly prices as an input. We also have introduced into the model the weekly behaviour of products, because it is of interest for management decisions. Having a proper knowledge of the prices cycles allows us to choose in a suitable way between different management measures:

- Closed seasons and
- reductions of one day of the week

We can choose to reduce the fishing effort on those days or in those months in which prices are the lowest, in order to get good biological results as well as less severe economic impacts on proceeds.

5.5 Operating (activity) data

This data set is resulting from the fishing activities and includes the time spent for these activities and the catch quantities by species on the different fishing grounds.

One of the most important and time consuming task was the preparation of fleet activities with respect to time input.

The total available time per year (potential time) can be divided in active time (production time) and inactive time, e.g. when no fishing activity takes place. In addition, the active time firstly contains the steaming time, i.e. the time from the port of departure to the fishing grounds and back to the port of landing. Secondly, the active time includes the so-called effort time for fishing and searching on the fishing grounds. Steaming time as well as effort time is calculated or taken directly from the records in the logbooks.

Thirdly, there are some additional time absorptions which are directly combined with the fishing activities like unloading, reparation, holidays and bad weather days.

In North European waters, fishing activities are often hindered by bad weather, so that estimations of time for staying in ports or non-fishing on the fishing grounds have to be involved into the production time. In this context it must be emphasised that the logbook data contain no information if the resting time in harbours is conditioned by bad weather or by other reasons.

Germany

As fishing is allowed in Germany at any day of the year – in contrast to the fisheries of the other participating countries where fishing is prohibited on weekends – inactive time can be calculated by deducting production time from potential time (365 days/year).

The activity data of German “standard vessels” of the Baltic and the North Sea are listed in the following tables.

Activities of German "Standard Vessel" **(Baltic / Sassnitz)**		
		No. / year
Days at sea		176
No. of trips		35
		h / year
Production time		5203
Steaming time[1)]		1116
Effort time[2)]		2527
Harbour time[3)]	*24h/trip*	840
Repair time[4)]	*30days*24h*	720
Potential time	*365 days*24h*	8760
Inactive time		3557

1) Time to and from fishing grounds to ports.- 2) Time at fishing grounds.-
3) Time for supply, unloading, etc,.- 4) Incl. holidays.

Activities of German "Standard Vessel" (North Sea / Cuxhaven)		
		No. / year
Days at sea		208
No. of trips		22
		h / year
Production time		6265
Steaming time[1)]		1522
Effort time[2)]		2967
Harbour time[3)]	*48h/trip*	1056
Repair time[4)]	*30days*24h*	720
Potential time	*365 days*24h*	8760
Inactive time		2495

1) Time to and from fishing grounds to ports.- 2) Time at fishing grounds.- 3) Time for supply, unloading, etc,.- 4) Incl. holidays.

The Netherlands

The activities of the Dutch standard vessels are composed as in the following tables. In the tables the inactive time is split up between weekends, when the Dutch cutter fishermen generally take time off (see 5.4.5) and actual idle time, that could have been spent fishing.

For the Eurocutters, the idle time may be partly related to bad weather. The idle time of the large beamers is partly caused by lack of quota. In both cases idle time is created by fishermen returning to port early, as they have a good catch or expect good prices, or by not going out again for a very short trip before the weekend.

Activities of Dutch "Standard Eurocutter"		Total	Beam	Shrimp	Pair	Otter
		No / year				
Days at sea		172	105	52	6	10
No. of trips		75	38	28	2	7
		h / year				
Production time		5 275	2 976	1 578	166	314
Steaming time		950	580	286	31	53
Effort time		3 179	1 940	957	105	176
Harbour time	*12 h/trip*	906	456	335	30	85
Repair time	*10days*24h*	240				
Potential time	*365days*24h*	8 760				
Inactive time		3 486				
weekends	*52*2 days*	2 496				
Idle time		990				

Activities of Dutch "Standard 2000 HP Beamer"		
		No / year
Days at sea		208
No. of trips		47
		h / year
Production time		6.441
Steaming time		757
Effort time		4.308
Harbour time	*24 h/trip*	1.136
Repair time	*10days*24h*	240
Potential time	*365days*24h*	8.760
Inactive time		2.319
weekends	*52*1 days*	1.248
Idle time		1.071

Spain

The way of dealing with time had to be unified in order to get homogeneous parameters, which could fit in the model simulation. So the explanation for the terms specified above in this paragraph, such as *total available time* per year, (*potential time), active time (production time*), *inactive time,* etc. has been followed by us, using the same criteria.

With regard to these time items, information has been collected by enquiries of fishermen and managers of the Co-operatives.

Necessary time for discharging (unloading) the landed fish and for supplying the boat with ice, food, etc. for the next trip amounts to 24 h per trip as a minimum.

Time for reparation, painting, etc. – routine work every year – takes about 3 weeks per year and holidays for the crew are calculated with the same annual time demand (3 weeks/year).

In the following table the activity data are listed of Spanish Mediterranean "standard vessels" from the Barcelona, Roses and Castelló harbours.

Activities of Spanish "Standard Vessels"

	Barcelona					Roses		Castelló					
	TRI	**TRII**	**TRIII**	**PSI**	**PSII**	**PSI**	**PSII**	**TRI**	**TRII**	**TRIII**	**PSII**	**PTRII**	**PTRIII**
Days at sea		237	233	148	148	15	17	188	190	193	145	107	109
Number of trips	197	237	233	148	148	15	17	188	190	193	145	107	109
Production time	(h/year)					(h/ month)		(h/year)					
Steaming time	197	237	233	296	278	45	51	188	190	193	290	107	109
Effort time	1 576	1 896	1 864	1 036	973	105	119	1 504	1 520	1 544	1 015	856	872
Harbour time	345	415	408	148	139	15	17	329	333	338	145	187	191
Reparation time	36	72	72	108	108	12	12	36	72	72	120	72	72
Potential time	2 880	2 916	2 940	2 088	2 328	192	204	2 880	2 916	2 940	2 328	2 916	2 940
Active time	2 154	2 620	2 577	1 588	1 498	177	199	2 057	2 115	2 147	1 570	1 222	1 244
Inactive time	726	296	363	500	830	15	5	823	802	793	758	1 694	1 696

5.6 Bookkeeping data (costs & earnings)

In order to obtain a uniform data basis with regard to the application in the simulation model, the data collected by all participants had to be compared and classified in a special way for planning purposes and model use.

In Germany, the data of costs and earnings originate from the particular bookkeeping accounts of the vessels and contain - compared to those of the Netherlands - more or less the same cost items. However, the costs accounts of the Spanish (Mediterranean) fleet are different to those of the Dutch and the German fleets. These differences will be described in detail in the national contributions.

Germany

A largely uniform presentation of costs and earnings of the German standard vessels is shown in the following table.

Cost Structure of German "Standard Vessels"				
1996	Standard vessel North Sea DM	*% of* proceeds	Standard vessel Baltic DM	*% of* proceeds
Costs				
Wages			147 629	28.4
Social insurances			32 920	6.3
Total	669 335	35.4	180 549	34.8
Provisions	30 047	1.6	8 217	1.6
Travel	3 874	0.2	763	0.1
Auction/marketing	298 042	15.8	103 072	19.9
Fuel/lubrication	275 928	14.6	41 237	7.9
Maintenance/repairs	279 470	14.8	32 703	6.3
Nets/gears	95 315	5.0	15 070	2.9
Ice	48 763	2.6	6 695	1.3
Insurance	66 506	3.5	11 077	2.1
Other	99 545	5.3	27 509	5.3
Total costs	1 866 825	98.7	396 486	76.4

The Netherlands

From the costs and earnings database of the Dutch cutter sector an extensive specification of costs is available. At this stage, for reasons of uniformity, the specification of the standard vessels has been condensed to the following table.

In order to avoid a false impression of very high profitability of the sectors concerned, the cost items depreciation and interest have been added. These items are imputed in the Dutch costs and earnings assessments on the basis of replacement value and an inflation corrected interest rate on the total invested capital. For the Eurocutter these costs claim nearly a quarter of the proceeds, for the large beamer this is even one third. But it has to be said that the resulting amounts generally are higher than the fiscal depreciation and the interest on vessel mortgages.

It should be indicated here, that in the wages the imputed share(s) for skipper-owners are included, so together with the social security they represent the full costs of labour. Generally the share-based wages are a percentage of the proceeds minus landing (auction and marketing) and fuel costs.

Cost Structure of the Dutch "Standard Vessels"

	Eurocutter		**2000 HP beamer**	
1995	NLG	*% of proceeds*	NLG	*% of proceeds*
Costs				
Wages	324 090	33.3	777 400	26.4
Social insurances	21 430	2.2	50 188	1.7
Total	345 520	35.5	827 588	28.1
Provisions	10 112	1.0	25 693	0.9
Travel	13 976	1.4	19 700	0.7
Auction/marketing	67 351	6.9	194 540	6.6
Fuel/lubrication	80 740	8.3	456 087	15.5
Maintenance/repairs	60 617	6.2	113 458	3.9
Nets/gears	44 032	4.5	151 966	5.2
Catch conservation	8 688	0.9	7 216	0.2
Insurance	39 990	4.1	114 258	3.9
Other	36 713	3.8	85 078	2.9
Total exploitation costs	707 739	72.8	1 995 584	67.9
Depreciation & interest	222 826	22.9	982 122	33.4
Total costs	930 565	95.7	2 977 706	101.3

Spain

The cost data have been obtained basically by enquiring the ship owners. We have designed a homogeneous enquiry, which includes the most relevant information for the project and which is attached in the Annex. In it we have asked the ship owners on data such as: crew members, payment method, costs before distributing the proceeds between the owner and the crew, etc.

Further information about the cost data has been provided by the *Cofradía*, and by ship owners in conversations about the situation of the sector.

The earnings data in general they have been extracted from the selling bills provided by the Cofradías. As a part of the sales go outside the auction, we have been in touch with the major market in the zone: MERCABARNA, in order to have a reliable approach to what happens in the way of selling fish from the boat to a minor market. After studying the behaviour of landings in the auction and the Mercas we have been able to estimate a correction factor to be applied to the auction sales bills. With this new landing data we have reached a better approach to what may be the real landings in these ports.

The way the earnings are shared between ship owners and fishermen is a traditional one which can vary in some of the percentages in some ports but which has a basic common structure. In order to make it clearer, we present an example of the “sistema a la part setmanal” the paying method used in the Spanish Mediterranean.

Below we present the specific case of a standard vessels in the trawler I segment (<15 metres BPP).

The method working is as follows:

- First of all, the fees to the Cofradía and the Social Insurance are deduced from the proceeds of the landings sold in the auction The obtained amount is called: *Monte Mayor* and it is so-called *Quantity X* in our study.

- From *Quantity X* we deduce the running costs such as morralla, fuel, oil, etc. The result of this operation is called *Quantity Y* or *Monte Menor* in the Spanish fishermen jargon.

- This quantity is the basis for the calculation of the crew wages and the part going to the shipowners, both a percentage on Quantity Y.

- From this percentage of *Quantity Y,* the shipowner’s part, in order to get the *Gross Margin*, we still have to subtract the vessels costs: gear, rope and engine.

TOTAL INCOME: 16 072 212 PTS
(23 031 kg)

- 5% of the total income for the *Cofradía*: 803 611 PTS

- 15% of the total income for the Social Insurance: 2 410 832 PTS

⇩

Quantity X: 12 857 770 PTS

- 8 % Morralla: 1 028 622 PTS
- Fuel: 1 137 675 PTS
- Oil: 121 746 PTS
- Ice: 315 200 PTS
- Bar and food: 177 300 PTS
- Stores: 354 600 PTS

⇩

Quantity Y: 9 722 627 PTS
50% of the quantity Y for the crew: 4 861 314 PTS

50% of the quantity Y for the owner: 4 861 314 PTS

- gear costs: 400 000 PTS
- rope costs: 345 000 PTS
- engine costs: 1 000 000 PTS

⇨

GROSS YIELD:
3 116 314

In the following table we present a scheme on all the studied segments. There we have put in what particular percentages are used in each port as well as the main costs and earning of each segment:

Costs and Earnings													
	Barcelona					Roses		Castelló					
	TRI	TRII	TRIII	PSI	PSII	PSI	PSII	TRI	TRII	TRIII	PSII	PTRII	PTRIII
Proceeds	16.072.212	44.882.117	50.233.796	31.050.308	45.100.194	2.205.760	3.025.951	11.270.667	18.159.169	28.059.840	42.021.647	36.445.444	36.784.023
Marketing	5%	5%	5%	5%	5%	5%	5%	3,5%	3,5%	3,5%	3,5%	3,5%	3,5%
Soc.insurance	15%	15%	15%	15%	15%	15%	15%	10%	10%	10%	12%	10%	10%
Result X	12.857.770	35.905.694	40.187.037	24.840.246	36.080.155	1.764.608	2.420.761	9.749.127	15.707.681	24.271.762	35.508.292	31.525.309	31.818.180
Morralla	8%	8%	8%	8%	8%	8%	8%	0%	0%	0%	0%	0%	0%
Fuel	1.137.675	4.081.140	6.023.283	777.000	1.459.500	78.750	178.500	987.000	3.192.000	4.863.600	2.436.000	1.348.200	2.746.800
Lubrication/oil	121.746	146.466	191.992	213.416	286.340	21.630	35.020	116.184	136.990	159.032	149.350	77.147	89.816
Ice	315.200	568.800	745.600	947.200	1.112.000	96.000	136.000	188.000	285.000	386.000	1.015.000	642.000	817.500
Lights (for PS)	0	0	0	390.720	366.960	39.600	44.880	0	0	0	0	0	0
Stores	354.600	1.422.000	1.864.000	0	0	0	0	999.972	1.500.050	1.999.866	1.595.000	1.284.000	1.129.458
Food&bar	177.300	426.600	489.300	236.800	250.200	240.000	306.000	0	0	0	0	0	0
Result Y	9.722.627	26.388.232	27.657.899	20.287.891	29.718.743	1.147.459	1.526.700	7.457.971	10.593.641	16.863.264	30.312.942	28.173.962	27.034.606
Wages	50%	50%	50%	60%	60%	60%	60%	50%	50%	50%	50%	50%	50%
Owner's part	50%	50%	50%	40%	40%	40%	40%	50%	50%	50%	50%	50%	50%
Vessel costs													
Gear	400.000	1.500.000	2.000.000	540.000	825.000	50.000	92.000	400.000	600.000	800.000	1.000.000	1.500.000	2.000.000
Rope	345.000	2.000.000	2.500.000	270.000	262.500	25.000	30.000	0	0	0	0	0	0
Engine	1.000.000	1.000.000	1.000.000	450.000	375.000	42.000	42.000	1.000.000	1.000.000	1.000.000	500.000	1.000.000	1.000.000
Gross Margin	3.116.314	8.694.116	8.328.949	6.855.156	10.424.997	341.984	446.680	2.328.985	3.696.821	6.631.632	13.656.471	11.586.981	10.517.303

There are some peculiar facts to be commented about the table above:

- In the Castelló purse seine, lights costs are included in stores as only one cost category.
- Similarly, in the Castelló trawler segment, rope costs are included in the stores.

6 Data preparation for model use

After collecting and updating the required data, comprehensive research was necessary to prepare the data under consideration in such a way that the figures were applicable for the project's targets. One of the most important issues was the examination of existing data and the establishment of the necessary data for the planned model. These discussions resulted in the following framework.

6.1 "Gross margin" – unit for measurement of economic impacts

For the measurement of economic impacts an interim result, the so-called "gross margin" has been chosen, representing the surplus of proceeds minus variable costs. This result does not include fixed costs like interest, insurance, etc., fixed portions of other cost items (reparation/maintenance, other costs, etc.) and depreciation.

The chosen term "gross margin" only includes operating costs which are dependent on fishing activities so that the impacts of the introduction of alternative and modifications of existent management measures and strategies (regulatory and individual) can be quantified.

The resulting "gross margin" will not disclose the economic performance of the selected fleet segment in total, because fixed costs and depreciation are not taken into account but can demonstrate very well the economic effects of modified management measures and strategies.

6.2 Time synopsis and distribution per month

Germany

In summary, the time demand of the German "standard vessel" and the available time are presented in the following tables.

Baltic cutters	Monthly Distribution of Time												
	Total	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Calendar days													
Total available	365	31	28	31	30	31	30	31	31	30	31	30	31
Days lost by bad weather	54	5	5	5	3	2	5	0	4	4	6	10	5
Repai (incl. holidays)	30	0	0	0	0	0	0	15	5	0	0	0	10
Available active days	281	26	23	26	27	29	25	16	22	26	25	20	16

North Sea cutters	Monthly Distribution of Time												
	Total	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Calendar days													
Total available	365	31	28	31	30	31	30	31	31	30	31	30	31
Days lost by bad weather	54	5	5	5	3	2	5	0	4	4	6	10	5
Repair (incl. holidays)	48	2	2	2	2	2	2	15	5	2	2	2	10
Available active days	263	24	23	26	27	29	25	16	22	26	25	20	16

The Netherlands

To take the traditional pattern of week trips into account in the model, for the Eurocutters 8 days are taken as fixed days in port each month and for the 2000 HP beamers 4 days.

The fishing restrictions for the Dutch cutter fleet that came up during the eighties offered fishermen opportunities to take holidays during the lean summer months, coinciding with those of schools and processing industry. Most fishing companies take three to four weeks off in July and/or August. Many owners use this period for regular maintenance as well. For both standard vessels in the model, 9 days in July and August each are taken as fixed holidays and maintenance days.

Bad weather during fall and winter reduces the number of available fishing days of the relatively small Eurocutters. In the model, successively 4, 4, 6, 6, 4 bad weather days per month from November to March are taken into account for this boat. The big 2000 HP beamers are only exceptionally forced to stay in port because of bad weather, so for this boat type no bad weather days are included in the model.

Altogether, this results in a number of available active days of 227 for the Eurocutter and of 299 for the 2000 HP beamer. A complete survey of the available days per month is given below.

Available Days by Month for Dutch "Standard Vessels"													
	Total	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Calendar days	365	31	28	31	30	31	30	31	31	30	31	30	31
Eurocutter													
weekend days	96	8	8	8	8	8	8	8	8	8	8	8	8
bad weather days	24	6	6	4								4	4
maintenance & holidays	18							9	9				
available active days	227	17	14	19	22	23	22	14	14	22	23	18	19
2000 HP beamer													
weekend days	48	4	4	4	4	4	4	4	4	4	4	4	4
maintenance & holidays	18							9	9				
available active days	299	27	24	27	26	27	26	18	18	26	27	26	27

Spain

Number of Effective Fishing Days (Barcelona)					
	TRI	**TRII**	**TRIII**	**PSI**	**PSII**
Total Days	365	365	365	365	365
Saturdays & Sundays	104	104	104	104	104
Full Moon	0	0	0	26	26
Bad Weather	19	9	7	50	34
Holidays & Reparation Days	45	15	21	37	62
Effective Days	197	237	233	148	139

Number of Effective Fishing Days (Roses)		
	PSI	**PSII**
Total Days	153	184
Saturdays & Sundays	44	52
Full Moon	10	14
Bad Weather	7	0
Holidays & Reparation Days	17	16
Effective Days	75	102

Number of Effective Fishing Days (Castelló)						
	TRI	**TRII**	**TRIII**	**PSII**	**PTRII**	**PTRIII**
Total Days	304	304	304	303	303	303
Saturdays & Sundays	86	86	86	86	86	86
Full Moon	0	0	0	24	0	0
Bad Weather	12	8	5	27	20	15
Holidays & reparation Days	18	20	20	21	90	93
Effective Days	188	190	193	145	107	109

Available Days by Month for Selected Fleet Segments

Barcelona	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	*Total*
Calendar Days	31	28	31	30	31	30	31	31	30	31	30	31	365
BCN – TR I													
Saturdays & Sundays	8	8	9	9	8	9	9	8	10	8	8	10	104
holidays & reparation days	5	0	2	5	3	1	4	8	6	3	3	5	45
bad weather days	6	4	4								1	4	19
available active days	12	16	16	16	20	20	18	15	14	20	18	12	197
BCN - TR II													
Saturdays & Sundays	8	8	9	9	8	9	9	8	10	8	8	10	104
holidays & reparation days	0	0	2	3	3	1	2	3	0	0	1	0	15
bad weather days	3									3	1	2	9
available active days	20	20	20	18	20	20	20	20	20	20	20	19	237
BCN - TR III													
Saturdays & Sundays	8	8	9	9	8	9	9	8	10	8	8	10	104
holidays & reparation days	1	0	2	4	3	4	2	3	0	0	2		21
bad weather days	2									3		2	7
available active days	20	20	20	17	20	17	20	20	20	20	20	19	233
BCN - PS I													
Saturdays & Sundays	8	8	9	9	8	9	9	8	10	8	8	10	104
Full Moon	2	2	2	2	2	3	3	2	2	2	2	2	26
holidays & reparation days	0	0	0	0	3	6	6	12	6	4			37
bad weather days	10	6	10	7	2					3	5	7	50
available active days	11	12	10	12	16	12	13	9	12	14	15	12	148
BCN - PS II													
Saturdays & Sundays	8	8	9	9	8	9	9	8	10	8	8	10	104
Full Moon	2	2	2	2	2	3	3	2	2	2	2	2	26
holidays & reparation days	0	0	0	7	7	7	13	15	8	4	0	1	62
bad weather days	6	2	6						2	5	6	7	34
available active days	15	16	14	12	14	11	6	6	8	12	14	11	139

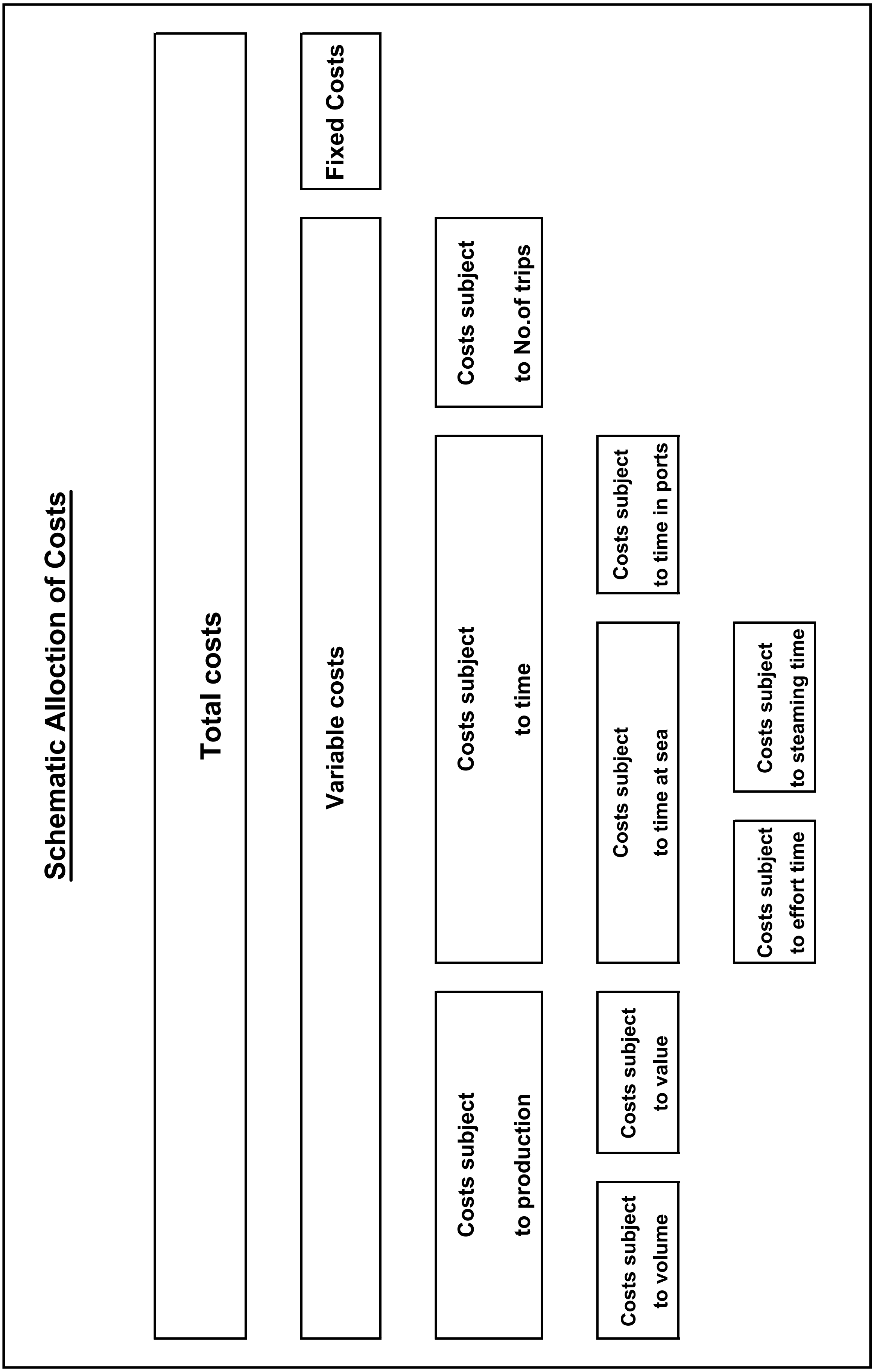
Available Days by Month for Selected Fleet Segments

Roses	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	*Total*
Calendar Days	31	28	31	30	31	30	31	31	30	31	30	31	365
Roses – PSI (monthly data)													
Saturdays & Sundays					8	9	9	8	10				44
Full Moon					2	2	2	3	1				10
holidays & reparation days					5	3	3	6					17
bad weather days					0	2	2	2	1				7
available active days					16	14	15	12	18				75
Roses – PSII (monthly data)													
Saturdays & Sundays					8	9	9	8	10	8			52
Full Moon					2	3	3	2	2	2			14
holidays & reparation days					0	0	1	1	6	8			16
bad weather days					0	0	0	0	0	0			0
available active days					21	18	18	20	12	13			102

Available Days by Month for Selected Fleet Segments													
Castelló	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	***Total***
Calendar Days	31	28	31	30	31	30	31	31	30	31	30	31	365
CST - TR I													
Saturdays & Sundays	8	8	9	9	8	c.s	c.s	8	10	8	8	10	86
holidays & reparation days	2	0		4	1	c.s	c.s	4	1	2	0	4	18
bad weather days	2	2	2		1	c.s	c.s			2	2	1	12
available active days	19	18	20	17	21	c.s	c.s	19	19	19	20	16	188
CST - TR II													
Saturdays & Sundays	8	8	9	9	8	c.s	c.s	8	10	8	8	10	86
holidays & reparation days	2	0	1	4	2	c.s	c.s	3	0	4	2	2	20
bad weather days	2	2	1			c.s	c.s				0	3	8
available active days	19	18	20	17	21	c.s	c.s	20	20	19	20	16	190
CST - TR III													
Saturdays & Sundays	8	8	9	9	8	c.s	c.s	8	10	8	8	10	86
holidays & reparation days	2	0	2	5	2	c.s	c.s	2	0	3	0	4	20
bad weather days	2	1	0	0	0	c.s	c.s	0	0	0	1	1	5
available active days	19	19	20	16	21	c.s	c.s	21	20	20	21	16	193
CST - PS II	**c.s**												
Saturdays & Sundays	c.s	8	9	9	8	9	9	8	10	8	8	c.s	86
Full Moon	c.s	1	3	2	3	3	3	3	2	2	2	c.s	24
holidays & reparation days	c.s	0	1	4	3	2	3	6	0	0	2	c.s	21
bad weather days	c.s	6	4	2					5	6	4	c.s	27
available active days	c.s	13	14	13	17	16	16	14	13	15	14	c.s	145
CST - PTRII2													
Saturdays & Sundays	c.s	8	9	9	8	9	9	8	10	8	8	c.s	86
holidays & reparation days	c.s	6	8	12	10	9	9	12	9	8	7	c.s	90
bad weather days	c.s	8	4						2	2	4	c.s	20
available active days	c.s	6	10	9	13	12	13	11	9	13	11	c.s	107
CST - PTR III													
Saturdays & Sundays	c.s	8	9	9	8	9	9	8	10	8	8	c.s	86
holidays & reparation days	c.s	5	7	10	10	12	8	13	10	10	8	c.s	93
bad weather days	c.s	7	5	1							2	c.s	15
available active days	c.s	8	10	10	13	9	14	10	10	13	12	c.s	109
c.s = closed season													

6.3 Identification of variable costs

The next step primarily focused on the identification of variable costs within the total cost framework, as only these parts will react if fishing activities change. In the long-run all costs – also fixed costs – are more or less flexible, but in short-term or medium-term scenarios an allotment of costs to fixed and variable components is possible without doubt. This was done with a view on the time horizon -- one year -- and on the basis of the knowledge and experience of the participating fisheries economists of their national circumstances. Likewise, we have assumed linear relations between activities and costs that were taken into account by special weightings of the cost factors.


Schematic Alloction of Costs
Total costs
Fixed Costs
Variable costs
Costs subject to No.of trips
Costs subject to time
Costs subject to production
Costs subject to time in ports
Costs subject to time at sea
Costs subject to value
Costs subject to volume
Costs subject to steaming time
Costs subject to effort time

Germany

In this context there are some cost elements that consist of fixed as well as variable components simultaneously. For instance reparation and other costs contain both components as costs accrue not only from fishing activities but also when lying in the harbour. For that reason, each cost element has to be examined with regard to variable components in total or partly.

The remuneration of the crews (including social insurance) is not uniform at all; in some cases there is a system of paying basic or ground wages and shares of the proceeds (with or without deducting fuel costs). But in most cases the crews only get shares of the proceeds of the vessel. Therefore, wages (including insurance) are declared as variable costs in this investigation.

Marketing costs of the landed fish also contain a few fixed elements but they are predominantly variable.

Fuel costs are only dependent on fishing activities and therefore variable costs. As mentioned above, reparation costs consist of variable and fixed elements.

Following Dutch investigations with regard to this matter, half of reparation costs will be allotted to variable and fixed costs, respectively.

Gear costs will be considered as variable and insurance as fixed costs. The item “Other costs” consists of various costs most of them being fixed; therefore, only 25% are allotted to variable costs.

The Netherlands

For both standard vessels, well-specified data on costs (and earnings) are available from the book keeping databases of the LEI panel. (Examples can be found in EC sponsored studies on costs and earnings and on the profitability of fishing boats (Davidse et al., 1993; 1997). However, the model asks for input of variable costs only, so these have to be identified within the total set of cost data. Subsequently the nature of the variability of the identified costs has to be established and the costs allocated accordingly to the proper independent variable(s).

Basically, the variable costs are those parts and items of the operational costs that in one way or another vary with the level of activity of the boat. In its annual assessment of economic results of individual and groups of cutters, LEI includes depreciation of equipment items -- like echo sounders, ice makers, conveyor belts, etc. – directly into the relevant costs items. These fixed parts of the operational costs have to be excluded for our present purpose. Specifications of the average operational costs in 1995, stripped of such depreciations, are given in Annex tables **NL-3 and NL-4** for Eurocutter and 2000HP beamer successively.

In the following table, the various items of the operational costs are summed up, together with the nature of their variability.

Variability of operational Cost Items

Cost item	Variability
Fish quota hire / rent	to be excluded
Fuel oil	active time
Lubrication oil	active time
Deck equipment	total time & fixed
Navigation & fish finding	time at sea & fixed
Maintenance and repair of hull	total time & fixed
Maintenance and repair of engine	active time & fixed
Fishing gear	effort time
Refrigeration and ice	active time
Minimum price fund	weight
Auction dues	value
Product Board levy	value
Unloading & sorting	value
Transport	weight
Shore agent	number of trips
Guarding	inactive time
Vessel insurance	fixed
Crew travelling	number of trips
Administration & general expenses	number of trips & fixed
Provisions	time at sea
Social security	fixed
Special allowances	(to be included in wages)
Crew wages	value – (landing & fuel costs)

As some of the items are not self evident, an explanation is given below:

- Although hiring and renting out of (parts of) ITQs has become normal practice in the Dutch fishing fleet, the proceeds and costs of it are excluded from the model to avoid complications.
- Costs of fuel and lubrication will vary not just by active time, but also depend on the different loading levels of the engine(s) during steaming, fishing and port activities.
- Apart from the fishing gear costs, that are totally dependent on the effort time, the other maintenance costs all have a certain fixed component, in addition to the variable parts that depend on different time spans. Maintenance and repair of engine will vary according to the engine loading factors used for oil costs; hull and deck equipment have different loading factors and all time in port has to be included.
- Both standard boats are supposed to be equipped with ice makers and refrigerated holds, as is customary in the Dutch cutter fleet. Costs of maintenance and repair of these are dependent on active time and not related to catches.
- Most of the landing costs depend on the value of the landings; that includes costs of unloading and sorting! Shore agents are only occasionally used and for the model it is supposed they have a fixed tariff per trip.
- Crew travelling costs include the cost of cars used for crew transport and are basically related to the number of trips.
- Vessel insurance is basically a fixed cost item, although some dependence on activity level and type of fishing can be imagined (but is not customary in the Dutch fleet).
- Part of the administration and general expenses, are taken to depend on the number of trips, but most of it are fixed.
- In contrast to what might be expected, social security costs at the Dutch cutter fleet are not dependent on crew wages (and indirectly on value of the catch), but more or less fixed as they depend on the number of crew mainly. This is connected to the special social security system for Dutch fishermen.
- As is usual in most fisheries, the crew wages depend on the value of the catches. In the Dutch sharing system, direct costs like landing costs and fuel are deducted from the proceeds before sharing. No fixed basic wages are included, so basically it is no catch, no pay. Special allowances (for holidays, or maintenance work

during longer periods in port) are only small and for the model are included in the wages.

Spain

Identification of variable costs has been obtained by enquiring the vessels owners in several interviews. We have divided them in two groups, depending on the variable that affects the cost; the catches value and the activity time:

- <u>Costs that vary with the catches value</u>: the *Cofradía* fees, the social insurance, *morralla*, wages and ice.
- <u>Costs that vary with the activity time</u>: fuel, oil, lights, food, gears maintenance, engine maintenance and ropes.
- <u>Costs that vary with the catches quantity</u>: only ice for the purse seine.

6.4 Allocations of variable costs to value, volume, time and number of trips

Germany

The relations between variable costs and operational factors of the vessels are treated differently in the model approaches. These dependencies of variable costs on operational factors have been demonstrated in the chart at the beginning of chapter 6.3.

According to these dependencies, the variable costs have been allocated to value, volume, effort time, steaming time and harbour time and to number of trips shown in the following tables.

Allocation of Variable Costs
Baltic "standard cutter"

			Weighting coefficients	Reference units
Landings	**332 944 kg**			
Proceeds		**519 190 DM**		
Costs	**DM**			
Fuel/lubrication	41 237		*Steaming time:1.00, Effort t.: 1.13, Harbour t.: 0.04*	**Steaming, effort & harbour time**
Maintenance/repairs	32 703		*Steaming time:1.00, Effort t.: 1.13, Harbour t.: 0.04*	**Fixed costs, steaming, effort, harbour & inactive time**
fix(50) : variabel(50)	fix	16352		
	variabel	16352		
Ice	6 695			**Catch (Volume)**
Nets/gears	15 070			**Effort time**
Auction/marketing	103 072		*19.9 %*	**Proceeds (Value)**
Provisions	8 217		*Hours at sea*	**Steaming & effort time**
Crew wages	181 312		*34.9%*	**Proceeds (Value)**
Other	27 509		*35*	**No. of trips**
fix(75) : variabel(25)	fix	20632		
	variabel	6877		

Allocation of Variable Costs North Sea "standard cutter"				
Landings	**1 656 500 kg**			
Proceeds		**1 891 687 DM**		
Costs	**DM**		**Weighting coefficients**	**Reference units**
Fuel/lubrication	275 928		*Steaming time:1.00, Effort t.: 1.13, Harbour t.: 0.04*	Steaming, effort & harbour time
Maintenance/repairs	279 470			
fix(50) : variabel(50)	fix	139 735	*Steaming time:1.00, Effort t.: 1.13, Harbour t.: 0.04*	Fixed costs, steaming, effort, harbour & inactive time
	variabel	139 735		
Ice	48 763			Catch (Volume)
Nets/gears	95 315			Effort time
Auction/marketing	298 042		*15.8 %*	Proceeds (Value)
Provisions	30 047		*Hours at sea*	Steaming & effort time
Crew wages	673 209		*35.6%*	Proceeds (Value)
Other	99 545		*22*	No. of trips
fix(75) : variabel(25)	fix	74 659		
	variabel	24 886		

The Netherlands

A survey of the allocation of variable costs is given in the tables on the following pages for the Eurocutter and 2000 HP beam trawler respectively. Here, the basic assumptions for those items that are not self evident from the table in 6.3 will be further explained.

Fixed / variable part

The split up between the fixed and the variable part of certain cost items mentioned above is primarily based on the expertise of the LEI Fisheries Division. For this purpose, a paper was produced, giving a survey of the various models developed and in use at the Division, where (operational) costs and their estimation are an important element (a.o. Pastoors, Dol & Rijnsdorp, 1997). Using this paper as a important element. Using this paper as a starting point, the split up was discussed with Fisheries Division experts and with some boat owners. This resulted in a split up of relevant cost items as given below.

Fixed part of cost items that are partly variable	
Cost item	**Percentage fixed**
Navigation & fish finding	50%
Deck equipment	50%
Maintenance & repair of hull	50%
Maintenance & repair of engine	25%
Administration & general expenses	75%

In the model, only the variable parts of these cost items are taken into account.

Load factors engine

For the allocation of oil and engine maintenance costs to the different active time elements, load factors of the engine(s) are used. The times spent on the various activities (effort, steaming, harbour) are multiplied by the appropriate load factors and the costs are allocated in proportion to the resulting products. For beam trawling, the load factors have been derived from RIVO reports on measurements on board beam trawlers (Blom, 1986, 1989, 1990). The load factor during steaming has been set at 1.00.

For the Eurocutter, a variety of effort time load factors for the different fisheries has been estimated by trial and error. As the steaming time and harbour time engine loadings can be supposed to be the same for all fisheries, differences in fuel consumption will depend on loading differences during fishing only. Starting from the already known load factor for beam trawling, the load factor for the other fisheries were juggled around, until a close match for all costs included (fuel, lubrication, engine maintenance and repair) was found. (As the cost data are averages from a number of boats with varying cost structures and fishing patterns, a complete fit cannot be reached.)

Load factors hull

Hull maintenance and deck equipment are subject to different loadings as well. Here, based on LEI Fisheries Division expertise, an educated guess is made, putting the loading during time spent at sea at four times the loading during time spent in port. For the Eurocutters, the costs of maintenance and repair of hull and deck equipment, as well as those of provisions, refrigeration and ice, and navigation and fish finding equipment are supposed to be the same for all types of fishing.

Allocation of Variable Costs
"Standard Eurocutter (300 HP)"

Landings	**178 306 kg**			
Proceeds		**972 577 NLG**		
Costs	**NLG**		**Load factors**	**Reference units**
Fuel/lubrication	80 740		***Staming time: 1.00*** ***Effort t. total: 1.07*** ***E.t. Beam tr.: 1.20*** ***E.t. Shrimp tr.: 0.87*** ***E.t. Pair tr.: 0.67*** ***E.t. Otter tr.: 0.93*** ***Harbour time: 0.03***	**Steaming, effort & harbour time**
Maintenance & repair:				
Engine	17 412			
fixed(25) ; variable(75)	fixed	4 353		
	variable	13 059	***as fuel / lubrication***	**Fixed costs, steaming effort, harbour & inactive time**
Hull & deck equipmt.	38 060			
fixed(50) ; variable(50)	fixed	19 030		
	variable	19 030	***Sea time: 1.00*** ***Harbour time: 0.25***	
Navig.& fish finding	5 145			
fixed(50) ; variable(50)	fixed	2 573		
	variable	2 572		**Steaming & effort time**
Fishing gear	44 032			**Effort time**
Refrigeration & ice	6 906		***Days at sea***	**Steaming & effort time**
Provisions	10 112		***Mandays at sea***	
Landing & auction	62 989		***6.40%***	**Proceeds**
Transport & min. price fund	4 321		***24.24 NLG / ton***	**Landings**
Shrimp conservation	1 782		***38.55 NLG / ton***	**Shrimp catch**
General expenses	36 708			
fixed(75) ; variable(25)	fixed	27 531		**Fixed costs**
	variable	9 177		
Crew travelling & shore agent	14 017		***75***	**No of trips**
Crew wages	323 915		***39.00%***	**Proceeds - fuel costs - landing & transport costs**

Allocation of Variable Costs "Standard 2000 HP beam trawler"				
Landings	**469 242 kg**			
Proceeds		**2 940 377 NLG**		
Costs	**NLG**		**Load factors**	**Reference units**
Fuel/lubrication	456 087		*Staming time: 1.00* *Effort time 1.20* *Harbour time: 0.03*	**Steaming, effort & harbour time**
Maintenance & repair:				
Engine	37 091			**Fixed costs, steaming effort, harbour & inactive time**
fixed(25) ; variable(75)	fixed	9 273		
	variable	27 818	*as fuel / lubrication*	
Hull & deck equipmt.	65 108			
fixed(50) ; variable(50)	fixed	32 554		
	variable	32 554	*Sea time: 1.00* *Harbour time: 0.25*	
Navig.& fish finding	11 259			
fixed(50) ; variable(50)	fixed	5 630		
	variable	5 629		**Steaming & effort time**
Fishing gear	151 966			**Effort time**
Refrigeration & ice	7 216		*Days at sea*	**Steaming & effort time**
Provisions	25 693		*Mandays at sea*	
Landing & auction	62 989		*6.40%*	**Proceeds**
Transport & min. price fund	6 934		*14.78 NLG / ton*	**Landings**
General expenses	84 900			
fixed(75) ; variable(25)	fixed	63 675		**Fixed costs**
	variable	21 225		
Crew travelling & shore agent	20 510		*47*	**No of trips**
Crew wages	777 450		*33.60%*	**Proceeds - fuel costs - landing & transport costs**

Spain

The following table shows the allocation of variable costs, that have been used as an input in the model. Here we only present the case of Trawler I and Purse seiner I in the Barcelona harbour. The other cases are included in the Annex, tables from **ESP-26** to **ESP-36**.

Allocation of Variable Costs

Barcelona Trawler I

			Remarks	Reference units
Landings (kg)	**23 031**			
Proceeds (pts)		**16 072 212**		
Costs (pts)				
Marketing (Cofradia)	803 610		*5% of proceed*	Value (proceed)
Social insurance	2 410 831		*15% of proceed*	Value (proceed)
Result X		**12 857 770**		
Moralla	1 157 199		*9% of result X*	Value (result X)
Fuel	1 167 471		*275l/day(trip)x197 trips*	Effort &
			=541750l/year - 21pts/l	steaming time
Oil	95 212		*690l/year,7,75l/day*	Effort &
			206pts/l	steaming time
Ice	118 200		*600kg/day(trip), 8pts/kg*	Days at sea (trips)
Stores	358 540		*1 800 pts/day(trip)*	Days at sea (trips)
Bar/Food	295 500		*1500pts/day(trip), 3 crew members*	
			500pts/man and day(trip)	Days at sea (trips)
Result Y		**9 665 647**		
Crew wages	4 832 823		*50% of result Y, 3 cew members*	Value (result Y)
			1 610 941 pts/crew member	
Owner's part	4 832 823		*50% of result Y*	Value (result Y)
Gear	400 000		*2 030pts/day(trip)*	Effort time
Rope	345 000		*1 751pts/day(trip)*	Effort time
Engine	1 000 000		*5 076pts/day(trip)*	Effort & steaming
				time, fixed
Gross margin		**3 087 823**		

Allocation of Variable Costs Barcelona Purse seiner I				
			Remarks	**Refence units**
Landings (kg)	**212 838**			
Proceeds (pts)		**31 050 308**		
Costs (pts)				
Marketing (Cofradia)	1 552 515		*5% of proceed*	Value (proceed)
Social insurance	4 657 546		*15% of proceed*	Value (proceed)
Result X		**24 840 246**		
Moralla	1 987 219		*8% of result X*	Value (result X)
Fuel	745 500		*250l/day(trip)x142 trips =35500l/year - 21pts/l*	Effort & steaming time
Oil	227 000		*1 100l/year, 7,75l/day 206pts/l*	Effort & steaming time
Ice	908 000		*800kg/day(trip), 8pts/kg*	Days at sea (trips)
Lights	374 880		*12 lights/week, 1 light-1 100pts 142 days(trips),341 lights/year 2,41 light/day(trip)-2651pts/day(trip)*	Days at sea (trips)
Bar	98 000		*690pts/day(trip), 16 crew members 43pts/man and day(trip)*	Days at sea (trips)
Result Y		**20 499 646**		
Crew wages	12 299 788		*60% of result Y, 16 cew members 768 737 pts/crew member*	Value (result Y)
Owner's part	8 199 858		*40% of result Y*	Value (result Y)
Gear	600 000		*4 225pts/day(trip)*	Effort time
Rope	300 000		*2 113pts/day(trip)*	Effort time
Engine	200 000		*1 408pts/day(trip)*	Effort & steaming time, fixed
Gross margin		**7 099 858**		

6.5 Calculation of variable costs

Finally it was possible to process the required data for the model in a uniform format. This concerns the activity data (times, catch quantities) as well as the variable costs that were calculated depending on quantity, proceeds and time. . The main results are given in the last column of the table "Calculation of Variable Costs" and represent in the end the inputs for the model.

Germany

Calculation of Variable Costs Baltic "standard vessel"					
Costs related to production					
Costs related to value					
	Total	**DM**	**Allocated costs**		**% of proceeds**
Value	*DM*	**519 190**			
Marketing	*103 072*		**103 072**		**19.9**
Wages	*181 312*		**181 312**		**34.9**
Costs related to volume					
		kg			
Volume		**332 944**			**DM/100 kg**
Ice	*6 695*		**6 695**		**2.01**
Costs related to time					
Costs related to time at sea					
		hour/year			**DM/hour**
Effort time		**2534**			
Fuel (incl. lubrication)	*41 237*		**29 427**	*Factor 1,13* [1)]	**11.61**
Nets/Gears	*15 070*				**5.95**
Maintenance/Repairs	*32 703*	*16 352(50%)*	**11 669** *2534x1.13=2863*	*Factor 1,13* [1)]	**4.64**
Steaming time		**1116**			
Fuel (incl. lubrication)	*41 237*		**11 471**	*Factor 1,00* [1)]	**10.28**
Maintenance/Repairs	*32 703*	*16 352(50%)*	**4 549** *1116x1.00=1116*	*Factor 1,00* [1)]	**4.08**
Effort & steaming time		**3650**			
Provision	*8 217*		**8 217**		**2.25**
Costs related to time in port		**834**			
Fuel (incl. lubrication)	*41 237*		**339**	*Factor 0,04* [1)]	**0.41**
Maintenance/Repairs	*32 703*	*16 352(50%)*	**135** *834x0.04=33* *4012*	*Factor 0,04* [1)]	**0.16**
Costs related to no. of trips			**Trips**		**DM/trip**
Other	*27 509*	*6 877 (25%)*	**35**		**196.49**
Gross margin (DM)	**140 358**				

[1)] Weighting coefficient.

Calculation of Variable Costs
North Sea "standard vessel"

Costs related to production					
Costs related to value					
	Total	**DM**	**Allocated costs**		**% of proceeds**
Value	*DM*	**1 891 687**			
Marketing	*298 042*		**298 042**		15.8
Wages	*673 209*		**673 209**		35.6
Costs related to volume					
		kg			
Volume		**1 656 500**			**DM/100 kg**
Ice	*48 763*		**48 763**		2.94
Costs related to time					
Costs related to time at sea					
		Hour/year			**DM/hour**
Effort time		**2967**			
Fuel	*275 928*		**188 161**	*Factor 1,13* [1]	63.42
(incl. lubrication)					
Nets/Gears	*95 315*		**95 315**		32.13
Maintenance/Repairs	*279 470*	*139 735 (50%)*	**95 288**	*Factor 1,13* [1]	32.12
			2967x1.13=3353		
Steaming time		**1522**			
Fuel	*275 928*		**85 410**	*Factor 1,00* [1]	56.12
(incl. lubrication)					
Maintenance/Repairs	*279 470*	*139 735 (50%)*	**43 253**	*Factor 1,00* [1]	28.42
			1522x1.00=1522		
Effort & steaming time		**4489**			
Provision	*30 047*		**30 047**		6.69
Costs related to time in port		**1056**			
Fuel	*275 928*		**2 357**	*Factor 0,04* [1]	2.23
(incl. lubrication)					
Maintenance/Repairs	*279 470*	*139 735 (50%)*	**1 194**	*Factor 0,04* [1]	1.13
			1056x0.04=42		
			4917		
Costs related to no. of trips			**Trips**		**DM/trip**
Other	*99 545*	*24 886 (25%)*	**22**		1 131,18
Gross margin	305 762				

[1] Weighting coefficient.

The Netherlands

In the following tables, the variable costs are calculated according to the schemes of 6.4. For the Eurocutter, the effort costs of the various gear types have been taken together. A breakdown per type of fishery is given in Annex table **NL-5**.

Calculation of Variable Costs
"Standard Eurocutter (300 HP)"

Costs related to production:			Allocated		
	Total	**NLG**	costs		**% of**
to Value:	*NLG*	**972 577**	NLG		**proceeds**
Landing and Auction	*62 989*		62 989		**6.4%**
		kg			
to Volume:		**178 306**			**NLG/ton**
Transport & Min. price fund	*4 321*		4 321		**24.24**
Shrimp conservation	*1 782*	**46 220**	1 782		**38.55**
Costs related to time		**hours/year**			
Effort time		**3 179**			**NLG/hour**
(All gear types)					
Fuel & lubrication oil	*80 740*		62 648	*(load factor 1.07)*	**19.71**
Fishing gear	*44 032*		44 032		**13.85**
Maintenance & repair of:					
Engine	*17 412*	*13 059 (75%)*	10 133	*(load factor 1.07)*	**3.19**
Hull & deck equipmt.	*38 060*	*19 030 (50%)*	11 023		**3.47**
Navigation & fish finding	*5 145*	*2 572 (50%)*	1 981		**0.62**
Refrigeration & ice	*6 906*		4 361		**1.37**
Provisions	*10 112*		7 786		**2.45**
Steaming time		**950**			
Fuel & lubrication oil	*80 740*		17 535	*load factor 1.00*	**18.47**
Maintenance & repair of:					
Engine	*17 412*	*13 059 (75%)*	2 836	*load factor 1.00*	**2.99**
Hull & deck equipmt.	*38 060*	*19 030 (50%)*	3 293		**3.47**
Navigation & fish finding	*5 145*	*2 572 (50%)*	592		**0.62**
Refrigeration & ice	*6 906*		1 303		**1.37**
Provisions	*10 112*		2 326		**2.45**
Harbour time		**906**			
Fuel & lubrication oil	*80 740*		557	*load factor 0.03*	**0.62**
Maintenance & repair of:					
Engine	*17 412*	*13 059 (75%)*	90	*load factor 0.03*	**0.10**
Hull & deck equipmt.	*38 060*	*19 030 (50%)*	922		**1.02**
Refrigeration & ice	*6 906*		1 242		**1.37**
Repair & maint. time		**240**			
Maint.& rep. hull & deck eq.	*38 060*	*19 030 (50%)*	244		**1.02**
Inactive time		**3 486**			
Maint.& rep. hull & deck eq.	*38 060*	*19 030 (50%)*	3 548		**1.02**
Guarding	*5*		5		**0.00**
Costs related to number of trips		**No of trips**			**NLG/trip**
		75			
Admin. & gen. expenses	*36 708*	*9 177 (25%)*	9 177		**121.60**
Crew traveling & shore agent	*14 017*		14 017		**185.73**
Crew wages	*323 915*		323 915	*proceeds-fuel costs -landing costs*	**39.0%**
Gross Margin			**379 920**		

Calculation of Variable Costs
"Standard 2000 HP beam trawler"

Costs related to production:			Allocated costs		
	Total	**NLG**			**% of**
to Value:	*NLG*	**2 940 377**	NLG		**proceeds**
Landing and Auction	*186 795*		186 795		**6.4%**
		kg			
to Volume:		**469 242**			**NLG/ton**
Transport & Min. price fund	*6 935*		6 935		**14.78**
Costs related to time		**hours/year**			
Effort time		**4 308**			**NLG/hour**
Fuel & lubrication oil	*456 087*		395 307	*load factor 1.20*	**91.76**
Fishing gear	*151 966*		151 966		**35.28**
Maintenance & repair of:					
Engine	*37 091*	*27 818 (75%)*	24 111	*load factor 1.20*	**5.60**
Hull & deck equipmt.	*65 108*	*32 554 (50%)*	22 770		**5.29**
Navigation & fish finding	*11 259*	*5 630 (50%)*	4 788		**1.11**
Refrigeration & ice	*7 216*		5 014		**1.16**
Provisions	*25 693*		21 853		**5.07**
Steaming time		**757**			
Fuel & lubrication oil	*456 087*		57 886	*load factor 1.00*	**76.47**
Maintenance & repair of:					
Engine	*37 091*	*27 818 (75%)*	3 531	*load factor 1.00*	**4.66**
Hull & deck equipmt.	*65 108*	*32 554 (50%)*	4 001		**5.29**
Navigation & fish finding	*11 259*	*5 630 (50%)*	841		**1.11**
Refrigeration & ice	*7 216*		881		**1.16**
Provisions	*25 693*		3 840		**5.07**
Harbour time		**1 136**			
Fuel & lubrication oil	*456 087*		2 894	*load factor 0.03*	**2.55**
Maintenance & repair of:					
Engine	*37 091*	*27 818 (75%)*	177	*load factor 0.03*	**0.16**
Hull & deck equipmt.	*65 108*	*32 554 (50%)*	1 777		**1.57**
Refrigeration & ice	*7 216*		1 321		**1.16**
Repair & maint. time		**240**			
Maint.& rep. hull & deck eq.	*65 108*	*32 554 (50%)*	376		**1.57**
Inactive time		**3 486**			
Maint.& rep. hull & deck eq.	*65 108*	*32 554 (50%)*	3 630		**1.57**
Guarding	*178*		178		**0.08**
Costs related to number of trips		**No of trips**			**NLG/trip**
		47			
Admin. & gen. expenses	*84 900*	*21 225 (25%)*	21 225		**448.61**
Crew traveling & shore agent	*20 510*		20 510		**433.50**
Crew wages	*777 450*		777 450	*proceeds-fuel costs -landing costs*	**33.6%**
Gross Margin			**1 220 320**		

Spain

The following tables are the ones for two of the studied segments: Purse Seine I and Trawler I, in the Barcelona harbour. The costs calculation has been made in the same way as used by the other countries in order to have homogeneous inputs for the model. The missing segments are included within the Annex, tables form **ESP-37** to **ESP-47**.

Calculation of Variable Costs

Barcelona Trawler I

Costs related to production							
		Total	**Pts**		**Allocation**		**Pts/1000 Pts value**
Value		*Pts*	**16 072 212**				
	Marketing (Cofradia)	*803 610*			**803 610**	*5% of proceed*	**50**
	Social insurance	*2 410 831*			**2 410 831**	*15% of proceed*	**150**
	Moralla	*1 157 199*			**1 157 199**	*8% of result X*	
	Crew wages	*4 832 823*			**4 832 823**	*60% of result Y*	
			kg				**Pts/100 kg**
Volume			**23 031**				
	Ice	*118 200*			**118 200**		**513**
Costs related to time			**Hours/year**				**Pts/hour**
Effort time			**1 576**				
	Fuel	*1 167 471*		***1 891***	**1 045 653**	*load factor 1,20*	**663**
	Oil	*95 212*		***1 891***	**85 277**	*load factor 1,20*	**54**
	Gear	*400 000*			**400 000**		**254**
	Rope	*345 000*			**345 000**		**219**
	Engine	*(500 000)*		***1 891***	**447 828**	*load factor 1,20*	**284**
Steaming time			**197**				
	Fuel	*1 167 471*		***197***	**121 818**	*load factor 1,00*	**618**
	Oil	*95 212*		***197***	**9 935**	*load factor 1,00*	**50**
	Engine	*(500 000)*		***197***	**52 172**	*load factor 1,00*	**265**
			1 773				
Harbour time			**345**				
Reparation time			**72**				
			2 190				
Costs related to no. of trips			**No. of trips**				**Pts/trips**
			197				
	Bar/Food	295 500			**295 500**		**1 500**

Calculation of Variable Costs

Barcelona Purse seiner I

Costs related to production						
	Total	Pts		Allocation		Pts/1000 Pts value
Value	*Pts*	31 050 308				
Marketing (Cofradia)	*1 552 515*			1 552 515	*5% of proceed*	50
Social insurance	*4 657 546*			4 657 546	*15% of proceed*	150
Moralla	*1 987 219*			1 987 219	*8% of result X*	
Crew wages	*12 299 788*			12 299 788	*60% of result Y*	
		kg				Pts/100 kg
Volume		212 838				
Ice	*908 000*			908 000		427
Costs related to time		Hours/year				Pts/hour
Effort time		852				
Fuel	*745 500*		*1 022*	583 385	*load factor 1,20*	685
Oil	*227 000*		*1 022*	177 637	*load factor 1,20*	208
Gear	*600 000*			600 000		704
Rope	*300 000*			300 000		352
Lights	*374 880*			374 880		440
Engine	*(100 000)*		*1 022*	78 254	*load factor 1,20*	92
Steaming time		284				
Fuel	*745 500*		*284*	162 115	*load factor 1,00*	571
Oil	*227 000*		*284*	49 363	*load factor 1,00*	174
Engine	*(100 000)*		*284*	21 746	*load factor 1,00*	77
		1 136				
Harbour time		142				
Reparation time		360				
		1 638				
Costs related to no. of trips		No. of trips				Pts/trips
		142				
Bar	98 000			98 000		690

7 Simplified presentation of the model

In the following, some explanation will be given of the model construction, its constraints and its data requirements (see also Annex G-1 and 2). Finally, a chart will illustrate the model structure including the different interdependencies.

7.1 Model description

The model is a Mixed Integer Programming Model, optimising the gross margin. It simulates fishery patterns in terms of times spent in various activities (effort, steaming, loading/unloading, etc.), choice of fishery and fishing grounds visited. The basic design has been worked out for a variety of 'standard vessels' from the countries involved. The model requires an extensive set of data and restrictions.

At many other institutes, a variety of simple, straightforward calculating models are in use, to estimate effects of changes in the ‘economic environment’ of fishing boats or fleets under *ceteris paribus* conditions. The model developed in this project was meant to go a step further, by taking into account the operational behaviour of the fisherman. The model’s boat operator should be able to make choices of fishing grounds, target species, fishing gears, landing ports, etc., like in real life, within the constraints of his normal practice and those imposed on him from outside. A time component included also allows different strategies within the observed gear.

The type of model that was chosen for this purpose is a Mixed Integer Programming model, that is a linear programming optimisation model, where some of the decision variables can only be whole numbers. The model is deterministic, i.e. no uncertainty is included. The model was developed with GAMS[8] and supported by the following is tools:

- GAMS – Programming language (Brooke et al., 1997)
- a matrix generator and
- a matrix solver with an optimizer (presolver) using CPLEX[9].

[8] Basically by Rainer Klepper (FAL Braunschweig, Germany)
[9] Release 2.25 update 5

Linear programming is a well-accepted and widely used technique in agronomy and agricultural economics. In fisheries economics, it has found little application and certainly our modelling of a fleet segment's or single vessel's behaviour and economic results is completely new.

The above implies the availability and input of a substantial and complex set of data. First, there is the definition of fishing grounds and ports, and the distances, or more precisely, the steaming times it takes from ports to grounds. For model, fishing grounds were defined in the Baltic and North Sea, each composed of a number of ICES rectangles where Dutch and German boats have been fishing.

Then, monthly average catch rates of the various relevant species on each ground are included for each type (in kg per hour fishing). In fact, these should be provided by biologists, but we have derived them provisionally from logbook and landing records. In addition to the catch rates, monthly average landing prices are given for each species.

The variable cost structure has been unravelled meticulously according to the dependence of the items on factors like: value and weight of landings, number of trips, type of fishery, fishing time, fishing ground, steaming time, port time, repair time and idle time. For each cost item, the relation with the relevant factors is entered. The allocation of costs is based partly on onboard measurements, partly on interviews with fishermen and partly on institute expertise.

A general time schedule is included to define the time available for activities, giving for each month the number of days in total and the days not available for fishing, e.g. because of holidays, repairs, bad weather. In contrast to German vessels, the Dutch fishermen, like the Spanish on the Mediterranean, generally stay in port during the weekend, so this has also been put into the model.

Finally, restrictions resulting from fisheries management (or any other interference with the fishery), like quotas or sea time restrictions, are implemented as constaints into the simulation model.

Evidently, all these data should be tuned to the type of vessel under consideration because this can make quite a difference in the simplicity or complexity of the model. Target item of the model, that is the one that has to be maximised, is the *gross margin*, the difference between the proceeds and the variable costs. As we restrict ourselves to developments on a short term, that is a single year, fixed costs can be left out of consideration. Within the implicit and explicit constraints given, the model builds up a sequence of trips from those ports to those fishing grounds, using those gears and catching those species that result in the highest gross margin.

The time component plays an essential role in the model. A distinction is made between active and inactive time. The first is the time connected to the fishing activity and the latter the remaining time. The active time is partitioned into trips, each composed of steaming time from port to grounds and back, fishing time or time on the grounds or effort time, and port time necessary for unloading and preparing the boat for the next trip. The inactive time includes time for repairs, holidays, bad weather delays and idle time (that might be used for fishing). Trip length can vary and scheduling of trips is done by the model on a monthly basis, but the optimum is basically sought over a whole year.

For assessing the effects of changes in the 'economic environment', apart from direct changes in inputs, such changes can also be brought into the model by using factors affecting catch rates, fish prices, cost levels, etc.

7.2 Model formulation

The objective of a fisherman's activities is maximizing profit from fishing. The *Profit* (Y) can be expressed as *Returns* (R) minus *Costs* (C). The costs are composed of fixed and variable costs. In the short run, fixed costs such as investments, insurance and some other costs, are not of interest for management decisions. So only variable costs are included in the model resulting in the *Gross Margin* (GM).

There are generally two possible activities: to leave the port for fishing or to stay in port. Because the fishermen can leave at different times, to different fishing grounds, and for only one or a couple of days at sea, the number of possible fishing activities is very high according to these influencing factors. For model use, the number of possible activities can be calculated as the sum of all feasible permutations of the following factors: days at sea, departure and landing port, fishing ground and the month in which the activities take place.

Furthermore a set of inputs (see table below) is related to each activity for calculating the proceeds, the costs and the *gross margin*, respectively. Each input factor itself depends on different parameters, as for example time period, fishing area, landing port and influences the activity related costs and earnings.

Inputs	depending on	Unit
Trip	-	d
Catch Rate	a, t, s	kg/h
Steaming Time	p, a, t	h
Effort Time	a, t	h
Loading and Unloading	constant	h
Fish Prices	t, s, p	m/kg
Auction Fees	landing port	% of the Proceeds (m)
Wages and Social Insurance	Proceeds	% of the Proceeds (m)
Provision	days at sea	m/d
Ice Cost	t, amount of fish, length of trip	m/kg
Gear Cost	a, effort time	m/h
Hull and Engine	h at sea	m/h
a = fishing area, t = time period, p = port, s = species, h = hour, d = days, kg = kilogram, m = equivalent to national currency		

These different cost and earning effects result in the profit (*gross margin*). Regarding this gross margin, the fisherman respectively the model solver has to decide on an activity. A chain of such decisions (activities) results in the behaviour of the fishery over the year. The objective for selecting an activity is maximisation of the *Gross Margin*.

Besides these many influences to the gross margin of an activity there are also some constraints. Constraints can be the number of days per month and year, necessary free time on-shore for maintenance and repairs of hull and engine, loading capacity of the vessel, catch quotas per species and time period, prohibited areas or prohibited time periods for fishing. In the developed simulation model, most of the constraints are variable and can optionally be included and adapted to the requirements.

The ***production function*** $E_{j,t,s}$ of the vessel *j* in period *t* of the fish species *s* can be written as:

$$E_{j,t,s} = \sum eV_j \circ F_{t,a,s} \circ H_i \circ D_i$$

where

eV_j is a set for the technical equipment of the vessel *j* as length, tonnage, engine power, age, gear type, fish finding equipment

$F_{t,a,s}$ catchability in month *t* in fishing ground *a* of the fish species *s*

H_i departure and landing port for trip *i*

D_i number of days at sea for trip *i*

$\circ$ this symbol is a kind of function characterising the interactions between the model variables

The production function used depends mainly on the catch rates $F_{t,a,s}$ that vary within the year and fishing grounds. The departure and landing port H_i as well as the number of days at sea D_i are used to calculate the remaining time for catching at the fishing area. For calculating the ***returns*** R_j of the vessel *j* the monthly fish prices of each species $P_{j,t,s,p}$ are multiplied with the values of the production function $E_{j,t,s}$ and sum over all species is taken as follows:

$$R_j = \sum E_{j,t,s} \circ P_{j,t,s,p}$$

with

$P_{j,t,s,p}$ denoting the fish price in month *t* of the species *s* at landing port *p* of vessel *j.*

The more complex ***cost function*** C_j of the vessel *j* can be expressed as:

$$C_j = \sum cV_j \circ D_i \circ W(R_j) \circ O_{i,j,p,a,t} \circ L_{i,j,p}(R_j) \circ I_{i,t}(E_{j,t,s})$$

where

cV_j costs of the vessel j influenced by size and the technical equipment

D_i number of days at sea per trip *i*

$W(R_j)$ wages and social insurance depending mainly on the returns R_j

$O_{i,j,p,a,t}$ fuel costs related to the vessel *j*, departure and landing port *p* and fishing ground *a* and days at sea per trip *i* and month *t*

$L_{j,i,p}(R_j)$ landing and auction costs of vessel *j* at port *p*, depending on R_j

$I_{i,t}(E_{j,t,s})$ ice and cooling cost depending on length and month of the trip *i* and amount of fish.

The costs depend partly on return items, such as wages, partly from time items, such as fuel and lubrication oil costs, or partly from the yield of fish, such as ice costs. But some cost items, like ice costs, also depend on the season, length of the trip and fish yield. Surely some of these (trip length and fish yield) interact with each other and these relations should be taken in consideration in the model formulation.

The resulting ***profit function*** Y_j is defined as:

$Y_j = R_j - C_j$

The ***gross margin*** will be calculated including only variable costs.

The following page gives an outline of the model structure and its interdependencies.

Around the Simulation Model as a centrepiece, the operational environment of a fishing boat is shown. To the left, two blocks represent the economical and the biological environment, that cannot be changed or influenced in the short run. The economics include the vessel and its cost structure, the ports and the markets with the prices. The biology turns around fishing grounds and species, their abundance and catch rates.

The left hand side of the scheme is that of management; one block for the regulations and measures from CFP and national authorities, another one for the individual management decisions of the boat owner and skipper.

Simplified Model Structure

Management decisions/strategies
(largely susceptible by policies and fishermen)

Regulatory measures

Output measures
(TACs, quotas)
Input measures
(licences setting a maximum on capacity/gear
gear & vessel restrictions
effort limitations setting maximum fishing days/hours)
minimum lay-over time between trips)

Technical measures
(size selectivity by setting min. mesh size
and/or size of fish landed)

Individual management strategies

No. of trips
Length of trip
Species fished
Fishing areas
Landing ports
Harbour time

Simulation Model
(Mixed Integer Model)

Maximising
Gross Margin

Feasibility tests

Basic solution

"Standard vessel"
Catches by species and areas, ports, no. and length of trips, variable costs, proceeds
Gross margin

Simulation
of
different scenarios
by GAMS Model
Maximising
Gross Margin

Parameters
(largely independent)

Economics

Fishing vessel ("Standard vessel")
(technical attributes, operational area)
Fishing ports
(vicinity to fishing grounds, fish marketing infrastructure)
Prices
(fish by species, cost items)

Biology

Fish species
(target species, other)

Fishing areas
(combined statistical rectangles
resulting in selected fishing areas)

Stock abundance
(natural and seasonal variation)
Catch rates
(specific areas, monthly)

The computer simulation model, dealing with all these aspects and elements, is a Mixed Integer Programming Model, maximising Gross Margin. In the scheme, the successive actions that have been undertaken with the model are summed up below it. First come the feasibility tests, eventually leading to the “Basic solution’ or ‘Basic run’. That is a solution acceptably close to reality to serve as a starting and reference point for the next and final phase of the project: the simulation of a number of scenarios with a variety of changes in management measures (and economical [fish prices, fuel costs] and biological parameters [catch rates]).

8 Limitations of the model

In general, it has to be expressed emphatically that the presented simulation model is a deterministic approach[10] containing deterministic data without uncertainties.

The present model has a number of limitations that are inherent to its design and construction. Some of these may be lifted with further development and possible changes of the model structure; others would require a completely different approach. The latter applies to the choice of an optimisation approach through a (linear) programming model, implying a higher efficiency than can be reached in reality. In practice fishermen will never be able to reach the results arrived at by the model, simply because they do not avail of the set of information that is put into the model. This includes the presumption that the course of events regarding catch rates by fishing ground, weather, possible breakdowns etc. can be foreseen, which in fact they can not. Also, the model does not know the feeling that some real life fishermen appear to have, that enough can be enough.

Firstly, in order to simplify the simulation solution process and to avoid complicate interpretations of the results in this approach, some decisions (assumptions) have to be made related to the model configuration. Secondly, data input and preparation may restrict the reliability of the simulation results. In particular, these facts lead to the following limitations:

- Only one fishing area can be fished during one trip. Visiting several fishing areas, that means a sequence of fishing grounds during one trip, is not allowed. This

[10] In contrast to stochastic models

would require a solution method necessary for the so-called "travelling salesman problem". If the fishing areas are not too small but wide-spread, this assumption will not be a restriction with regard to reality as the sampled vessels are not able to reach different fishing grounds within the trip time expressed in number of days.

- A basic limitation of the model is, that its time horizon is one year. This implies that the model can not assess the longer-term effects of (changes in) management measures, resulting also from changes in the fish stock situation connected with the measures. A remedy for this could be, to run the model a number of times representing a succession of years, with varying sets of catch rate inputs representing the evolution of the stocks as predicted by fishery biologists.

- The model is built as a Mixed Integer Programming model. The integer part in it is mainly represented by the fact that only whole numbers of trips can be made, with a duration that is expressed in whole numbers of days only. Considering any trip to be a trip, the first integer element is unavoidable, but the latter is not, as trips can take any amount of time and not necessarily whole days. At this stage the model is restricted only to full days at sea. No parts of days are allowed. This limitation may cause problems in special cases but simplifies the presented first model approach. Already in the Dutch cases, a small deviation from the fixed number of days has been introduced for tuning purposes by reducing the number of hours per trip day fractionally, using constant factors per trip length. A complete relaxation of this limitation may be possible; this should be explored with further development of the model. Generally, the model configuration is also able to work with fishing time activities expressed in terms of hours.

- A limitation that is partly connected to the former is that the model does not follow the whole structure of the calendar. On the one hand, months are a vital structural element in the model, as catch rates are put in on a monthly basis and trips are within the months, filling the available time per month optimally. On the other hand, weekly available time is not taken into consideration. This excludes the possibility to take into account fully the daily and weekly fishing patterns of the Spanish and Dutch fleets, respectively. As a result, the operating time as made available by the inputs tends to be used more efficiently than it is in reality. Again, this limitation may be relaxed with further development of the model, possibly by introducing some extra restrictions.

- Furthermore, the port of departure is also the port of landing. Therefore, only distances (steaming time) between ports and fishing areas are calculated but not between different ports.

- The most important point is related to catch rates. The included catch rates are sometimes only based upon small samples. With regard to future model work multi-annual catch rates at the different fishing grounds and assistance from biological research is required.

- Another aspect related to limitations of results is that there are no price differences considering size and quality of fish. Furthermore, no price elasticity is included taking into consideration small and abundant landings. As mentioned above, there is every reason to believe that the catches of the selected fleet segments cannot influence the existing North European price level for the target species cod, saithe and flatfish.

- Structural changes, like changes in gear types or boat sizes and equipment, however, could still not be taken into account. This would require not only an insight into the investment behaviour of fishing firms, but also modelling it and incorporating it in the present model. That is far beyond the goals set for this project and in fact concerns a whole new field of research.

- Basically, the model has been designed and built for active fisheries, in fact trawling. In these fisheries, the fishing effort and the resulting catch is more or less directly connected with the active time of the boat, or at least with the time on the fishing grounds. In passive fisheries, like gill netting or lining, the connection between boat activity and fishing effort is less straightforward. Therefore, the model is not directly applicable for such fisheries, requiring a rather different set up.

- The model is originally designed for fisheries managers, politicians and administrators wanting to know how their decisions affect the fishing fleets economically. For that purpose, the fleets are supposed to be composed of more or less homogeneous segments that can be represented by a single boat, having average characteristics and operational behaviour. This works rather well in cases where the segments are more homogeneous indeed, like the German Baltic and Spanish examples, where the boats come from one port and are all having the same fisheries on the same grounds. In the Dutch case, however, the segments are less homogeneous, in the sense that the boats included are from different ports, and are fishing on different grounds. By artificially stationing the model boats in the centrally situated (and major) port of IJmuiden, they are enabled to visit a variety of the grounds frequented by the segments they represent. In the model, they do so in an almost natural manner, but they leave many grounds untouched that in reality attract substantial effort from the segments involved. As a consequence, the fleet segment's behaviour as a whole is less well represented. Apparently the delineation of fleet segments should take this aspect into account and aim at (more) homogeneity in homeports and fishing grounds as well.

- In fact, the model can only simulate the behaviour of a single boat, and as such serve very well as a planning device for skippers or fishing boat operators in general, allowing them to analyse the consequences of various operational options. For the private operator, the superior efficiency of the model may not be much of a problem, as he can put in data and tune the model to his best knowledge, and play around with the assumptions, to assess the sensitivity of his decisions for uncertainties in those.

9 Presentation of fisheries activities of “standard vessels” in model form

The aim of this chapter is to present the activities of the standard vessels of the selected fleet segments in model form close to the reality. This task requires on the one hand a detailed data recording, an exact differentiation of fixed and variable costs and the allocation of variable costs to fishing activities. On the other hand the model configuration must be able to establish suitable economic relations between input data reflecting the interrelations in a proper way.

9.1 Feasibility tests and necessary model adjustments

After collecting the necessary figures, allocating costs and calculating cost units related to fishing activities, in the following these data are introduced in the elaborated simulation model and the results discussed.

Based on the following inputs

- fishing areas,
- catch rates of different species on relevant fishing areas,
- ports and distances (time) to relevant fishing areas,
- fish prices,
- available quotas,
- available time distributed per months and
- variable costs allocated to operating time

the elaborated simulation model will deliver outputs (results) containing

- catches per month by species and fishing areas,
- proceeds per month by species and fishing areas,
- number and length of trips per month by ports,
- days at sea per month,
- breakdown of variable costs per year and
- gross margin per year.

These outputs can be considered as the main criteria for testing the feasibility of the model configuration (structure) and the suitability of the model solutions. In the following the output data produced by the simulation model are compared to the empirical results of the selected “standard vessels” operating in the Baltic and the North Sea.

Germany

The main results of the first model runs of the Baltic and the North Sea (standard) vessels, using the collected and calculated data set and maximising the defined gross margin, are listed in the following tables.

Baltic Cutter "Standard vessel" *FIRST solution*			
	"FIRST" solution	Average (observed)	Remarks
Catch (t)	**551**	**333**	
Baltic cod	*299*	*296*	***Quota: 300 t***
Others	*252*	*37*	
Proceeds (1 000 DM)	**755**	**519**	
Number of trips	**33**	**35**	***Max.: 6 days***
Days at sea[1)]	**192**[2)]	**176**	***Harbour time: 24 hours***
Gross margin (1 000 DM)	**228**	**140**	
1) Incl. loading/unloading time in port. 2) No catches in May and July.			

North Sea Cutter "Standard vessel" *FIRST solution*			
	"FIRST" solution	Average (observed)	Remarks
Catch (t)	**2 169**	**1 657**	
Saithe	*1 140*	*1 226*	***Quota:1 300 t***
Others	*1 029*	*431*	
Proceeds (1 000 DM)	**3 027**	**1 892**	
Number of trips	**26**	**22**	***Max.: 7 days***
Days at sea1)	**213**[2)]	**208**	***Harbour time: 24 hours***
Gross margin (1 000 DM)	**907**	**305**	
1) Incl. loading/unloading time in port. 2) No catches in June and July.			

The presented results, as calculated by the simulation model, are not surprising. In general, the model-based gross margins will be higher compared to those in reality. For example, taking into account the available annual quotas of Baltic cod and the by-catches of some other species, in the Baltic case the total yield – leading to the maximum gross margin - can be fished within fewer months and with fewer trips. In practice it means that no fishing activities are necessary in June and July in order to fish out the quota and to obtain a maximal gross margin.

The result of the "FIRST solution" of the North Sea vessels is characterised by an only partial exhaustion of the (quotaed) saithe and perceptibly higher catches of others, non-target species (cod, haddock, ling, etc.). This yield and the corresponding maximum gross margin can be realised within only 10 months, but demands some additional days at sea (and number of trips).

What are the reasons of these differences between these first model solutions and the empirical situation in the relevant fleet segments? In general, the differences between the model solutions and the results in reality may be caused by

- deficiencies of data
- behaviour of fishermen and
- model-inherent reasons.

Firstly, there are deficiencies of data, as some data are not available in the required detail (i.e. cost data). Other data, like prices, are averages from regional statistics but not first sale prices of the selected fleet segments.

Time data cannot be allocated exactly in each case; effort time contains time for fishing as well as time for searching fish, and harbour time includes not only necessary time for unloading and supplying the vessel for the next trip, but also resting time of the crew. Furthermore, the distinction between fixed and variable costs and the weighting (loading) coefficients of costs to time units are mainly based on estimations founded on statements of fishermen and expert experiences. Only in a few cases there are investigations to reduce this insufficient knowledge about existing interrelations. In the same way, the introduced loss days caused by bad weather are also estimations based on experiences in the past.

Secondly, discrepancies between model solutions may be caused by the behaviour of the fishermen, because their activities are sometimes not only determined by economic factors, that is, in the case in question, maximising the gross margin. Their preferences for landings in their home ports, staying there with their families more time between two trips than economically necessary and making holidays in summertime during school vacations are some of such uneconomic factors of behaviour which influence the results in reality.

In this context, it is noteworthy to mention that the individual fisherman normally disposes only of a limited set of information, whereas the simulation model decides by using the total imputed data of all vessels included in the study. Additionally, it includes in its solution for example the (possible) catch rates of all relevant fishing grounds, while in general the fisherman has only knowledge of those where he is normally fishing or by information of other vessels.

Furthermore, attempting to maximise the gross margin at the beginning of a year contains some incalculable risks for the fisherman, as he is uncertain about fishing possibilities in the course of the year, especially with regard to the full utilisation of his quotas and the price situation on the markets. Although his decisions are also based on data and results of the recent year or years – in the same way as in the model – the fisherman will avoid to follow a model solution which recommends e.g. non-fishing in January and/or February in order to maximise the gross margin. Moreover, markets will require regular supplies of fish all over the year and therefore it is difficult to stop fishing totally for a longer period. Otherwise, this may create the problem of losing market shares to foreign competitors (imports).

Thirdly, the limitations of the model configuration already above mentioned may be responsible for differences between the model solutions and the realistic (empirical) results.

Based on the variety of possible sources of errors that cannot be estimated separately, we consider the application of the usual indicators for errors to be inappropriate. With that certainties resp. uncertainties would be conjured up that on the basis of the quality of the data would have just little, if any evidential value.

The Netherlands

The first runs for the Dutch standard vessels were made after adapting the model that was used for the German boats. This adaptation implied exchange of data sets on catch rates, prices, variable costs, available time, distances to fishing grounds, etc. In addition, the model had to be adapted to the specific situation and requirements of the Dutch vessels. All in all this turned out to be a rather complex operation, that was gone through in a trial and error process. As a consequence, the early runs for both standard vessels after all were of little value in terms of comparability with economic results in reality. Therefore, they are not presented here.

Eventually, after a number of trials and adjustments of the model, gradually eliminating 'bugs' and clearing data mix ups, for both standard vessels a 'basic run' was arrived at, that describes their behaviour and economic performance acceptably well.

As a correction for the inherently better financial results of the model (connected to it's concept), the duration of trip length in hours has been reduced by ten percent, so e.g. a four day trip takes only 3.6 x 24 hours. (As has been explained, this includes time in port for unloading and preparing the boat for the next trip.)

Another element that was introduced during the trial runs, was the conversion factor for each species or group of species, serving to convert landing weights into live weights or vice versa. On seeing the high proceeds per day in shrimp fishing, it was realised that certainly for shrimp this factor could not be neglected in a situation where catch rates refer to live weight and prices refer to landed weight. The conversion factors that are used in the model are given below.

Conversion factors live weight to landed weight	
Species	Conversion factor
Plaice	0.962 (1.04)
Sole	0.952 (1.05)
Cod	0.870 (1.15)
Whiting	0.877 (1.14)
Shrimp	0.848 (1.18)
By-catches	0.909 (1.10)

Although the cost structure of both Dutch standard vessels is basically the same, the differences in fishing pattern ask for considerable differences in approach. These differences and the necessary adaptations of the model program to arrive at useful basic runs are explained below for both types separately.

Eurocutter

The Eurocutter is in fact the most complicated of the two standard vessels, with its four different types of fisheries and two fishing ports. At an early stage, it became apparent that the model could not be run with all types of gear simultaneously, so it was decided to leave the otter trawling out. Pair trawling seems to be a more interesting activity, with occasional high catch rates, low fuel consumption, but very high gear costs. It is also a fishery that is more separate from beam trawling and shrimping than otter trawling, as the latter can rather easily be combined with the former two (and it fairly often is in practice). In reality the four fisheries are rarely practised all by one vessel; most boats restrict themselves to two or three.

The complexity of the case makes it impossible to solve the model for a whole year in one run, so the year has to be split up into halves and the results have to be combined into full year results.

Early runs resulted in an unusually low number of relatively long trips, with very high proceeds (1.5 million guilders and more, where just under 1 million was the average in 1995). It appeared the model was too generous by allowing trips of five active days (four at sea and one in port), whereas the average trip duration is about three for beam trawling and two for shrimping. So the model was adjusted to a maximum trip duration of four active days in general and three for shrimp fishing, taking account of the highly perishable nature of the product.

At first, the ITQs were split up into equal parts for each half-year, but this resulted in under-utilisation of the sole quota and an unusually high level of shrimp fishing in the first half year. From the logbook data it appears that on average two-thirds of the sole ITQ is caught in the first half year. The split up of the ITQ has been adjusted accordingly, relieving the apparent restriction on beam trawling in the first half year.

2000 HP beamer

To arrive at an acceptable basic run for the 2000 HP beam trawler was much simpler than for the Eurocutter. After early mix ups of the input data were cleared and the model adaptations on day length and conversion factors described above had been made, the basic run resulted more or less straight away.

With regard to the German and Dutch fleet segments it was not particularly surprising that the "First runs" with the assessed data inputs and the chosen restrictions/constraints arrived at better results (gross margins) than in practice. It rather speaks for the soundness of the "approaches", as theoretically it is to be expected that a fisherman cannot behave optimally on the basis of limited information. Additionally fishermen have, to our knowledge, a series of personal habits that are not directed at achieving the economic optimum.

Furthermore we have indicated the uncertainties in the data inputs (specially the catch rates) and also paid attention to the possible influence of the chosen model structure on the results.

Spain

In the Spanish fisheries vessels are not required to keep account books. So, we had to obtain the costs and earnings data by enquiries of ship owners and from the sales bills from the *Cofradías*.

The effort has been estimated on the basis of the sales bills and the knowledge that by law it is not allowed fishing on Saturday and Sunday.

This fishing effort estimation was specially complicated when we dealt with the purse seine segment. The selling bills don’t match with the effective fishing days. The reason is that with this gear vessels often go fishing but come back to the port without any fish. In those days they have really gone out, but sales bills are not produced for those non-successful trips and there is no official registration for those days. We took some samples of effective fishing days by enquiries and we contrasted them with the selling bills. From this exercise we could make a proper estimation of the effective fishing days in the purse seine.

In the Spanish case we haven’t used any conversion factor for each species or group of species, because landing weights correspond to live weights. In the Spanish Mediterranean vessels go away for one day trip and come back to the harbour with fresh fish, which is sold in this form. So, catch rates as well prices, presented in following paragraphs, refer to live weight and this correspond to landed weights.

Therefore, we have a conversion factor equal to one for all cases and it is not necessary to present a table with equivalences between catches and landings.

9.2 Basic runs of the "standard vessels"

Before simulating the effects of changes in fisheries management or other elements of the fishing company's environment, extensive tuning and feasibility tests (runs) were necessary , before a set of so-called "Basic runs" emerged that simulated reality acceptably well. In the execution of the feasibility tests, we have basically in a kind of trial and error process – based on the long standing experience of the team members as national and international fisheries experts – tested and applied changes that, in our opinion, have led to plausible results. As could be expected, the results were the better the more homogeneous the proportions of the selected fleet segments were.

These test runs produced a variety of different indications of reasonable and useful adaptations which were partly considered during the approximation process to the "BASIC solutions" for the Dutch and German (standard) cutters of the selected fleet segments.

Germany

Baltic "standard cutter"

The comparison of the model-calculated (estimated) outcome of the "FIRST solution" and the logbook and bookkeeping data shows higher catches and corresponding higher proceeds than in reality, realising a perceptibly increased gross margin. These outcomes were mainly caused by abundant catches of flounders, which are - in contrast to Baltic cod (300 t) - not limited by a quota. In practice the catch of flounder did not exceed the quantity of about 30 t per year. The market is limited and it must be feared that the price for flounder will decrease sharply, close to that of fish meal raw ware. Therefore, in the BASIC solution the (unquoted) catch of flounders is limited to 35 t.

With regard to the estimated and observed fishing time expressed in days at sea (including steaming and effort time as well as harbour time) and number of trips, there are deviations and an adjustment is necessary. In this context, the harbour time, i.e. the time for unloading and supplying for the next trip is extended from 24 hours to 48 hours (2 days) per trip. In reality, this means that the time of steaming and fishing is reduced to 4 days as the total duration of a trip is limited to 6 days.

Furthermore, the BASIC solution demands trips, and accordingly catches, within all months of the year except in July.

These adjustments introduced in the model lead to the following “BASIC solution”, the standard of comparison for all simulation results.

Model Solution (basic run)
Baltic Sea

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	%
Landings / Proceeds															
Cod	*kg*	4 195	46 591	21 000	42 987	56 285	25 315	0	22 977	40 723	24 118	4 720	10 914	299 824	87.2
	DM	5 891	74 446	36 944	79 788	96 294	39 429	0	55 442	76 901	50 020	8 646	21 578	545 379	91.7
Flounder	*kg*	202	5 119	0	0	0	389	0	3 707	0	6 583	3 716	15 078	34 795	10.1
	DM	127	3 525	0	0	0	535	0	2 773	0	4 644	3 348	8 843	23 796	4.0
Others	*kg*	153	297	0	2 157	19	108	0	577	0	2 995	320	2 659	9 288	2.7
(HER+PLE+STT)	*DM*	413	1 176	0	2 961	32	161	0	1 676	0	6 721	1 098	11 483	25 721	4.3
TOTAL	*kg*	4 550	52 008	21 000	45 144	56 304	25 812	0	27 262	40 723	33 696	8 755	28 652	**343 907**	100.0
	DM	6 431	79 148	36 944	82 749	96 327	40 125	0	59 891	76 901	61 385	13 092	41 905	**594 896**	100.0
Fishing areas															
Arcona Sea															
Western Baltic															
Bornholm West															
Bornholm East															
Eastern Baltic															
Distribution of time															
Total available		31	28	31	30	31	30	31	31	30	31	30	31	365	100.0
Days lost by bad weather		5	5	5	3	1	0	0	0	1	4	5	5	34	9.3
Reparation (incl. holidays)		0	0	0	0	0	0	15	10	0	0	0	10	35	9.6
available for fishing		26	23	26	27	30	30	16	21	29	27	25	16	296	81.1
days at sea [1)]		6	23	18	24	29	18	0	18	24	23	6	12	**201**	**55.1**
inactive days		25	5	13	6	2	12	31	13	6	8	24	19	164	44.9
Number of trips		1	4	3	4	5	3	0	3	4	4	1	2	**34**	
Gross margin	*DM*													**178 107**	

1) included harbour days

Baltic Cutter "Standard vessel" *BASIC solution*			
	"BASIC" solution	Average (observed)	Remarks
Catch (t)	**344**	**333**	
Baltic cod	*300*	*296*	***Quota: 300 t***
Others	*44*	*37*	***Limited:30 t***
Proceeds (1 000 DM)	**595**	**519**	
Baltic cod	*545*	*491*	
Others	*50*	*28*	
Number of trips	**34**	**35**	
Days at sea[1)]	**201**[2)]	**176**	***Harbour time: 48 hours***
Variable costs (1 000 DM)	**417**	**363**	
subject to value	*326*	*284*	
to volume	*7*	*7*	
to time	*77*	*65*	
to number of trips	*7*	*7*	
Gross margin (1 000 DM)	**178**	**140**	

1) Incl. loading/unloading time in port. 2) No catches in July.

North Sea "standard cutter"

The comparison of the outcome of the so-called "FIRST solution" with the observed empirical results shows higher catches and remarkably higher proceeds. These results are realised within 10 months – without catches in June and July – by making 213 days at sea and 26 trips and lead to a gross margin amounting to 907 000 DM, threefold that determined from the accounts of the sampled vessels (305 000 DM).

While the catch of saithe, the target species, remains more or less at the same level as observed in reality, the quantities of the other species are more than doubled. These catches mainly consist of (North Sea) cod, haddock, ling and whiting normally achieving higher prices than saithe; this is the reason for the perceptible increase of the proceeds in the "FIRST solution".

In practice, the composition of the total catch of the sampled vessels was different regarding the shares of saithe and other species. Saithe ranges from 60% (and 40%

other species) to 85% within the total yield of the vessels investigated. Obviously, some of the sampled vessels can reach relatively good catch rates when fishing for other species than saithe, leading to a higher percentage of species like cod and other kinds of fishes in the model solutions.

Furthermore, in this “FIRST solution” the fishing areas of the Northern North Sea, the Shetlands Islands and the Hebrides are not used. But in practice, the sampled North Sea cutters (or some of them) used all the above mentioned fishing grounds, while in the “FIRST solution” some areas (i.e. the Northern North Sea and the grounds around the Hebrides and the Shetlands Islands) – being relatively far from the ports - are not necessary to obtain the maximum gross margin. This result means that – based on the introduced catch rates – these areas don’t contribute to the model-calculated (maximum) gross margin.

Another fact of the model solution is noteworthy. Because of the great distances to the fishing areas, the homeport of the sampled North Sea vessels Cuxhaven will not appear in the model solution. Only the Danish harbour Hanstholm and the Faeroe port of Runavik are used for landings due to their short distance to the fishing grounds.

In comparison to the Baltic vessels, the lower homogeneity of the North Sea cutters and the less uniform fishing practice considerably complicate the task to obtain a “BASIC solution” close to the reality. This situation produced considerable difficulties to obtain a realistic “BASIC solution” and demanded several adjustments.

As a result of a multitude of feasibility tests the following adjustments have been added into the data set used for the modelling process.

Regarding the data, the catch rates – especially those of other species than saithe – do not seem to be realistic averages because of the small sample basis, but more random figures. Therefore, the catch rates of all other species (except saithe) have been halved when calculating the “BASIC solution”. In addition, there has been made a limitation of the catch of (North Sea) cod amounting to 200 ton per year.

Furthermore, equal average prices for all ports (Runavik, Hanstholm, Cuxhaven) had been introduced in the “FIRST solution”. This assumption can not be taken as valid as in practice the prices in the Faeroe Islands (Runavik) are much lower compared to those in Hanstholm and Cuxhaven. For this reason, the achievable price level of all species landed in Runavik has been reduced to 60%.

Whereas in the “FIRST solution” the homeport Cuxhaven is not used, one landing in this port – in the month of December – is forced into the “BASIC solution” in accordance with the traditional behaviour of the crews.

Two additional adjustments have been implemented into the data set: The maximum duration of a trip is extended to 9 days as well as the extended harbour time – necessary for unloading of the catch and preparing for the next trip – from 24 hours to 48 hours per trip.

Finally, these adjustments lead to the following “BASIC solution” for the North Sea cutters close to reality.

Model Solution (basic run)

North Sea

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	%
Catches / Proceeds															
Saithe	*kg*	138 613	93 500	38 887	110 919	304 450	2 854	0	11 782	133 918	124 110	100 420	14 417	1 073 871	65.4
	DM	187 877	98 195	39 254	89 512	294 860	2 820	0	7 930	196 191	105 765	90 729	15 139	1 128 271	58.0
Cod	*kg*	3 564	6 125	11 116	52 334	109 796	106	0	0	15 292	338	0	560	199 231	12.1
	DM	4 717	8 304	15 251	70 952	150 630	158	0	0	22 460	353	0	889	273 714	14.1
Others	*kg*	14 164	4 800	32 639	19 463	29 244	640	0	0	29 493	3 668	231 496	2 721	368 327	22.4
	DM	41 137	13 030	84 974	32 548	51 427	1 257	0	0	53 782	2 580	256 680	5 580	542 997	27.9
TOTAL	*kg*	156 341	104 425	82 642	182 716	443 490	3 600	0	11 782	178 703	128 116	331 916	17 698	**1 641 429**	100.0
	DM	233 731	119 529	139 479	193 012	496 917	4 235	0	7 930	272 433	108 698	347 409	21608	**1 944 982**	100.0
Fishing areas															
German Bight															
Danish West Coast															
Northern North Sea															
Hebrides, NW Scotland															
South West Norway															
Shetland Islands															
Northern Wiking Bank															
Distribution of time															
Total available		31	28	31	30	31	30	31	31	30	31	30	31	365	100.0
Days lost by bad weather		6	6	6	4	2	0	0	0	2	5	6	6	43	11.8
Reparation (incl. holidays)		0	0	0	0	0	0	15	10	0	0	0	10	35	9.6
available for fishing		25	22	25	26	29	30	16	21	28	26	24	15	287	78.6
days at sea [1)]		24	18	18	22	29	9	0	6	27	17	24	9	**203**	**55.6**
inactive days		7	10	13	8	2	21	31	25	3	14	6	22	162	44.4
Number of trips		3	2	2	3	4	1	0	1	3	2	3	1	**25**	
Gross margin	*DM*													**427 589**	

1) included harbour days

North Sea Cutter "Standard vessel" *BASIC solution*			
	"BASIC" solution	Average (observed)	Remarks
Catch (t)	**1 641**	**1 657**	
Saithe	*1 075*	*1 226*	***Quota:1 300 t***
Others	*566*	*432*	***Cod: 200 t***
Proceeds (1 000 DM)	**1 945**	**1 892**	
Saithe	*1 128*	*1 594*	
Others	*817*	*298*	
Number of trips	**25**	**22**	***Max.: 9 days***
Days at sea[1)]	**203[2)]**	**208**	***Harbour time: 48 hours***
Variable costs (1 000 DM)	**1 517**	**1 587**	
subject to value	*1 000*	*971*	
to volume	*48*	*49*	
to time	*441*	*542*	
to number of trips	*28*	*25*	
Gross margin (1 000 DM)	**428**	**305**	

1) Incl. loading/unloading time in port. 2) No catches in July.

The Netherlands

Eurocutter

With the adaptations described in 9.1, the result comes sufficiently close to reality, concerning fishing pattern as well as total proceeds, to consider this as our 'basic run'. The result of this 'basic run' is displayed in the next table.

The simulated fishing pattern comes remarkably close to what can and does happen in reality:

- The first quarter of the year is spent beam trawling trips mostly off the South coast grounds, with a single trip in February offshore England.
- In April a series of shrimping trips is made from the port of Havneby in the Sylt area, with an additional trip from homeport IJmuiden off the South coast, leaving one day unused.
- Beam trawling is resumed in May in the German Bight, continuing in June off the Danish coast, where also a solid pair trawling trip is made.

- In July another pair trawling trip is made in the German Bight, and subsequently beam trawling is taken up off the South coast.
- After the holiday period, a short pair trawling trip is made off the North coast, but the rest of August is spent beam trawling on the Friesian grounds.
- This goes on into September with a single trip off the Danish coast, and then the southern shrimping season gets going, continuing until deep into October.
- Then there is a wavering and a short switch to beam trawling off the South coast is made, but then it appears the shrimp fishery is shifting North and the season ends in November in the German Bight, fishing from Havneby again.
- The year is wound up with returning to beam trawling once more, this time off the North coast.

Model Solution (basic run)
300 HP Eurocutter

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	%
Landings / Proceeds															
Plaice	*kg*	7 510	3 215	2 314	0	9 394	9 212	958	1 308	5 488	561	0	5 326	45 286	*23.5*
	NLG	22 530	8 488	7 336	0	32 127	33 165	3 352	4 643	17 453	1 902	0	17 470	148 466	*14.7*
Sole	*kg*	2 547	2 254	6 653	0	6 218	493	1 818	2 370	46	205	0	2 441	25 045	*13.0*
	NLG	37 514	30 973	90 344	0	79 211	7 177	27 340	32 283	652	2 802	0	33 543	341 839	*33.8*
Cod	*kg*	0	0	0	0	0	10 699	11 589	1 887	0	0	0	0	24 175	*12.5*
	NLG	0	0	0	0	0	30 706	32 450	5 019	0	0	0	0	68 175	*6.7*
Whiting	*kg*	0	0	0	0	0	27	18	32	0	0	0	0	77	*0.0*
	NLG	0	0	0	0	0	47	27	66	0	0	0	0	140	*0.0*
Shrimp	*kg*	0	0	0	6 279	1 225	0	0	0	13 662	22 064	15 319	0	58 549	*30.3*
	NLG	0	0	0	42 258	7 069	0	0	0	88 258	116 280	85 481	0	339 346	*33.5*
Flatfish bycatch	*kg*	1 326	1 044	1 562	246	1 183	696	927	928	366	369	211	1 589	10 447	*5.4*
	NLG	8 144	6 410	9 591	1 221	7 221	4 161	5 465	5 485	1 980	1 948	1 047	9 758	62 431	*6.2*
Other bycatch	*kg*	3 404	2 679	4 009	1 264	3 136	1 818	2 406	2 408	1 529	1 637	1 083	4 079	29 452	*15.3*
	NLG	5 924	4 662	6 976	2 503	5 503	3 238	3 975	3 990	2 942	3 178	2 145	7 098	52 134	*5.1*
TOTAL	*kg*	14 787	9 192	14 538	7 789	21 156	22 945	17 716	8 933	21 091	24 836	16 613	13 435	**193 031**	*100.0*
	NLG	74 112	50 533	114 247	45 982	131 131	78 494	72 609	51 486	111 285	126 110	88 673	67 869	**1 012 531**	*100.0*
Fishing areas															
Danish coast															
German Bight															
Offshore England															
Friesian grounds															
North coast															
South coast															
Distribution of time															
Total available		31	28	31	30	31	30	31	31	30	31	30	31	365	*100.0*
Available for fishing		17	14	19	22	23	22	14	14	22	23	18	19	227	*62.2*
Days at sea [1)]		17	14	19	21	23	22	14	14	22	23	18	19	**226**	***61.9***
Number of trips		5	4	5	7	6	6	4	4	7	8	6	5	**67**	
Gross margin	*NLG*													**424 636**	

1) included harbour days

All except one available active days are used in 67 trips, spending 159 days at sea. Like in reality, the sole ITQ has been almost completely taken, but only about 60% of the plaice ITQ. Whiting is caught in negligible quantities, in contrast to cod, where the catch (again like in reality) considerably overshot the original ITQ. (Probably part of the plaice quota has been rented out and additional cod quotas have been hired) Shrimping is done to a larger extent than in reality, probably because no switching time and costs have been taken into consideration.

As has been argued before, the model is basically more efficient than reality. Taking this into account, the model performs very well in the Eurocutter case: estimated total catches are less than 10% higher than in reality and total proceeds even only 4% (40 000 NLG on a million). The efficiency of the model comes most to expression in the lower numbers of trips and days at sea, resulting in lower variable costs and consequently in a substantially (11.5%) higher gross margin.

Comparison Between Estimated and Observed Results

Basic Run	Model calculated (estimated) results	Average (observed)	Remarks	Model calculated (estimated) results	Average (observed)	Remarks
Catch (t)	193.0	178.3	*Quotas:*	504.3	469.2	*Quotas:*
Plaice	45.3	30.4	*74.4*	259.1	218.6	*259.9*
Sole	25.0	26.6	*28.6*	122.1	123.7	*125.3*
Cod	24.2	19.2		-	-	
Whiting	0.1	3.6		-	-	
Shrimp	58.5	46.2		-	-	
Flatfish by-catch	10.4	13.6		61.2	57.6	
Other by-catch	29.5	38.5		61.9	69.4	
Proceeds (1000 NLG)	1 012.5	972.6		3 093.8	2 940.4	
Days at sea	159	171		210	208	
No. of trips	67	75		47	47	
Gross margin (1000 NLG)	**424.6**	**379.9**		**1 383.3**	**1 220.3**	

The data for this comparison are summarised in the table above, together with those of the 2000 HP beam trawler.

2000 HP beam trawler

The result of the Basic Run simulation for the 2000 HP beam trawler is displayed in the next table.

Model Solution (basic run)

2000 HP Beamer

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	%
Landings / Proceeds															
Plaice	*kg*	49 910	38 320	22 396	5 831	939	10 343	7 840	32 003	20 917	17 622	26 367	26 652	259 140	*51.4*
	NLG	149 231	100 782	70 994	20 060	3 238	38 889	27 753	116 491	69 862	59 564	93 339	85 553	835 756	*27.0*
Sole	*kg*	13 559	12 203	11 112	4 265	1 754	9 793	7 756	5 507	16 064	15 714	8 632	15 700	122 059	*24.2*
	NLG	200 950	169 005	151 348	53 051	23 238	145 719	116 963	75 168	231 800	212 300	116 362	223 101	1 719 005	*55.6*
Flatfish bycatch	*kg*	4 244	6 494	7 134	2 445	502	5 402	3 543	2 775	6 584	11 227	5 499	5 348	61 196	*12.1*
	NLG	34 460	40 846	40 307	11 221	2 954	35 115	23 244	17 730	44 044	77 351	35 634	39 144	402 050	*13.0*
Other bycatch	*kg*	9 027	8 777	4 858	1 575	915	5 950	3 432	2 415	5 793	8 510	5 562	5 091	61 905	*12.3*
	NLG	18 596	16 501	11 658	3 891	2 058	14 637	6 383	5 988	14 252	19 404	13 127	10 487	136 982	*4.4*
TOTAL	*kg*	76 740	65 794	45 500	14 116	4 110	31 488	22 571	42 700	49 358	53 073	46 060	52 791	**504 301**	*100.0*
	NLG	403 237	327 134	274 307	88 223	31 488	234 360	174 343	215 377	359 958	368 619	258 462	358 285	**3 093 793**	*100.0*
Fishing areas															
Northern North Sea															
Danish coast															
German Bight															
Offshore England															
Friesian grounds															
North coast															
South coast															
Distribution of time															
Total available		31	28	31	30	31	30	31	31	30	31	30	31	365	*100.0*
available for fishing		27	24	27	26	27	26	18	18	26	27	26	27	299	*81.9*
days at sea [1)]		27	24	27	10	4	24	18	18	26	27	25	27	**257**	***70.4***
Number of trips		5	4	5	2	1	4	3	3	5	5	5	5	**47**	
Gross margin	*NLG*													**1 383 273**	

1) included harbour days

When looking at the fishing pattern of the 2000 HP beamer, the eye is immediately caught by the low fishing activity in the months of April and May. Clearly the ITQs of plaice and sole are insufficient to keep the boat fully employed throughout the year. It is a peculiarity of the optimisation model that it tends to concentrate periods of inactivity, and apparently April and May is the best time of the year to lay up the boat temporarily. Normally, because of the uncertainties of future fishing opportunities, an owner would not dare to lay up his vessel for some time this early in the year, and his crew would protest fiercely on the lack of income at that.

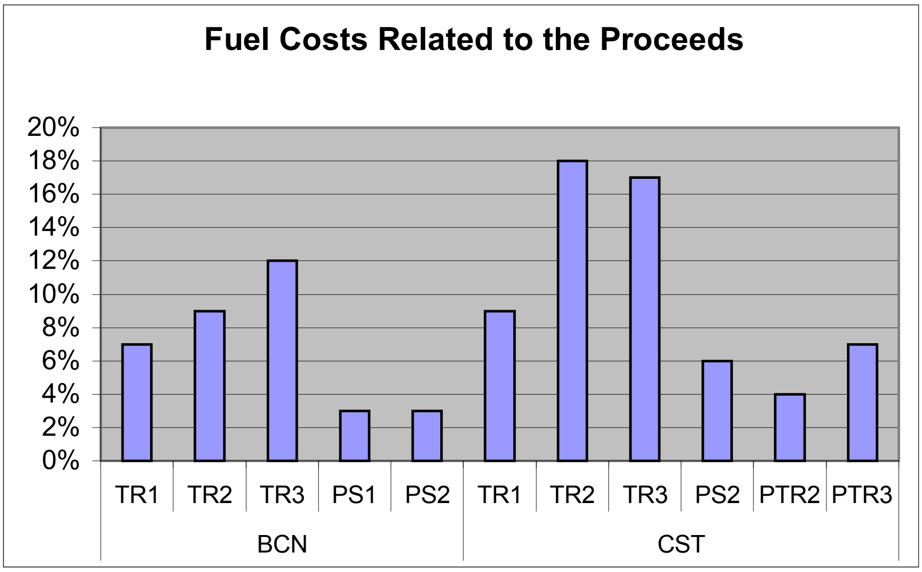
The simulated fishery follows a fairly natural course, the only exception being the trip to the Northern North Sea in November, not directly the season to venture into these inhospitable waters. The offshore England and the Friesian grounds are the most popular, as they absorb more than two thirds of the total effort, with 95 and 82 active days respectively, both grounds contributing more than one third to the total proceeds. The Danish coast and the North and South coasts of Holland only make minor contributions, that of the German Bight is practically negligible.

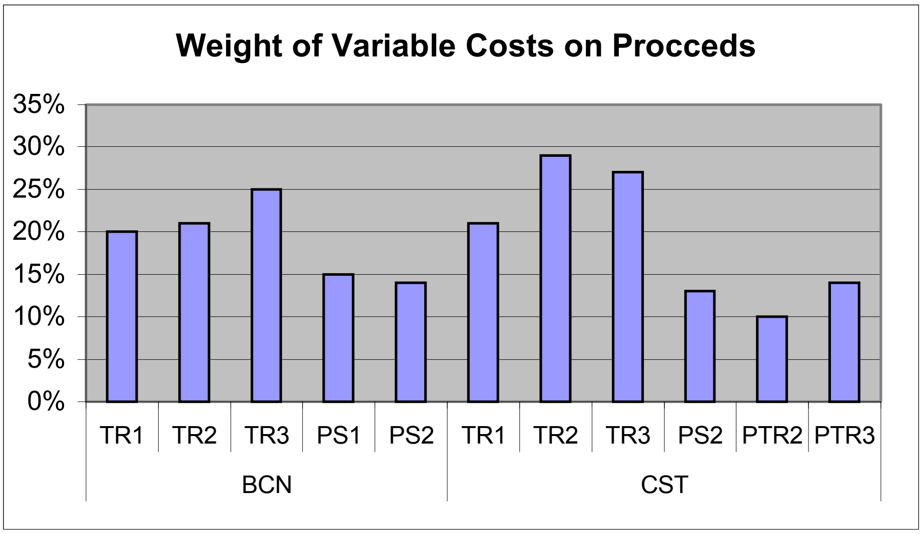
Eventually 42 days, 14 percent of the potential active days, are left unused. The 257 active days used in 47 trips indicate a total sea time of 210 days, that is exactly the same number of trips and slightly more days at sea than the standard vessel made in reality (see table above).

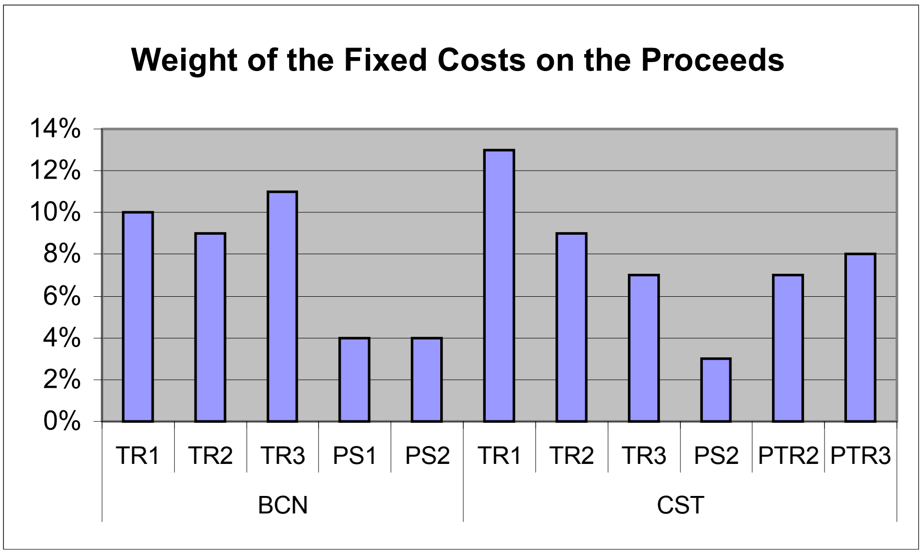
Again, as a result of the efficiency of the model, the simulated catch is slightly higher than in reality, with an almost completely exhausted plaice ITQ and a couple of percents of the sole left. The simulated proceeds are only 5% above those in reality, but the big difference is once more in the gross margin that is about 13% higher than in reality. Apparently in picking it's grounds the model is more cost efficient than real boats are.

Spain

We have worked with so many different fleet segments because of the high variability in all variables: catches, costs, fishing days, etc, existing within the Spanish Mediterranean fleet. That makes very important considering the peculiar factors when applying administrative regulations. This point can be the most relevant to be commented, relating the basic runs. It is important to have a clear idea of how the costs, wages sharing, etc. work, in order understand correctly the simulations results. Those points have been properly developed in previous chapters but we want to intensify the attention on costs structures. In the following graphics it is possible to notice how relevant are variable costs and fixed costs for the different fleet segments In addition to that, how fuel costs have an important weight in the cost structure.







From the graphics we can extract two main conclusions:

- Variable as well as fixed costs, are lower in Purse Seine and Pelagic Trawler fleets, for both harbours
- Fuel costs highly determine the variable costs of a fleet segment.

Here, in the following page there is the Whole Basic runs Results table, which is the basis for simulating administrative regulations. All the simulations asked to the model and its results are explained in chapter 10.3.

Proceeds and Costs (basic runs)

	Barcelona					Roses		Castéllo					
	TRW I	TRW II	TRW III	PS I	PS II	PS I	PS II	TRW I	TRW II	TRW III	PS II	PT II	PT III
Proceeds	16 073 089	41 527 657	50 235 232	34 610 560	45 102 067	27 236 733	32 913 617	11 270 621	20 465 149	31 363 711	42 116 959	38 865 896	37 780 699
Costs													
Wages (total)	5 038 680	12 718 880	14 761 392	9 109 209	11 887 287	8 704 520	10 203 195	4 229 193	7 043 831	10 860 487	15 934 566	15 776 043	14 513 450
per crew member	1 679 560	2 119 813	2 108 770	569 326	660 405	544 032	566 844	1 409 731	1 408 766	1 551 498	995 910	3 155 209	2 073 350
Steaming time	165 874	446 034	633 527	233 840	371 964	383 400	740 520	151 152	361 190	520 907	545 200	181 686	314 792
Effort time	2 338 784	7 781 184	10 581 928	2 181 816	2 919 973	1 973 160	3 537 156	1 851 424	3 868 400	5 800 808	4 884 180	3 243 384	5 021 848
Auction	803 654	2 076 383	2 511 762	1 730 528	2 255 103	1 361 837	1 645 681	394 472	716 280	1 097 730	1 474 094	1 360 306	1 322 324
Soc. Insurance	2 410 963	6 229 149	7 535 285	5 191 584	6 765 310	4 085 510	4 937 043	1 127 062	2 046 515	3 136 371	5 054 035	3 886 590	3 778 070
Moralla	1 028 678	2 657 770	3 215 055	2 215 076	2 886 532	1 743 151	2 106 472	-	-	-	-	-	-
Fuel oil	1 138 069	4 080 429	6 024 215	777 296	1 460 056	945 720	2 141 592	986 436	3 192 190	4 863 793	2 435 420	1 347 879	2 746 909
Lubrication oil	121 746	146 466	191 526	213 120	286 618	259 560	420 648	116 184	137 560	158 646	149 495	77 468	89 598
Ice	315 318	473 102	745 306	1 064 358	1 113 209	978 402	446 501	188 081	284 941	386 197	-	641 567	816 898
Lights	-	-	-	171 976	366 821	475 020	538 356	-	-	-	-	-	-
Store	-	-	-	-	-	-	-	-	-	-	120 785	-	-
Food & bar	177 300	426 600	489 300	473 600	250 200	2 880 000	3 672 000	-	-	-	-	-	-
Gear & rope	745 448	3 500 016	4 499 696	810 152	990 514	899 640	1 142 302	400 064	399 760	799 792	999 775	1 499 712	2 000 368
Engine	452 312	453 144	452 952	181 300	151 788	251 640	251 736	452 704	452 960	452 392	201 985	452 824	452 568
Gross Margin	3 840 920	8 765 720	9 808 744	12 672 361	16 688 628	4 651 733	5 086 694	3 376 425	6 191 111	9 608 303	14 732 806	13 823 507	12 060 514

10 Application of the model by simulating different scenarios (*country by country*)

The application of the simulation model will be started from the adapted solution elaborated in the preceding chapter, the so-called "basic solution" which is quite according to the situation in reality.

The simulation model allows to assess the economic impacts of various management decisions at the same time; the following simulation runs will demonstrate modifications of different regulatory measures and individual management decisions, as well as the impacts of varying economical and biological parameters separately. Furthermore, combinations of a variety of such measures and changing parameters will be taken into account and investigated with regard to the economic impacts (particularly the gross margins).

According to the respective situation in the participating countries and the selected fleet segments, the results of the different simulation runs are presented under separate chapters country by country. Depending on the importance within the different fisheries, most of the above mentioned biological and economical parameters as well as management measures were simulated separately and in combination.

10.1 Germany

10.1.1 Simulating different regulatory measures

Baltic cutters

In the following the simulations shall demonstrate the impacts of some regulatory measures. In practice these are mainly political decisions of the national administration or the European Commission. These decisions can be differentiated in:

- Output measures and
- input measures.

In general, output measures are directed towards the catch, regarding the quantity and the size of fish and these regulations include quotas, length of the fish, etc. Input measures mainly regulate the effort of fishing, i.e. time at sea, closure of seasons and areas, etc.

- ***Output measures (quotas)***

To demonstrate the impact of a quota reduction, the COD – quota is reduced by 30% from 300 tons to 210 tons. All other parameters are constant as described in the BASIC-solution.

In this case the simulation results show that the fisherman will fish out the available COD – quota by catching 209 tons cod requiring 163 days at sea (BASIC: 201 days) and 31 trips (BASIC: 34 trips).

The gross margin now amounts to 132 000 DM, more than 46 000 DM less than the BASIC run (178 000 DM), as result of a lower total catch (-91 tons) and reduced proceeds (-149 000 DM).

Comparison between estimated and BASIC results			
	Baltic standard cutter		
	Model calculated (estimated) results	BASIC solution	Remarks
Catch (t)	253	344	
Baltic Cod	209	300	***Quota: 210 t***
Flounder	35	35	*Limited: 35 t*
Proceeds (1000 DM)	446	595	
Days at sea	163	201	*Harbour time: 48 hours*
No. of trips	31	34	*Coercive trips except July*
Gross margin (1000 DM)	**132**	***178***	

- ***Input measures (restriction of time)***

Besides the reduction of quotas, the limitation of fishing days is discussed more and more as a measure to avoid over-fishing. The impacts of such a measure on the economic situation (gross margin) shall be demonstrated in this chapter.

Again, the BASIC solution with 201 days at sea is the standard of comparison with the following simulation results.

The first run of this chapter includes a reduction of days at sea by 10% from 201 days to 180 days while in the second simulation the number of days at sea will decrease to only 160 days (-20% of the BASIC solution).

10% Reduction of time at sea

In this case the gross margin decreases to 161 000 DM, 9% less than the BASIC solution. In order to achieve this optimum, the fisherman needs 33 trips (with 179 days at sea), nearly the same number - but shorter - trips as in the BASIC solution (34 trips). The realised catch is 312 tons (BASIC: 344 tons) representing proceeds of 530 000 DM (BASIC: 595 000 DM).

Comparison between estimated and BASIC results			
	Baltic standard cutter		
	Model calculated (estimated) results	BASIC solution results	Remarks
Catch (t)	312	344	
Baltic Cod	271	300	*Quota: 300 t*
Flounder	35	35	*Limited: 35 t*
Proceeds (1000 DM)	530	595	
Days at sea	179	201	*Harbour time: 48 hours* ***180 days***
No. of trips	33	34	*Coercive trips except July*
Gross margin (1000 DM)	**161**	***178***	

A noteworthy result of the simulation of impacts of time restriction is that there is no more the possibility to fish out the imputed Cod quota of 300 tons. Based on the existing biological (possible catch rates), price and cost situation, only a reduced catch of cod amounting to 271 tons will bring the maximum gross margin. In contrast to that the 10% reduction still allows to exhaust the total available quantity of flounder (35 tons).

20% reduction of time at sea

A further reduction of fishing days by 10% to 20% in total (160 days at sea) will reduce the gross margin to only 160 000 DM compared with 161 000 DM in the previous solution. This model-estimated small decrease of the gross margin is caused by a considerable reduction of the number of trips, from 34 in the BASIC solution to 27 trips (159 days at sea) resulting in lower costs.

Comparison between estimated and BASIC results			
	Baltic standard cutter		
	Model calculated (estimated) results	BASIC solution	Remarks
Catch (t)	307	344	
Baltic Cod	270	300	*Quota: 300 t*
Flounder	32	35	*Limited: 35 t*
Proceeds (1000 DM)	516	595	
Days at sea	159	201	*Harbour time: 48 hours* ***160 days***
No. of trips	27	34	*Coercive trips except July*
Gross margin (1000 DM)	**160**	***178***	

In this case the Cod quota cannot be exhausted and simultaneously the catch of flounder with 32 tons does not reach the limitation of 35 tons.

If all quota and limitations are cancelled and only the fishing time (days at sea) is limited to 160 days, the simulation brings a maximum gross margin of 180 000 DM, about 1 700 DM more than the BASIC solution. This outcome has been achieved by rising catches of flounders (78 tons instead of 35 tons in the BASIC solution).

Comparison between estimated and BASIC results			
	Baltic standard cutter		
	Model calculated (estimated) results	BASIC solution	Remarks
Catch (t)	356	344	
Baltic Cod	272	300	***No limit***
Flounder	78	35	***No limit***
Proceeds (1000 DM)	563	595	
Days at sea	160	201	*Harbour time: 48 hours* ***160 days***
No. of trips	27	34	*Coercive trips except July*
Gross margin (1000 DM)	**180**	***178***	

A simulation run including a 10% time reduction – otherwise the same conditions – leads to a gross margin of 195 000 DM realised by catches of flounders of about 109 tons.

Comparison between estimated and BASIC results			
	Baltic standard cutter		
	Model calculated (estimated) results	BASIC solution	Remarks
Catch (t)	411	344	
Baltic Cod	293	300	***No limit***
Flounder	109	35	***No limit***
Proceeds (1000 DM)	619	595	
Days at sea	180	201	*Harbour time: 48 hours* ***180 days***
No. of trips	30	34	*Coercive trips except July*
Gross margin (1000 DM)	**195**	***178***	

In both cases of sea time restrictions, the catch of cod did not exceed 300 tons although there were no quota limitation.

At this point doubts must be expressed if the prices of flounder – as introduced in the model (0,75 DM/kg) – are attainable when the catches of flounders are more than doubled.

10.1.2 Simulating changing economic and biological parameters

➢ ***Variations of prices***

Therefore, the following simulation runs will take into account the impact of different prices on the gross margin.

A further simulation executed with a time limitation (160 fishing days) and a reduction of flounder prices to 0,32 DM/kg estimates the following results:

Comparison between estimated and BASIC results			
	Baltic standard cutter		
	Model calculated (estimated) results	BASIC solution	Remarks
Catch (t)	354	344	***Not limited***
Baltic Cod	276	300	
Flounder	71	35	***Price: 0.32 DM/kg***
Proceeds (1000 DM)	543	595	
Days at sea	160	201	*Harbour time: 48 hours* ***160 days***
No. of trips	27	34	*Coercive trips except July*
Gross margin (1000 DM)	**170**	***178***	

Now, the maximum gross margin amounts to 170 000 DM, about 8 000 DM lower than in the BASIC solution, with catches of cod and flounder of 276 tons and 71 tons respectively requiring 27 trips (BASIC: 34 trips).

An increase of cod prices by 30% - otherwise the same data set as indicated in the BASIC solution – leads to a maximum gross margin of 251 000 DM, about 72 000 DM more than the BASIC solution. Furthermore, this price increase induces the fisherman to undertake 37 trips (+3) catching 299 tons of cod and 32 tons of flounders both species quoted by 300 tons and 35 tons respectively.

Comparison between estimated and BASIC results			
	Baltic standard cutter		
	Model calculated (estimated) results	BASIC solution	Remarks
Catch (t)	338	344	
Baltic Cod	298	300	*Quota: 300 t* ***Price: 130%***
Flounder	32	35	*Limited: 35 t*
Proceeds (1000 DM)	748	595	
Days at sea	203	201	*Harbour time: 48 hours*
No. of trips	37	34	*Coercive trips except July*
Gross margin (1000 DM)	**251**	***178***	

These results demonstrate that the modelling procedure is not only a multiplication process, but will bring also changes with regard to the use of the available time and the composition of yields.

➢ ***Increasing costs***

The next step will demonstrate the impact of costs, e.g. fuel cost on the gross margin. An increase by 30% compared with the BASIC solution leads to a reduction of the gross margin of about 12 000 DM (167 000 DM).

Comparison between estimated and BASIC results			
	Baltic standard cutter		
	Model calculated (estimated) results	BASIC solution	Remarks
Catch (t)	342	344	***Fuel price: 130%***
Baltic Cod	298	300	*Quota: 300 t*
Flounder	35	35	*Limited: 35 t*
Proceeds (1000 DM)	597	595	
Days at sea	211	201	*Harbour time: 48 hours*
No. of trips	38	34	*Coercive trips except July*
Gross margin (1000 DM)	**167**	***178***	

Noteworthy is the increased number of trips (38 trips with 211 days at sea) instead of 34 trips with 211 days in the BASIC solution.

The higher fuel price forced the fisherman to undertake more but shorter trips to nearer fishing grounds. This fact is evident when comparing the fishing areas used. For example, in this solution the Arcona Sea and the Western Baltic are used five times, compared to only one time in the BASIC solution.

➢ ***Decreasing catch rates***

In this model the biological situation of the fish resources is mainly reflected by different catch rates on the fishing areas used. Of course, these data do not describe the biological situation in a comprehensive scientific sense, but reflect the biological situation for the fisherman by representing the fishing possibilities (catchability) for the existent vessels of a specific fleet segment in quantitative terms. The reservations with regard to the quality of the data were already discussed in a previous chapter.

In the following two simulation runs the catch rates of cod and flounder are reduced by 20%, respectively.

Compared with the BASIC solution the simulation considering a 20% COD – catch rate reduction had a serious impact on the gross margin which decreased by about 35 000 DM to 143 000 DM. This solution still includes yields of 281 tons of cod and 35 tons of flounders but requires 248 fishing days and 43 trips.

Comparison between estimated and BASIC results			
	Baltic standard cutter		
	Model calculated (estimated) results	BASIC solution results	Remarks
Catch (t)	325	344	
Baltic Cod	281	300	*Quota: 300 t* ***Catch rate:80%***
Flounder	35	35	*Limited: 35 t*
Proceeds (1000 DM)	557	595	
Days at sea	248	201	*Harbour time: 48 hours*
No. of trips	43	34	*Coercive trips except July*
Gross margin (1000 DM)	**143**	***178***	

Reduced catch rates of flounders have only a negligible impact on the gross margin (177 000 DM / - 1 000 DM), the total catch (295 tons of cod and 35 tons of flounder) as well as the number of fishing days (200 days / - 1). But the result requires an increased number of (shorter) trips (37 trips / + 3).

Comparison between estimated and BASIC results			
	Baltic standard cutter		
	Model calculated (estimated) results	BASIC solution results	Remarks
Catch (t)	339	344	
Baltic Cod	295	300	*Quota: 300 t*
Flounder	35	35	*Limited: 35 t* ***Catch rate:80%***
Proceeds (1000 DM)	587	595	
Days at sea	200	201	*Harbour time: 48 hours*
No. of trips	37	34	*Coercive trips except July*
Gross margin (1000 DM)	**177**	***178***	

If both, cod and flounder catch rates are reduced by 20% simultaneously, the maximum gross margin will only become 139 000 DM (BASIC: 178 000 DM) demanding 225 fishing days (BASIC: 201 days) and 39 trips (BASIC: 34 days). While the flounder quota (35 tons) can be fully used in this solution, cod will be caught only up to 263 tons, i.e. 88% of the existing quota.

Comparison between estimated and BASIC results			
	Baltic standard cutter		
	Model calculated (estimated) results	BASIC solution results	Remarks
Catch (t)	308	344	
Baltic Cod	263	300	*Quota: 300 t* ***Catch rate:80%***
Flounder	35	35	*Limited: 35 t* ***Catch rate:80%***
Proceeds (1000 DM)	525	595	
Days at sea	225	201	*Harbour time: 48 hours*
No. of trips	39	34	*Coercive trips except July*
Gross margin (1000 DM)	**139**	***178***	

10.1.3 Simulating individual management strategies

➢ ***Choice of additional target species (e.g. sprat)***

In recent years, some of the Baltic cutters caught – besides the traditional species (Baltic) cod and flounders – sprat mainly used as raw material for fishmeal. Sprat was fished from February to May realising 0,17 DM/kg.

The following run simulates the impact of an additional catch of sprat on the gross margin, including a cod quota of 300 tons and estimated catch rates of sprat amounting to 1 000 kg/h. The simulation outcome achieves catches of 296 tons of cod, 176 tons of flounder and 168 tons of sprat, producing a maximum gross margin of 208 000 DM, about 30 000 DM more than the BASIC solution. In this case these fishing activities require 265 days at sea (+ 64 days) and 46 trips (+ 12 trips).

Comparison between estimated and BASIC results

	Baltic standard cutter		
	Model calculated (estimated) results	BASIC solution results	Remarks
Catch (t)	654	344	
Baltic Cod	296	300	*Quota: 300 t*
Flounder	176	35	***Not limited***
Sprat	168		***Febr.-May Catch rate:1 t/h***
Proceeds (1000 DM)	733	595	
Days at sea	265	201	*Harbour time: 48 hours*
No. of trips	46	34	*Coercive trips except July*
Gross margin (1000 DM)	**208**	***178***	

Apart from this serious increase of activity time it is unlikely to get the imputed price (0,75 DM/kg) for such a high catch of flounder.

Therefore, in the next simulation run the price of flounder is reduced to 0,36 DM/kg. This results in a maximum gross margin of 187 000 DM, only a little more than the BASIC solution (178 000 DM). In this case the catch consists of 299 tons of cod, 92 tons of flounder and 218 tons of sprat, but it requires 228 days and 40 trips.

Comparison between estimated and BASIC results			
	Baltic standard cutter		
	Model calculated (estimated) results	BASIC solution	Remarks
Catch (t)	621	344	
Baltic Cod	299	300	*Quota: 300 t*
Flounder	92	35	***Not limited Price: 50%***
Sprat	218		***Febr.-May Catch rate:1 t/h***
Proceeds (1000 DM)	646	595	
Days at sea	228	201	*Harbour time: 48 hours*
No. of trips	40	34	*Coercive trips except July*
Gross margin (1000 DM)	**187**	***178***	

It seems very improbable that additional sprat fishing will attract many vessels in order to gain only about 8 500 DM more than the less time absorbing BASIC solution.

If the price for flounder will decrease further to only 0,21 DM/kg, the simulated maximum gross margin (178 000 DM) is almost precisely the amount of the BASIC solution but requiring 236 days at sea and 42 trips.

Comparison between estimated and BASIC results			
	Baltic standard cutter		
	Model calculated (estimated) results	BASIC solution	Remarks
Catch (t)	660	344	
Baltic Cod	299	300	*Quota: 300 t*
Flounder	97	35	***Not limited Price: 30%***
Sprat	252		***Febr.-May Catch rate:1 t/h***
Proceeds (1000 DM)	635	595	
Days at sea	236	201	*Harbour time: 48 hours*
No. of trips	42	34	*Coercive trips except July*
Gross margin (1000 DM)	**178**	***178***	

➢ *Utilisation of supplementary fishing areas (Baltic→North Sea)*

In the past, some of the Baltic vessels fished in the Southern part of the North Sea (Danish West Coast) during the summer months, especially when fishing in the Baltic Sea was forbidden (closed season).

The following simulation runs will investigate the economic impact on the gross margin of Baltic cutters of the summer fishery in the North Sea. Primarily it has to be noted that in this case the possibilities to fish in the North Sea are limited to the months of June, July and August. The catch rates of (North Sea) cod (not quotaed) are estimated at 150 kg/h and a steaming time of 30 h is assumed.

The simulation outcome achieves a maximum gross margin of 195 000 DM, about 17 000 DM more than the BASIC solution. But this result, including catches of 294 tons of (Baltic) cod, 35 tons of flounder and 49 tons of (North Sea) cod, with 257 days and 44 trips absorbs an additional activity time of 56 days and 10 trips.

Comparison between estimated and BASIC results

	Baltic standard cutter		
	Model calculated (estimated) results	BASIC solution	Remarks
Catch (t)	390	344	
Baltic Cod	294	300	*Quota: 300 t*
Flounder	35	35	*Limited: 35 t*
North Sea Cod	49		***June and August Catch rate:150kg/h***
Proceeds (1000 DM)	679	595	
Days at sea	257	201	*Harbour time:48h* ***Steaming time:30h***
No. of trips	44	34	*Coercive trips except July*
Gross margin (1000 DM)	**195**	***178***	

If assuming only a catch rate of 100 kg cod per hour in the North Sea, the maximum gross margin (179 000 DM) will amount to almost precisely to the same result as the BASIC solution (178 000 DM), but this requires 259 days at sea and 44 trips, clearly more than in the BASIC run (201 days and 34 trips).

Comparison between estimated and BASIC results			
	Baltic standard cutter		
	Model calculated (estimated) results	BASIC solution	Remarks
Catch (t)	371	344	
Baltic Cod	296	300	*Quota: 300 t*
Flounder	33	35	*Limited: 35% t*
North Sea cod	32		***June and August Catch rate:100kg/h***
Proceeds (1000 DM)	639	595	
Days at sea	259	201	*Harbour time:48h* ***Steaming time:30h***
No. of trips	44	34	*Coercive trips except July*
Gross margin (1000 DM)	**179**	***178***	

Based on these simulations, the opportunity to fish cod in the North Sea seems to be an economically reasonable compensation only if the cod quotas or/and catch rates are decreasing further. The closure of the Baltic Sea for cod fishing in July practised at the present time, gives no incentive for Baltic cutters to change from the Baltic waters to the fishing areas of the North Sea.

North Sea cutters

10.1.1 Simulating different regulatory measures

➢ ***Output measures (quotas)***

The results of the "BASIC solution" show that the official saithe quota (1 300 t) is no catch limitation in the model, as the allowable quantity is not exhausted. Furthermore, the limitation of cod fishing (200 t) is only introduced in the model for the purpose of adaptation.

For this reason, no simulation runs with different quotas were made for the selected fleet segment of North Sea vessels.

➢ ***Input measures (restriction of time)***

The next tables demonstrate the impact of restricted fishing time by reducing the days at sea per year to 160 and 180, respectively.

Comparison between estimated and BASIC results			
	North Sea standard cutter		
	Model calculated (estimated) results	BASIC solution	Remarks
Catch (t)	1 490	1 641	
Saithe	917	1 075	*Quota: 1 300 t*
Other	573	566	*Limited: Cod 200 t* *Catch rates: 50%*
Proceeds (1000 DM)	1 836	1 945	*Price: Runavik 60%*
Days at sea	180	203	*Harbour time: 48 hours* ***180 days***
No. of trips	21	25	*Coercive trips except July Dec: Cuxhaven*
Gross margin (1000 DM)	**425**	***428***	

A limitation of fishing activities by about 10% (to 180 days per year) reduces the catch quantity by 14% to a total of 1 490 tons. But this measure has only a small impact on the gross margin which decreases to 425 000 DM, about 3 000 DM less than the BASIC solution (428 000 DM). This simulation result is achieved in 180 days and 21 trips, i.e. 23 days 4 trips less than in the BASIC solution.

Comparison between estimated and BASIC results			
	North Sea standard cutter		
	Model calculated (estimated) results	BASIC solution	Remarks
Catch (t)	1 412	1 641	
Saithe	875	1 075	*Quota: 1 300 t*
Other	537	566	*Limited: Cod 200 t* *Catch rates: 50%*
Proceeds (1000 DM)	1 659	1 945	*Price: Runavik 60%*
Days at sea	159	203	*Harbour time: 48 hours* ***160 days***
No. of trips	19	25	*Coercive trips except July Dec.: Cuxhaven*
Gross margin (1000 DM)	**396**	***428***	

The reduction of fishing days from 203 days (BASIC solution) to 160 days induces a decrease of the total catch amounting to 14%, mainly concerning saithe. As a consequence, this limited activity - demanding less number of trips (19) - results in a lower gross margin (396 000 DM/-7%) than that in the BASIC solution (428 000 DM).

10.1.2 Simulating changing economic and biological parameters

- ***Variations of prices***

The main problem of the German North Sea vessels seems to be the relatively high costs of fishing combined with the currently achievable market prices and the existing catch rates. In the following, some examples with higher prices and lower catch rates are simulated with regard to the impact on the gross margin.

The impact of an increase of saithe prices by 20% (other parameters equal to those in the BASIC solution) is demonstrated in the following table.

Comparison between estimated and BASIC results

	North Sea standard cutter		
	Model calculated (estimated) results	BASIC solution results	Remarks
Catch (t)	1 634	1 641	
Saithe	1 212	1 075	*Quota: 1 300 t* ***Price: 120%***
Other	422	566	*Limited: Cod 200 t* *Catch rates: 50%*
Proceeds (1000 DM)	2 035	1 945	*Price: Runavik 60%*
Days at sea	187	203	*Harbour time: 48 hours*
No. of trips	22	25	*Coercive trips except July Dec.: Cuxhaven*
Gross margin (1000 DM)	**496**	***428***	

This assumption leads to a higher gross margin, totalling 496 000 DM (+16%) achieved with 22 trips (-3) and 187 days (-16).

- ***Decreasing catch rates***

In practice, increasing prices are often accompanied by rising fishing effort on the fish stocks, resulting in lower catch rates on the fishing grounds. Therefore, in the following table the impact of reduced catch rates has been calculated.

Comparison between estimated and BASIC results			
	North Sea standard cutter		
	Model calculated (estimated) results	BASIC solution	Remarks
Catch (t)	1 552	1 641	
Saithe	962	1 075	*Quota: 1 300 t* ***Catch rate: 80%***
Other	590	566	*Limited: Cod 200 t* *Catch rates: 50%*
Proceeds (1000 DM)	1 778	1 945	*Price: Runavik 60%*
Days at sea	202	203	*Harbour time: 48 hours*
No. of trips	24	25	*Coercive trips except July Dec.: Cuxhaven*
Gross margin (1000 DM)	**348**	***428***	

This simulation contains a reduction of saithe catch rates by 20%, leading to a gross margin of 348 000 DM, i.e. 9% or 80 000 DM less than the BASIC solution. With 24 trips and 202 days, this result demands nearly the same activities as the BASIC solution.

- ***Increasing costs***

The impact of rising costs, e.g. an increase of fuel cost, on the gross margin is calculated and illustrated in the following table.

Comparison between estimated and BASIC results			
	North Sea standard cutter		
	Model calculated (estimated) results	BASIC solution	Remarks
Catch (t)	1 774	1 641	***Fuel price: 120%***
Saithe	1 210	1 075	*Quota: 1 300 t*
Other	564	566	*Limited: Cod 200 t* *Catch rates: 50%*
Proceeds (1000 DM)	2 043	1 945	*Price: Runavik 60%*
Days at sea	216	203	*Harbour time: 48 hours*
No. of trips	25	25	*Coercive trips except July Dec.: Cuxhaven*
Gross margin (1000 DM)	**383**	***428***	

Rising fuel prices by 20% leads to a solution presenting a decreased gross margin of 383 000 DM (-11%). This reduced result demands higher catches (1 774 tons/+8%), the same number of trips (25 trips) but 216 days at sea, 13 days more than the BASIC solution.

If this fuel price increase (+20%) is accompanied by rising prices (saithe +20%, other species +30%), there is still a positive impact on the gross margin (see next table).

Comparison between estimated and BASIC results			
	North Sea standard cutter		
	Model calculated (estimated) results	BASIC solution	Remarks
Catch (t)	1 706	1 641	***Fuel price: 120%***
Saithe	1 138	1 075	*Quota: 1 300 t* ***Price: 120%***
Other	568	566	*Limited: Cod 200 t* *Catch rates: 50%* ***Price: 130%***
Proceeds (1000 DM)	2 466	1 945	*Price: Runavik 60%*
Days at sea	211	203	*Harbour time: 48 hours*
No. of trips	25	25	*Coercive trips except July Dec.: Cuxhaven*
Gross margin (1000 DM)	**610**	***428***	

The simulation calculates a total of 610 000 DM, about 43% more than the BASIC solution (428 000 DM).

When imputing lower catch rates of saithe (-20%) in addition to the above mentioned price and cost increases, the total catch declines to 1 522 tons (BASIC: 1 641 tons) but leads to a gross margin of 511 000 DM representing an increase 83 000 DM or 19% compared with the BASIC solution. With 25 trips and 207 days at sea this simulation result demands almost the same activities as the BASIC solution.

Comparison between estimated and BASIC results			
	North Sea standard cutter		
	Model calculated (estimated) results	BASIC solution	Remarks
Catch (t)	1 522	1 641	***Fuel price: 120%*** *Quota: 1 300 t*
Saithe	959	1 075	***Price: 120%*** ***Catch rate: 80%***
Other	563	566	*Limited: Cod 200 t* *Catch rates: 50%* ***Price: 130%***
Proceeds (1000 DM)	2 227	1 945	*Price: Runavik 60%*
Days at sea	207	203	*Harbour time: 48 hours*
No. of trips	25	25	*Coercive trips except July Dec.: Cuxhaven*
Gross margin (1000 DM)	**511**	***428***	

The latter result illustrates to a large extent the actual economic situation of the selected fleet segment of German (North Sea) cutters.

Without discussing the examples of the model application presented above in detail, it can be stated that the existing quota of Baltic cod (300 t) seems to be in fact a limitation for the fishing activities of Baltic cutters to achieving better economic results.

In contrast to this, the quota of saithe obviously do not represent a limitation for the activities of the North Sea cutters, because these vessels never exceed the saithe quota of 1 300 tons in the model solutions. Rather, the existing cost structure in combination with the achievable catch rates on the fishing grounds used and the market prices prevent further fishing before reaching the quota limitation.

The selected target entity “gross margin” is another fact demanding attention. As an economic interim result, this figure has exceptional importance in relation to the economic performance. But some simulation results, particularly in the Baltic fleet segment, show that sometimes a small improvement of the gross margin requires a significantly higher number of days at sea. Therefore, in practice the fisherman may decide to stay in port although an additional improvement of the gross margin is possible. Because of that fact, in principle but not always in practice the *gross margin* will represent the target of the fishermen's behaviour.

10.2 The Netherlands

10.2.1 Simulating different regulatory measures

The simulation model has been run for each of the Dutch standard vessels with basically the same regulatory measures. As an output measure the quotas of the main target species are reduced; as an input measure the number of allowed days at sea is restricted.

➤ ***Output measures (quotas)***

For both the Eurocutter and the 2000 HP beam trawler, a reduction of the plaice quota by 15% and of the sole quota by 10% without changing the catch rates has been simulated.

In the following table the results of this simulation for the Eurocutter are compared with the basic run.

Comparison between estimated and BASIC results			
ITQ plaice -15% ITQ sole -10%	**Eurocutter**		
	Model calculated (estimated) results	BASIC solution	Remarks
Catch (t)	189,5	193,0	
Plaice	41,0	45,3	*ITQ: 62.9*
Sole	23,3	25,0	*ITQ: 25.7*
Cod	25,8	24,2	
Shrimp	60,6	58,5	
Proceeds (1000 NLG)	989,5	1.012,5	
Days at sea	157	159	
No. of trips	66	67	
Gross margin (1000 NLG)	**413,9**	**424,6**	

It appears that such rather severe quota reductions of the main target species (with unchanged catchability) affect the results of the Eurocutter only to a small extent. Part of the quota reductions can be compensated by making extra shrimping (2) and pair trawling (1) trips, while on the other hand the sole ITQ is still not completely caught. Total proceeds are only 2% lower and the gross margin is just 11 000 guilders or 2.5% lower than in the basic run.

For the large beamer the effect of the quota reductions is more serious, although still less than might be expected, as appears from the following table.

Comparison between estimated and BASIC results			
ITQ plaice -15% ITQ sole -10%	2000 HP beam trawler		
	Model calculated (estimated) results	BASIC solution	Remarks
Catch (t)	458,8	504,3	
Plaice	220,8	259,1	*ITQ: 220.9*
Sole	112,7	122,1	*ITQ: 112.8*
Proceeds (1000 NLG)	2.872,2	3.093,8	
Days at sea	193	210	
No. of trips	41	47	
Gross margin (1000 NLG)	**1.289,7**	**1.383,3**	

Both ITQs are practically completely caught, but the total catch is less than 10% below that of the basic run. Some compensation has been found in increased by-catches of flatfish, which is quite in accordance with actual practice. The fishery is now highly concentrated offshore England and these grounds contribute about three-quarters to total catches and proceeds. As a result, the proceeds are only some 7% lower than those of the basic run and so is the gross margin. Apparently, in spite of the exclusion of price flexibility from the model, higher average prices can be realised. In addition, more than half of the loss in proceeds is compensated by lower costs, partly resulting from the reduction in number of trips and days at sea.

➢ ***Input measures (restriction of time)***

As an input measure the allowed number of days at sea was reduced to 130 days for the Eurocutter and to 170 for the 2000 HP beam trawler. This reduction of sea time by nearly 20% is more or less in line with the reductions that have been applied in 1999 to the Dutch cutter fleet segments as a consequence of MAGP IV. In order to realise this reduction, for both standard vessels a regular pattern of temporary lay up days per month was introduced in the model.

The following table gives a comparison of the results of the Eurocutter under this restriction and the basic run.

Comparison between estimated and BASIC results			
Days at sea maximum: 130	Eurocutter		
	Model calculated (estimated) results	BASIC solution	Remarks
Catch (t)	161,7	193,0	
Plaice	39,3	45,3	*ITQ: 74.4*
Sole	24,9	25,0	*ITQ: 28.6*
Cod	24,9	24,2	
Shrimp	36,6	58,5	
Proceeds (1000 NLG)	851,0	1.012,5	
Days at sea	130	159	*maximum:130*
No. of trips	50	67	
Gross margin (1000 NLG)	**354,9**	**424,6**	

The reduction of sea time by nearly 20% for the Eurocutter results in a reduction of both catches and proceeds by 16% and the gross margin is reduced to the same extent. The plaice ITQ take up is reduced by nearly 15%, but the sole ITQ is caught to nearly the same extent as in the basic run and the cod catch is even slightly higher. In fact the restriction only seriously affects the non-quota shrimp fishery, that is reduced by more than one-third. So the measure hardly reduces the fishing pressure of the Eurocutter on the vulnerable target species as it is intended to, and as such is ineffective.

For the 2000 HP beam trawler the measure is effective, although not to the extent that one might expect, as appears from the table below.

Comparison between estimated and BASIC results			
Days at sea maximum: 170	**2000 HP beam trawler**		
	Model calculated (estimated) results	BASIC solution results	Remarks
Catch (t)	431,7	504,3	
Plaice	231,7	259,1	*ITQ: 259.9*
Sole	103,9	122,1	*ITQ: 125.3*
Proceeds (1000 NLG)	2.600,2	3.093,8	
Days at sea	170	210	*maximum: 170*
No. of trips	34	47	
Gross margin (1000 NLG)	**1.169,6**	**1.383,3**	

The nearly 20% reduction of effort (sea time) results in a reduction of catches and proceeds of only around 15% compared to the basic run and a similar reduction of the gross margin. The sole catch is reduced by this general percentage, but the plaice catch is only down by 10%. Most of the catch reduction is coming from the by-catches that are about 22% lower than in the basic run. Again, this is not really the effect that the measure is aiming at.

Part of the limited effect of the measure lies in the shift of effort to more nearby grounds: whereas in the case of reduced quotas the fishery was concentrating on the grounds offshore England, the fishery now concentrates on the Friesian grounds with reduced days at sea. This results in about 4 hours extra actual fishing time per trip. Another factor raising the efficiency of the beamer is the fact that only full week trips are used to fill up the restricted sea time, resulting in the most efficient ratio between fishing time and trip duration. In this case the input into the model has been specially arranged to that effect. It is not at all sure that skippers can arrange it that way in practice as well, so in reality the outcome would most probably be less relatively favourable.

It is interesting to note that for both types of regulatory measures the resulting economic effects are less severe than would be expected at first sight. Apparently there are internal compensating mechanisms that can alleviate the effects of drastic measures to a certain extent, even when price flexibility is not taken into account.

10.2.2 Simulating individual management strategies

For each standard vessel an individual management strategy has been chosen. The Eurocutter skipper has decided not to use the port of Havneby and to fish only from the homeport IJmuiden. The skipper of the 2000 HP beam trawler is reducing his activity in January and February, aiming at better quality plaice that fetches higher prices later in the year.

➢ ***Choice to fish from the homeport only (Eurocutter)***

For a Eurocutter skipper the decision to make trips only from the homeport excludes the possibility to exploit the prolific shrimp grounds in the Sylt area, using the port of Havneby as a basis. Seeing that in the basic run considerable effort is put into this fishery in spring as well as in the fall, it is to be expected that a decision like this can only be to the detriment of the economic result. The table below confirms this expectation, although the differences are rather marginal: catches, proceeds and gross margin are all reduced by less than 5%.

Comparison between estimated and BASIC results			
No fishing from Havneby	**Eurocutter**		
	Model calculated (estimated) results	BASIC solution	Remarks
Catch (t)	185,8	193,0	
Plaice	42,2	45,3	*ITQ: 74.4*
Sole	27,4	25,0	*ITQ: 28.6*
Cod	25,5	24,2	
Shrimp	48,4	58,5	*not from Havneby*
Proceeds (1000 NLG)	981,3	1.012,5	
Days at sea	157	159	
No. of trips	65	67	
Gross margin (1000 NLG)	**404,8**	**424,6**	

Like before, we see a compensatory mechanism limiting the damage of reduced shrimp catches and returns by a slight increase and shift of effort to the second half of the year of beam trawling and a small but successful shift of pair trawling effort to the first half year. In total a couple of trips and a couple of days at sea less are made, seeing to some reduction of costs.

All in all it might well be that in practice the differences would be negligible, as the model does not take into account the extra costs of operating from Havneby, like the trip(s) from homeport to Havneby and back and the extra crew travelling involved.

➢ ***Temporary lay up in January and February (2000 HP beam trawler)***

The annual spawning run of plaice in the first months of the year provides for quite attractive catch rates, but the quality of the spawning and spent plaice is bad and in combination with high landings this results in low prices. However, the high catch rates generally prevail over the low prices, so as a whole the fishery tends to be profitable.

Already for decades, plaice processors have tried to discourage this fishery, as the filleting yield of the lean plaice is low. Certainly in a quota situation, landing such poor fish instead of the better quality that can be caught later in the year seems to be a waste. This point has also been taken up by fisheries organisations and occasionally they have succeeded in agreeing on temporary lay up schemes during January and February. The present simulation is meant to demonstrate what the effect would be of a similar voluntary lay up period for a single 2000 HP beamer. The result is shown in the table below.

Comparison between estimated and BASIC results			
Reduced activity in January and February	**2000 HP beam trawler**		
	Model calculated (estimated) results	BASIC solution results	Remarks
Catch (t)	514,8	504,3	
Plaice	259,8	259,1	*ITQ: 259.9*
Sole	123,8	122,1	*ITQ: 125.3*
Proceeds (1000 NLG)	3.166,4	3.093,8	
Days at sea	218	210	*one week lay up in Jan and Feb each*
No. of trips	49	47	
Gross margin (1000 NLG)	**1.407,0**	**1.383,3**	

Rather surprisingly, the result is even slightly better than that of the basic run that is supposed to represent the best result that could be reached when the operator was left free, apart from the ITQs of plaice and sole. The reason for this is a technical one, connected to the model itself. Solving the model stops as soon as the process comes up with a solution that is within a certain margin from the ideal LP solution. In the case of the basic solution, the margin with the ideal solution is larger than in the present simulation. (The 24 000 guilders difference in gross margin represents less than 2% margin!) The present solution suggests that the set of possible solutions form a plateau with only small differences in height and that the model just picks the first little knoll that has an acceptable height (close enough to the ideal top).

Still, the present solution suggests that the skipper of a big beamer does not have to lose anything if he decides to go for the better quality plaice later in the year. Even with the lay up time in the early months, the model leaves 20 days unused in April and May, like in the basic run. The grounds offshore England contribute nearly half of the catches and proceeds and the Friesian grounds a quarter, a small but significant shift from the basic run.

10.2.3 Simulating changing economic and biological parameters

Like in the ones above, the simulations under this heading were not made for both Dutch standard vessels. A variation of landing prices was only simulated for the Eurocutter with a drop of the shrimp price. Increasing costs caused by a rise of the fuel oil price were only simulated for the 2000 HP beam trawler, and so was a decrease of the catch rate of sole.

- ***Variations of prices***

A drop in the shrimp price by 25% has been simulated for the Eurocutter. Such drops and more severe ones used to be no exception in the North Sea shrimp fishery. Only in the last couple of years Producer Organisations from the Netherlands, Germany and Denmark have succeeded to arrive at agreements on fishery restrictions in order to keep prices at an acceptable level.

The result of this simulation is compared to the basic run in the following table.

Comparison between estimated and BASIC results			
25% price drop of shrimp	**Eurocutter**		
	Model calculated (estimated) results	BASIC solution	Remarks
Catch (t)	198,2	193,0	
Plaice	63,2	45,3	*ITQ: 74.4*
Sole	27,0	25,0	*ITQ: 28.6*
Cod	25,5	24,2	
Shrimp	40,3	58,5	*25% lower price*
Proceeds (1000 NLG)	942,8	1.012,5	
Days at sea	160	159	
No. of trips	66	67	
Gross margin (1000 NLG)	**380,2**	**424,6**	

The drop of the shrimp price brings about considerable changes in the fishing pattern and the catch composition of the Eurocutter. Fishing for shrimp has clearly become less attractive and the number of shrimping trips is reduced from 27 to 20. Consequently catches of shrimp are down by more than 30% and the returns from shrimp drop from nearly 240 000 guilders to less than 175 000 NLG. Some compensation of the loss in proceeds is found by an increase of the beam trawling effort in the second half year, increasing the plaice catch by 40%. In addition, the sole catch and the cod catch are up slightly. Still, total proceeds are about 7% lower than in the basic run and as effort has shifted from cheap shrimping to expensive beam trawling, the loss in gross margin is more than 10%.

➢ ***Increasing costs***

A 40% rise of fuel prices has been simulated for the 2000 HP beam trawler. A rise like this may seem to be rather extreme, but events in 1999 show that boat operators can experience such fuel price rises on rather short notice as a result of a combination of only minor shifts in US$ exchange rates and world oil production levels. In the Dutch situation, for part of the operators this resulted within one year in an increase of the fuel price from about 22 ct/l to about 30 ct/l.

The effects of this operating cost increase are shown and discussed below.

Comparison between estimated and BASIC results			
40% rise of fuel oil price	**2000 HP beam trawler**		
	Model calculated (estimated) results	BASIC solution	Remarks
Catch (t)	514,6	504,3	
Plaice	258,0	259,1	*ITQ: 259.9*
Sole	125,3	122,1	*ITQ: 125.3*
Proceeds (1000 NLG)	3.181,1	3.093,8	
Days at sea	215	210	
No. of trips	48	47	
Gross margin (1000 NLG)	**1.322,5**	**1.383,3**	*40% higher fuel cost*

At first sight, the results of this simulation look more or less the same as those of the temporary lay up in January and February. The catches are quite similar, with a little bit less plaice and a little bit more sole. Total proceeds are just a little bit higher than in that case, with one trip and three days at sea less. The big difference of course is in the gross margin, that is 85 000 guilders or 6% lower than in the temporary lay up case. With the Dutch sharing system for crew wages, the owner is not the only one to loose, as the crew wages are down by 46 000 guilders, more than 5%. In this way the extra steaming costs of 28 000 NLG and the extra effort costs of 117 000 NLG are shared between owner and crew.

Again the offshore England and Friesian grounds contribute most to the proceeds: 57% and 26% respectively. Rather surprisingly the contribution of the nearby grounds off the North and South coast is reduced compared to the basic run and the temporary lay up simulation to a mere 7%.

➢ ***Decreasing catch rates***

A decrease of the sole catch rates by 20% (without changing the ITQ) has been simulated for the 2000 HP beam trawler. The result is summarised in the table below.

Comparison between estimated and BASIC results			
sole catch rates 20% down	**2000 HP beam trawler**		
	Model calculated (estimated) results	BASIC solution	Remarks
Catch (t)	501,7	504,3	
Plaice	257,1	259,1	*ITQ: 259.9*
Sole	112,9	122,1	*ITQ: 125.3*
Proceeds (1000 NLG)	2.976,1	3.093,8	
Days at sea	228	210	
No. of trips	49	47	
Gross margin (1000 NLG)	**1.267,3**	**1.383,3**	

The drop in sole catch rates has considerable consequences for the economic results of the beamer. Total catches are slightly lower than those of the basic run and so are the plaice catches. The sole catch is some 8% lower than in the basic run, but higher by-catches provide for some compensation. Total proceeds are 4% below those of the basic run as a result of lower sole proceeds.

Two extra trips and 18 extra days at sea are insufficient to catch the ITQs, but still some days have been left unused. This lay up time is shifted from April and May to February, when only half of the available days is used. The fishing pattern is not very different from that of the basic run, with about 70% of catches and proceeds coming from the offshore England and Friesian grounds in more or less equal shares. The grounds off the Danish and the North coast make further substantial contributions (8% and 11% respectively).

The final result of this all is that the gross margin is 116 000 NLG (8%) lower than in the basic run. This demonstrates that when quotas are higher than the actual fishing opportunities allow, economic efficiency is reduced, as fishermen, like the model, will go out and try to catch their quotas as long as the trip result contributes to the gross margin.

The simulations presented in this chapter very well demonstrate the potential of this model to cope with a wide variety of changes in the operational environment of various fleet segments and to come up with quite viable and realistic results. It is interesting to note that even the simple and straightforward changes of single factors simulated here bring about complex changes in operational pattern, generally directed at somehow compensating for the negative effects of the change. This very well reflects what happens in reality and fairly often surprises fishery policy makers and managers. This model, if used judiciously, could contribute to the reduction of the occurrence of such mostly unpleasant surprises.

10.3 Spain

10.3.1 Simulating different regulatory measures

We have experimented with some important scenarios in the field of management. The most important simulations have been made on: time restrictions, price and costs variations and effort reduction. Those limits are usually implemented by establishing limitations on the number of active vessels licenses, the vessels power, he possible active days or allowed timetable or by establishing closed seasons.

In the Spanish case we haven't estimated changes based in output measures because in the Mediterranean area we don't have those sort of restrictions. The reason is in there are so many harbours and vessels that would be impossible or not rational to establish TAC's or ITQ's restrictions. Instead of that, the Spanish government uses effort and time restrictions to get sustainability aims. The following table shows all the questions put to the model.

It has to be remarked that in general the model arrives at the theoretically expected results, so it has been successful in its task. In the following points some of the questions are commented which give peculiar results or otherwise require explanation.

SIMULATION EXAMPLES

	QUESTION		HYPOTHESIS	*OBSERVED OUTCOMES*		*EFFECTS*
1)	Reducing two months the fishing time (16%). The selected months are the month with minor income from landings	a)	Constant catches (increasing catchability + 16%) Constant fish prices	PROFIT WAGES	▼	Variable Costs
		b)	Catches reduction - 16% (constant catchability) Constant fish prices	PROFIT WAGES	▼ ▼	Variable Costs Landing Value 16%
		c)	Catches reduction - 16% (constant catchability) Increasing fish prices + 16%	PROFIT WAGES	▼ ▼ ▲	Variable Costs Landing Volume 16% Landing Prices 16%
2)	Reducing one day per week (Wednesday)	a)	Constant catches (increasing catchability + 20%)	PROFIT WAGES	▼ ▲	Variable Costs Landings Value
		b)	Catches reduction - 20% (constant catchability) increasing fish prices + 5%	PROFIT WAGES	▼ ▼ ▲	Variable Costs Landing Volume 20% Landing Prices
3)	Enlarging one day per week	a)	Constant catches (decreasing catchability - 19%) Constant fish prices	PROFIT WAGES	▲	Variable Costs
		b)	Catches enlargement + 20% (constant catches) Constant fish prices	PROFIT WAGES	▲ ▲	Variable Costs Landing Value 20%
4)	Effort Reduction (- 16%, equal to 2 months)	a)	Constant catches (increasing catchability + 16%) Constant fish prices	PROFIT EMPLOYMENT WAGES	▼ ▼	Variable Costs Fix Costs
		b)	Catches reduction + 16% (catchability constant) Constant fish prices	PROFIT EMPLOYMENT WAGES	▼ ▼ ▼	Variable Costs Fix Costs Landing Volume 16%
		c)	Catches reduction - 16% (constant catchability) Increasing fish prices + 16%	PROFIT EMPLOYMENT WAGES	▼ ▼ ▼	Variable Costs Fix Costs Landings Value
5)	Increasing the fuel price, from 21ptas. to 50ptas.	a)	Potential effects in the different fleets segments at short term No changes in catches No changes in the number of Vessels	COMPARATIVE GROSS MARGIN BETWEEN SEGMENTS	▼	Profit

In the following two pages the results of the simulations are given, in absolute values respectively as indexes, taking the basic run as 100.

Application Results of different Scenarios (absolute values)

Experiment	Fleet Segment Outcomes	TR I , BCN	TR II, BCN	TR III, BCN	PS I, BCN	PS II, BCN	TR I, CST	TR II, CST	TR III, CST	PS II, CST	PT II, CST	PT III, CST
Basic Run	gross margin	3 840 920	8 765 720	9 808 744	12 672 361	16 688 628	3 376 425	6 191 111	9 608 303	14 732 806	13 823 507	12 060 514
	wages	5 038 680	12 718 878	14 761 390	9 109 209	11 887 287	4 229 193	7 043 830	10 860 486	15 934 566	15 776 045	14 513 450
	proceeds	16 073 089	41 527 657	50 235 232	34 610 560	45 102 067	11 270 621	20 465 149	31 363 711	42 116 959	38 865 896	37 780 699
1.a)	gross margin	4 282 785	9 764 586	11 723 153	13 376 137	18 320 957	3 489 720	6 385 367	10 020 098	15 476 406	14 803 408	12 901 807
	wages	5 334 618	13 100 586	15 953 098	9 462 272	12 854 970	4 183 728	7 067 545	11 019 253	16 429 526	16 482 225	14 949 669
	proceeds	16 641 699	41 575 394	52 164 723	35 436 532	47 958 985	10 923 297	19 736 607	30 542 888	42 603 174	40 289 743	38 243 534
1.b)	gross margin	3 459 938	7 686 781	9 127 786	11 306 817	15 496 652	2 850 768	5 226 823	8 223 820	13 062 271	12 445 478	10 676 466
	wages	4 511 778	11 022 780	13 357 729	8 082 736	10 972 098	3 544 776	5 909 000	9 222 969	14 015 391	14 124 295	12 724 327
	proceeds	14 346 293	35 840 857	44 969 589	30 548 734	41 343 952	9 416 635	17 014 316	26 330 076	36 726 874	34 732 537	32 968 564
1.c)	gross margin	4 304 648	9 797 091	11 775 596	13 465 269	18 417 850	3 502 399	6 404 214	10 045 861	15 545 008	14 848 970	12 957 891
	wages	5 356 488	13 133 094	16 005 542	9 521 696	12 919 572	4 196 407	7 086 390	11 045 013	16 498 128	16 527 785	15 005 753
	proceeds	16 641 699	41 575 394	52 164 723	35 436 532	47 958 985	10 923 297	19 736 607	30 542 888	42 603 174	40 289 743	38 243 534
2.a)	gross margin	4 370 973	10 855 634	12 444 420	14 234 107	18 735 053	3 982 901	7 289 616	10 739 359	16 601 381	15 528 681	13 964 852
	wages	5 398 494	14 241 672	16 695 623	10 056 587	13 147 475	4 713 197	8 021 160	11 809 879	17 637 381	17 207 500	16 080 232
	proceeds	16 770 846	44 776 052	54 229 492	37 557 390	49 001 423	12 213 028	22 187 861	32 713 280	45 745 886	41 966 582	40 984 046
2.b)	gross margin	3 541 328	8 149 863	9 182 200	11 579 575	16 145 750	3 118 679	5 714 708	8 814 286	13 467 442	12 558 637	11 080 967
	wages	4 568 847	11 535 906	13 433 399	8 286 898	11 421 273	3 848 975	6 446 252	9 884 806	14 503 442	14 237 455	13 196 344
	proceeds	14 457 626	37 313 377	45 191 243	31 297 825	42 876 245	10 177 524	18 489 884	28 201 104	38 121 571	34 972 152	34 153 371
3.a)	gross margin	3 580 401	7 196 986	7 694 181	13 406 294	18 176 635	3 045 287	5 600 460	9 608 303	14 782 380	14 804 568	12 485 918
	wages	4 944 600	12 017 508	13 752 144	9 830 729	13 164 182	4 093 103	6 646 164	10 860 486	16 340 524	17 541 770	15 906 527
	proceeds	16 309 035	41 001 021	4 913 170	37 973 568	50 820 633	11 246 548	20 415 333	31 363 711	44 087 150	43 704 100	42 408 584
3.b)	gross margin	4 950 492	10 681 437	11 881 890	17 176 404	23 085 846	4 164 296	7 638 345	11 833 963	19 026 783	19 153 655	16 680 994
	wages	6 314 691	15 501 954	17 939 852	12 344 136	16 436 990	5 212 112	8 684 049	13 365 131	20 584 927	21 890 855	20 101 606
	proceeds	20 134 611	50 618 545	61 127 371	46 880 949	62 321 994	13 884 627	25 204 115	38 549 762	54 428 580	53 955 678	52 356 276
4.a)	gross margin	3 976 458	9 319 299	10 587 794	12 549 361	16 549 275	3 470 380	6 345 858	9 830 227	14 659 220	13 817 069	12 250 645
	wages	4 982 577	12 639 954	14 748 020	8 921 454	11 672 539	4 186 705	7 062 145	10 882 061	15 668 699	15 457 200	14 311 108
	proceeds	15 661 618	40 464 549	48 949 210	33 724 529	43 947 454	10 982 093	19 941 241	30 560 800	41 038 765	37 870 929	36 813 513
4.b)	gross margin	3 202 686	7 297 167	8 153 284	10 581 018	13 962 190	2 827 880	5 175 408	8 033 069	12 335 792	11 600 985	10 109 423
	wages	4 208 805	10 617 822	12 313 511	7 609 225	9 947 816	3 544 205	5 891 695	9 084 904	13 345 270	13 241 115	12 169 892
	proceeds	13 501 395	34 883 232	4 294 595	29 072 870	37 885 737	9 467 322	17 190 725	26 345 517	35 378 246	32 647 352	31 735 787
4.c)	gross margin	3 976 458	9 351 092	10 637 878	12 635 191	19 744 196	3 483 019	6 365 006	9 856 179	14 727 361	13 860 182	12 305 540
	wages	5 003 766	12 671 748	14 798 105	8 978 674	13 802 490	4 199 344	7 081 290	10 908 014	15 736 840	15 500 315	14 366 009
	proceeds	15 661 618	40 464 549	48 949 210	33 724 529	50 979 047	10 982 093	19 941 241	30 560 800	41 038 765	37 870 929	36 813 513
5.a)	gross margin	3 055 111	5 948 281	5 649 167	12 028 316	15 478 868	2 695 315	3 986 980	6 249 970	13 051 206	12 892 828	10 163 838
	wages	4 252 872	9 901 440	10 601 815	8 679 845	11 080 780	3 548 083	4 839 700	7 502 154	14 252 966	14 845 365	12 616 772
	proceeds	16 073 089	41 527 657	50 235 232	34 610 560	45 102 067	11 270 621	20 465 149	31 363 711	42 116 959	38 865 896	37 780 699

Application Results of different Scenarios (relative values)

Experiment	Fleet Segment Outcomes	TR I , BCN	TR II, BCN	TR III, BCN	PS I, BCN	PS II, BCN	TR I, CST	TR II, CST	TR III, CST	PS II, CST	PT II, CST	PT III, CST
Basic Run	gross margin	100	100	100	100	100	100	100	100	100	100	100
	wages	100	100	100	100	100	100	100	100	100	100	100
	proceeds	100	100	100	100	100	100	100	100	100	100	100
1.a)	gross margin	112	111	120	106	110	103	103	104	105	107	107
	wages	106	103	108	104	108	99	100	101	103	104	103
	proceeds	104	100	104	102	106	97	96	97	101	104	101
1.b)	gross margin	90	88	93	89	93	84	84	86	89	90	89
	wages	90	87	90	89	92	84	84	85	88	90	88
	proceeds	89	86	90	88	92	84	83	84	87	89	87
1.c)	gross margin	112	112	120	106	110	104	103	105	106	107	107
	wages	106	103	108	105	109	99	101	102	104	105	103
	proceeds	104	100	104	102	106	97	96	97	101	104	101
2.a)	gross margin	114	124	127	112	112	118	118	112	113	112	116
	wages	107	112	113	110	111	111	114	109	111	109	111
	proceeds	104	108	108	109	109	108	108	104	109	108	108
2.b)	gross margin	92	93	94	91	97	92	92	92	91	91	92
	wages	91	91	91	91	96	91	92	91	91	90	91
	proceeds	90	90	90	90	95	90	90	90	91	90	90
3.a)	gross margin	93	82	78	106	109	90	90	100	100	107	104
	wages	98	94	93	108	111	97	94	100	103	111	110
	proceeds	101	99	10	110	113	100	100	100	105	112	112
3.b)	gross margin	129	122	121	136	138	123	123	123	129	139	138
	wages	125	122	122	136	138	123	123	123	129	139	139
	proceeds	125	122	122	135	138	123	123	123	129	139	139
4.a)	gross margin	104	106	108	99	99	103	102	102	100	100	102
	wages	99	99	100	98	98	99	100	100	98	98	99
	proceeds	97	97	97	97	97	97	97	97	97	97	97
4.b)	gross margin	83	83	83	83	84	84	84	84	84	84	84
	wages	84	83	83	84	84	84	84	84	84	84	84
	proceeds	84	84	9	84	84	84	84	84	84	84	84
4.c)	gross margin	104	107	108	100	118	103	103	103	100	100	102
	wages	99	100	100	99	116	99	101	100	99	98	99
	proceeds	97	97	97	97	113	97	97	97	97	97	97
5.a)	gross margin	80	68	58	95	93	80	64	65	89	93	84
	wages	84	78	72	95	93	84	69	69	89	94	87
	proceeds	100	100	100	100	100	100	100	100	100	100	100

➢ ***Input measures (restriction of time)***

In the following points, we will see how proper time restrictions can be determined by catchability variations. Depending on it, these measures will involve good, medium or bad results. But this parameter is a biological one. It has been determined exogenously and it is not enclosed by the model itself. Therefore, it is very important to be very careful in how we interpret the results of this scenario. We control the effort time but not the stock evolution, so if we assume a hypothesis of an increasing catchabilty it has to be considered as well, the possibility of a catchabilty decrease or a maintainment in the situation.

On the other hand, there are the prices fluctuations. Although some prices reactions can be known by the manager experience, prices must be taken as a very important factor, which highly affects the results. This is not a completely exogenous factor, the amount of fish brought to the market affects its price, but the linking mechanism between quantity and price is not authomatic or easy to calculate by a formula. So, we have considered it as another factor to have into account in our simulations, and we have established it by hypothesis.

***Question 1)* Reducing two months the fishing time, near 16%**

In the first case there is an initial assumption of 2 months time reduction, in those months with minor incomes from landings.

Here, it is important to take into account the way used by the model to apply, in practise, this time reduction. First of all, incomes from landings in all the cases are studied. When we have all the 1995 year incomes, we choose for each fleet segment those two months with minor proceeds. They haven't to be the same two months for each segment. After that, we extract those months from the input proceeds data and use the other ones to calculate the annual incomes. The choice is made based only in the incomes from 1995 landings data.

The **1.a), 1.b)** and **1.c)** simulations are reliable for playing with results on 1995, but it has to be studied very careful how it would work for the following years. It would be necessary to have a long/mid term series in order to have a suitable incomes distribution and results possible to be extrapolate.

Question 1.a) Constant prices, catchability increase 16%

Although the fishing time has been reduced, the same fish volume is caught, due to a proportional increase in the catchability, and it has no different revenues in the market, because prices are constant.

Constant fish prices, means that for those months, which don't have the minor incomes from landings, we maintain *ceteris paribus* the existing prices. This simulation gets the following results:

In some cases the effects on the *Gross Margin* represents only about a 5% increase. What it is relevant are those cases in which the increase is nearly 10% on the *Gross Margin*. This is the situation of the main part of the Barcelona fleet, excepting PS1. The meaning of the obtained results is that the decrease in the variable costs is general for all the fleet segments, due to the reduction in fishing time, and that it has positive effects on profits of all the fleet segments. Moreover, this performance improvement is major in **1.a)** that in **4.a),** because the effort reduction is implemented by choosing the rejected months.

In **4.a)** we are going to find that the explanation in the costs variability among groups is the different cost structures but here, this fact only can explain a little part of the variation. The most important observed fact here comes from the rejected months choose.

In general, when we talk on P*roceeds*, *Wages* and *Gross Margin,* we find better results in the Barcelona harbour than in the Castelló one. The explanation comes from the different prices variation in one port and the other. If prices variability is higher in one port, difference between highest and lowest prices is bigger. That makes that skipping two months for a harbour with highly low prices in one months, affects in a more important way than in the case that prices have soft variations.

The effect of rejecting the two chosen months in BCN Trawler is very important and the cost structure cannot totally explain it. Therefore, that means that in the Basic Run situation, the fleet was fishing during two non-highly profitable months. To fish during inefficient months was making low the incomes and was producing some avoidable costs. In the simulation, when we avoid those two months we are not only permitting the resource recovering, but eliminating an inefficiency factor.

Another important conclusion can be obtained by the results on **1.a)** simulation. If we observe *Wages* we find that they don't decrease but increase in most of the cases. As it has been already explained, wages in the Mediterranean Spanish area, are shared basing in the weekly part system. Therefore, wages are directly proportional to the Gross Margin. The interpretation to that is the effect of closing the fishing activity for two months, when we choose the correct ones, can have positive results on the crew situation. It can be seen as an improvement of their situation, because they must work less time and receive the same or higher incomes for their work.

Question 1.b) Catches reduction 16%

When a time reduction affects proportionally catches in the proportion caught during the rejected months, and we don't get higher prices than the expected ones it obviously produces a negative evolution in *Proceeds*, *Profit* and *Wages* for all cases.The decrease in these variables could be more important than it is, but the effect of the reduction in those variable costs related to the fishing time, diminish the global effect.

The results variation within the different fleet segments, can be explained as in the previous simulation and for the following one basically by the rejected months and not by the cost structure.

Question 1.c) Catches reduction, price increase 16%

If there is an increase in fish prices as a result of the decrease in the volume of landings, in most of the cases we are in a similar situation as in the point **1.a).** That indicates that from an economical point of view, it is indifferent when reducing the effort if catchability or the price of fish increases in a proportion that compensates that loss in the volume of landings.

It has to be pointed out that, for the Mediterranean area, this can only be possible for those local products, which cannot be substituted by imported ones (e.g. fresh fish). We also assume that consumers behaviour is going to maintain loyal to the local fresh products and that are not going to consume fish in another ways. This point is going to be commented again in **4.c).**

In this simulation we get higher results in *Proceeds*, W*ages* and G*ross Margin* for the most of the fleets, excepting in the *Proceeds* for Castelló TRI, II and III. The decrease in the previous segments is about 3-4%, not relevant, because it can be caused by a minor non-fully compensating factor between the increase in prices and the reduction in catches.

Question 2) **Reducing one day per week, Wednesday**

Here below we have a deep explanation on the prices behaviour in the Spanish Mediterranean market, and why it is important to take them into account when we want to work on management simulations.

Box: ***Weekly Cycles***

We have already explained some characteristics of the markets in which the catches of these fleets are sold. It is important to know these characteristics in order to define useful management simulations for the model. The price is a relevant variable for taking managing decisions.

All of the North Mediterranean market is well integrated. There are the same fishing industries, the same trade companies, the same way of transporting goods (by high road), the same consumers concentrated in the Barcelona periphery.

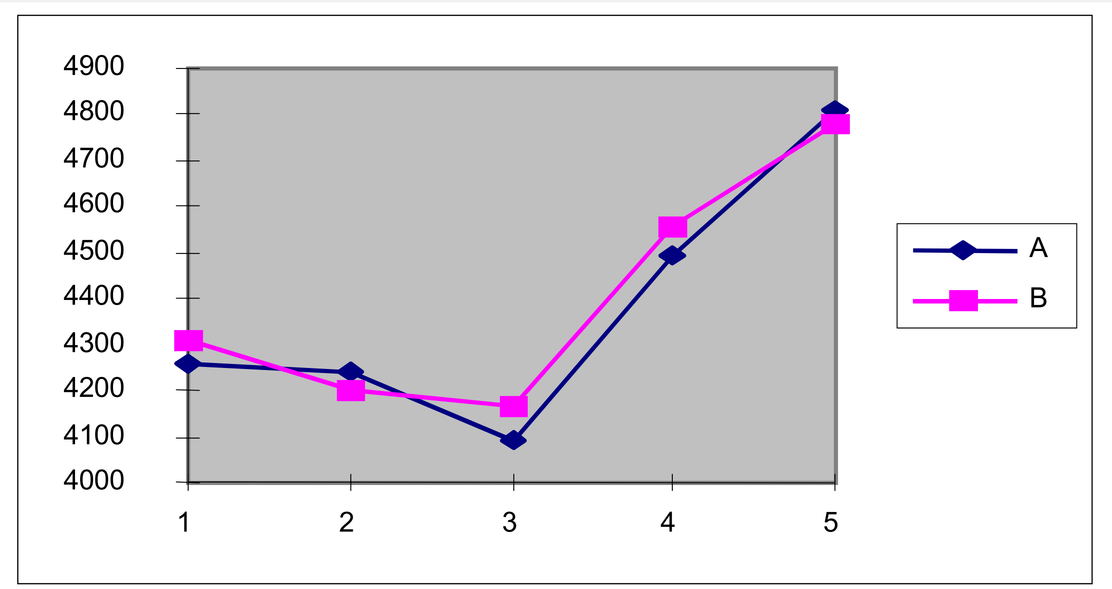
The fish price in the Barcelona harbour has the characteristic behaviour of fish prices in the whole Spanish Mediterranean area.

In the next table we present information on the most important species landed in the Barcelona harbour, giving the yearly average price evolution of each species by the different days of the week.

	Mon	Tue	Wed	Thu	Fri	Sat	Average
Shrimp	4.256	4.243	4.090	4.491	4.809		4.377
Hake	1.335	1.343	1.287	1.288	1.295		1.309
Small Octopus	2.749	2.582	2.426	2.461	2.690		2.581
Hake + morralla	1.093	1.156	1.099	1.107	1.163		1.123
Mullet	650	651	620	665	635		643
Angler Fish	996	998	951	967	978		978
Blue Whiting	336	343	349	335	339		340
Norway Lobster	3.665	3.597	3.447	3.748	4.171		3.725
Hake + Shrimp	1.518	1.500	1.410	1.564	1.624		1.523
Hake +Lobster	1.648	1.635	1.649	1.658	1.537		1.625
Soup Fish	431	426	393	408	409		413
Pilchard	80	78	73	85	73	108	82
Anchovy	296	256	193	210	217	209	229
Horse Mackerel	126	126	115	102	95	133	116
Bonito	390	431	398	454	402	420	415
Lechas	505	670	720	532	675	596	616

The evolution of the different species during the week has a similar behaviour. As an illustration of this point, we will present a single case, the shrimp, of which we consider evolution of two prices.

The line A is the result of dividing the total value of the shrimp catches by the total kilos for every day of the week, and the line B is the arithmetic mean of the prices. As we can see, there is not a big difference between both lines. In both cases Wednesday is the day with the lowest price. The price gets higher at the end of the week, Friday being the day with the highest price. At the beginning of the week the price is high but lower than in Friday, and it then goes down till the minimum (in Wednesday). So the price evolution graph during the week is V-shaped.



Evolution of the price of the shrmp during the week

By observing this fact we can consider different simulations, such as: what is the result of not fishing on Wednesday (question 2.a) and 2.b)), or not fishing on Wednesday but fishing on Saturday or another extra day (questions 3.a) and 3.b)).

To make this type of simulation easier, we change the absolute price data into relative ones by transforming them to index numbers. We can obtain the average evolution of the price during the week for each species in order to make the proposed simulation.

The following table gives the distribution of prices changed into index numbers. We have taken the weekly average prices by species as the 100 bases. This table shows a quite important cyclic distribution. The day of the week is an important variable influencing the final price. Obtained results are between indexes of 82 (minimum) and 130 (maximum). That presents an important level of average variability. Species with the highest variability are - as expected - the pelagic ones (pilchard, anchovy, etc.).

For the main part of the species it can be established that the prices are higher on Monday and on Saturdays and lower on Wednesdays.

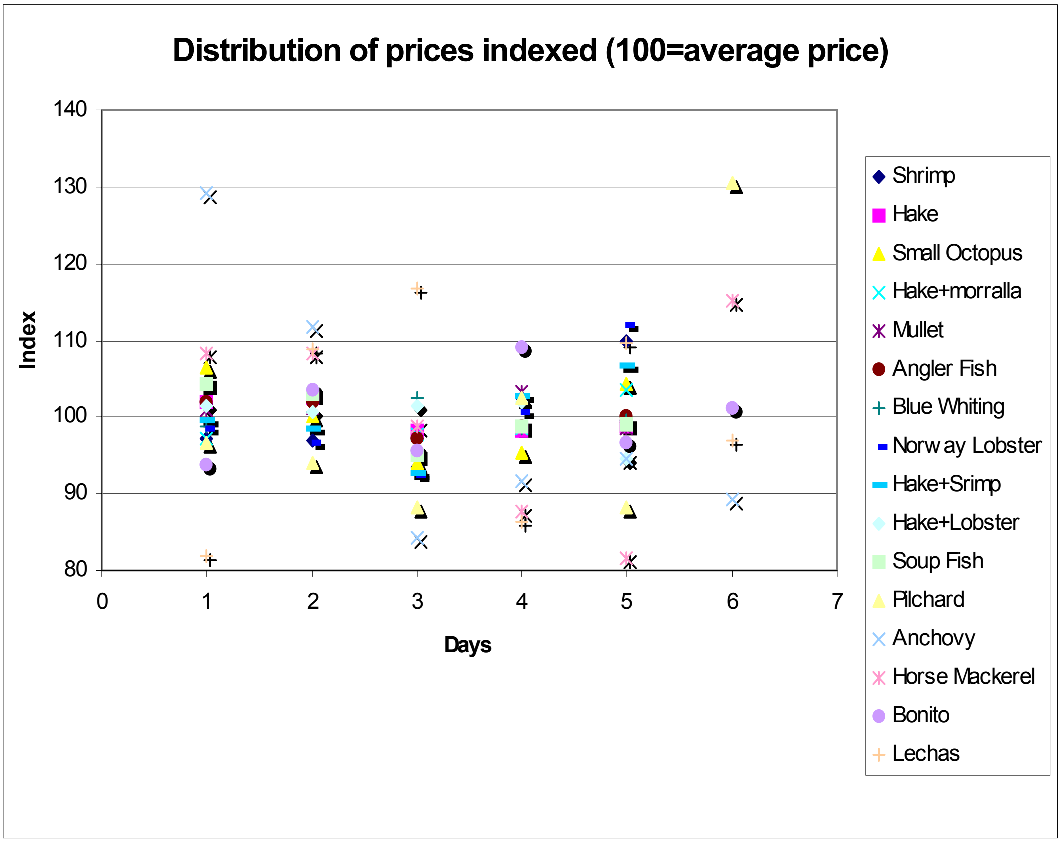
Weekly Indexed Evolution of Cycle Prices
(Base 100 = average price by species)

	Mon	Tue	Wed	Thu	Fri	Sat
Shrimp	97	97	93	103	110	0
Hake	102	103	98	98	99	0
Small Octopus	106	100	94	95	104	0
Hake + Morralla	97	103	98	99	104	0
Mullet	101	101	96	103	99	0
Angler Fish	102	102	97	99	100	0
Blue Whiting	99	101	103	98	100	0
Norway Lobster	98	97	93	101	112	0
Hake + Shrimp	100	98	93	103	107	0
Hake + Lobster	101	101	101	102	95	0
Soup Fish	104	103	95	99	99	0
Pilchard	97	94	88	103	88	130
Anchovy	129	112	84	92	95	89
Horse Mackerel	108	108	99	88	82	115
Bonitol	94	104	96	109	97	101
Lechas	83	109	117	86	110	97

To get the meaning of this table more properly, we have presented the price distribution by day of the week and by species in a graphic. From it, we observe that prices are relatively the lowest on

Wednesdays. On the contrary, in the beginning and the end of the week prices are higher. That made us thinking about a simulation. What would happen with the fishermen's incomes and profitability of exploitation when the production and selling of the fish would be made in a different way along the weekly cycle, for instance by not allowing catching or selling the fish on Wednesdays. The cyclic price behaviour is related to the fresh fish consumer's behaviour, as they have more difficulties to go shopping during the working days. From all the previous analyses on the Barcelona harbour, it can be noticed that the price varies depending on the day of the week we are making our observation. At the beginning and at the end of the week prices are higher, and usually prices of Wednesday are the lowest ones. We get a very important conclusion on all that: price is a relevant variable for taking managing decisions and that is the reason because we are playing with it.

If we are thinking in reducing one day of fishing in order to reduce the fishing effort it is very important to choose that day in which prices are the lowest ones. After having studied the evolution of prices during the week we have a suitable reduction proposal: reduce one fishing day, but specifically Wednesday. With that action, we loose one fishing day but it happens when market prices are the lowest ones. So we manage to reduce the fishing effort and at the same time we are able to produce the minor possible effects on proceeds.



After observing all the previous, we have considered really interesting simulating a one day per week decrease, choosing especially Wednesday due to its lowest prices.

In view of this, the second question is dealing with a reduction of one day per week and two different variations:

Question 2.a) Constant catches (catchability decreases 19%)

The obtained results validate theoretical previsions of profits increases.

Deeply analysing the effect of this reduction we have to remark how reducing Wednesday has allowed to increase the average weekly price, which is observed as higher proceeds in all the segments.

This positive performance is repeated when paying attention on *Wages* and *Gross Margin.* Observed differences between groups can be adduced to differences in wages sharing or fixed costs. However good results are obtained in all cases with minor or major intensity.

Question 2.b) Catches reduction (constant catchability), increasing fish prices 5%

When an effort reduction also implies a proportional reduction in catches, negative evolutions are observed for all cases, excepting when there are increases in prices, which compensate the lower catches in volume. Although variable costs have decreased due to the reduction in fishing days, that decrease is not enough to compensate the lower catches, and losses for all fleet segments are noticed.

Differences between segments are not as high as in other simulations. *Proceeds*, *Wages* and *Gross Margin* are about 90% the Basic Run results and the higher deviation is PSII, BCN, with:

- *Proceeds* *95*
- *Wages* *96*
- *Gross Margin* *97*

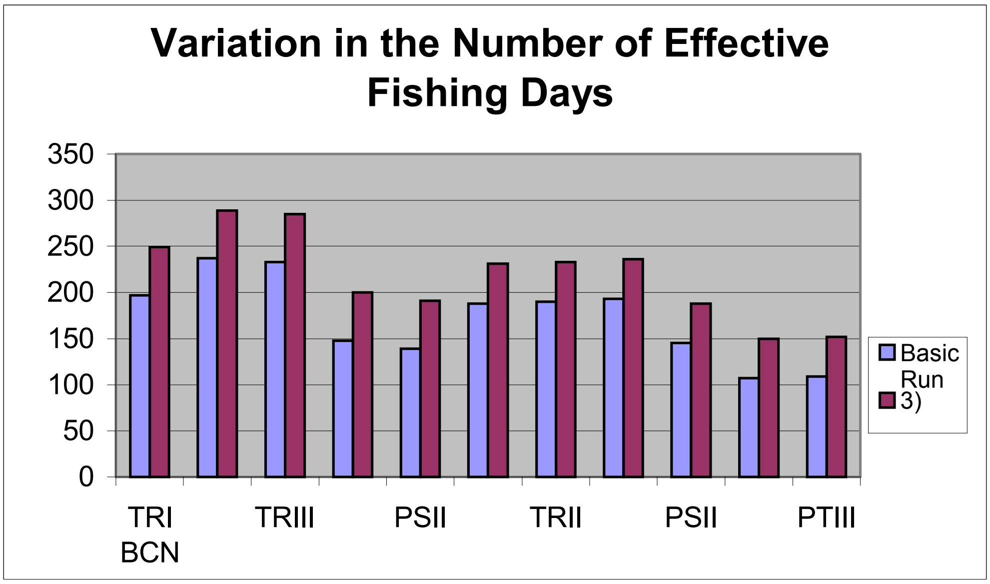
***Question 3)* Enlarging one day per week**

In this third case, the simulation deals with an extra fishing day per week. This point has been implemented in practise as an increase of an absolute number of days per year and not as an increase in percentage. The addition of days has been:

- 52 days for Barcelona
- 43 days for Castelló

The closed seasons and established holidays in the Castelló port, explains why the hypothesis of one extra day per week has been translated into a minor increase.

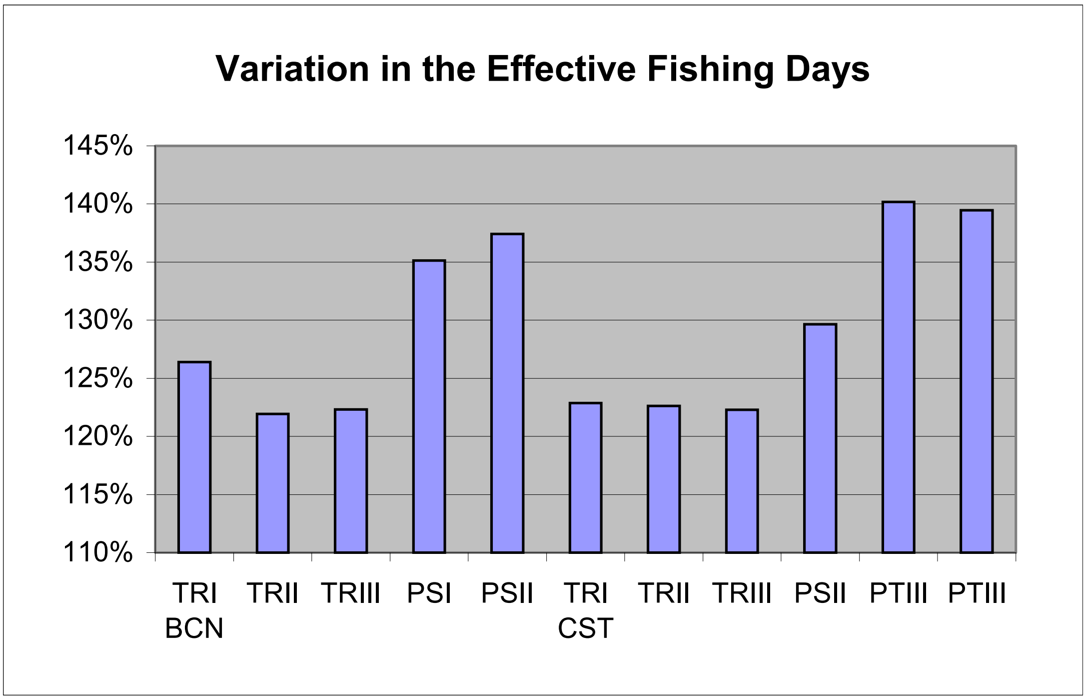
The initial and final effective fishing days are presented in the following graphic and table:



Effective Fishing Days											
	Barcelona					Castelló					
	TRI	TRII	TRIII	PSI	PSII	TRI	TRII	TRIII	PSII	PTRII	PTRIII
Basic Run	197	237	233	148	139	188	190	193	145	107	109
3)	249	289	285	200	191	240	242	245	197	159	161

This way of enlarging the fishing time, affects the simulation results. The initial fishing days in the Purse Seine or the Pelagic Trawler segments are less than in the Trawler, in the both studied ports. Therefore, the effect of an absolute increase is higher in those segments with minor initial effective fishing days. This can be detected if we compare the variations within one port and the other.

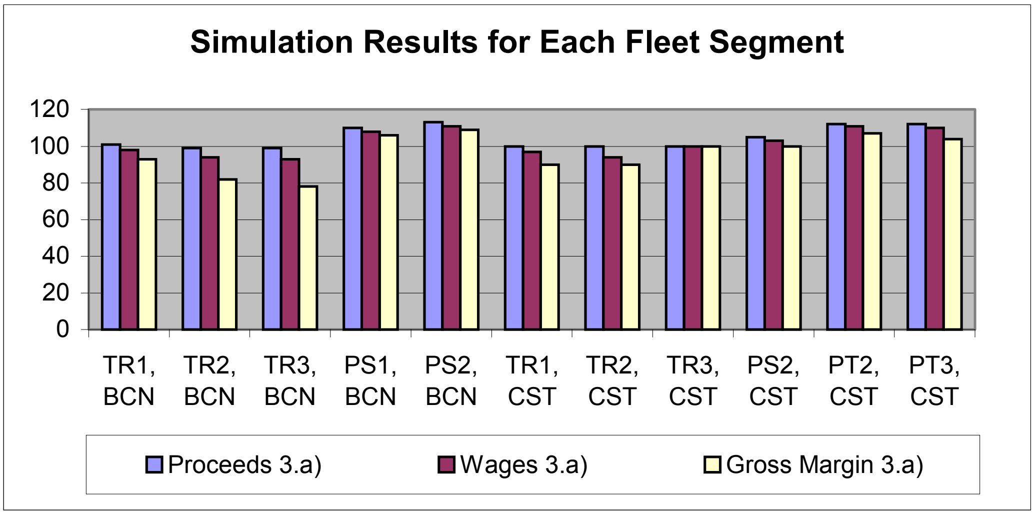
In the following graphic, there are the variations in relative terms, indexed by the number of effective fishing days in the Basic Run.



Question 3.a) Constant catches (19% catchability decrease), constant price

Here we consider the same catches than when fishing one day per week less with an arbitrary reduction in catchability and constant prices. With this simulation we assume more fishing days, in which we catch the same fish volume. The reason is we suppose that the stock doesn't allow higher catches because it is fully exploited.

If we have a look to the simulation results, plotted in the graphic above, we notice that different results are obtained in some segments. As we have explained in the previous point, major results on PS and PTR are due to the major proportional in-



crease in the number of effective fishing days. As their costs every day that they go fishing are also lower they obtain better results than in the case of TR.

Question 3.b) Catches enlargement (constant catchability), constant prices

The hypothesis in this case is similar than in the **3.a)** an extra day per week and constant fish prices. However, here we consider and increase in the catches indirect relation to the fishing days enlargement. The assumption in this case is the resource still can be more intensively exploited. This is an assumption only realistic in the Mediterranean area in a short-term view. However, in the long-term result probably would be an over-exploitation of the stock.

The results are positive in all cases, but again they are more positive for the PS and PTR fleet segments. That is represented in the following graphic, which has a similar shape than the one in the **3.a)** simulation.

Question 4) **Effort reduction, -16%, equal to 2 months)**

In this case, a 16% effort reduction is considered. The way it is applied in practise in the model is, as in *Question 1*, like a time restriction. Here, it is considered an effort reduction of 16% that is more or less equal to a two months reduction in the fishing time. The way the effort limitation is implemented varies substantially from the way used in *Question 1*. Here we reject two months as they represent about a 16% effort reduction These months are not chose by any special criteria apart from their equivalence in fishing time. We are going to see how crucial is this point in the obtained results compared to the ones in *Question 1*.

Here we take into account three assumptions:

Question 4.a) Constant prices, a 16% catchability increase

We assume that catches are the about the same using less fishing time. The decrease in fishing time is nearly completely compensated by the increase in catchability, so *Proceeds* are about 100.

The effects on Wages are nearly inexistent, so the crew has to work less time, but the increase in catchability, allow them to get about the same earnings than in the case when they fish two more months.

The Gross Margin is higher than in the Basic run, so for the Ship owner this is a good chance of increasing its profits.

If we compare the results of this simulation with the ones in 1.a), we can observe, assuming the same hypothesis ***constant prices and 16% catchability increase***, that results in the **1.a)** simulation are better than in **4.a)**.

The reason is, in **1.a)** we apply a selective effort reduction by eliminating those months with minor incomes and in **4.a),** we consider a general two months reduction without choosing the best alternative. We can observe the differences between the two results in the following graphic:

The main conclusion of this graphic is we improve the fleet segment economical performance if we choose properly those months in which are better to establish a closed season. This explanation is perfectly suitable for situations **4.b)** and **4.c)**. This point has important implications for the Administration. A good or a bad choose in the closed season months, can imply not only negative effects on ship owner profits, but it can have important social implications, with decreases in wages. When we are comparing two situations as **1.a)** and **4.a)** we are not in critical levels, we have better or worse results but in reasonable terms. But if the situation beside the effort reduction is that prices maintain their levels and so do the catchability, as it is assumed in **1.b)** and **4.b),** the effect on the crew can go from bad to worse. The choice of the two skipped months has been made here, very easily, by having a look to the annual series. But a year is not enough time to get a confident series in which trust on when we have to establish a closed season. There is another factor to be considered. The responsability of establishing the closed season correctly or non-correctly is directly of the Administration, but what about the biological framework? In this model we haven't considered the biological dimension of the fishery. We have established exogenously the biological hypothesis relating increases or decreases in the catchability, by assuming variations in the stock, which haven't occurred i n the real world. So, he we have to be very careful with another point: the behaviour of the resource can affect extremely the obtained results. That would be the difference between achieving **1.a)** or **1.b)** or, equally it would be like consider **4.a)** or **4.b).** It implies a substantial difference; it goes from having a constant situation or having quite a good result to have bad results with effects both in *Profits* and *Wages*.

Question 4.b) Constant prices, the catchability maintainment

The time reduction affects proportionally to catches in the proportion of the fish not caught during the rejected months. Moreover, we don't get higher prices in market than the expected ones. All that, produces a similar negative reaction in *Proceeds*, *Profit*s and *Wages* for all cases (a 16% decrease).The reduction in these variables is more important than in the case **1.b),** because here the effort reduction has been made by rejecting two months aleatorily, and not the more appropriate ones. By observing the obtained results on this case **4.b)** and the one in simulation **1.b)**, it is clear that the Administration should try to have long term series on incomes in order to know which are the months in which incomes from landings are the lowest, and choose them for being rejected. The point is, an effort reduction can have more positive results or less negative ones in this case, if the choice is properly made.

Question 4.c) Catches reduction 16% but prices increasing 16%

If we get an increase in the fish prices as a result of a decrease in the volume of catches, in most of the segments we are expecting to get the same level of wages and higher benefits. The results in this case are as expected and presented in the Simulation Examples Table, in page 149. The effort reduction has been produced by an increase in the fish prices; although the amount of caught fish have decreased because there haven't been a higher catchability.

On the contrary than in case **1.b)**, here, we have a compensating effect provided by the increase in prices and it is positive for the crew and the ship owners. The hypothesis of constant catchability and increasing prices is quite realistic, because a closed season, in the short term usually has no important repercussions on the stock, On the contrary effects on fish prices tend to be more automatic, when the market has a hole of fresh fish during a period. Here, we haven't considered the possible loss in market share. Although the fresh fish is very appreciated in the Mediterranean market and a punctual closed season probably wouldn't affect the consumers' preferences it isn't unreasonable to consider a consumption deviation to foreign fresh fish or alternative presentations: frozen, cooked, canned, smoked, salted, etc.

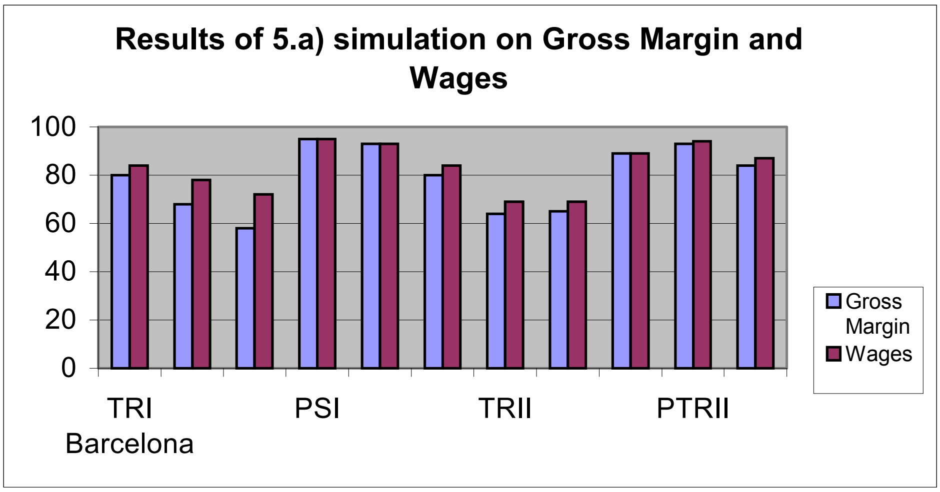
10.3.2 Simulating changing economic and biological parameters

➢ ***Increasing costs***

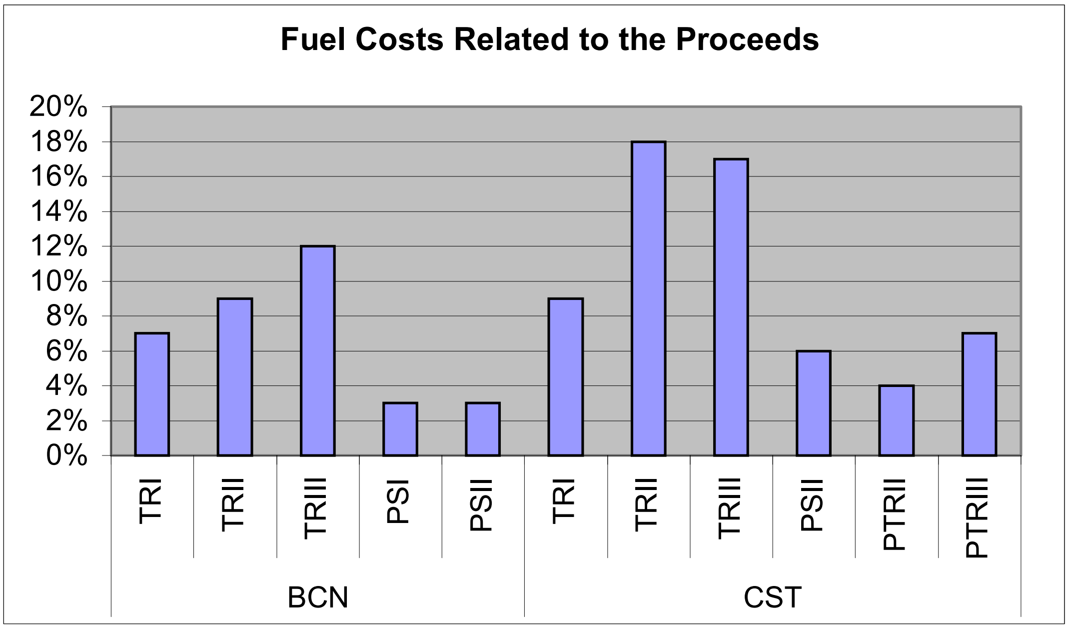
Question 5) **Increasing the fuel price, from 21 PTS. to 50 PTS**

In this last simulation we present an increase in the market fuel price. This analysis does not consider changes in the effort produced by the cost variation, so the proceeds, obtained in the auction, are the same than in the Basic Run, and it is represented by a 100 row in the **5.a)** simulation, within the relative value table, below.

	Barcelona					Castelló					
	TRI	TRII	TRIII	PSI	PSII	TR	TRII	TRIII	PSII	PTII	PTIII
Gross Margin	80	68	58	95	93	80	64	65	89	93	84
Wages	84	78	72	95	93	84	69	69	89	94	87
Proceeds	100	100	100	100	100	100	100	100	100	100	100



Having a global look the worst effect of an increase in the fuel price in the Gross Margin is suffered by the TRIII BCN and the lowest effect is on the PSI BCN. To find the link between this behaviour and the fuel costs we have to look to the following graphic.



To get deeper conclusions we can analyse the simulation, segment by segment.

We can compare directly the effect of an increase in the fuel price on the wages in percentage, for both, the Barcelona and the Castelló trawler. The reason is the Y result sharing is 50% for the crew and 50% for the ship owner, equal in the two harbours.

The worst effect on the crew wages is obtained in the Castelló TRII and TRIII. It is clearly linked to those fleets high fuel cost, which represent around 18% the proceeds. The lowest effects on the wages are registered in the TRI of both, Barcelona and Castelló harbours. Again it has a close relation to the fuel weight, in each fleet segment. In general if we consider the table “Fuel Costs Related to Proceeds” and the previous one titled: “Results of **5.a)** simulation on Gross Margin and Wages” we observe the fuel costs have an inverse proportion to the effects of an increase in its prices. Higher the fuel prices are, lower are the wages when there is a fuel price increase.

Comparing the Gross Margin of the Barcelona and Castelló trawler is more difficult, because it implies different fixed costs on the ship owner’s part that have to be considered. Here we should take into account not only the Result Y sharing, but also those fixed costs assumed by the ship owner that determines the final Gross Margin he obtains. Anyway, apart form the BCN, TRIII, which suffers a worse situation in

Gross Margin terms than in Wages terms, the behaviour of the segments can be again explained by the fuel weight in proceeds.

The previous explanation is extremely clear for the Barcelona and Castelló PS fleets. Their average fuel consumption is lower, so their fuel costs, and higher prices in fuel affect them in a minor way on wages and Gross Margin. This situation is so clear that their different Result Y sharing doesn't affect this point. That can be observed, graphically, in the above tables. This explanation can be also attributed to the PSII, CST segment.

11 Necessary future research work

The future research work should mainly be focussed on the fields of

- completion and improvement in the data base,
- complement and adaptation of the model and
- application of the simulation model in practice by empirical tests

11.1 Development and construction of a long-term data base

For this study, the national teams collected and used data and information from different sources, e.g. data from official statistics, from unpublished records, from enquiries and from personal conversations with individuals (fishermen, managers of POs, accountants, etc.), from scientific publications and investigations and from the available expertise in the participating institutes. All these data and information refer to the year 1995 or 1996, respectively, i.e. the present investigation is only considering a one-year data set.

Other data used in the model had to be estimated due to non-availability or non-accessibility of data.

The shortcomings of data became evident particularly on the fields of

- activity data (time of activities),
- catch data (composition of catch by size/grading, catch rates),
- cost data (allocation of different cost items) and
- price data (concerning size/grading, landing ports).

In few cases, data are available in the existing records but unprocessed and not fit for use in economic models without further work. This refers to official (published) as well as unofficial (unpublished) statistics and data records. For example, extensive amounts of data are recorded in the logbooks – available only since 1996 as regards reliability – but data processing (management) demands considerable effort. This lack of processed data concerns especially information about fishing activities like duration of trips, time of departure and landing, effort and steaming time, etc., representative information on catch rates of different species caught on the different fishing grounds and composition of catches with regard to size and grading.

In other cases, e.g. fish prices - non-uniform in different ports - are not recorded and have to be collected. For example, prices are different depending on distances of ports to markets (e.g. Faeroe harbours). Furthermore, demand structures with respect to specific species (e.g. flatfish in The Netherlands) and to number of buyers (only a few on Bornholm Island) are an important factor for prices paid.

Moreover, cost data are often considered as confidential and difficult to collect at sufficient scale. But in contrast to other data, cost figures are fairly constant so that cost data can be used over longer periods compared with prices and catch rates.

In summary, the availability of a multi-annual computerised database related to reliable and appropriate data (actual and average figures) is essential for the application of models in practice and politics. Therefore, data collection and processing for model use is indispensable but very costly and time-consuming. In this context the recently presented proposal for a Council Decision of the European Commission[11] providing a secure financial basis for a programme of data collection and management has to be welcomed.

11.2 Completion and adaptation of the model relating to additional fields of application and extended problem formulations

Without doubt, the developed model can be applied in other fleet sectors too without problems, provided that the necessary data base is available. In general, the model

[11] Proposal for a Council Decision on a financial contribution from the Community towards the expendure incurred by the Member States in collecting data, and for financing studies and pilot projects for carrying out the Common Fisheries Policy. Brussels, 3. 11. 1999

results will be the better the more homogeneous the structure of the targeted fleet segment is.

Except from the deterministic character of the model structure, most of the limitations described in chapter 8 can be overcome.

In some cases only the limited capacity of the computers used hindered further specifications and applications.

But in principle, the developed model is applicable in other fleet segments and relating to further questions without problems.

Although the model, as tuned into a special version for each of the standard vessels, works fairly well now, nevertheless, a number of adaptations and further improvements can be made in order to achieve an even better and more user friendly model. This could e.g. involve cleaning up and streamlining of the model programs that have grown more or less organically; bringing the programs into a modular structure; and eventually building a user friendly interface around it. But these are rather minor and not very urgent activities.

11.3 Empirical tests of the simulation model in practice

In order to demonstrate the usefulness of the developed simulation model not only theoretically but also in practice, the application of the model in the private fishery sector should be pursued too.

In this context, the planning of fishery operations of a single vessel or of a “standard vessel” defined for a fairly homogeneous group of cutters within a producer organisation, for example could be the starting point of a practical test.

Co-ordinated and escorted by a scientific institute, such a practical application of the model basing on the necessary comprehensive data basis could supply up-to-date information to the fisherman (or to the manager of the PO) with regard to optimal fishing areas and time, target species, landing ports, etc. and maximisation of the gross margin.

A first step in this direction is already done in Germany with the approach of model-based planning of a single Baltic cutter[12]. Furthermore, the developed simulation model will be used in practice for calculating the impacts of activities of Baltic cutters in the Spring herring fishery[13]. But in general there are problems of financing these tests, particularly concerning data collection and processing for model use.

Appropriate financial assistance is required for applying the simulation model in practice as well as carrying out economic simulations connected with decisions planned under the CFP and their impacts, especially on the structures and the economic performance in different fleet sectors.

12 Previous and planned activities of dissemination and publication

On the occasion of the 3rd Marine and Technology Congress, Lisbon/Portugal (May 1998) and the IIFET Conference, Tromsoe/Norway (July 1998), the German participants reported on the model structure and interim results then published in

- Klepper, R./Lasch, R.: The Usefulness and Applicability of Model-based Instruments for the Assessment of Economic Impacts of Fishery Management Decisions within the Scope of the Common Fishery Policy. In: Conference Proceedings of the 3rd European Marine Science and Technology Conference. Lisbon. 23-27. 05. 1998. P. 167-169

- Klepper, R./Lasch, R.: A Simulation Model for the Measurement of Economic Impacts in Specific Fleet Sectors. In: Proceedings of the IX. IIFET Conference. 8-11 July, 1998. Tromsoe/Norway. Volume 2. P. 171-180.

In the Netherlands, on several occasions the project and its results have been presented to and discussed by the Fisheries Division of LEI, the Dutch partner in the project.

A paper on the model was presented at the XIth Annual Conference of the European Association of Fishery Economists in Dublin, 7--10 April 1999

[12] SAS 101 “Heringshai” (Owner: Ziegner)
[13] In cooperation with the administration of Mecklenburg-Western Pomerania and the PO “Sassnitzer Seefischer”

- De Wilde, J.W.: Measurement of Economic Impacts of Fishery Management Decisions; The Dutch Case

Furthermore, a presentation of the model is foreseen for an 'open day' of the LEI Fisheries Division.

On the side of the Spanish participants, this study was used in a paper presented in the Xth Annual Conference of the EAFE in the Hague; Netherlands; April 1-4. 1998

- Romeo, L./Franquesa, R.: Analysis of profitability of two Spanish fleets of the Mediterranean: Barcelona and Castelló.

The GEM participates in the Annual Economic Report (AER), a concerted action promoted by the European Commission (FAIR PL97-3541). Our work is to prepare an annual report on the economic performance of selected segments within a group of several European countries. The data basis included in this work has been useful in two ways. First of all, as a basis for selection of data, this report has been useful in establishing a proper methodology of study of data, normally unprocessed in our area. On the other hand, as a starting point for the AER we built up a historical series of landings and we could use the data included in this report as a part of it.

- Franquesa, R./Romeo, L.: Analysis of profitability of the Spanish fleets of the Mediterranean. Concerted Action “Promotion of Common Methods for Economic Assessment of EU Fisheries”. Tromsoe/Norway. July 1998.

The situation of the data in the area makes any effort to process them very useful not only for economical purposes but also for biological ones. As a result of the great effort made by the IEO and the CSIC in order to compile all the necessary data, they presently also dispose of these databases for scientific purposes.

The information on costs, compiled by the enquiries of the vessels owners and a part of the methodology of this project are very useful to give scientific advise on the Purse Seiner Plan and the Trawler Plan; a multi-annual plan developed by the Generalitat of Catalonia (the Regional Government of Catalonia). The GEM, as well as the CSIC, are working together to analyse both plans, developing a scientific project on the impact of the plans (ESPLAT), supported by the background of this project.

When the project is finally finished we are going to share its main characteristics and working methods to make its use easier for the scientific field as well as for fishing managers.

Moreover, we are working on publishing a summary of the “Measurement of Economic Impacts of Fishery Management Decisions” in several Spanish specialised reviews in the fishing sector as: "Europa Azul", "Mar", etc.

Provided that costs stay within acceptable limits, the project report will be published on the internet site of the EAFE and the internet home page of the Federal Centre of Agricultural Research (Institute of Market Analysis and Agricultural Trade Policy) for downloading.

Abbreviations and acronyms

AER	Annual Economic Report
BCN	Barcelona
BLE	Bundesanstalt für Landwirtschaft und Ernährung
BMELF (=BML)	Bundesministerium für Ernährung, Landwirtschaft und Fischerei
BPP (=EPP)	(Length) between perpendiculars
CST	Castelló
CBSModel	Computer Based Simulation Model
CFP	Common Fisheries Policy
ct/l	Dutch cents per litre
DG XIV	Directorate General XIV (Fisheries)
DAFIST	DAtabase for FIshery STatistics (LEI / RIVO)
DM	German Mark (1 DM = 100 Pfennig = 0.51129 Euro)
EAFE	European Association of Fishery Economists
EC	European Commission
ECU	European Currency Unit
EEZ	Exclusive economic zone
ESP	Spain
EU	European Union
FAIR	Fishery and Agro-Industry Research (programme)
GAMS	General Algebraic Modeling System
GEM	Gabinete de Economía del Mar (Barcelona)
GER	Germany
GRT	Gross Register Ton (ship volume measured according to the Oslo Convention on Tonnage Measurement of 1947)
GT	Gross Ton (ship volume measured according to the Internatio- nal Convention on Tonnage Measurement of Ships of 1969)
H	hour
HP	Horse power (1 HP = 0.7355 kilowatt)
ICES	International Council for Exploration of the Sea
ICM	Instituto de Sciencies del Mar (Barcelona)
IEO	Instituto Español de Oceanografia (Castelló)
IFLM	Institut für Landwirtschaftliche Marktforschung (Braunschweig) *Institute for Agricultural Market Research*
ITQ	Individual Transferable Quota
kg/h	kilogram per hour
kn	knot (1 nautical mile per hour)
kW	Kilowatt
LEI	Landbouw-Economisch Instituut (Den Haag) *Agricultural Economics Research Institute*
m	meter
MAGP	Multi-Annual Guidance Plan
NEAFC	North East Atlantic Fisheries Committee
NL	The Netherlands
NLG	Dutch guilder (1 NLG = 0.45378 Euro)
No.(=no.)	Number
OECD	Organisation for Economic Co-operation and Development
PO	Producer Organisation
PS(n)	Purse seiner, type n
PTS(=pts)	Spanish peseta (1 PTS = 0.00601 Euro; mPTS = 1000 pesetas)
PTR(n)	Pelagic trawler, type n

RIVO	Rijksinstituut voor Visserij Onderzoek (IJmuiden) *Netherlands Fisheries Research Institute*
STEFC	Scientific, Technical and Economic Committee on Fisheries
t	ton
TAC	Total allowable catch
TBB	Twin beam trawl, bottom
TR(n)	Trawler, type n
US$	United States dollar
VDL	Visserij Databank LEI
VIRIS	VIsserij Registratie en Informatie Systeem (Netherlands) *Fisheries Registration and Information System*
v.v.	vice versa

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