Fleet Structures Model:

An Overview, and its use in Decision Support

MAFF Commission
Technical Report No. 300
November 1987

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SEA FISH INDUSTRY AUTHORITY
Industrial Development Unit

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AN OVERVIEW, AND ITS USE IN DECISION SUPPORT

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SUMMARY

The Fleet Structures Model (FSM) is a predictive model developed by Sea Fish Industry Authority Industrial Development Unit. Its purpose is to simulate aspects of the structure and operation of a national sea fishing fleet in order to make comparative assessments of fleet management policy scenarios. This work has been performed as part of the MAFF Commission, under reference JAD 16.

The model output contains predictions of:

i) the total number of vessels (by subregion and length group)

ii) the following fleet results:
- total number of boats and the percentage change over the previous year;
- the number of boats built, bought secondhand; decommissioned, bankrupt and accidentally lost;
- the total amounts of building and decommissioning grants paid;
- the total number of crew;
- the total effort (in terms of days at sea);
- the total catch;
- the total earnings and percentage change over the previous year;
- the operating surplus and added value.

(by subregion, fishing method, length group and age group).

iii) the following biological results:

- the biomass,
- the total international landings;
- the total UK landings;
- the catch rates relative to the base year (by species/stock).

Two appendices are included to show the policy input sheets for the model and the output produced by a typical run of the model.

This report is one of a series describing Mark 1.1 of the model and presents an overview of the philosophy, methodology and structure of FSM; detailed descriptions of the computer programs, the mathematics of each model phase, and the required data analysis will be covered by separate reports.

The other reports in this series are to include:

TR 301 FSM - Program Documentation

TR 302 FSM - Activity, Landings and Earnings Phase

TR 303 FSM - Vessel Group Structure Phase

TR 304 FSM - Biological Feedback Stage

TR 305 FSM - Data

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1 INTRODUCTION

The Fleet Structures Model (FSM) is a computer model developed by the Industrial Development Unit of the Sea Fish Industry Authority, under MAFF Commission Reference JAD 16.

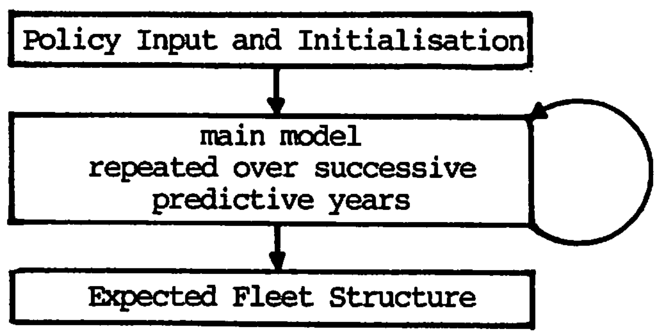
The primary purpose of the project is to enable policy makers to obtain improved quantitative comparisons of the expected responses of the UK sea fishing fleet to various proposed fleet management policy scenarios, under differing assumptions about fleet behaviour and economic factors. Of particular interest is the effect of such scenarios on the structure of the fleet, this being defined by classifying vessels according to size, age, fishing method and base port locations.

Secondary benefits of the project derived from the extension of fisheries modelling into areas not previously explored, providing opportunities for a better understanding of the behaviour of the fleet.

It is useful to distinguish between the main model, which operates over a (user-defined) number of yearly cycles, and two "once-and-for-all" phases, namely the Policy Input and Initialisation (PII) phase and the Expected Fleet Structure (EFS) phase. The former of these two quantifies the policy scenarios as well as fixing other parameter values within the main model, as described in Section 11, while the latter is any interactive post-processor which enables the user to assess in detail the results from a run of the model (see Section 12).

This is illustrated in Figure 1 below.

Figure 1



FSM is a large complex model and development has perforce been piecemeal. A conceptually useful partitioning of functions gave rise to independent development of what were seen as three phases making up each annual cycle of the main model, these being separately documented in detail (References 1, 2, 3). The description presented herein takes a more holistic view of the functions within the main model, but aspects relevant to each of the respective phases are identified.

2 PHILOSOPHY AND METHODOLOGY

The rationale of FSM rests on the assumption that fleet development is determined by financial performance at discriminatory levels throughout the fleet. Such performance is defined by the relationship between earnings and expenses, these being controlled by technical, economic and ecological factors, and with fleet management policies potentially tempering the interactions. All values in successive predictive years are expressed in base year equivalent units.

The fleet management policies come under the headings:

i) resource management policies, which consist of landings control by vessel, sectoral or unallocated quotas, and activity control by total or discriminatory prohibition from fisheries for part or whole of a year.

ii) policies intended to directly influence fleet structure, namely decommissioning grants and assistance in vessel purchase.

iii) anticipated response of prices to marketing strategy, over and above the effects of price elasticity (i.e. change in demand schedule).

FSM comprises a complex interaction of elemental models which can be classified as either data determined or theoretical mathematical models, although the distinction is not absolute and the two types are in some cases combined. The former type summarise observed and recorded historical data as a basis for prediction. The data sources used for these elemental models are as follows:

i) MAFF/DAFS base year landings files

ii) MAFF Annual Sea Fisheries Statistical Tables

iii) MAFF/DAFS annual vessel lists and monthly amendments

iv) Seafish/DAFS Costs and Earnings Surveys

v) ICES Working Group fish stocks time series data.

The latter type, i.e. the theoretical models, define hypothesised relationships between variables, and are controlled by tuning parameters which can be adjusted to modify response. These may quantify either policy inputs, or assumptions about either fleet behaviour or the operating environment of the model.

Models can be classified according to a number of criteria, one of which is purpose. In this respect models may be either predictive or optimising, and FSM is of the latter type. Thus it determines expected results based on development of the existing fleet rather than defining a "best" fleet under particular conditions.

As an analytic model rather than a Monte Carlo sampling or discrete event simulation model, FSM calculates expected (i.e. average) values directly from formulae instead of generating large numbers of sample results using pseudo-random numbers. As is typical with analytic models the mathematical aspects are more complex, but this is a trade-off against a better run-time efficiency.

FSM is implemented in a series of programs written in Turbo-Pascal under the operating system MSDOS, ensuring a high degree of inter-machine portability, with a structured language well suited to such a complex model.

An example parameterisation is complete using data sources which are judged to be of sufficient quality to establish the forms of elemental models and to demonstrate FSM. However certain inadequacies in the data became evident during analysis and also the data sources were not uniformly up to date. As a result the example parameterisation cannot be used for authentic predictive purposes.

3 SYSTEM DEFINITION

The implementation of the FSM main model can be expressed in terms of nested loops, where a simple loop would be, for example, as follows:

Figure 2

```
┌►for each predictive year:
│             ↓
│   ┌───────────────────────┐
│   │ perform calculations  │
│   └───────────────────────┘
│             ↓
└─repeat for next predictive year until finished
```

In the nested loop structure calculations are repeated for each predictive year...

...and these include a series of calculations performed for vessels of each subregion (in which base port is located)...

...which in turn include a series of calculations performed for vessels of each fishing method...

...and so on. This is shown as follows:

Figure 3

```
┌►for each predctive year:
│              ↓
│    perform calculations including...
│  ┌►for each subregion:
│  │           ↓
│  │   perform calculations including...
│  │ ┌►for each fishing method:
│  │ │         ↓
│  │ │  ┌──────────────────────┐
│  │ │  │ etc...               │
│  │ │  └──────────────────────┘
│  │ │         ↓
│  │ └─repeat for each method until finished
│  │           ↓
│  └─repeat for each subregion until finished
│              ↓
└─repeat for each predictive year until finished
```

The implementation of the [illegible] main model can be expressed in terms of nested loops, where a single loop would be, for example, as follows:

Figure 2

```
for each predictive year:
    perform calculations
repeat for next predictive year until finished
```

In the nested loop structure calculations are repeated for each predictive year...

...and these include a series of calculations performed for results of each sub-region (in which case part is looped)...

...which in turn include a series of calculations performed for vessels of each fishing method...

...and so on. This is shown as follows:

Figure 3

```
for each predictive year:
    perform calculations including...
    for each sub-region:
        perform calculations including...
        for each fishing method:
            etc...
        repeat for each method until finished
    repeat for each sub-region until finished
repeat for each predictive year until finished
```

Factors which control the repeated calculations are referred to as indices. These are, in hierarchical order: predictive year, subregion, method, length group, year built group, fishing ground, species, stock.

In FSM predictive calculations are performed in yearly incremental steps, over a period defined by the user, in order to show the trends brought about by particular policy scenarios and also to highlight the effects of changing policies during the predictive period. In specifying the predictive horizon it must be borne in mind that predictive uncertainty is cumulative and a period of not more than seven years is suggested, although up to ten years may be specified.

In the example parameterisation there are 15 subregions (including the nation as a whole), 10 methods, 19 length groups, 10 year built groups, 16 grounds, 28 species and up to 9 stocks of any particular species. In future parameterisations these numbers can be reassigned, but subject to maximum values (32, 12, 20, 12, 20, 32 and 12 respectively) fixed by the computer coding.

Equally, the way in which each vessel is assigned to a subregion, method, length group and year built group, and the specification of grounds and stocks of species of fish could be redefined if so desired.

Each vessel is assigned to a subregion which is a major port or a regional group of ports. The subregions used in the example parameterisation are the English and Welsh subregions, excluding Isle of Man, as defined in Appendix I of Seafish Technical Report 197 (Ref. 4). Each vessel is assigned to the subregion in which the greatest proportion of landed value was recorded in the base year, but any definition may be used, for instance in Scotland the district of residence of the skipper would be most appropriate.

FMS combines the simulation of a number of local fleets, defined by subregion, with a less detailed simulation of the national fleet. This latter is achieved by treating the national fleet as a separate subregion, subject to a number of simplifying assumptions, in order to provide a more authentic operating environment for the local fleet simulations. The FSM national fleet does not necessarily include the whole of the UK; for instance in the example parameterisation it comprises English and Welsh vessels, with the Scottish and Northern Irish fleets regarded as foreign vessels. All of the genuine subregions within the FSM national subregion may be included in the parameterisation, but this is not an essential requirement.

In fact in order to focus attention on particular regional sectors of the fleet, the user can specify which of the genuine subregions are to be included with the national subregion in a given run of the model.

In the example parameterisation ten fishing methods are used, combining minor methods, as defined by MAFF method of capture codes. Vessels are assigned to an FSM method according to the recorded method contributing to the highest proportion of landed value in the base year.

A fairly fine gradation of registered length is used in defining length groups, so that there is not too great a variation in expected performance within each.

The definition of year built groups includes an 'age-unknown' group and a 'predictive-built' group. The average age of the former can be assigned by analysing the peformance characteristics of the vessels involved, and comparing with the rest of the fleet. In the example parameterisation it is set at the average age for the rest of the fleet. FSM permits the inclusion of a second (i.e. later) predictive built group.

The indices which define vessel characteristics are referred to as vessel attributes. Vessels of a given subregion, method and length group constitute a vessel group, whereas the finest classification defined by all vessel attributes is referred to as a vessel category.

The initial and predicted fleet structures are defined in terms of base year and expected numbers of vessels in each vessel category, and the age structure within each vessel group plays a crucial role in the conceptual structure of FSM.

Fishing effort and stock location are defined in terms of ICES divisions, as illustrated in Appendix III of Seafish Technical Report 304 (Ref. 3). Further subdivision would give the user a finer control over the specification of resource management policies, but at the expense of increased computer run-time and memory demand, and greater difficulty in the analysis of historical data required to establish parameters in the model.

FSM allows the definition of up to 32 species, which may in fact be individual species or groupings of species. This is considered a sufficient number to include not only those of economic importance to the fleet but also others of particular interest to policy makers as well as miscellaneous remnant groupings.

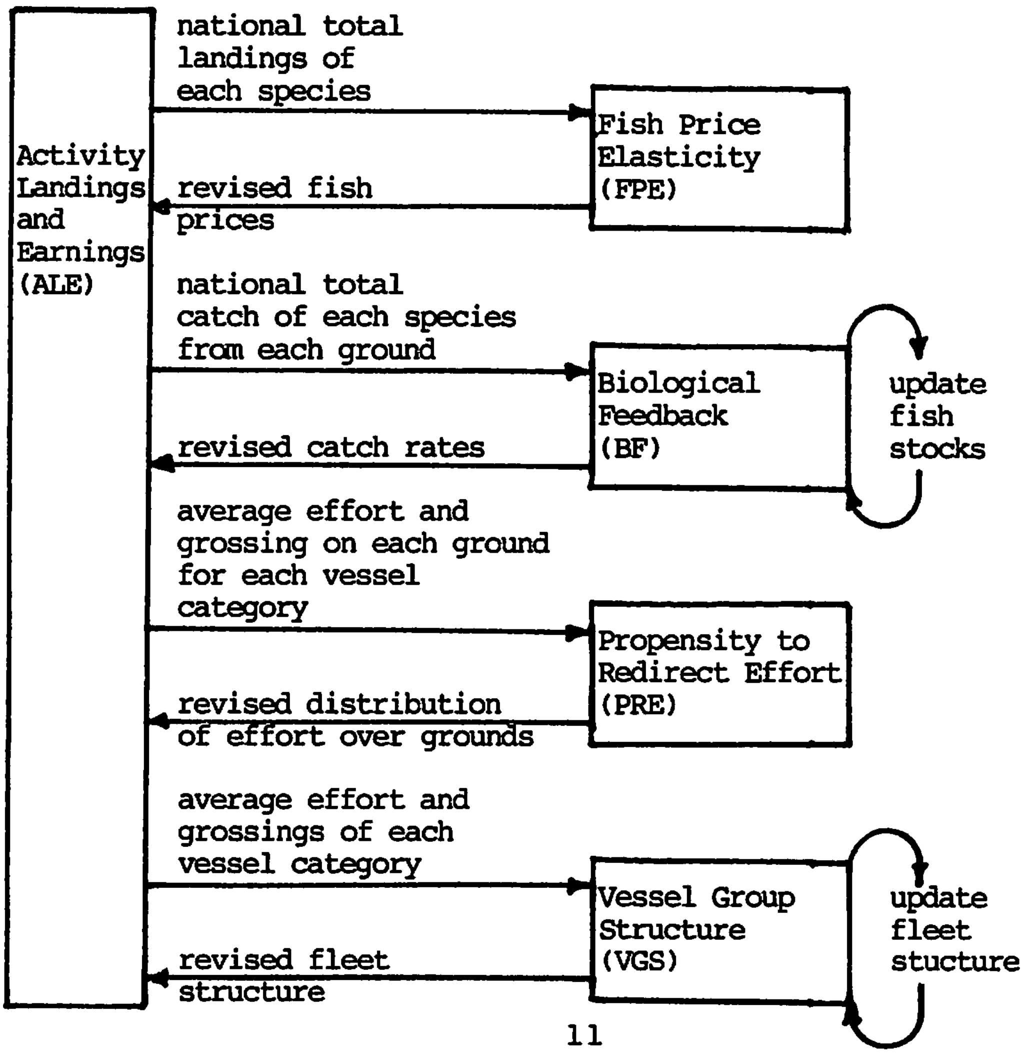
FSM stocks are separate and distinct units of population within each species, spread over any number of grounds. Their definition is a compromise between the desirability of comforming to the biological concept of a stock and the two major constraints of run time efficiency and accessibility of appropriate historical data for parameterisation. In general the exploitation patterns for one stock should not materially affect catch rates of other stocks of the same species in the short-to-medium-term, but heavy exploitation in one part of a stock should be compensated for by redistribution of the remainder. Stock definition is illustrated in the example parameterisation presented in Appendix III of SFIA Technical Report 304 (Ref. 3).

There are many combinations of indices which result in null passes through the nested loop structure. For example there may be no vessels of a certain method in a given subregion, so that all the corresponding calculations would predict zero earnings from nonexistant vessels. As a further example: at a different level in the index hierachy there may be no catches of certain species from a particular ground, which would again result in null calculations. A mechanism is incorporated in FSM to eliminate a considerable proportion of the null passes using validity arrays. These are look-up tables which the model uses to control the calculations when progressing through the nested loop system and which record the more easily identifiable null passes, obtained from analysis of base year data. It is not possible to censor all null passes without an unacceptably high amount of data input. To distinguish between the null passes which have and have not been censored the term invalid pass is used for those censored. Some valid passes will of course be null. The validity arrays are discussed in detail in Section 2.6 of Seafish Technical Report 302 (Ref. 1).

4 RELATIONSHIPS BETWEEN FUNCTIONS OF THE MODEL

The structure for each yearly cycle in the main model is conveniently described first in the absence of external control by policy inputs. This structure can be regarded as an Activity Landings and Earnings (ALE) procedure, which performs a number of calculations to produce data for four further procedures, and in turn receives data back from them. This is shown diagrammatically below:

Figure 4



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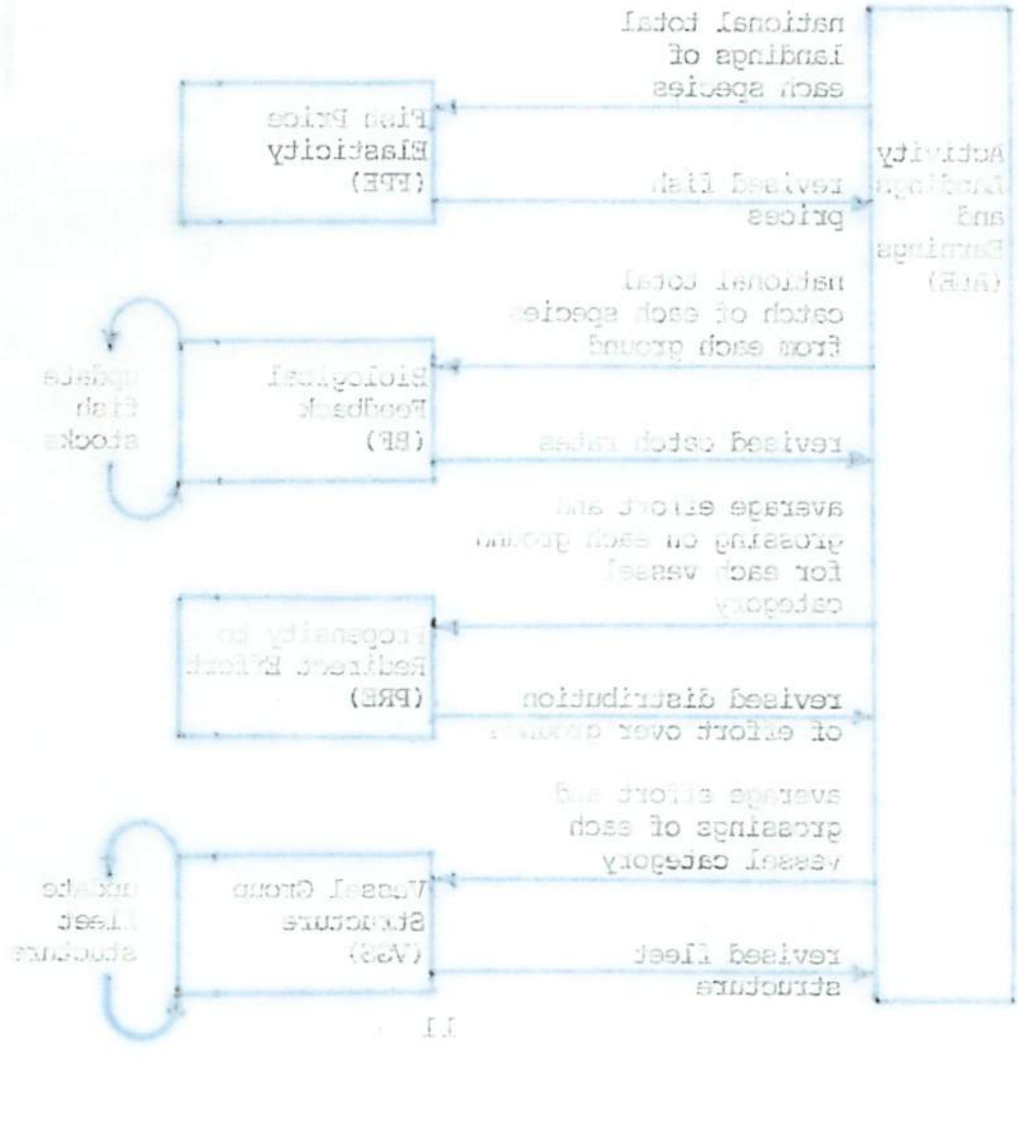

5 INFORMATION GENERATED IN THE ACTIVITY, LANDINGS AND EARNINGS PROCEDURE

In each predictive year FSM calculates the expected unrestricted average annual effort, in days at sea, for each vessel category, and distributes this effort over the grounds fished. On each ground the expected catch rate is calculated in tonnes of fish per day and distributed over species.

The extracted MAFF 1984 England and Wales landings data have been analysed to establish the forms of the models to predict unrestricted activity and catches (distributed over species) and to provide the example parameterisation values.

Effort is expressed as a function of all vessel attributes. The proportionate distribution of effort over grounds for each vessel category is predicted by averaging out this distribution of effort in the base year data over the vessel group. Thus it is assumed to be independent of age.

The total daily catch rate on each ground is expressed as a function of method, length and age of vessel. The distribution of individual species within this catch for each vessel category on each ground is predicted using the average distribution of the relevant combination of method, length group, and ground. It is thus assumed to be independent of subregion and age.

Activity and catches are modified in response to resource management policy inputs (discussed in Section 6) and the expected annual average prices, subject to variability by region and method, are used to calculate the contribution from each species on each ground to the average annual grossings of each vessel category.

INFORMATION GENERATED IN THE ACTIVITY, LANDINGS AND [illegible] PROCEDURE

In each predictive year FSM calculates the expected unallocated average annual effort, in days at sea, for each vessel category, and distributes this effort over the grounds (Fig. 1). On each ground the expected catch rate is calculated in tonnes of fish per day and distributed over species.

The extracted MAFF 1984 England and Wales landings data [illegible] analysed to establish the forms of the models to predict unallocated activity and catches (distributed over species) and to provide the example parameterisation values.

Effort is expressed as a function of all vessel [illegible]. The proportionate distribution of effort over grounds for each vessel category is predicted by averaging out this distribution of effort in the base year data over the vessel group. Thus it is assumed to be independent of age.

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Activity and catches are modified in response to management policy inputs (discussed in Section 6) and the annual average prices, subject to variability by region and method, are used to calculate the contribution from each species on each ground to the average annual grossings of each vessel category.

The difference between unrestricted catches and landings (i.e. due to discards) are subsumed in the relationships in the relevant elemental models. However additional discards resulting from mismatch of quotas in mixed fisheries are explicitly recognised in FSM, and a distinction is therefore made between catches and landings.

For each predictive year, as calculations are performed for each species caught by each vessel category on each ground, a number of annual totals are progressively accumulated for use as inputs to other procedures in the main model. These are listed in Table 1.

6 EXTERNAL CONTROL OVER ACTIVITY, LANDINGS AND EARNINGS

External control over the ALE procedure is by the following inputs made during the PII phase:

i) Landings restriction factors to quantify the effects of policies intended to directly restrict effort and/or landings.

ii) Effort restriction parameters to control the fleet's behavioural response to resource management policies.

iii) Effort variation parameters to control the fleet's behavioural response to the difference in financial reward of fishing alternate grounds (described in Section 9).

Resource management is controlled by the Activity/Landings Control Policy (ACP). This models the effect of activity control by the selective closure of fisheries for part or whole of a predictive year and the effects of landings control on a species, ground and yearly basis, both at non-discriminatory and discriminatory levels within the fleet; based on the assumption that, in the absence of changes in fish stocks, activity and landings are reduced in direct proportion. Reductions are expressed as a proportion of uncontrolled activity/landings. The effects of activity controls are independent of species, whereas the effects of landings controls vary in general with species.

The direct interpretation of restrictions in terms of maximum permitted effort or landings (i.e. in absolute rather than relative terms) is considered to require an excessively complex model structure as well as a considerable increase in policy input data required for each run of the model.

The less common types of quota which controls catch rates and thereby reduces landings without a corresponding reduction in effort (e.g. with a "per vessel per day" specification) is not modelled in FSM. If the specification period (e.g. "per week") is at least as long as the average trip length it is assumed that activity and landings will be proportionately reduced, and can therefore be expressed in the ACP model.

At the non-discriminatory level, which "equalises the agony" throughout the fleet, a general activity/landings proportionate reduction, which can vary with predictive year, is applied to each species on any ground, and is expressed as a Landings Restriction Factor (LRF).

At the discriminatory level, a special case reduction factor (SCM) is applied which can also vary with method and length group (in addition to the year, ground and species specification of LRF's). The inclusion of subregion in this specification is considered unnecessary since discrimination on a regional basis is desirable only as a result of the distribution of vessels of particular types.

In the implementation of the ACP model in ALE, special case restriction factors override the general case LRF's, so that both exemptions and total prohibitions can be specified at appropriate discriminatory levels.

The LRF values, in the general and special cases, are entered interactively in the PII phase (detailed in Section 11).

The less common types of quota which controls catch rates and thereby reduces landings without a corresponding reduction in effort (e.g. with a "boat week per day" specification) as are modelled in FSM. If the specification period (e.g. "per week") is at least as long as the average trip length it is assumed that activity and landings will be proportionately reduced, and can therefore be expressed in the ACP model.

At the non-discriminatory level, which [illegible] through the fleet, a general activity/landing [illegible] reduction, which can vary with predictive year, is applied to each [illegible] any group, and is expressed as a Landings Restriction Factor (LRF).

At the discriminatory level, a special case restriction factor (SRF) is applied which [illegible] in addition to the year, gear [illegible] species [illegible] of LRF's. The inclusion of subregion in this specification [illegible] unnecessary since discrimination on a regional basis is desirable only as a result of the distribution of [illegible] of particular types.

In the implementation of the ACP model in ALM, special case restriction factors override the general case LRF's, so that both restrictions and total prohibitions can be specified at appropriate discriminatory levels.

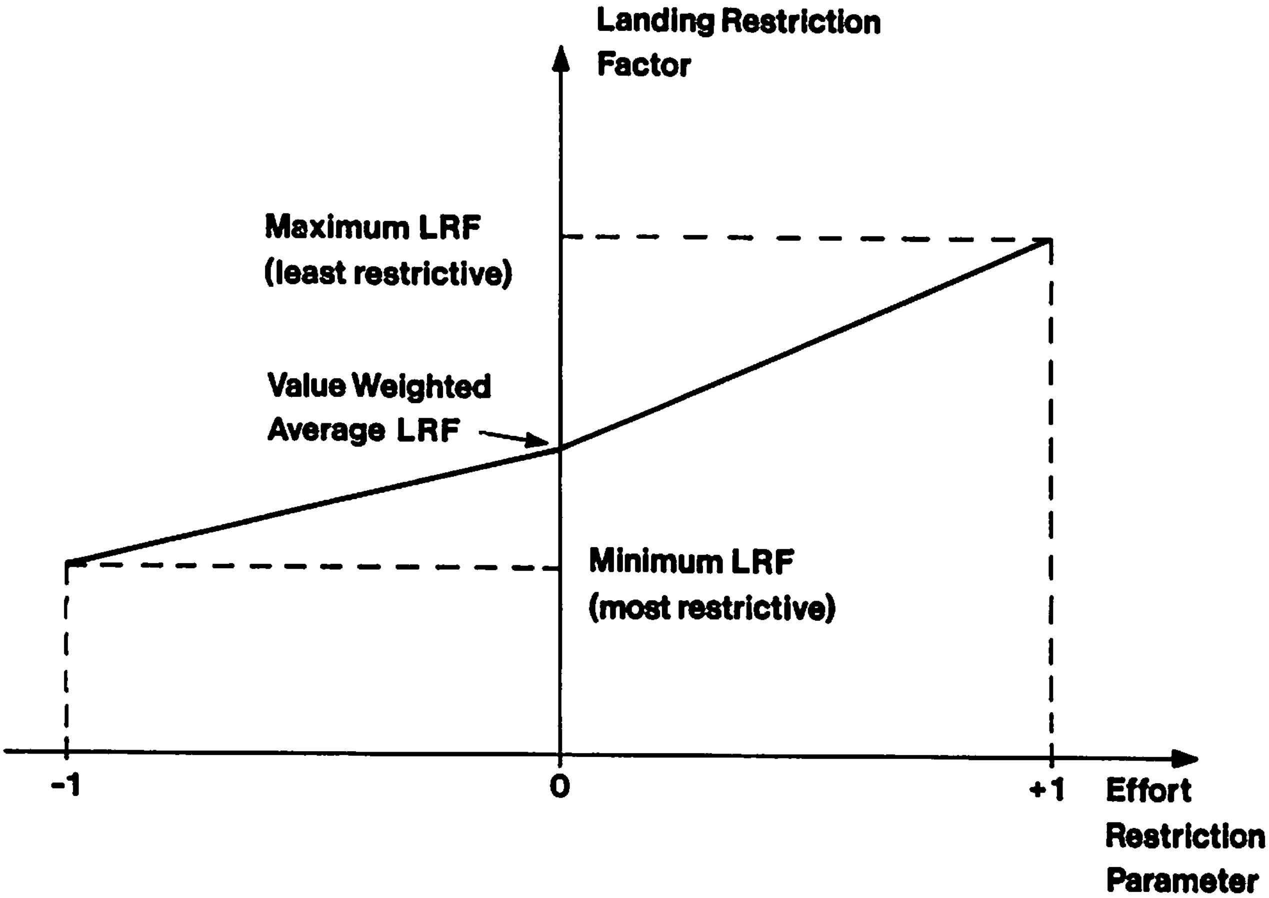
The LRF values, in the general and special case, [illegible] interactively in the PRE phase (detailed in Section [illegible]).

There is a range of possible responses to a mismatch between the restrictions placed on landings of different species in a mixed fishery. One extreme, the minimum effort response, is to stop fishing as soon as the most restrictive quota has been attained. The other extreme, the maximum catch response, is to stop fishing only when the least restrictive quota has been caught, and discard all the excess catches of other species. An "anchor point" for the theoretical model controlling this behaviour is provided by the average of the restriction factors for the different species; weighted by the expected unrestricted landed value of the species as a measure of the economic importance of that species to the vessel category being considered.

An Effort Restriction Parameter (ERP) is used as a tuning parameter to adjust the model for this behavioural response between the extremes, and thereby quantify the operating assumptions of FSM with respect to the behaviour, as illustrated in Figure 5 below.

The user can vary ERP over any one vessel attribute to permit the running of FSM under behavioural assumptions at discriminatory levels.

Figure 5


Landing Restriction
Factor
Maximum LRF
(least restrictive)
Value Weighted
Average LRF
Minimum LRF
(most restrictive)
-1
0
+1
Effort
Restriction
Parameter

7 FISH PRICE VARIATION (INCLUDING FISH PRICE ELASTICITY)

FSM assumes three independent effects on fish prices which for convenience are discussed together, namely Fish Price Elasticity (FPE), marketing policy and region/method price variation.

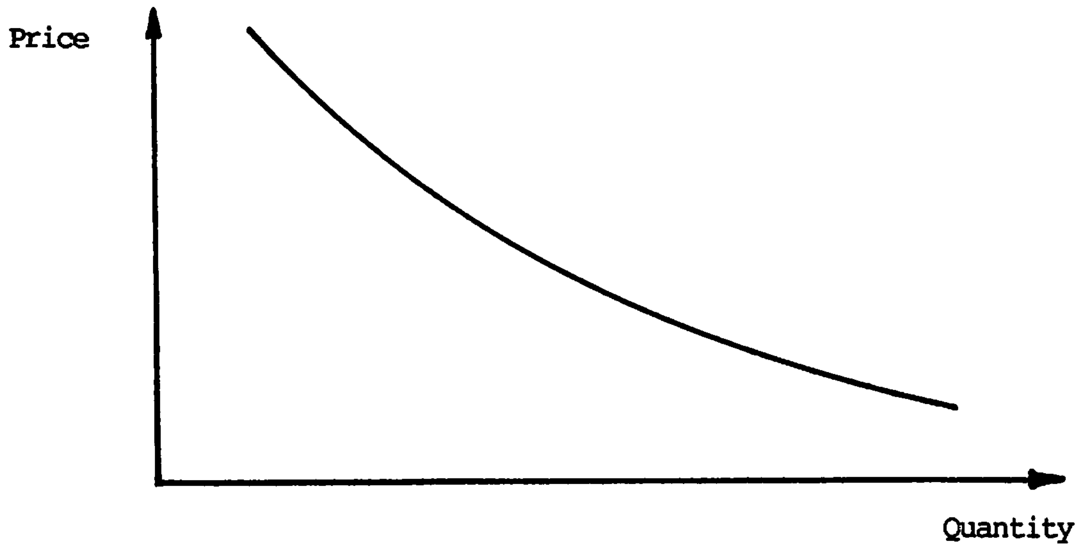
The FPE procedure deals with the first effect only, and does so on the "least bad" assumption that the balance between the UK fleet's landings into the home market, foreign fleets' imports into the UK and the UK fleet's exports will remain roughly the same over the predictive period; thus the UK fleet's landings are used as predictors for the influence of supply on average annual prices, modelled on the past relationships between these two sets of variables.

A further simplifying assumption in the FPE model is that the average annual price of each species depends only on landings of that species, and is independent of the landings of other species (i.e. ignoring cross-elasticities).

The example parameterisation recognises two types of behaviour in the analysis of historical data:

i) "Classical" response in the case of species with established markets, as illustrated by Figure 6 overleaf.

Figure 6



ii) "Perverse" response in the case of species which do not have established markets, so that increasing landings stimulate demand whereas decreasing landings detract from demand. This is mathematically equivalent to a "negative elasticity", with a positive slope in the landings/prices relation, as shown below:

Figure 7

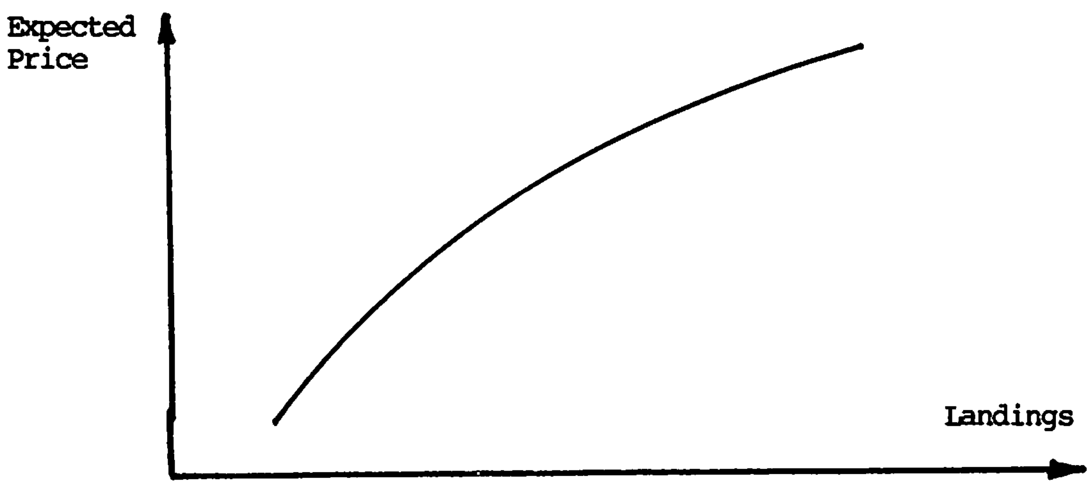
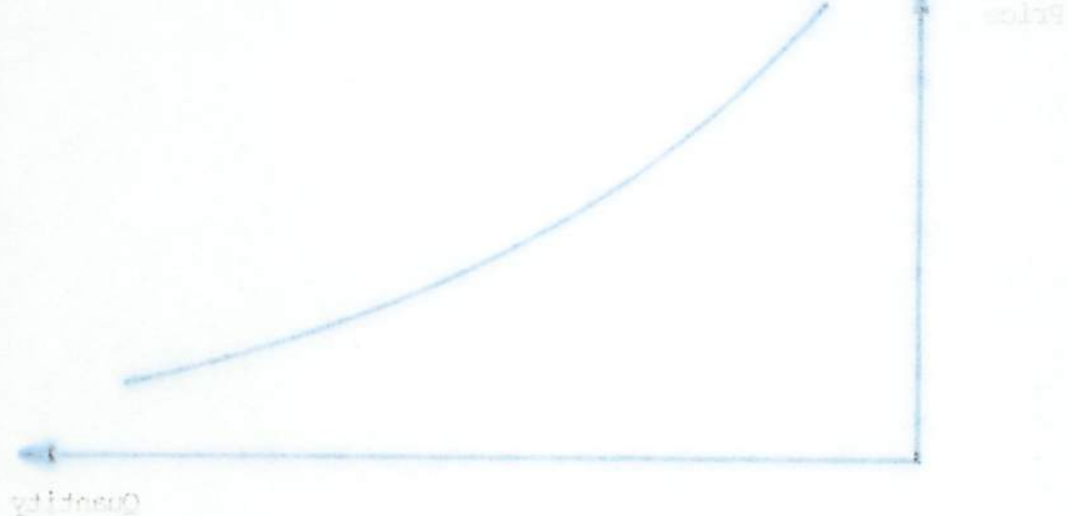


Figure 6



(ii) "Perverse" response in the case of species which do not have established markets, so that increasing landings stimulate demand whereas decreasing landings detract from demand. This is mathematically equivalent to a "negative elasticity", with a positive slope in the landings/prices relation, as shown below:

Figure 7

The inputs to the FPE procedure, other than the landings predicted in ALE, are parameters to specify the expected relationships between average annual prices and landings of each species.

The example parameterisation is based on analysis of time series data from MAFF Sea Fisheries Statistical Tables using a Paasche fish price index over all FSM species to adjust for inflation. The user may substitute his own parameterisation of the FPE model as a policy input in PII in order to run FSM under alternative assumptions about fish price behaviour.

In each yearly cycle of FSM the average annual price of each species can also be adjusted in response to a policy input Marketing Strategy Coefficient (MSC). This quantifies the anticipated response of prices to marketing policy and other assumed changes in demand, over and above the "status quo" relationship between prices and landings. It is assumed to be a national effect with no regional variation.

FSM recognises that for some species there are different markets according to the method of capture, and that regional variation in relative demand will also effect the price of each species. The region/method price variations are determined from base year landings data and remain constant over the predictive period, independent of the FPE and MSC effects.

The inputs to the FPE procedure, other than the landings predicted in FSM, are parameters to specify the expected relationships between average annual prices and landings of each species.

The example parameterisation is based on analysis of time series data from MAFF Sea Fisheries Statistical Tables using a wholesale fish price index over all the species to adjust for inflation. The user may substitute his own parameterisation of the FPE as a policy input in PII in order to run FS[illegible] under alternative assumptions about fish price behaviour.

In each yearly cycle of FS[illegible] the average annual price of each species can also be adjusted in response to a policy input Marketing Strategy Coefficient (MSC). This quantifies the anticipated response of prices to marketing policy and other assumed changes in demand, over and above the "status quo" relationship between prices and landings. It is assumed to be a national effect with no regional variation.

FPE recognises that for some species there are different markets according to the method of capture, and that regional variation in relative demand will also affect the price of each species. The region/method price relationships are determined from base year landings data and remain constant over the projective period, independent of the FPE and FSM effects.

8 BIOLOGICAL FEEDBACK

The Biological Feedback (BF) procedure determines the effects of each year's predicted catches on expected catch rate in successive years, and is modelled on the basis of three areas of assumption.

Firstly there must be some assumed relationships between the UK and other fleets' exploitation of fish stocks in successive predicted years. The user is offered the option of a number of possible scenarios under the Other Countries' catch Policy (OCP) input routine in PII. These relate other countries' catches from each stock, and possible variations in successive predictive years, to the base year catches by other countries (the "predetermined catches" option), to predicted biomasses (the "effort-related" option) or to UK catches (the "effort-matching" and "trade-off" options). If FSM is run with the national subregion comprising less than the whole UK fleet then the remaining regional fleets are included with other countries, as with the example parameterisation.

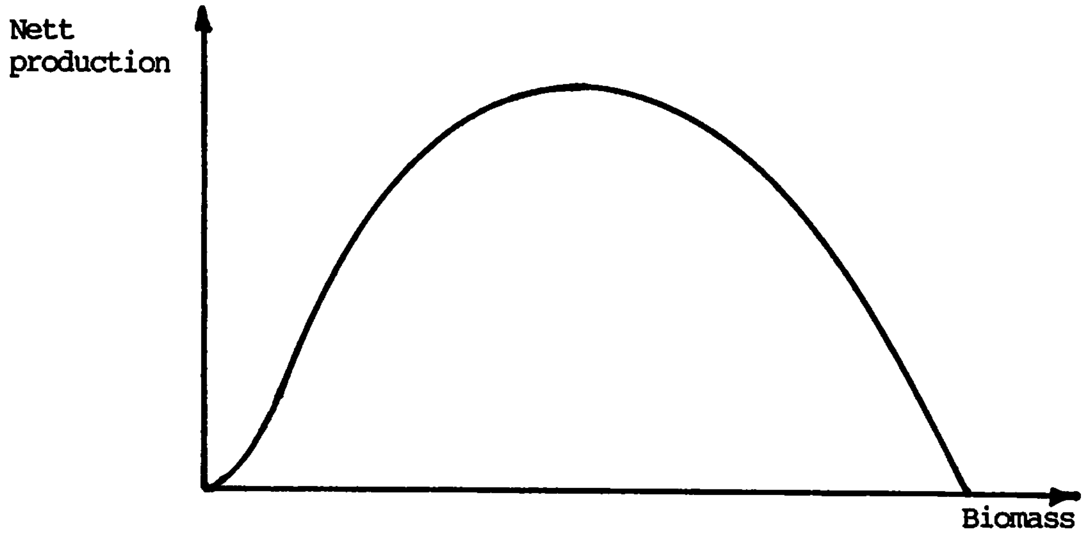
Secondly nett production function is used to predict annual nett production for each stock (i.e. recruitment to the exploited biomass, subsuming natural mortality and growth within the exploited biomass) as a function of existing biomass, using a characteristic nett production function as illustrated in Figure 8 overleaf.

The Biological Feedback (BF) procedure determines the eff[illegible] each year's predicted catches on expected catch rates in successive years and is modelled on the basis of three areas of assumption.

Firstly there must be [illegible] relationships [illegible] and other fleets' exploitation of fish stocks in successive predicted years. The [illegible] the options [illegible] possible scenarios under [illegible] Countries' [illegible] input routine in PII. These relate other countries' [illegible] each stock, and possible variations in successive predictive years, to the base year catches by other countries (the "predetermined catches" option), to predicted processes (the "effort-related" option) or to UK catches (the "[illegible]-scaling" and "trade-off" options). If FSM is run with the national subregion comprising less than the whole UK fleet then the remaining regional fleets are included with other countries, as with the example parameterisation.

Secondly, a nett production function is used to [illegible] production for each stock (i.e. recruitment to the exploited biomass, subsuming natural mortality and growth within the exploited biomass) as a function of existing biomass, using a characteristic nett production function as illustrated [illegible] overleaf.

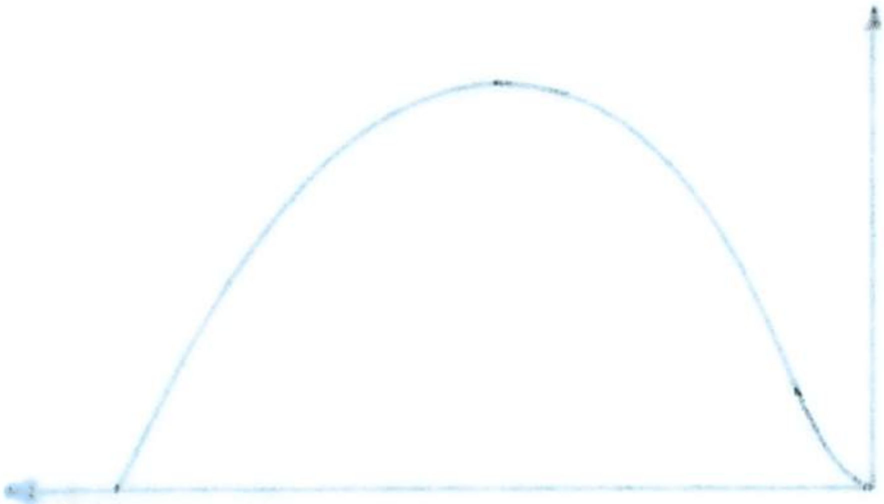
Figure 8



In each successive predictive year the biomass of each stock is adjusted by the difference between nett production and global (i.e. total UK plus other countries) catch. The effect of catches is assumed to be evenly spread over all the grounds on which a given stock is located regardless of the distribution of the catch over those grounds. Nett production is predicted on a stock by stock basis under the simplifying assumption of no inter-species effects on any given ground. Parameterisation is determined by analysis of ICES Working Groups biological time series data.

Thirdly a catch rate model adjusts catch rates in response to change in biomass for each stock, the proportionate variation from base year level being referred to as a Catch Rate Multiplier (CRM). The characteristic CRM function is illustrated in Figure 9 overleaf.

Figure 8



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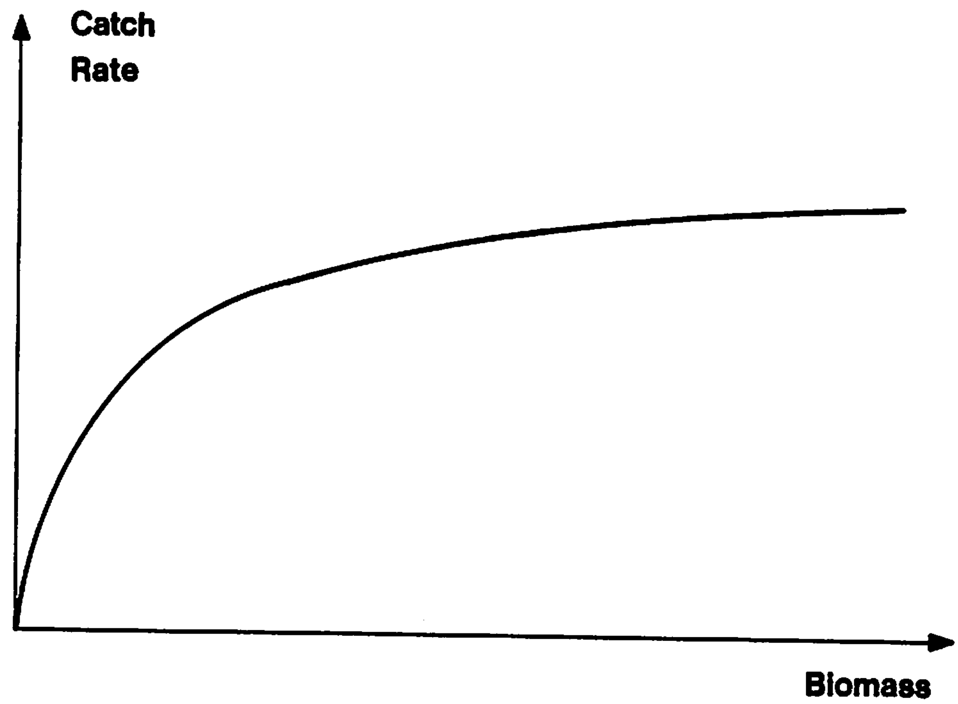

Example parameterisation, which scales the curve in relation to the position of the base year biomass and is a measure of both the state of stocks and the shoaling behaviour of the species, is provided on the basis of informed estimate by MAFF Laboratory, Lowestoft.

9 REDIRECTION OF EFFORT IN RESPONSE TO FINANCIAL PERFORMANCE

Although FSM is mostly a purely predictive model, the Propensity to Redirect Effort (PRE) procedure does introduce an optimum-seeking element, with a degree of redistribution of effort between gounds in response to relative performance, in an attempt to model fleet behaviour authentically.

Of the possible measures of financial performance, landed value of the daily catch is proposed as the one most appropriate to the prediction of this aspect of fleet behaviour. This measure is averaged out over the vessels of each vessel group in each predictive year in order to predict the desired distibution of effort (i.e. before the restrictive effects of resource management policies in the ACP model are applied) in the following year.

The extent of the redistribution is controlled by a desired Effort Variation Parameter (EVP), a tuning parameter under the control of the user through input in PII. EVP can be assigned at discriminatory levels for any one vessel attribute in order to run FSM under varying assumptions about this aspect of fleet behaviour. The EVP values define behaviour between the two extremes of no redistribution of effort and absolute redirection of each vessel group's effort to its best ground.

Since the FSM national subregion is not necessarily the composite of all the genuine subregions it is not possible to determine the redistribution of effort for the former by summing the effects over each of the latter in each predictive year. Furthermore the proposed PRE model is not directly appropriate in the case of the national subregion as it would imply, for example, that Scottish handliners would redirect their effort to grounds fished by their Cornish counterparts if these were more productive. A simplifying assumption is therefore made that there is no nett redistribution of effort by the national subregion.

REDIRECTION OF EFFORT IN RESPONSE TO FINANCIAL PERFORMANCE

Although FSM is mostly a purely predictive model, its adaptation to Redirect Effort (RRE) procedure does introduce an optimum-seeking element, with a degree of redistribution of effort between grounds in response to relative performance, in an attempt to model fleet behaviour more realistically.

Of the possible measures of financial performance, landed value per unit catch is proposed as the one most appropriate for simulation of this aspect of fleet behaviour. This measure is averaged out over the months of each vessel group in each predictive year in order to predict the desired redistribution of effort (i.e., before the cumulative effect of [illegible] management policies in the ACP model are applied) in the following year.

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Since the FSM national subregion is not necessarily the composite of all the genuine subregions it is not possible to calculate the redistribution of effort for the former by summing the redistribution of the latter in each predictive year. Furthermore the proposed RRE model is not strictly appropriate in the case of the national subregion as it would imply, for example, that Scottish fishermen would switch their effort to grounds [illegible] their Cornish counterparts if these were more productive. The assumption is therefore made that there is no redistribution of effort by the national subregion.

Because both resource management, through ACP, and desired redistribution through PRE, control the effort allocation to each ground, reconciliation between the two must be explicit in FSM. Where there is activity/landings control for a vessel group on a given ground, the landings restriction factors are specified with reference to base year distribution of effort, although updated catch rates are assumed when predicting the response to mismatched landings restrictions. The actual predicted effort will then be the most restrictive of the two effects. If there is no activity/landings restriction then only the PRE model is applied and effort can rise freely on a ground as well as fall.

Where both resource management, through TAC, and effort redistribution through RRs, control the effort allocation to each ground, reconciliation between the two must be explicit in VPA. Where there is activity/landings control for a vessel group on given ground, the landings restriction factors are specified with reference to base year distribution of effort, although update catch rates are assumed when predicting the response to mismatched landings restrictions. The actual predicted effort will then be the most restrictive of the two effects. If there is no activity/landings restriction then only the RRs model is applied and effort can rise freely on a ground as well as fall.

10 VESSEL GROUP STRUCTURE

10.1 Overview

The Vessel Group Structure (VGS) procedure predicts changes in fleet structure as a result of three separate effects, namely constructive total loss (accidental), fleet regeneration (investment) and fleet decay (disinvestment).

The VGS procedure receives, as inputs from the fleet operation in ALE, the expected grossings and effort of vessels in each vessel category. These are used in the prediction of the distributions of measures of financial performance directly relevant to investment and disinvestment. Parameters for the functional relationships between grossings and effort (as inputs), and intermediate measures of financial performance, are found by analysis of the base year landings data and costs and earnings surveys. However it is not possible to base the actual investment and disinvestment models on analysis of the effects of fleet management policies, and theoretical models are used based on hypothesised relationships. These models are controlled by parameters which quantify the effects of fleet restructuring policies under appraisal (i.e. as policy inputs) or the behavioural assumptions for the operating environment (i.e. as tuning parameters). In contrast the model for constructive total loss is determined entirely from analysis of historical data.

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10.2 Constructive Total Loss

The average incidence of Constructive Total Loss (CTL) is around 1% per year across the fleet but there are significant variations between different sections of the fleet.

Because of these variations it is not possible to subsume CTL in the financial models for fleet changes.

All vessel attributes could be recognised in predicting the risk of CTL for each vessel category. The effects would be taken to be independent, since interactions between the effects of different attributes would not contribute sufficiently to the predictive power of the VGS procedure to warrant the additional data analysis that would be required.

The subregion, method and length effects are assumed to remain constant over the predictive period. It is assumed that vessel age rather than year built is significant so the risk for each vessel category will vary over the predictive period. Two age effects are recognised, for which there are separate parameters, namely a general increasing risk with age and a "burn-in" effect (i.e. transient high risk for new vessels).

However the example parameterisation uses only subregion and age as predictors for CTL, as these appear to be the two strongest effects.

10.3 Fleet Regeneration

Fleet regeneration in the form of investment in new and secondhand vessels is assumed to be dependent on an objective measure of financial performance, namely nett profit. The level of investment within any vessel group is assumed to be dependent on the financial performance of all the constituent vessel categories in the vessel group.

The expected distribution of nett profit (in terms of average and spread) for each vessel category is predicted from the grossings and effort, modulated by vessel attributes, and allowing for financial commitment in the form of outstanding loans. For each vessel category the average commitment is specified in terms of the average proportion of the vessels value financed by loan, and the corresponding loan period and interest rate.

These parameters are controlled by the user at levels of disaggregation of any one vessel attribute. The parameters of the model for the distribution of nett profit in terms of earnings related elements (from grossings), activity related elements (from effort) and fixed elements (specified by vessel attributes) are determined from analysis of costs and earnings surveys.

From the individual distributions appropriate to each vessel category, the overall distribution of nett profit for the vessel groups are obtained.

The Sum of Greater than Mean (SGM) nett profits is proposed as a measure of available investment generating capital produced by the vessel group. This measure responds appropriately to variation in the numbers of vessels in the vessel group, and the mean and spread of nett profits (including cases where mean nett profit is negative). This is illustrated in Figure 10.

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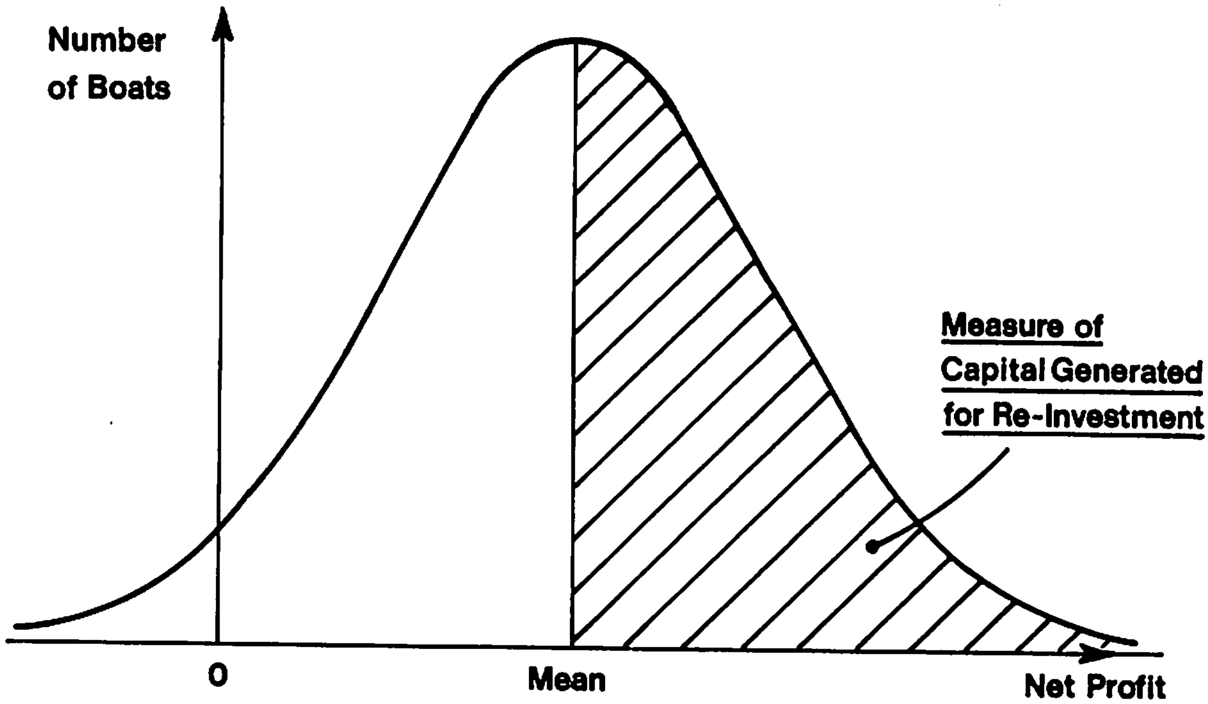
Figure 10



The relationship between the SGM nett profits in a vessel group and the actual capital investment made by the industry is controlled by a tuning parameter which scales the available capital (at discriminatory levels by any one vessel attribute if desired).

The proportionate allocation of available capital to the vessel group's respective purchases of new and secondhand vessels is controlled by a further tuning parameter, again discriminated by one (not necessarily the same) vessel attribute.

The age profile of secondhand vessels purchased is determined by the relative availabilities, nationally, of vessels of the same length group, thus assuming unrestricted transfer between regions and change of method on acquisition. The corresponding costs (i.e. secondhand values) are determined from analysis of the costs and earnings surveys.

The prediction of newbuilt purchases requires the levels of financial support in terms of grant and loan as a proportion of total cost to be specified by policy input. The grant can be assigned in up to four separate additive factors, variable over predictive year, subregion, method and length group. This is to reflect the additive nature of such support; for example all vessels of a certain size range may attract grants but with certain subregions receiving additional assistance regardless of size. The loan may be assigned at discriminatory levels over any one vessel attribute and is downweighted by a tuning factor in order to express it in terms of the grant level which would have the same effect in inducing investment. For example on a £80,000 new vessel attracting a 25% (£20,000) grant and 25% (£20,000) loan, the nett of financial assistance cost would be £40,000 if the loan were recognised as being as valuable as the grant and £60,000 if the loan were not considered to contribute to inducing purchase at all. Downweighting the loan to 0.4 of 25% (i.e. to £8,000) would recognise an equivalent assistance level of £28,000 and an equivalent nett of assistance cost of £52,000.

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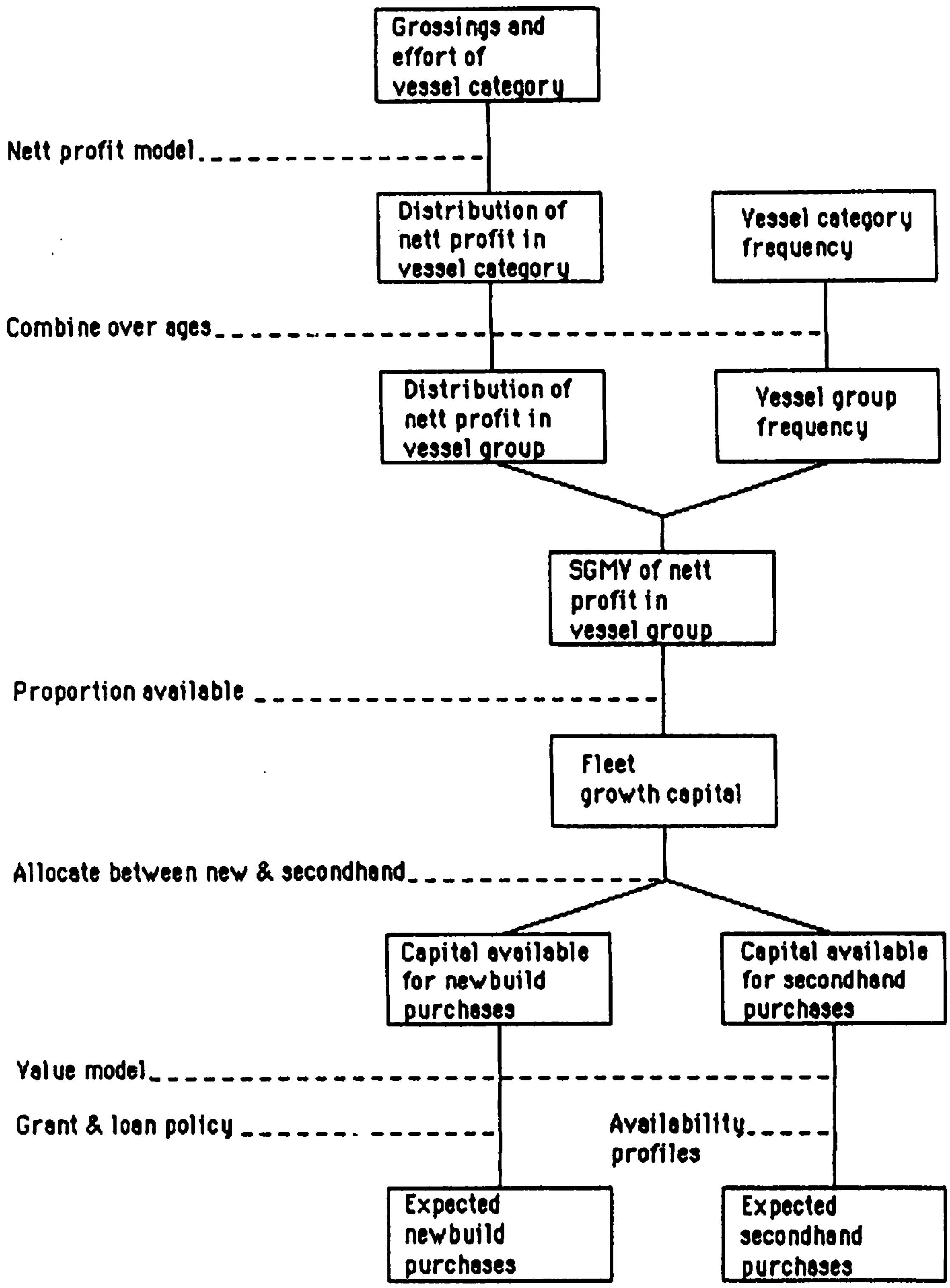
The fleet regeneration model is presented schematically below:

Figure 11



10.4 Disinvestment

In contrast to the investment model which relies on an objective measure to quantify financial performance, the disinvestment model brings in subjective responses by vessel owners to financial constraints and inducement.

A first aspect of subjective response is quantified in what is referred to as available share. After the minimum required personal share (i.e. immediate livelihood) has been deducted from the individuals portion of the labour share the residue is called available share. It is that portion of the income with which on-board owners might be prepared to subsidise notionally unprofitable vessels (i.e. to protect their future livelihood in fishing).

The minimum required personal share per crew member, and the level of on-board ownership (which determines how much of the residue will be available), are controlled by the user in PII, as behavioural assumptions, each disaggregated by any one vessel attribute.

Costs and earnings data are used to establish the models for the average number of crew per vessel, as a function of vessel attributes, and for the expected labour share in a category, as a function of vessel attributes (fixed elements), grossings (earnings related elements) and effort (activity related elements).

The nett profit, augmented by the available share, is referred to as perceived profit. It is assumed that it is the owner's subjective perception of profitability, as distinct from a precise accountant's interpretation, which will be the better predictor of a low-performance vessel's continued operation.

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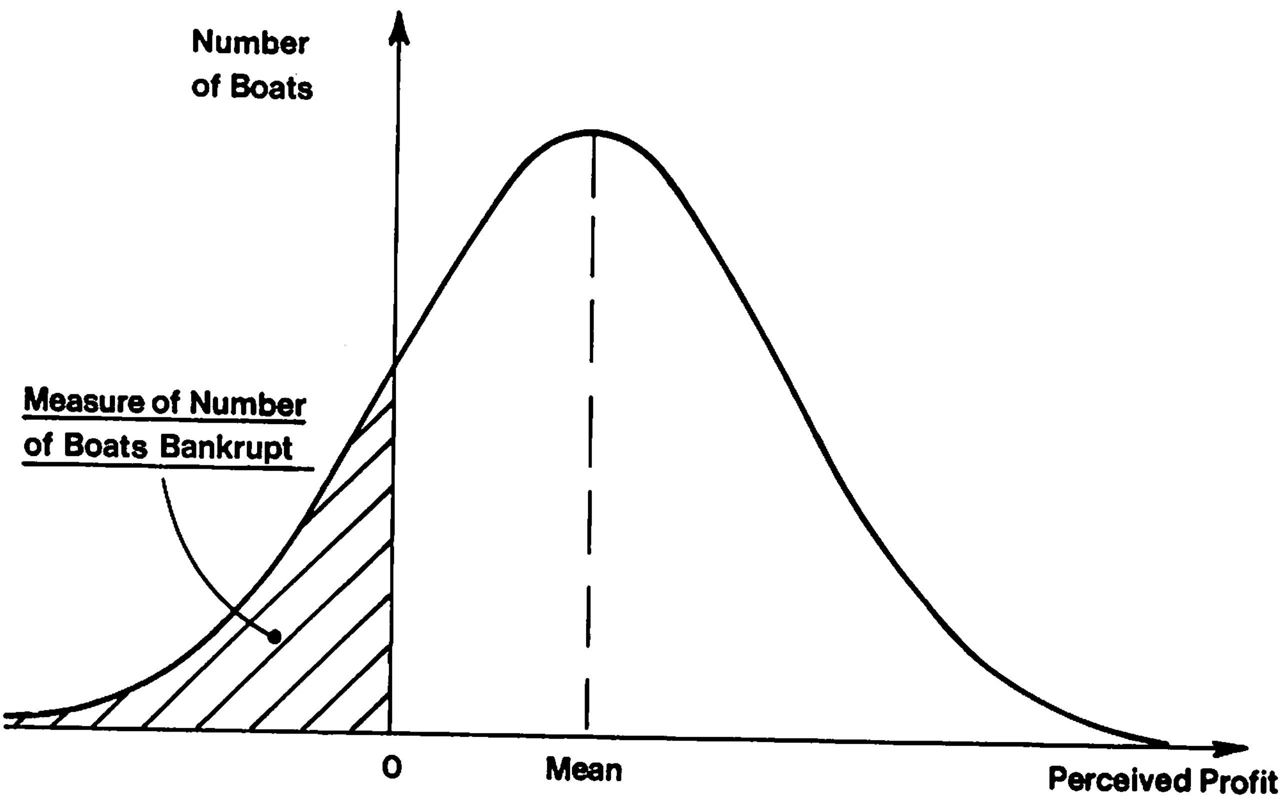
The expected proportion of vessels bankrupt in each vessel category in each predictive year can be defined simply as those with negative nett profit (i.e. those which cannot be perceived as profitable even with the support of the available share) as shown below. To allow some additional flexibility in the behaviour of the model a tuning parameter, referred to as the Financial Loss Parameter (FLP), disaggregated by any one vessel attribute, is used to adjust the proportion of loss making vessels which become bankrupt.

Figure 12



Decommissioning grants may be available to vessel owners and the user can specify the grant level and its selective availability to fleet sectors by policy input in PII. A simplified model for the average Gross Register Tonnage (GRT) of vessels in each vessel category, established from analysis of costs and earnings data, assumes that only one definition of GRT will be applied in the determination of grants. The GRT model is used to convert a grant level expressed in £ per GRT into expected capital value for a given vessel category.

A second aspect of subjective response in the disinvestment model lies in the owner's appraisal of the value of a decommissioning grant and its power of inducement to cease operating a marginally profitable vessel.

A model for the appraisal is hypothesised in two stages. Firstly, in order to compare with a yearly income, the expected capital value of a grant is converted to an equivalent annual income using an interest rate assigned by the user at discriminatory levels of any one attribute. (Typically, larger vessels, attracting larger capital amounts, might be associated with correspondingly higher interest rates). The interest rate should reflect commercial rates expected in the predictive period, but with some allowance for the operation of FSM in base year equivalent units.

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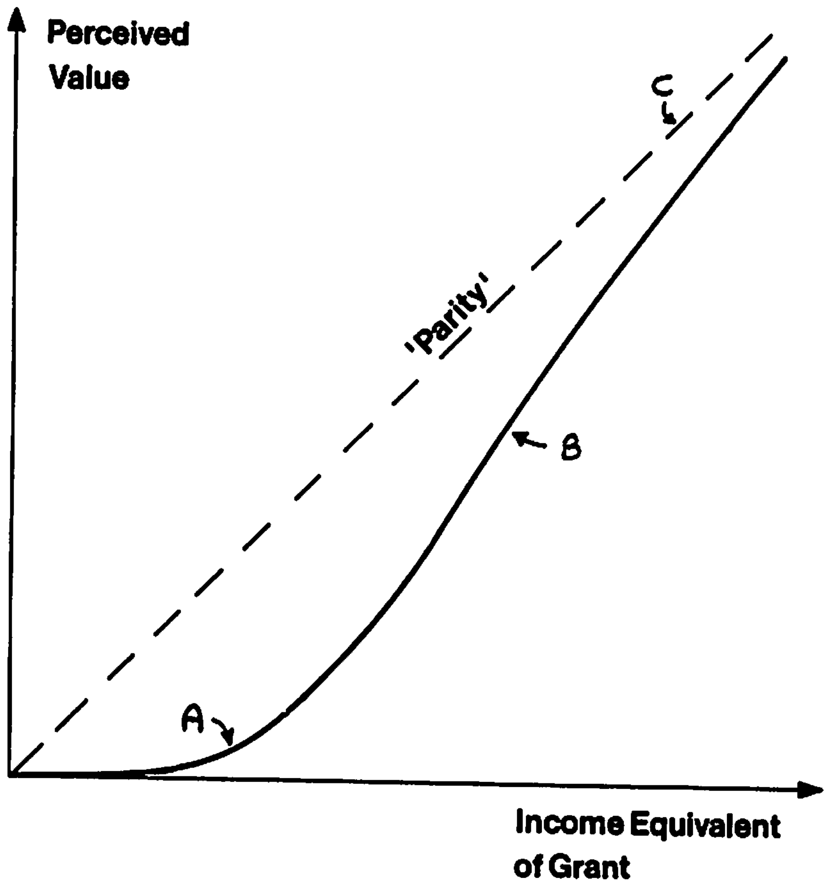
Secondly a utility function is used to compare the grant's equivalent annual income with an income which an owner would perceive as being of the same value to him if it were derived from the continued operation of his fishing vessel. The characteristic function is illustrated below.

Figure 13

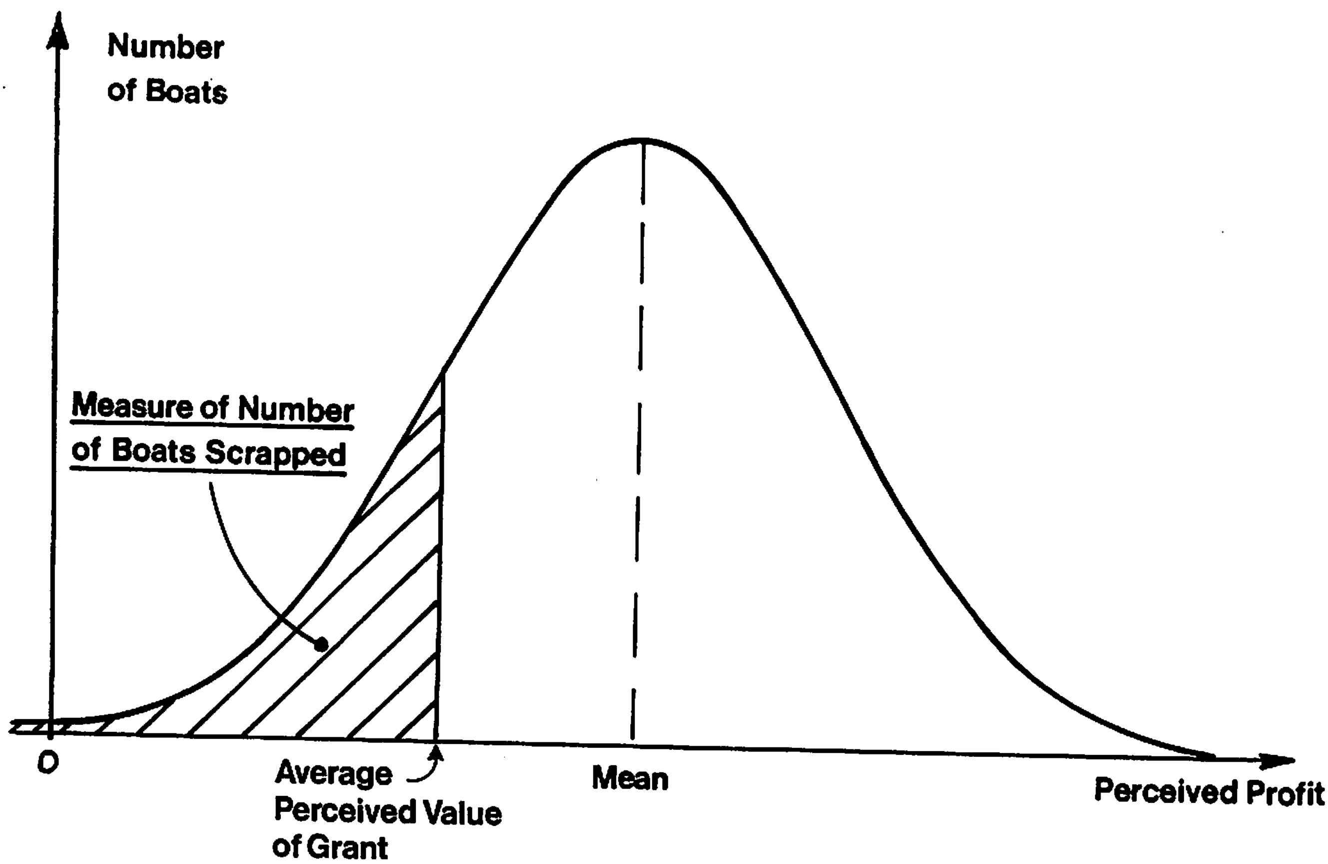


Typically, at low levels (A) the grant would be perceived as "worth next to nothing". At higher levels it starts to have an appreciable perceived value (B) and to approach the parity line (C) more closely.

The utility function is controlled by two tuning parameters. One downweights the perceived value of a grant and registers a disinclination to cease fishing despite poor income (i.e. the "bulge" away from the parity line). This would typically be associated with the level of ownership participation, assumed to vary between fleet sectors. The other simply scales the utility model according to the value of the vessel and its potential earning capacity. Both parameters are under user control, disaggregated by one vessel attribute, as quantification of the model's assumed operating environment.

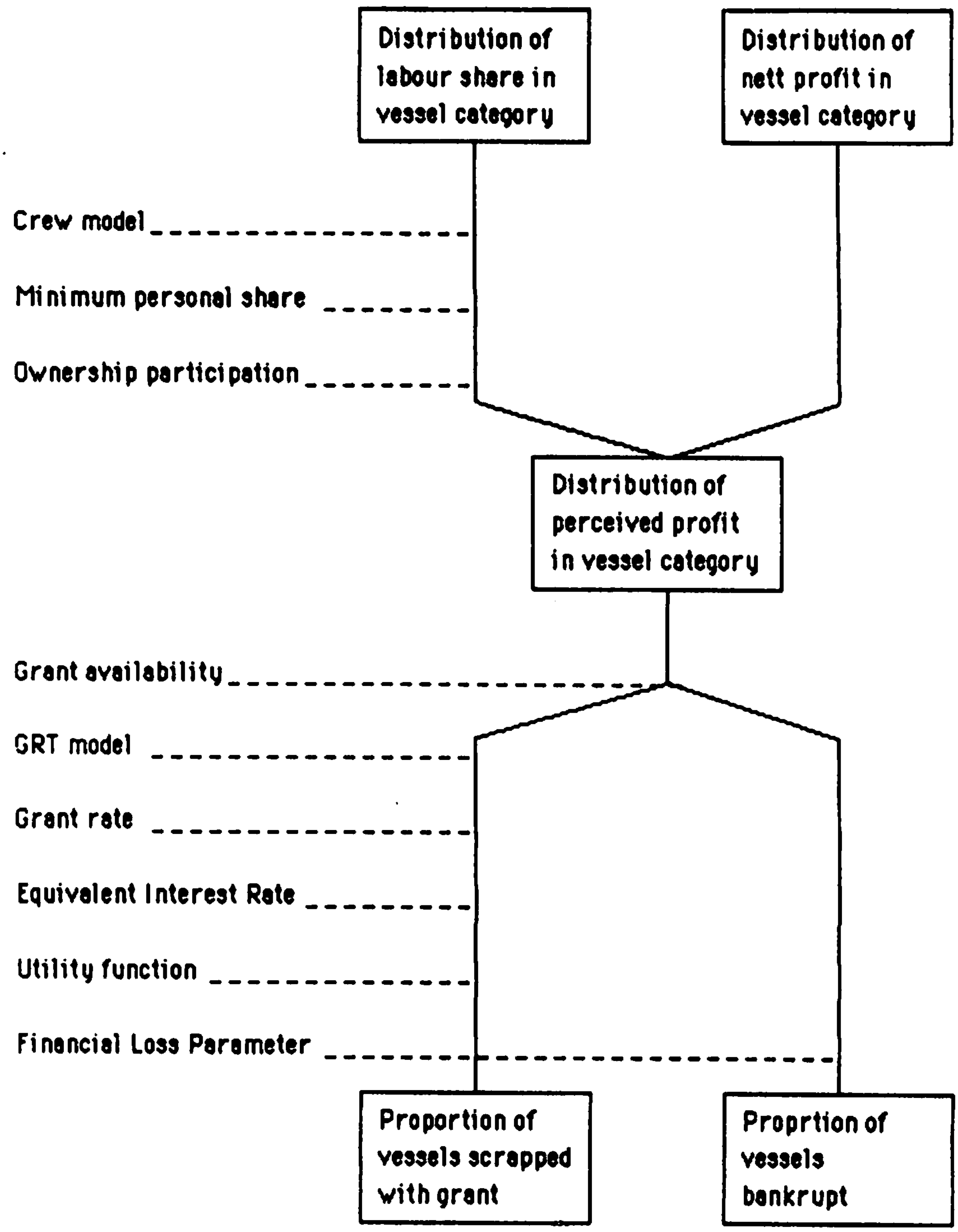
If a decommissioning grant is available the proportion of vessels scrapped with grant in a vessel category is predicted by considering the distribution of perceived profit (as with bankruptcy) and using as the demarcation line the average perceived value of the grant to vessels of the category (again, with the proportion adjusted by FLP as in the case of bankruptcy). This is illustrated below:

Figure 14



The disinvestment model is presented schematically below:

Figure 15



11 POLICY INPUT AND INITIALISATION

A series of typical record sheets which may be used to record the policy inputs chosen in PII for a particular run of the model is attached as Appendix I. A short explanation of each of these inputs is given below, together with a reference to more detailed information.

Firstly a name (maximum of 8 characters) is given to the run itself together with a reference name under which the caretaker's files (which contain all the data derived parameters) may be found. A run file (.RUN) consists of a short amount of set-up information, plus the names of policy strategy files.

Next the regions to be considered in the run are specified (pages 7&8) together with the number of predictive years (page 7). Finally within the set-up segment the user is requested to specify which option with regard to other country's catches he requires (page 22). If option 1 is selected, i.e. other countries catch varies in direct ratio to the UK's, a minimum UK percentage of the total catch is requested, to avoid this option being applied where the UK catch is relatively low.

To complete the run file it is then only necessary to provide the names of each of the files containing the various elements of policy strategy, to define where the model output is to be directed, and to instruct whether detailed effort and landings or detailed fleeet structure databases are required, and if so for which years.

The Landings Restriction Factor (.LRF) file simply contains the values of LRF by species, predictive year, and ground (page 16).

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The Landings Restriction Factor (.LRF) file simply contains the values of LRF by species, predictive year, and ground (page 16).

The Special Case Multipler (.SCM) file simply contains a value for each SCM, followed by a specification of which predictive year(s), method(s), length(s), ground(s) and species(s) it applies to (page 16).

The Policy file (.POL) contains values of New Build Grants by predictive year, sub-region, method and length (Page 31), followed by New Build Loan and Loan Downweight Factor (page 31), both of which may be varied by any one of the following attributes: predictive year, sub-region, method or length. A similar variation (but including age group) is available for Scrapping Grant Rate (page 35) and for Scrapping Grant Availability Factors 1 and 2. Note that the same attribute cannot be chosen for any two of these three inputs. SGA1 and SGA2 take the value 1 if decommissioning grant is to be available, and zero otherwise.

The Fish Price policy file (.PRI) contains values of Marketing Strategy Coefficient (page 21) by predictive year and species, and also the value of a single Fish Price Elasticity (applying to all species and replacing the values derived by data analysis) if so desired (page 21).

The Financial and Social Environment file (.ENV) contains details of the Loan Period, Loan Interest Rate and Loan Percent Outstanding (page 28) defining the capital servicing commitment in each vessel category; together with the parameters controlling disinvestment, viz: Onboard Ownership Coefficient and Minimum Personal Share (page 33) and decommissioning, i.e. Investment Rate, (page 35) and Perceived Value Coefficients 1 and 2 (page 37). If the parity option is required then PV1 and PV2 should be zero. All these parameters may be varied by any one of the following attributes: predictive year, sub-region, method, length group or age group; as can the parameters contained in the .TWK file below.

The Behavioural Assumptions file (.TWK) contains: two parameters controlling fleet activity - Effort Variation Parameter (page 25) and Effort Restriction Parameter (page 17); two parameters controlling investment - Proportion of Capital Available (page 30) and New Build Constant (page 30); and a single parameter controlling disinvestment - Financial Loss Parameter (pages 34 and 37).

12 OUTPUT

Two types of output are produced from FSM. The first is a printed summary for each predictive year.

This summary contains predictions of:

i) the total number of vessels (by subregion and length group)

ii) the following fleet results:

- total number of boats and the percentage change over the previous year;
- the number of boats built, bought secondhand; decommissioned, bankrupt and accidentally lost;
- the total amounts of building and decommissioning grants paid;
- the total number of crew;
- the total effort (in terms of days at sea);
- the total catch;
- the total earnings and percentage change over the previous year;
- the operating surplus and added value.

(by subregion, fishing method, length group and age group).

iii) the following biological results:

- the biomass,
- the total international landings;
- the total UK landings;
- the catch rates relative to the base year (by species/stock).

An example of the tables produced for one predictive year is given in Appendix II.

The second type of output consists of detailed effort and landings, and/or detailed fleet structure information, stored as a datafile for subsequent analysis by another computer package. This is provided so that ad-hoc enquiries may be answered.

13. REFERENCES

1. Shalliker J. A., Tucker C. E., Upfield J. A. 1988
Fleet Structures Model: Activity Landings and Earnings Phase
Seafish Technical Report No. 302

2. Shalliker J. A., Tucker C. E., Upfield J. A. 1988
Fleet Structures Model: Vessel Group Structure Phase
Seafish Technical Report No. 303

3. Shalliker J. A., Tucker C. E., Upfield J. A. 1988
Fleet Structures Model: Biological Feedback Phase
Seafish Technical Report No. 304

4. Tucker C. E. and Brugge W. J. 1983
Fleet Restructuring Model: Progress Report
Seafish Technical Report No. 197

APPENDIX I

Input Record Sheets

FLEET STRUCTURES MODEL.

Date __/__/__

Run Set-up Record Sheet

Name of Run: [| | | | | | |]

Name of Caretaker's Files (Data): [| | | | | | |]

Regions to be included in Run:

	1	2	3	4	5	6	7
8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23
24	25	26	27	28	29	30	31

Number of Years for Run: [ ]

Other Countries Catch Option (OCPOPT)

Constant Ratio to National catch	1
Related to Biomass for Constant Effort	2
Constant Global Catch (National + Others)	3
Constant Other Countries Catch	4

Low Test Ratio (LTR). (Only if OCPOPT = 1): [ ]

FLEET STRUCTURES MODEL

Policy Strategy Input Record Sheet 1

Page __ of __

Date __/__/__

Landings Restriction Factor (LRF)

LRF File ________

Year [ ]

Data Files ________

LRF expressed as percentage(%)

Specie	Ground																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1																				
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FLEET STRUCTURE MODEL

Policy Strategy Input Record Sheet 2

Page __ of __
Date __/__/__

Special Case Multiplier (SCM)

SCM File ________

Data Files ________

SCM NO. ______   Value [   ]   (expressed as percentage%)

Attributes for this SCM:

Years	All	1	2	3	4	5	6	7	8	9	10

Methods	All	1	2	3	4	5	6	7	8	9	10	11	12

Lengths	All	1	2	3	4	5	6	7	8	9
10	11	12	13	14	15	16	17	18	19	20

Grounds	All	1	2	3	4	5	6	7	8	9
10	11	12	13	14	15	16	17	18	19	20

Species										
All	1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20	21
22	23	24	25	26	27	28	29	30	31	32

FLEET STRUCTURES MODEL

Policy Strategy Input Record Sheet 3a

Page __ of __

Date __/__/__

SCM File ________

Data Files ________

Structural Policy Parameters

New Build Grant (NBG) = NBG1 + NBG2 + NBG3 + NBG4.
(expressed as percentage %)

NBG1 (Variation by year)

1	2	3	4	5	6	7	8	9	10

NBG2 (Variation by region)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32

NBG3 (Variation by method)

1	2	3	4	5	6	7	8	9	10	11	12

NBG4 (Variation by length)

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20

New Build Loan (NBL)

(Expressed as percentage %)

Attribute:	Years	Regions	Methods	Length	None

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32

FLEET STRUCTURES MODEL

Policy Strategy Input Record Sheet 3b

Page __ of __
Date __/__/__
Pol File ______

Structural Policy Parameters(Continued)

Data Files ______

Loan Downweight Factor (LDF)

(Expressed as percentage %)

Attribute:	Years	Regions	Methods	Length	None

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32

Scrapping Grant Rate (SGR)

(Expressed as £/GRT)

Attribute:	Years	Regions	Methods	Lengths	Ages	None

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32

Scrapping Grant Availability Factor 1 (SGA1)

(0 or 1)

Attribute:	Years	Regions	Methods	Lengths	Ages	None

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32

Scrapping Grant Availability Factor 2 (SGA2)

(0 or 1)

Attribute:	Years	Regions	Methods	Lengths	Ages	None

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32

FLEET STRUCTURES MODEL

Policy Strategy Input Record Sheet 4

Page __ of __

Date __/__/___

Fish Price Policies

Pri File _________

Marketing Strategy Coefficient (MSC)

Data File _________

(expressed as percentage %)

Specie	Year									
	1	2	3	4	5	6	7	8	9	10
1										
2										
3										
4										
5										
6										
7										
8										
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10										
11										
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30										
31										
32										

Fish Price Elasticity

Over write Option:	Y/N	Value:	

FLEET STRUCTURES MODEL

Policy Strategy Input Record Sheet 5a

Page __ of __
Date __/__/__
Env File ________

Financial and Social Environment

Data Files ________

Loan Period (LPR)

(Expressed in years)

Attribute:	Years	Regions	Methods	Lengths	Ages	None

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32

Loan Interest Rate (LIR)

(Expressed as percentage %)

Attribute:	Years	Regions	Methods	Lengths	Ages	None

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32

Loan Percent Outstanding (LPO)

(Expressed as percentage %)

Attribute:	Years	Regions	Methods	Lengths	Ages	None

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32

Investment Rate (INV)

(Expressed as percentage %)

Attribute:	Years	Regions	Methods	Lengths	Ages	None

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32

FLEET STRUCTURES MODEL

Policy Strategy Input Record Sheet 5b

Page __ of __
Date __/__/__
Env File ________

Financial and Social Environment (Contined)

Data Files ________

Onboard Ownership Coefficient (OOC)

(Expressed as percentage %)

Attribute:	Years	Regions	Methods	Lengths	Ages	None

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32

Minimum Personal Share (MPS)

(Expressed in £'s)

Attribute:	Years	Regions	Methods	Lengths	Ages	None

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32

Perceived Value Coefficent 1 (PV1)

Attribute:	Years	Regions	Methods	Lengths	Ages	None

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32

Perceived Value Coefficient 2 (PV2)

Attribute:	Years	Regions	Methods	Lengths	Ages	None

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32

FLEET STRUCTURES MODEL

Policy Strategy Input Record Sheet 6

Behavioural Assumptions

Page ___ of ___
Date ___/___/___
Twk File ______
Data Files ______

Effort Variation Parameter (EVP)

(0 ➔ 1)

Attribute:	Years	Regions	Methods	Lengths	Ages	None

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32

Effort Restriction Parameter (ERP)

(- 1 ➔ + 1)

Attribute:	Years	Regions	Methods	Lengths	Ages	None

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32

Proportion of Capital Available (PCA)

(0 ➔ 1)

Attribute:	Years	Regions	Methods	Length	None

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32

New Build Constant (NBC)

(0 ➔ 1)

Attribute:	Years	Regions	Methods	Length	None

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32

Financial Loss Parameter (FLP)

(- 1 ➔ + 1)

Attribute:	Years	Regions	Methods	Lengths	Ages	None

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32

APPENDIX II

Example Output

FLEET STRUCTURES MODEL

SUMMARY OUTPUT FOR YEAR = 2

DATA FILES = FPMDEMO1
RUN NAME = exam-out

NUMBERS OF VESSELS BY SUBREGION AND LENGTH GROUP

LENGTH GROUP

SUB -	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	TOTAL
REGION	25.0	32.5	37.5	42.5	47.5	52.5	57.5	62.5	67.5	72.5	77.5	85.0	95.0	105.0	115.0	125.0	135.0	150.0	240.0		
CONTRY	77	74	96	33	74	77	65	36	25	15	21	14	13	11	6	5	6	1	1	.	652
NSHLDS	0	1	3	2	3	8	11	4	4	2	3	0	0	0	.	.	.	.	.	.	42
N.E.SP	22	26	20	6	24	29	15	3	5	2	.	.	1	0	.	.	.	.	.	.	154
HULL	.	.	.	0	2	1	0	1	.	1	.	.	.	0	0	2	1	0	1	.	10
GRMSBY	1	1	0	.	5	22	31	19	3	4	2	.	.	.	.	1	6	.	.	.	94
LWSTFT	2	3	9	1	8	2	1	2	2	2	4	1	3	2	4	1	.	1	.	.	49
E.ANG.	7	4	6	1	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	21
S.E.	26	11	14	4	5	3	1	.	1	0	1	1	.	.	.	.	.	.	.	.	65
PLYMTH	1	3	3	4	3	3	0	1	2	0	3	1	1	0	1	.	.	.	.	.	25
FALMTH	1	2	6	.	1	1	1	1	1	1	3	1	2	3	1	.	1	.	.	.	27
S.WEST	7	17	34	13	24	11	10	4	7	4	8	11	5	1	1	1	.	.	.	.	157
M.HAVN	.	.	0	.	1	1	.	.	.	.	.	.	1	2	1	.	.	.	.	.	6
WALES	13	8	7	2	5	2	0	2	1	1	1	.	.	.	.	.	.	.	.	.	43
FLTWOD	3	3	3	2	3	5	4	3	3	2	0	3	.	1	.	.	.	0	.	.	35
N.WEST	1	3	4	3	2	2	1	1	1	0	.	0	1	.	.	.	.	.	.	.	20
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TOTAL	84	81	110	39	88	90	76	41	29	19	25	18	14	10	8	6	7	2	1	.	749

SUMMARY OUTPUT FOR YEAR = 2

RESULTS BY SUBREGION

DATA FILES = FPMDEMO1
RUN NAME = exam-out

	NO. BOATS	% CHNGE	NO. BUILT	NO. S-HND	NO. DECOM	NO. BKRPT	NO. LOST	BUILDING GRANTS-$	DE-COM'G GRANTS-$	NO. CREW	EFFORT SEA-DAYS	TOTAL CATCH-T	TOTAL EARNS-$K	% CHNGE	OPERAT'G SURPL-$K	ADDED VALUE-$K
2 NSHLDS	42	-38.0	1.0	0.9	14.6	12.1	1.4	180471	490722	189	5013	3564	2197	-36.9	-158	599
3 N.E.SP	154	-28.4	5.7	4.9	38.4	28.8	4.4	587568	946965	459	18146	8689	5446	-32.0	334	2227
4 HULL	10	-30.9	0.3	0.2	2.8	2.2	0.2	101801	815573	94	1969	8520	5138	-21.0	55	1585
5 GRMSBY	94	-27.5	2.4	2.4	26.1	12.7	1.6	494703	1426250	448	18539	17748	11484	-24.3	204	3838
6 LWSTFT	49	-31.6	0.8	0.9	15.9	8.1	0.3	155642	981206	214	8126	11527	7185	-28.0	-175	2154
7 E.ANG.	21	-33.9	0.5	0.4	8.4	3.1	0.1	32300	100282	38	2183	355	368	-41.1	-17	140
8 S.E.	65	-30.9	1.8	1.5	25.7	6.3	0.6	135647	291068	120	7311	1896	1597	-26.5	80	700
9 PLYMTH	25	-27.9	0.8	0.7	6.6	4.2	0.5	107440	273152	107	2625	5541	1866	-26.4	126	742
10 FALMTH	27	-38.7	0.5	0.4	5.6	11.7	0.5	98594	177488	150	1783	14957	2231	-33.0	-87	653
11 S.WEST	157	-25.0	4.6	5.0	37.3	21.7	2.8	506113	1125137	590	19107	12297	11473	-22.0	1201	4981
12 M.HAVN	6	-39.0	0.1	0.1	2.5	1.3	0.2	14514	342755	36	747	791	676	-45.0	-106	112
13 WALES	43	-24.9	1.6	1.4	13.4	2.7	1.2	124742	330258	86	2589	1404	633	-37.3	120	387
14 FLTWOD	35	-34.2	0.8	0.7	14.7	4.3	0.8	106340	496627	113	4827	3511	2022	-37.4	-151	533
15 N.WEST	20	-39.3	0.4	0.4	10.5	2.8	0.5	43901	310218	56	1759	1096	594	-40.1	-69	155
16	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
17	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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TOT. OF SUBRGNS	749	-29.8	21.2	19.9	222.5	121.8	15.0	2689776	8107701	2700	94722	91896	52910	-27.5	1357	18807

RESULTS BY METHOD

	NO. BOATS	% CHNGE	NO. BUILT	NO. S-HND	NO. DECOM	NO. BKRPT	NO. LOST	BUILDING GRANTS-$	DE-COM'G GRANTS-$	NO. CREW	EFFORT SEA-DAYS	TOTAL CATCH-T	TOTAL EARNS-$K	% CHNGE	OPERAT'G SURPL-$K	ADDED VALUE-$K
1 DEM.OT.TWL	331	-32.2	9.5	8.7	113.2	54.3	7.6	1181490	4871308	1140	43807	31835	20568	-34.2	-611	6129
2 DEM.PR.TWL	73	-27.1	2.0	1.4	11.2	18.2	1.2	513998	415595	399	9854	31297	12174	-13.2	909	4752
3 BEAM TRAWL	59	-20.9	0.8	1.9	13.3	4.0	1.0	84214	852342	318	8464	7380	8357	-19.0	689	3354
4 PL.S/B.TWL	3	-28.5	0.1	0.1	0.2	1.1	0.0	3481	6078	12	563	1197	296	-26.5	-6	86
5 PEL.PR.TWL	8	-41.3	0.1	0.1	4.1	1.8	0.1	10541	66132	34	477	4220	630	-7.8	-74	139
6 SEINE NET	70	-35.8	1.6	1.7	26.0	14.6	1.5	261526	874862	300	12837	7780	4832	-36.6	-333	1323
7 OTHER NETS	41	-36.5	1.0	1.0	18.1	7.0	0.8	115023	189927	113	4925	2306	1890	-25.8	18	700
8 POTS	99	-8.7	5.1	3.8	7.1	9.6	1.7	323651	107837	173	7305	985	900	-36.9	793	1222
9 LINES	31	-40.6	0.5	0.6	15.5	6.3	0.5	63100	294328	87	2892	1508	1020	-37.1	-117	283
10 SHELL T&D	34	-34.9	0.7	0.6	13.9	4.9	0.7	132752	429294	125	3598	3389	2243	-27.2	87	820
11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
12	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
TOT. OF METHODS	749	-29.8	21.2	19.9	222.5	121.8	15.0	2689776	8107701	2700	94722	91896	52910	-27.5	1357	18807

SUMMARY OUTPUT FOR YEAR = 2

DATA FILES = FPMDEMO1
RUN NAME = exam-out

RESULTS BY LENGTH GROUP

		NO. BOATS	% CHNGE	NO. BUILT	NO. S-HND	NO. DECOM	NO. BKRPT	NO. LOST	BUILDING GRANTS-$	DE-COM'G GRANTS-$	NO. CREW	EFFORT SEA-DAYS	TOTAL CATCH-T	TOTAL EARNS-$K	% CHNGE	OPERAT'G SURPL-$K	ADDED VALUE-$K
1	25.0	84	-23.6	3.5	3.1	27.1	4.0	1.4	128325	114865	103	6118	590	490	-34.6	288	578
2	32.5	81	-29.9	2.9	1.9	19.1	18.9	1.5	181384	159728	153	7674	1398	1161	-36.3	182	685
3	37.5	110	-32.2	3.5	2.6	31.2	25.0	2.0	288706	377394	247	11586	3193	2460	-33.8	79	1041
4	42.5	39	-33.3	1.1	1.2	15.3	5.6	0.8	111170	255368	102	4691	1707	1105	-37.9	18	428
5	47.5	88	-30.2	2.6	3.1	33.4	8.4	2.0	340191	744779	266	11006	5381	3413	-31.1	194	1399
6	52.5	90	-31.3	2.5	2.4	30.9	12.9	2.1	395093	896558	325	13024	8023	5054	-30.2	122	1830
7	57.5	76	-31.0	2.0	2.1	25.5	10.8	1.8	373528	935552	309	12327	8318	5299	-29.2	98	1854
8	62.5	41	-31.6	0.9	0.8	11.7	8.3	0.9	202987	534957	191	7002	6616	3877	-30.6	-21	1236
9	67.5	29	-27.5	0.7	0.8	7.1	4.8	0.7	156182	398634	144	3924	4044	2858	-23.6	138	1059
10	72.5	19	-28.5	0.4	0.4	3.8	4.0	0.4	111173	257765	101	2661	3742	2250	-25.7	36	754
11	77.5	25	-28.5	0.4	0.4	4.3	6.4	0.4	130455	343608	161	3393	10201	3840	-21.3	84	1312
12	85.0	18	-22.2	0.2	0.4	4.0	1.6	0.3	44727	414503	124	2682	4177	3270	-21.0	210	1241
13	95.0	14	-25.3	0.2	0.3	2.7	2.3	0.2	38837	365999	107	1991	5719	3088	-21.7	160	1144
14	105.0	10	-35.0	0.1	0.1	2.1	3.2	0.2	40580	381321	88	1442	8082	2467	-27.4	-51	729
15	115.0	8	-34.7	0.0	0.0	1.2	3.0	0.1	14576	279211	77	1670	3516	2730	-34.7	-216	627
16	125.0	6	-19.7	0.1	0.1	0.9	0.7	0.1	82116	263809	71	1306	7199	4663	-8.7	426	1848
17	135.0	7	-25.2	0.1	0.1	1.4	1.2	0.1	44734	472786	91	1567	7287	3225	-25.0	-33	923
18	150.0	2	-33.3	.	0.0	0.4	0.5	0.0	5011	160755	20	424	1153	702	-37.3	-82	132
19	240.0	1	-50.2	.	.	0.5	0.2	0.0	.	750107	20	235	1550	956	-46.8	-276	-13
20		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
TOT. OF LENGTHS		749	-29.8	21.2	19.9	222.5	121.8	15.0	2689776	8107701	2700	94722	91896	52910	-27.5	1357	18807

RESULTS BY AGE (YEAR BUILT) GROUP

		NO. BOATS	% CHNGE	NO. BUILT	NO. S-HND	NO. DECOM	NO. BKRPT	NO. LOST	BUILDING GRANTS-$	DE-COM'G GRANTS-$	NO. CREW	EFFORT SEA-DAYS	TOTAL CATCH-T	TOTAL EARNS-$K	% CHNGE	OPERAT'G SURPL-$K	ADDED VALUE-$K
1	62.5	133	-29.1	.	4.3	56.0	.	2.7	.	638141	240	11740	3045	2258	-34.7	478	1414
2	26.7	39	-27.1	.	1.1	15.1	.	0.3	.	336219	89	4086	1559	993	-27.0	217	596
3	45.0	72	-28.9	.	2.1	29.5	.	1.9	.	1017657	240	9671	5726	3919	-26.8	515	1860
4	55.0	128	-29.9	.	3.6	54.9	.	3.3	.	2122040	489	18179	14054	9788	-25.8	853	4090
5	62.5	69	-31.8	.	1.8	32.4	.	1.6	.	1806429	308	9991	9433	6568	-29.6	206	2325
6	67.5	76	-30.9	.	2.0	34.6	.	1.5	.	2187215	340	11072	10672	7946	-29.4	194	2747
7	72.5	84	-34.7	.	2.0	.	45.2	1.4	.	.	383	12689	15994	8442	-35.7	-592	2111
8	77.5	67	-35.9	.	1.5	.	38.3	0.9	.	.	329	9244	24317	9153	-25.4	-4	2901
9	82.5	42	-38.6	.	1.0	.	26.6	0.8	.	.	140	5396	4788	2389	-34.3	-269	534
10	88.5	39	32.9	21.2	0.6	.	11.7	0.5	2689776	.	141	2654	2307	1454	.	-242	229
11		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
12		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
TOT. OF AGE.GPS		749	-29.8	21.2	19.9	222.5	121.8	15.0	2689776	8107701	2700	94722	91896	52910	-27.5	1357	18807

SUMMARY OUTPUT FOR YEAR = 2

STOCK MANAGEMENT INFORMATION BY SPECIES AND STOCK

(CONTINUED)

DATA FILES = FPMDEMO1
RUN NAME = exam-out

	BIOMASS (KT)	LANDING TOT. (T)	LANDING NAT. (T)	CATCH RATES		BIOMASS (KT)	LANDING TOT. (T)	LANDING NAT. (T)	CATCH RATES		BIOMASS (KT)	LANDING TOT. (T)	LANDING NAT. (T)	CATCH RATES		BIOMASS (KT)	LANDING TOT. (T)	LANDING NAT. (T)	CATCH RATES
MAC					SCD					PIL					OFF				
1	191.7	47335	15584	0.87	1	272.9	111800	223	0.97	1	7.1	6666	682	0.69	1	0.4	268	75	0.36
2	3361.2	508762	39814	1.00	2	.	.	.	.	2	.	.	.	.	2	6.0	5006	540	0.36
3	.	.	.	.	3	.	.	.	.	3	.	.	.	.	3	1.5	1298	41	0.36
4	.	.	.	.	4	.	.	.	.	4	.	.	.	.	4	3.0	2305	116	0.43
5	.	.	.	.	5	.	.	.	.	5	.	.	.	.	5	2.1	1781	195	0.36
6	.	.	.	.	6	.	.	.	.	6	.	.	.	.	6	3.8	2903	921	0.36
7	.	.	.	.	7	.	.	.	.	7	.	.	.	.	7	.	.	.	.
8	.	.	.	.	8	.	.	.	.	8	.	.	.	.	8	.	.	.	.
9	.	.	.	.	9	.	.	.	.	9	.	.	.	.	9	.	.	.	.
10	.	.	.	.	10	.	.	.	.	10	.	.	.	.	10	.	.	.	.
11	.	.	.	.	11	.	.	.	.	11	.	.	.	.	11	.	.	.	.
12	.	.	.	.	12	.	.	.	.	12	.	.	.	.	12	.	.	.	.
SHR					NPH					LOB					CRB				
1	7.2	2008	.	1.01	1	4.9	1602	.	1.02	1	0.4	135	.	1.02	1	4.6	1871	.	0.98
2	1.8	882	.	0.83	2	4.6	3246	3246	0.56	2	0.6	207	99	1.03	2	5.5	1829	208	1.02
3	0.5	31	.	1.15	3	24.7	8996	.	1.00	3	.	65	65	.	3	1.0	129	129	0.68
4	0.1	27	.	0.83	4	21.9	6466	2859	0.95	4	0.7	219	.	1.04	4	3.9	1708	.	0.87
5	.	3	.	0.84	5	.	.	.	.	5	0.3	117	66	0.90	5	.	125	125	.
6	.	.	.	.	6	.	.	.	.	6	0.3	123	18	0.94	6	2.2	723	586	1.04
7	.	.	.	.	7	.	.	.	.	7	1.0	314	61	1.00	7	.	51	51	.
8	.	.	.	.	8	.	.	.	.	8	0.1	47	16	0.94	8	2.5	575	17	0.91
9	.	.	.	.	9	.	.	.	.	9	0.2	111	.	0.95	9	0.6	185	16	1.02
10	.	.	.	.	10	.	.	.	.	10	.	.	.	.	10	.	.	.	.
11	.	.	.	.	11	.	.	.	.	11	.	.	.	.	11	.	.	.	.
12	.	.	.	.	12	.	.	.	.	12	.	.	.	.	12	.	.	.	.
SCL					GUN					SQD					OSH				
1	4.0	1170	1170	0.85	1	0.3	5142	5142	0.40	1	1.3	801	71	0.80	1	0.1	127	.	0.36
2	21.1	5420	65	1.11	2	2.0	512	.	1.12	2	4.0	915	3	1.01	2	0.6	463	79	0.36
3	12.3	1464	1464	1.03	3	22.4	9921	4909	0.98	3	0.7	732	29	0.42	3	.	41	41	.
4	2.3	2766	161	0.37	4	.	4452	4452	.	4	3.2	1944	102	0.85	4	1.3	1110	16	0.36
5	15.1	4349	2058	1.07	5	.	.	.	.	5	.	.	.	.	5	8.7	7678	29	0.36
6	.	297	297	.	6	.	.	.	.	6	.	.	.	.	6	0.9	807	21	0.36
7	.	232	232	.	7	.	.	.	.	7	.	.	.	.	7	0.7	472	199	0.36
8	.	.	.	.	8	.	.	.	.	8	.	.	.	.	8	1.7	1474	26	0.36
9	.	.	.	.	9	.	.	.	.	9	.	.	.	.	9	.	.	.	.
10	.	.	.	.	10	.	.	.	.	10	.	.	.	.	10	.	.	.	.
11	.	.	.	.	11	.	.	.	.	11	.	.	.	.	11	.	.	.	.
12	.	.	.	.	12	.	.	.	.	12	.	.	.	.	12	.	.	.	.
1	.	.	.	.	1	.	.	.	.	1	.	.	.	.	1	.	.	.	.
2	.	.	.	.	2	.	.	.	.	2	.	.	.	.	2	.	.	.	.
3	.	.	.	.	3	.	.	.	.	3	.	.	.	.	3	.	.	.	.
4	.	.	.	.	4	.	.	.	.	4	.	.	.	.	4	.	.	.	.
5	.	.	.	.	5	.	.	.	.	5	.	.	.	.	5	.	.	.	.
6	.	.	.	.	6	.	.	.	.	6	.	.	.	.	6	.	.	.	.
7	.	.	.	.	7	.	.	.	.	7	.	.	.	.	7	.	.	.	.
8	.	.	.	.	8	.	.	.	.	8	.	.	.	.	8	.	.	.	.
9	.	.	.	.	9	.	.	.	.	9	.	.	.	.	9	.	.	.	.
10	.	.	.	.	10	.	.	.	.	10	.	.	.	.	10	.	.	.	.
11	.	.	.	.	11	.	.	.	.	11	.	.	.	.	11	.	.	.	.
12	.	.	.	.	12	.	.	.	.	12	.	.	.	.	12	.	.	.	.