BIOLOGICAL SAMPLING OF NON-QUOTA SPECIES

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PREFACE

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ABSTRACT

The objective of this study was to develop an effective biological sampling programme for fish species in the English Channel (ICES Divisions VIId and VIIe) which are not subject to quota management, and to prepare these data for use in multi-species, multi-fleet models being developed by the Channel Fisheries Study Group. Length and age data were collected for six non-quota species, and length data for a further five species. The samples were collected over a period of two years from important ports on the French and UK coasts. The exploitation patterns of each species were described by allocating catches from similar catching gears, regions, seasons and target species into common units referred to as métiers. The most important métiers in terms of landed weight for each species were sampled, and a description of the seasonality and regionality of the fishery was prepared. The results and conclusions of the sampling for each species were presented by métier, and showed that the fisheries for all the species studied were to some extent seasonal and exploited regionally within VIId and VIIe. The data were also assessed in terms of the suitability for use in fisheries models. The data collected were adequate for simple modelling studies for the more abundant species. Data for those species which exhibited high seasonality in their fisheries were adequate whilst the fishery was in season, but poor for the remainder of the year. In all cases aggregation of the data on a six monthly or annual basis has been recommended.

KEYWORDS: Biological sampling, Commercial species, Exploitation, Fishery management.

SUMMARY FOR NON SPECIALISTS

As the numbers of fishing boats have increased in the English Channel the abundance of the main commercial fish species have declined. In an attempt to protect the fisheries from over exploitation and return them to their most productive level, control of the numbers of fishing boats, the types of fish they land, and the fishing gear that they use, has become necessary. One method of management is to control the total weight of fish removed from the stock, and this has been done for the main commercial species by introducing a Total Allowable Catch (TAC). Those species not managed in this way are referred to as non-quota species, and often the knowledge of the biology and fisheries of these species is poor. Over exploitation of the TAC species and consequent limits on their landings has caused fishing effort to be diverted towards non-quota species. As a consequence the potential for conflict between different groups of fishermen competing for the same species or fishing grounds has increased. It is some of these non-quota species that are the subject of this report.

Effective fish stock management requires information about the population biology of each species, and normally this information is collected by recording the lengths and ages of fish landed at ports by commercial fishing boats. These data, which are routinely collected for those species under TAC management, have now been collected in a similar way for a number of non-quota species in the English Channel. Length data were collected by measuring samples of the fish caught by commercial fishing boats, and age data were collected by removing ear stones (otoliths) or scales from fish, both of which have visible rings that can be used for ageing. These data were used to provide estimates of the size and age range of fish caught by particular fisheries. For most of the species studied in this sampling programme, this represents the first attempt to collect length or age data. In addition, information on the fisheries catching each species was collected to allow more detailed description of the fishery as a whole. The project enables guidelines for further sampling of these species to be laid out, should it become necessary in the future.

Conclusions were made about the suitability of the data for use in mathematical models. For most species it was not possible to collect enough data for the populations to be assessed on a quarterly basis, for some species the data collected were adequate when combined on a six monthly assessment, but for most species the combination of data on an annual basis has been recommended.

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1. INTRODUCTION

The majority of the fisheries in the English Channel (ICES divisions VIId and VIIe, hereafter referred to as the Channel) are subject to high levels of exploitation. The potential yield of many of these stocks is not realised, as the catch has become dominated by young fish which have not had a chance to grow and contribute more to the fishery. Annual assessments of the most important stocks are co-ordinated by The International Council for the Exploration of the Sea (ICES), which are undertaken using commercial catch and fishing effort data and fisheries-independent data arising from research vessel surveys, to estimate trends in abundance and mortality due to fishing. These assessments are used when considering management measures designed to protect the stocks from over exploitation, and return them to their most productive level.

Management of fisheries in the Channel is established under the EU's Common Fisheries Policy (CFP), in which quotas of an annual Total Allowable Catch (TAC) of each fish stock are allocated to member states. Fisheries in the Channel are dependent on a wide range of demersal, pelagic and shellfish species, and TAC's have been set for species which dominate the landings, including herring, mackerel, plaice, sole, cod, whiting, hake and anglerfish. As these species have become fully exploited, and because fisheries in the Channel are multi-specific, fishing effort has been increasing directly and indirectly towards other species for which no TAC has been allocated (referred to as non-quota species). For some of these non-quota species relatively little information is available. As a consequence, fisheries management has become more difficult and the potential for conflict between different fleets competing for the same species or fishing grounds has increased.

The biogeographical distribution of most of the commercial fish and shellfish stocks in the Channel has recently been described in the EC Report *Biogeographical Identification of English Channel Fish and Shellfish Stocks* (Anon, 1993). This report has provided us with a better understanding of stock identity and the distribution of twenty five species in the region, as an important step towards developing a rational strategy for the management of their fisheries. The present study extends our knowledge of the biology and fisheries of the non-quota species covered in this report, and also includes some additional species. A list of the species included in the present study is given in Table 1.

In order to use existing models to predict the effects of different management measures, it is necessary to extend the collection of length and age data to cover all exploited species within their geographic range. Length and age data are collected for all the TAC species in the Channel, but little or no data have been collected for the non-quota species.

The broad aim of this study was to assess the importance of these non-quota species to fisheries in the Channel, and to collect basic biological data for use in models of multi-species and multi-fleet interactions. The specific objectives were:

TABLE 1 English, French and Latin names of species studied.

English Name	French Name	Latin Name
Brill	Barbue	*Scophthalmus rhombus* (Linnaeus)
Turbot	Turbot	*Scophthalmus maximus* (Linnaeus)
Red Gurnard	Grondin Rouge	*Aspitrigla cuculus* (Linnaeus)
Lemon Sole	Limande-Sole	*Microstomus kitt* (Walbaum)
Bass	Bar	*Dicentrarchus labrax* (Linnaeus)
Black Bream	Dorade Grise	*Spondyliosoma cantharus* (Linnaeus)
Red Mullet	Surmulet	*Mullus surmuletus* (Linnaeus)
John Dory	Saint-Pierre	*Zeus faber* (Linnaeus)
Cuttlefish	Seiche	*Sepia officinalis* (Linnaeus)
Spider Crab	Araignée de Mer	*Maia squinado* (Herbst)
Scallop	Coquille Saint-Jacques	*Pecten maximus* (Linnaeus)

a) To develop an effective sampling programme to collect biological data for the main non-quota species within the Channel over a period of two years.

b) To prepare the data for incorporation into an age/length model to enable fleet and species interactions to be studied.

A database suitable for storage of the international multi-species and multi-fleet data collected in this study has been described in the EC report; *Base de Donnes Internationales en vue de L'Evaluation Biologique et Economique des Stocks de la Manche*, (Dintheer *et al.*, 1995). Data can be output in a format suitable for inclusion into mathematical models of biological and technical interactions. A multi-species, multi-fleet, bio-economic model, capable of predicting the effects of biological and technical changes, is the long-term objective for the programme of study in the Channel.

2. BACKGROUND INFORMATION

2.1 Physical and Biological Characteristics of the Channel

The Channel is a generally shallow area of the north-east Atlantic continental shelf. It has a maximum depth of approximately 100m in the west, decreasing to a depth of approximately 40m at the Dover Strait. The Channel also narrows from approximately 150 km wide at the western entrance to 30 km wide in the Dover Strait.

The coasts of both England and France feature several large inlets and bays, which support a variety of sandy and rocky shore communities, and some of which provide shelter from the prevailing south-westerly winds. A map of the Channel including locations mentioned in the text is given in Figure 1.

The Channel is subject to strong tidal currents, with the residual flow from the Atlantic to the North Sea, though gyres and boundaries also exist which may have roles in containing planktonic fish eggs and larvae within the Channel (Anon, 1993). The water column in the eastern Channel remains relatively homogenous throughout the year, but in the western Channel a thermocline develops during the spring and summer months (Anon, 1993).

The Atlantic has relatively stable physical conditions, but despite this stabilising influence relatively large changes in the physical and biological conditions are known to occur in the Channel, (Russell *et al.*, 1971). The eastern Channel is thought to act as a northern boundary for the common occurrence of several warmer water fish species which have their centre of abundance further to the south or west, and some of these species are included in this study. Seasonal changes in environmental conditions will have considerable affect on the spawning success, growth rate and distribution of these species within the Channel. These changes are reflected in the seasonal and annual patterns of exploitation of the fisheries, which presents complex problems for fisheries management.

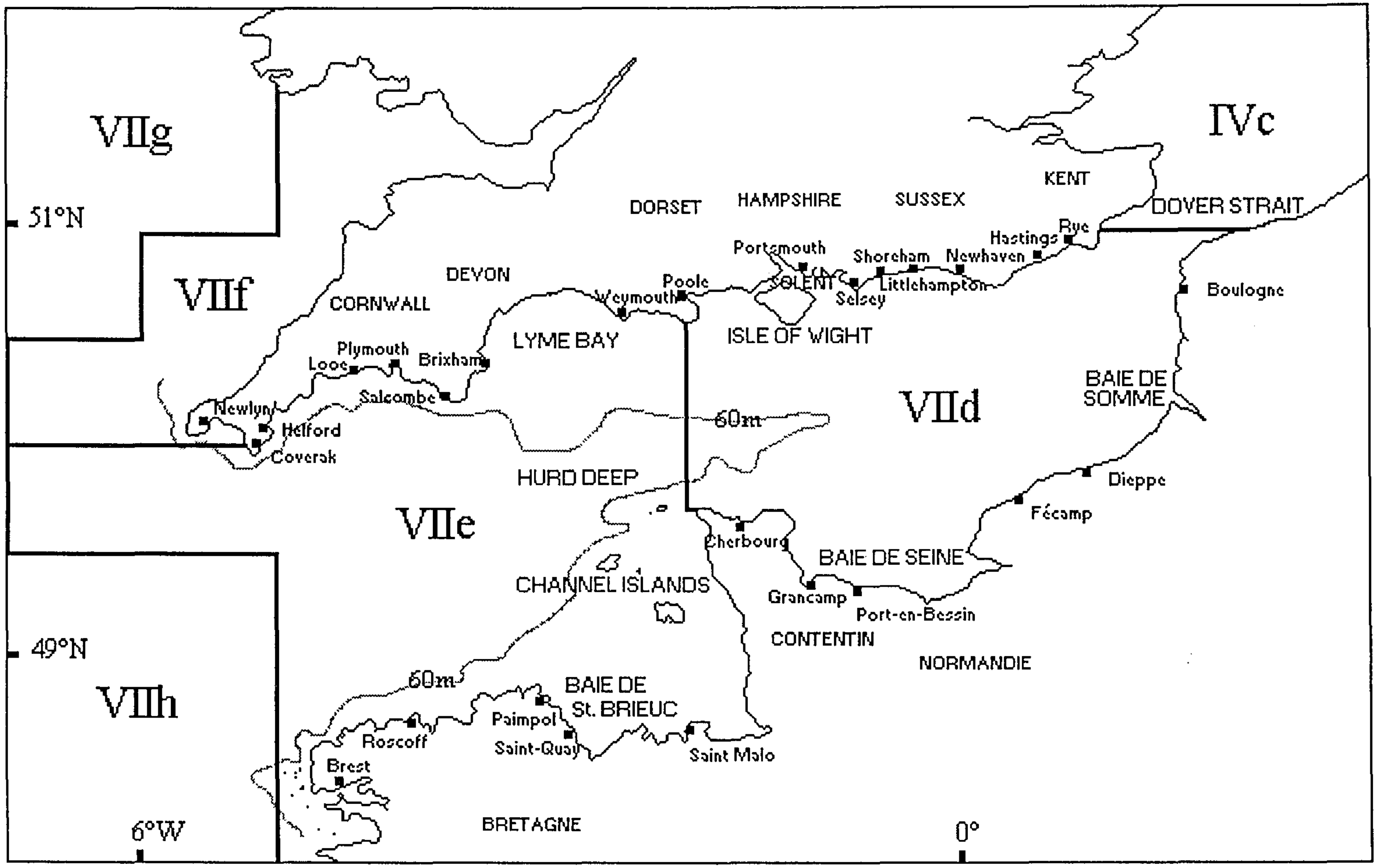

FIGURE 1 The English Channel (ICES Divisions VIId and VIIe)

2.2 The Métier Concept

The métier concept is a useful tool for describing fishing activity and for planning a biological sampling programme, and has been used throughout this report. A métier is defined as a fishing activity which is characterised by one catching gear and a group of target species, operating in a given area during a given season (Tétard *et al.*, 1995). Within the métier the catches taken by any unit of fishing effort account for the same pattern of exploitation by species and size group. Targeting sampling effort by métier is more efficient than random sampling of the different ports, gears and areas at different times of year. Sampling by métier helps to structure sampling effort and is also more effective at providing a lower bias estimate of the length composition of each species in the fishery as a whole. However, flexibility of the métier sampling targets was maintained in order to allow sampling of any important métiers that had not originally been identified. A study of the métiers in the Channel has been presented in the Report *International Catalogue of Fishing Fleet Activity in the English Channel* (Tétard *et al.*, 1995). This publication gives a list of all the métiers known to be operating in the Channel during 1991 and 1992, giving a summary description of each métier and allocating it a code. The total fishing fleet in the Channel is thought to involve approximately 4000 boats, of which approximately 90% are restricted to working in the Channel, and the other 10% are larger boats which also fish outside of the Channel. Approximately 50% of the total landings from the Channel are accounted for by these larger vessels (Tétard *et al.*, 1995). It is important to recognise that the distribution of fishing activity between métiers is dynamic and constantly responding to the changing fishing opportunities in the region. A list of the métiers and codes along with a brief description of the fishing activity they represent is given in Appendix I.

3. METHODS FOR COLLECTING LENGTH SAMPLES

Of the eleven species chosen for sampling during this project, five species were considered more important and accordingly given higher length sampling targets; these were bass, lemon sole, red gurnard, turbot and brill. In order to achieve an effective sampling programme for collecting length composition data, most of the important métiers for each species were identified before the sampling work began. These métiers, and the corresponding quarterly sampling targets for each species, are identified in Appendix II.

3.1 Timing

Length samples were collected on a quarterly basis for the two years between January 1994 and December 1995. Because of a delay in implementing the sampling programme, some species were not sampled until April 1994. However sampling of these species continued into the first quarter of 1996 in order to provide two full years of data.

3.2 Location

Length samples were only taken from fish for which there was evidence that they had been caught in the Channel. Length samples were taken from the landings of commercial fishing vessels available at wholesale fish auctions, on the fishing vessel, or from wholesale fish merchants. Some métiers were sampled at sea if the landings were not easily accessible at the auctions, or if the fish were caught in different métiers but mixed together when landed, for example the English cuttlefish pots and fixed nets, the French bass long liners, black bream long liners and large mesh nets for turbot. Although sampling at sea produced good quality data it was too time consuming to adopt this method for all métiers. Sampling at the merchants was often difficult as the source of the fish was uncertain unless the samples were taken before the fish were sorted. Sampling at merchants also relied heavily on their compliance, however, as there were no auctions on the south coast of the UK between Hastings and Brixham, this form of sampling was essential. Most sampling was carried out at wholesale auctions, before the sale of the fish. At the auctions the fish were removed almost immediately after sale, so it was often necessary to start taking samples as far from the starting point of the auction as possible, to allow time for the samples to be completed. This is not likely to introduce any bias as the position of landings on the market was determined by the order of arrival, which followed no set pattern. Sampling at auctions was simple, and was used as the preferred method of data collection.

3.3 Measuring

Measurements of size were taken in the most appropriate way, the finfish species were sampled for total length, the cuttlefish for dorsal mantle length, the spider crab for carapace length, and the scallop for shell height. Measurements of finfish and cuttlefish were made to the nearest centimetre below. Scallops were measured to the nearest half centimetre (France) or millimetre (England) below, and spider crab were measured to the nearest millimetre below.

The standard sample unit was a minimum of 50 fish, often equivalent to one box of fish at the auction (see Appendix II). When the individual fish were large, more than one box of fish would be measured. When the fish were small a subsample would be taken by measuring every second or third fish in one box, ensuring that the number of fish measured was greater than fifty. If the landings by individual boats were small, it was necessary to measure fish from several boats to obtain the minimum of 50 fish. Each length sample was recorded with the sample weight, total weight (kg), vessel registration, date and place of landing.

There were differences in the French and English sampling strategies as a result of different market practices for sorting fish in England and France. In France, the species studied in this project were sorted into defined commercial categories. French sampling work has confirmed that the length composition of each species in each commercial category is not dependant on the métier (Tétard, pers. comm.). Therefore, to provide comprehensive length frequency data, it was necessary to collect adequate samples from each commercial category, which could be from any métier, and then obtain information on landings to each category by each métier. However, when differences in size grading of commercial categories were observed between markets (e.g. red gurnard), length data were raised separately for each different market.

In England the only species in this project sorted into the well defined commercial categories were those specified by the EU, i.e. red gurnard and lemon sole (Anon, 1990a). Although the other species were also sorted into commercial categories, the length composition of these categories varied between métiers and between markets, often depending on the length composition of the catch. Although theoretically sampling of lemon sole and red gurnard could be undertaken in the UK, samples were not taken by commercial category but were instead based on collecting length samples from each métier separately. Because separate samples are required from each métier, the overall number of samples required to describe a fishery in the UK is relatively high.

In England, lemon sole, spider crab and bass were also sampled as part of the Biological Sampling Programme carried out by MAFF port staff. These samples were included in the study in addition to those measurements taken directly as part of this contract.

In France some existing data on length compositions was included for John dory, cuttlefish, spider crab, brill, turbot and scallop.

4. METHODS FOR COLLECTING AGE SAMPLES

Age data were collected for brill, turbot, lemon sole, bass, black bream and red gurnard according to the targets shown in Appendix II. The methods for collecting materials for age determination (scales and otoliths), and the technique used for reading these materials, varied between species. For every aged fish details of total length (cm), weight (g), date of landing and area caught were recorded.

4.1 Turbot, brill and lemon sole

Turbot, brill and lemon sole are all flatfish species, and thus similar techniques were used for their age determination. For turbot and brill the technique of removing otoliths through the gill opening was used to minimise damage to the external appearance. As a result otoliths could be taken directly from the market or at wholesale fish merchants without having to purchase the fish. Lemon sole otoliths were also removed through the gill opening of English samples, whilst in France the lemon sole were purchased and then the otoliths removed from a dorsal cut across the head. The sex and maturity stage of these species were also recorded (mature/not mature, with maturity stage if possible), as the gonads remained after the fish had been gutted by the fishermen.

The individual techniques for otolith reading were similar between each of these species. Brill otoliths were read whole for young fish up to an age of approximately three to four years. Whole otoliths were viewed under water in a black dish using reflected light and a microscope with low magnification. The otoliths of older brill were also read whole, but as these were more difficult to read accurately one of two additional methods were then used, and thus the otoliths were read twice. The older brill otoliths were either mounted in a polyester resin, sectioned through the nucleus, treated with acid and then stained with toluene blue, with the cut surface of the otolith then viewed under a microscope with transmitted light, or alternatively the otolith was broken through the nucleus by hand and then burned over a methanol flame, and the cut surface viewed with reflected light. The staining method made the otoliths slightly easier to read, but the otoliths were more time-consuming to prepare. Most English brill otoliths were read using the 'break and burn' technique, and in France all brill otoliths were mounted in clear resin then sectioned and stained.

When the flatfish otoliths were viewed whole with reflected light the winter rings appeared as white hyaline bands against darker opaque summer annuli. When stained or burned the winter rings would appear as blue stained or black/brown burnt rings respectively on the cut surface of the otolith.

Turbot otoliths were read whole for young fish up to an age of three to four years. In France older otoliths were also read whole, and then either treated like brill otoliths, some broken and then mounted, and some broken and burned. In England the otoliths of older turbot were read whole, and also after being broken and burned.

All lemon sole otoliths were read in Lowestoft. The lemon sole otoliths were all read twice, they were first read whole, and then after being broken and burned.

4.2 Black bream and bass

Both black bream and bass were aged using scales. Scale removal resulted in minimal external damage and they were easily removed from fish without the need for them to be purchased. A minimum of five scales were removed from each fish from a position posterior and ventral of the pectoral fin. Individual scales were viewed under a microscope using transmitted light. Scales which had been regenerated after the original scale was lost were removed from the sample as they would underestimate the true age of the fish. On the remaining scales circuli were visible, and the distance between these circuli decreased as the growth rate decreased or ceased during winter (Perodou and Nedelec, 1980; Pickett and Pawson, 1994). Winter annuli were visible as dark rings where the circuli appeared relatively close together or appeared broken. As bass and bream were not gutted before being sold it was not possible to record the sex and maturity.

4.3 Red Gurnard

Red gurnard otoliths were all removed after a dorsal cut to the head of the fish, and in France this was after a ventral break of the skull. This resulted in external damage to the fish, and it was therefore necessary to purchase the fish for the otolith samples. As the whole fish had been purchased it was also possible to record the sex and stage of maturity (mature/not mature with maturity stage if possible).

Red gurnard otoliths were all read in Port en Bessin. The otoliths were initially cleaned with a 3% hydrogen peroxide solution, then burned whole on a heated plate for 1-2 minutes until dark brown/light brown rings became clear. The otoliths were then read whole with transmitted light viewed on a television screen, where the winter rings appeared as the darker rings.

5. DATA RAISING

Raising sample data to the total landings is necessary for estimating the exploitation pattern of fisheries or for carrying out assessments. Fisheries models used for assessments can use the raised length distributions (in length-based models) or the raised age-length distributions (in age-based models).

5.1 Methodology

Length samples were first raised to the total landings for the corresponding métier, to give a métier length distribution. The age-length key (ALK) obtained from the sampling was then applied to this length distribution to produce an age-length distribution (ALD) for the métier. The ALD for the stock can be produced by combining the ALD's from all métiers.

In France the preferred method of sampling was to sample by commercial category, when it was possible. To produce a length frequency distribution for a métier, the sample length distributions for each category are raised to the total landings made in each category, then the resulting raised category length distributions are summed together. The collection of the landings information is the responsibility of the "Affaires Maritimes", and the data are collected by the "Centre Régional de Traitement des Statistiques" (CRTS). The CRTS network includes four regional centres based in Boulogne sur Mer, Saint Malo, La Rochelle and Lorient, with several staff located on the coast near main auctions. The CRTS provided all the detailed information on species, gear and area fished, for landings made at auctions. These data allowed a simple automatic allocation of each landing to a métier, using the same methodology as outlined in the métier catalogue (Tétard *et al.*, 1995). Away from the auctions, other information is collected mainly by the "Syndics des Affaires Maritimes". This information is less detailed and does not permit allocation to a métier. All the French data raising for the eastern Channel used the CRTS database, which covered an estimated 80% of the landings for this division. Not all the markets in the western Channel are covered by the CRTS, and additional methods were included when collecting commercial category data for the French VIIe fisheries. In the absence of commercial category data the samples can be raised to the total landings for the boat trip. Accurate details of landings are only available from the western Channel for trawling métiers and some netting métiers, consequently estimates were used for the landings from other métiers.

In England, because few non-quota species are sorted into well defined commercial categories, the length composition in each category may vary between landings. The length sample is therefore raised to the total landing for the boat trip. Details of landings are collected by the MAFF Sea Fisheries Inspectorate (SFI) staff and entered onto the MAFF Fishing Activity Database (FAD). The SFI staff are located at most of the important ports on the south coast of England, with main offices located at Hastings, Poole, Brixham, Plymouth and Newlyn. A length frequency distribution for a métier is calculated by combining all the relevant boat-raised length samples, and then multiplying the resulting numbers at length by the raising factor (total métier landings/weight sampled). Sufficient information is present in the FAD for métier allocation to be carried out for boats >10m registered length. However métier allocation is difficult for <10m vessels (which do not fill in log books) as their landings data are often integrated with those of other <10m boats before they are entered into the FAD. The boat identity and métier is therefore lost although a summary of area fished and gear type used are recorded; this usually represents the dominant fishing activity for that landing. In the Channel, <10m boats make a major contribution to the landings of some non-quota species, and consequently they cannot be ignored.

5.2 Problems associated with data raising

A number of problems were encountered when determining the exploitation pattern for the fishery as a whole. These fall into two categories: the estimates of landings and the quality of the samples.

Problems associated with estimates of landings:

- Poor estimates of landings do not allow the sampled data to be raised with any confidence.
- There is no legal requirement for any vessel to record landings of non-quota species. Landings which do not pass through monitored auctions or merchants may not be recorded, and other merchants may chose not to record landings of non-quota species. In France (western Channel) these landings can be estimated, but the allocation to a métier is not possible. When these landings cannot be estimated, as is the case in the UK, this leads to an underestimation of landings.
- Mis-reporting of landings on log books, both in weight landed and area fished. This is most often a side effect of mobile offshore vessels mis-reporting landings of TAC species to avoid quota restrictions.
- In log-books or landings declarations, non-quota species may be recorded as mixed species, not identified correctly, or occasionally TAC species may be recorded as a non-quota species to avoid the TAC restrictions.
- Sometimes the métier corresponding to a landing is not known with certainty and this leads to poor métier allocation.

Problems associated with samples:

- Small length samples do not allow data to be raised with any confidence. If the length samples are too small, gaps will occur in the length distribution.

- Small age samples result in poor ALK's with lengths groups for which no age data are available, and this presents problems when combining the length distribution and the ALK. Guidelines have been suggested for the quality of ALD's for stock assessment work, and the sample numbers required to satisfy these may be large (Flatman, 1990).

The problems associated with poor sampling can be overcome by combining data, this may mean combining quarters to give half year, or annual data, combining data from different areas, or grouping together data from similar métiers. The method of combination will depend on the quality of the data, but information could be lost if they are aggregated on a large scale.

6. SPECIES REVIEW

For each species, a brief description of the published biology is followed by a summary of the fishery using the data collected during the study, and a review of the sampling programme. A summary of the length and age data collected is presented, and selected age-length keys and length distributions are shown.

6.1 Results of length sampling

A total of 103,662 fish have been measured. A summary of the total number of length samples collected by species, quarter and country is given in Table 6.1.

The number of fish measured by species and métier, for the first full year of sampling, is given in the Métier Sampling Summary tables in each species section. For French data the year January 1994 to December 1994 was used, and for the UK data the year April 1994 to March 1995. The samples taken by each laboratory are presented separately and in the same order in each table; Port en Bessin; Brest; and then Lowestoft. The sampled weight is the total weight of the sample, but this is not always the same as the weight of the measured fish, as subsamples may have been taken. When sampling has taken place by commercial category, the sampled weight, number of fish sampled and number of vessels sampled, will be the same for each métier and for the total (this applies to all data from Port en Bessin). When sampling was not based on commercial categories, or where commercial category data were poor, each table gives the number and weight of fish measured from each métier, after being raised to the boat trip. A guide to the ease of sampling by métier is given by several factors: a) the mean number of fish measured per boat (the average size of the landings); b) the weight sampled expressed as a percentage of the landings (the availability of the landings); c) the total landings of all the sampled métiers compared to the total landings (the overall coverage of the fishery by sampling). Where possible for each species and métier, details are given of the most important sampled ports and the time of peak fishing activity.

6.2 Results of age sampling

A total of 9139 otoliths and 9148 scales were taken. A summary of the number of otoliths or scales collected during each quarter of sampling is given in the Otolith or Scale Collection Summary tables. They are separated by country of origin, quarter, ICES division and sex. When the precise ICES division of origin was not known for a fish, but it was known to come from the Channel, it has been recorded under 'VIId or VIIe', otherwise the data have been provided separately.

6.3 Quality of age and length data

If the length and age data collected for a métier are scarce, then doubts will be raised about the ability of these data to accurately represent the true exploitation pattern of the métier. Because of the considerable costs involved in biological sampling for stock assessment, there has been much research into the effective sampling of large scale commercial landings of fish (Gulland, 1955; Pope and Knights, 1975;

Southward, 1976; Kimura, 1977; Jinn *et al.*, 1987; Flatman, 1990; Lai, 1993; Cotter, in press). A number of methods are available to assess the sampling strategy, these may be either simulation procedures (e.g. Nicolajsen and Grástein, 1993) or use a statistical approach (e.g. Kimura, 1977; Lai, 1993). One method used to analyse the sample data has been to use the coefficient of variation of the estimate of numbers at age (CV) (Gulland, 1955; Burd and Gulland, 1956; Johnston *et al.*, 1974; Johnston *et al.*, 1975; Flatman, 1990). The CV is made up of two components, the variance due to length sampling and the variance due to age sampling. Generally, for well sampled commercial stocks the variance due to age sampling is the major component, and the variance due to length sampling is negligible (Pope and Knights, 1975; Flatman, 1990).

In this study a basic appraisal of the data collected was undertaken using the CV as a guide to the data quality. A CV of less than 10% across all ages has been adopted as an international target for stock assessment work (Flatman, 1990). The CV is useful as it allows comparisons with data collected for assessed species (Burd and Gulland, 1956; Flatman, 1990), but it is only intended as a rough guide to the quality of the sample data, as it does not include the additional variances associated with the raising factors. The calculations for the component variances and the CV are shown in Appendix III.

In general, it is desirable to raise data in the most disaggregated form. However it may be necessary to aggregate data in order to achieve an acceptable data quality for raising. It is not normally desirable to aggregate age data from separate years

(Westerheim and Ricker, 1978; Hoenig *et al.*, 1993), however, it is possible to aggregate data from quarters within the same year. Aggregating age data from separate quarters will generally improve the ALK and reduce the variance due to age sampling, and therefore reduce the CV. Aggregating quarterly age data will introduce bias due to plus growth unless the number of age samples taken in each quarter is proportional to the landings made in each quarter. The bias will therefore be greater when a non-random sampling strategy has been employed (Cochran, 1977; Kimura, 1977), which would apply to age samples taken during this study. However, the scarcity of some non-quota species has meant that the age sampling was effectively random, and these species are detailed in the following species sections. The age data may also be improved by combining the sexes, although ideally the sexes should remain separate as the biological parameters for each are likely to be different. There will be no bias incurred when aggregating age data by combining sexes, because the sampling by sex was random. It is possible to combine data from different regions, i.e. by combining VIId and VIIe, or French and UK data, but in doing so stock integrity must be assumed (Kimura, 1977). For all the species in this report there is either no information on stock identity, or evidence that separate stocks do exist in the Channel. It is also possible to combine data from similar métiers, for example by combining data for all trawls together, or all nets together, but the more detailed information about the exploitation pattern will be lost. In addition, the data may be aggregated by increasing the size of the length groups, for example from 1cm to 5cm classes. This is common for species which occur over a large size range, but although the CV will be reduced, more detailed information about the exploitation pattern may then be lost.

The fisheries for many of the species in this study were seasonal, and this caused difficulty in collecting adequate length samples throughout the year. The calculations of the variance due to length sampling assume that all the samples are equally representative of the catch, regardless of the sample size (see Appendix III). Thus, having seasonal data aggregated annually introduces large differences in sample size for many non-quota species, and can therefore produce a relatively high variance due to length sampling (Johnston *et al.*, 1975; Flatman, 1990). Despite this problem, the calculations have been used in the following species section.

In the following species sections the CV is first described for age data alone by assuming the variance due to length sampling is negligible and equal to zero (hereafter described as CVa). The CVa is shown for quarterly data, and then the effect of aggregating data (by combining quarters, sexes) on the CVa is described. On the basis of these descriptions conclusions are made about the quality of the age data. The length data are described separately, and are described as adequate when there are data available for all length groups within the bulk of the distribution. Finally, an example is given of the true CV with both the variances due to age and length sampling (except for French data where variances of numbers at length are not available).

TABLE 6.1. Quarterly Length Sampling Summary

FRANCE - IFREMER Port en Bessin and Brest

	1994				1995				1996
	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Quarter 1
Brill	10	170	342	159	301	307	13	123	0
Turbot	16	78	8	45	64	77	26	45	0
Red Gurnard	1325	2828	2043	1733	3142	2594	1799	2087	0
Lemon Sole	524	1047	62	140	719	808	351	153	0
Bass	108	280	330	492	319	634	111	23	0
Black Bream	149	605	534	727	229	493	502	181	0
Red Mullet	405	8	367	283	652	0	331	592	0
John Dory	0	175	600	107	123	691	107	175	0
Cuttlefish	0	0	111	483	0	260	222	435	0
Spider Crab	0	112	0	665	0	142	0	0	0
Scallop	3716	3000	0	4074	445	2000	0	2579	0

UK - MAFF Lowestoft

	1994				1995				1996
	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Quarter 1
Brill	0	431	427	737	303	230	426	444	425
Turbot	0	308	257	386	251	134	163	187	221
Red Gurnard	0	769	691	1049	582	543	483	786	535
Lemon Sole	2952	3599	2322	1653	2793	3268	2479	1235[1]	0[1]
Bass	953	2937	1849	2134	1371	899	1243	513[1]	0[1]
Black Bream	0	204	127	193	193	3128	109	45	305
Red Mullet	0	374	543	775	498	341	481	696	848
John Dory	0	109	641	683	269	305	198	215	163
Cuttlefish	0	152	265	760	302	219	481	456	129
Spider Crab	657	1292	446	407	532	1071	291	583	0[1]
Scallop	0	0	0	49	120	240	0	120	120

1 Data incomplete: samples taken but not processed.

6.4 BASS

The bass, *Dicentrarchus labrax*, is distributed in north-east Atlantic shelf waters from southern Norway and Scotland south to the Mediterranean, the Black Sea and north-west Africa (Pickett and Pawson, 1994). Bass attain maturity at 31-35cm for males and 40-45cm for females and spawning starts in the western Channel in February. By May there are additional areas of spawning around the Channel Islands and Beachy Head, and by June spawning is completed (Kennedy and Fitzmaurice, 1972; Thompson and Harrop, 1987) The juveniles remain in estuary nursery areas through the first and second years after which they migrate to deeper overwintering areas, but may return to an estuary in the summer until their fifth year (Kelley, 1988; Pawson *et al.*, 1987). At maturity the bass assume the migratory patterns of the adults, which have been indicated in the Channel by tagging juvenile and adult fish (Pawson *et al.*, 1987). Bass that spend the summer in areas on the south coast of England and the Thames estuary start to migrate to overwintering areas in the western Channel as the water temperature begins to drop in October (Pawson and Pickett, 1996). After spawning adults move to feeding grounds in the eastern Channel and southern North Sea. Growth rates and length-weight parameters are available throughout the range of the bass (Pickett and Pawson, 1994). There is a minimum landing size of 36cm and protection of nursery areas on the UK coast (Anon, 1990b).

THE FISHERY

The fishery for bass was well developed and there were a large number of métiers that either targeted bass, or for which bass was an important by-catch. In the eastern Channel, the fishery lasted from spring until autumn, and in the western Channel peak landings occurred overwinter. The most important métiers in the eastern Channel were otter trawls (F1.2, F1.4, and U1.2), nets (F5.5, U5.3 and U5.8), and lines (U8.1), (Table 6.4.1). In the western Channel the most important métiers were otter trawls (F1.1, F1.3 and U1.2), midwater trawls (F3.1), nets (F5.2), and lines (F7.2) (Table 6.4.1).

The bass has been the subject of continued study by MAFF for over ten years, and regular biological samples, along with research into the biology and UK fisheries for bass, has allowed assessments to be made of the UK stocks. This level of knowledge is not typical of the species studied for this report. In France however, the two years sampling carried out for this programme represent the first regular biological samples taken.

The French length samples were not adequate on a quarterly basis for all métiers in the eastern Channel, but adequate length distributions were produced after aggregating the data from both years by commercial category. In the western Channel French length data were only adequate for the pelagic trawl métier F3.1 in quarter 2. The métier F3.1 was opportunistic and sampling was only possible for quarters 1 and 2 (not shown in Table 6.4.1 as this métier was only sampled in 1995). For the remainder of the year bass could be sampled from longline métiers at sea (F7.2), but although relatively well sampled (shown as a high percentage of landings sampled in Table 6.4.1), quarterly samples from this métier were not adequate. When aggregated annually the length data are adequate for F7.2, but the length data for F5.2, F1.1 and F1.3 are not adequate quarterly or annually.

French age data were not collected for all quarters (Table 6.4.2). The French age data for the eastern Channel were not adequate quarterly, but when aggregated annually achieved the required CVa for the more abundant ages 5 and 6 (e.g. F1.2, Table 6.4.3; Table 6.4.5). The French age data for the western Channel were also not adequate by quarter, but after annual aggregation the required CVa was nearly achieved for ages 5 and 6 (e.g. F3.1, Table 6.4.3).

In the UK, length and age samples were collected by staff from the SFI, and the sampling levels were good (Table 6.4.1; Table 6.4.2; Table 6.4.6). The MAFF study has shown that the UK landings of bass were in fact much higher than the FAD figures suggested. The UK landings for the Channel were estimated from a voluntary logbook scheme at 1500 tonnes for 1994 (G. Pickett, pers. comm.), against 302.6 tonnes from the FAD, although the order of importance of the métiers was roughly the same. The landings and percentage sampled given in Table 6.4.1 use the FAD data.

For this report, the UK data provides a useful guide to the levels of CVa and CV produced by data which have been used in a stock assessment. For the UK assessment the length and age data from the Channel were combined on an annual basis and into four gear groups and two regions (Pickett *et al.*, 1995). The gear groups were all trawls, all nets, longlines and pots, and handlines, and the regions were VIId with IVc, and VIIe with VIIh. The regions were based on stock identity, as there appear to be separate stocks in the eastern Channel and North Sea, and the western Channel and Irish Sea (Pickett *et al.*, 1995). The age data were combined annually and so some bias may occur as the age sample targets were not random (Appendix II). The resulting CVa is well below the required level for most age groups (Table 6.4.3), however the CV (including variances due to age and length sampling) is above the required level, as a result of the high variances due to length sampling (Table 6.4.4).

In order to collect enough French age samples for an annual assessment comparable to the UK data, approximately 4 times as many fish would need to be sampled, (approximately 1000 samples per annum; Appendix III). This would require additional sampling effort, or some remanagement of sampling effort.

TABLE 6.4.1 Métier Sampling Summary - BASS

Sampled Métier	Total landings first year[1] (tonnes)	Sampled Weight first year[1] (tonnes)	(%)	Number of Fish Sampled	Number of Vessels Sampled	Mean number of Fish Sampled per Boat	Months of peak fishing activity	Most important sampled ports
F1.2	162.7	0.519	0.32				Jun & Nov	Port en Bessin
F1.4	29.7	0.519	1.75				Mar & Oct	Port en Bessin
F3.2	10.9	0.519	4.76				Apr-May	Port en Bessin
F5.5	9.9	0.519	5.24				Oct-Dec	Port en Bessin
F.other	10.3	0.519	5.04				N/A	Port en Bessin
Total	**223.5**	**0.519**	**0.23**	**588**	**5**	**117**		
F3.1	100.0	0		0	0		Feb-Apr	Lorient
F5.2	80.0	0.0150	0.02	24	1	24	Jun-Sep	Roscoff
F1.1	60.0	0.195	0.32	115	6	19	Feb-Apr	Saint-Malo; Saint-Quay
F7.2	35.0	0.6006	1.72	277	17	16	May-Nov	Roscoff
F1.3	30.0	0.086	0.28	89	14	6	Jul-Aug	Saint-Quay
Total	**305.0**	**0.8966**	**0.29**	**505**	**38**	**13**		

(cont.)

1. Source: IFREMER (Jan - Dec 1994); MAFF (Apr 1994 - Mar 1995)

TABLE 6.4.1 (cont.) Métier Sampling Summary - BASS

Sampled Métier	Total landings (tonnes) first year	Sampled Weight first year (tonnes)	(%)	Number of Fish Sampled	Number of Vessels Sampled	Mean number of Fish Sampled per Boat	Months of peak fishing activity	Most important sampled ports
U8.1	86.0	1.715	1.99	1029	51	20	Apr-Dec	Portsmouth; Selsey
U5.3	80.0	1.811	2.26	1865	93	20	May-Oct	Hastings; Littlehampton; Selsey
U1.2	70.0	1.093	1.56	1366	36	38	May-Nov	Newhaven; Shoreham
U1.1	24.5	1.674	6.83	1221	28	44	Aug-Mar	Brixham; Plymouth; Weymouth
U5.8	17.7	0.620	3.50	871	22	40	Jun-Dec	Worthing; Littlehampton
U5.2	6.4	0.482	7.53	470	16	29	Aug-Dec	Brixham
U2.1	2.0	0.290	14.5	205	2	102	Unknown	Brixham; Portsmouth
U2.3	2.0	0.165	8.25	106	4	27	Nov-Mar	Brixham; Plymouth
U2.2	1.7	0.378	22.23	339	14	24	Jan-Mar	Brixham; Newlyn
U6.2	1.6	0.029	1.81	21	10	2	Unknown	Selsey; Littlehampton
U3.1	0.04	0.156	(390)	154	3	51	Unknown	Looe
U7.1	0.4	0.135	33.75	105	5	21	Jul-Aug	Selsey; Portsmouth
U7.2	0.03	0.103	(343)	80	3	27	Sep-Nov[2]	Brixham
U3.2	0	0.390	-	464	9	52	Unknown	Shoreham
U.other	10.2	0		0	0		N/A	
Total	**302.6**	**9.041**	**2.98**	**6316**	**296**	**21**		
Total Landings all Métiers	831.1							

1. Source: IFREMER (Jan - Dec 1994); MAFF (Apr 1994 - Mar 1995)
2. Approximate data.

TABLE 6.4.2 Scale Collection Summary - BASS

IFREMER Port en Bessin

		VIId	VIIe	VIId or VIIe	
Year	Quarter	Unsexed	Unsexed	Unsexed	**Total**
1994	1	67			**67**
1994	2	91			**91**
1994	3				**0**
1994	4	98			**98**
1995	1	125			**125**
1995	2	45			**45**
1995	3				**0**
1995	4	93			**93**
Total		**519**	**0**	**0**	**519**

IFREMER Brest

		VIId	VIIe	VIId or VIIe	
Year	Quarter	Unsexed	Unsexed	Unsexed	**Total**
1994	1		37		**37**
1994	2		101		**101**
1994	3		30		**30**
1994	4				**0**
1995	1				**0**
1995	2		207		**207**
1995	3		15		**15**
1995	4				**0**
Total		**0**	**390**	**0**	**390**

MAFF Lowestoft

		VIId	VIIe	VIId or VIIe	
Year	Quarter	Unsexed	Unsexed	Unsexed	**Total**
1994	1	364	206		**570**
1994	2	1360	181		**341**
1994	3	1503	144		**1647**
1994	4	931	430		**1361**
1995	1	888	93		**981**
1995	2	396[1]	49[1]		**445[1]**
1995	3	373[1]	291[1]		**664[1]**
1995	4	104[1]	42[1]		**146[1]**
Total		**5919[1]**	**1436**	**0**	**7355[1]**

1 Data incomplete: samples collected but not processed.

TABLE 6.4.3 CVa for UK bass samples

Age	F Annual 1994 F1.2	F Annual 1994 F3.1	UK Annual 1994 All nets VIId/IVc	UK Annual 1994 Longlines & pots VIId/IVc	UK Annual 1994 Handlines VIId/IVc	UK Annual 1994 All trawl VIId/IVc
2	-	-	46	-	-	98
3	55	-	47	59	49	21
4	19	95	**7**	**7**	**7**	**6**
5	**6**	11	**1**	**1**	**1**	**1**
6	**9**	11	**5**	**5**	**5**	**5**
7	27	30	**6**	**6**	**7**	**6**
8	54	22	48	26	25	33
9	67	18	69	**6**	71	71
10	53	25	22	22	24	40
11	53	15	**10**	**9**	**9**	14

TABLE 6.4.4 CV for bass: annual 1994; UK all trawls; VIId and IVc

Age	Catch at age	Variance due to age sampling	Variance due to length sampling	CVa	CV
2	19	3.49E+02	9.53E+01	98	111
3	1963	1.74E+05	1.43E+05	21	29
4	23858	1.92E+06	1.31E+07	**6**	16
5	203421	2.34E+07	9.86E+08	**1**	16
6	13316	4.71E+05	1.26E+07	**5**	27
7	6330	1.59E+05	4.89E+06	**6**	35
8	522	2.94E+04	3.70E+04	33	49
9	17	1.45E+02	3.97E+02	71	137
10	384	2.42E+04	2.61E+04	40	58
11	2024	8.30E+04	1.82E+06	14	68

TABLE 6.4.5 Bass: ALK; French; annual 1994; VIId; unsexed.

	Age													
Length	2	3	4	5	6	7	8	9	10	11	12	13	14	15
24	1													
25	1													
26	3													
27	3													
28	3	1												
29		1		1										
30	1	5												
31		3												
32		5	2											
33														
34		2	2	1										
35			3	5										
36			4	9	2									
37			5	8	2									
38			4	8	1									
39			1	16										
40			1	16	6									
41			2	8	3									
42				17	1									
43			1	11	4									
44				7	8	1								
45				4	6	1								
46				2	7	1								
47				2		1								
48				1	4	2								
49					3	1								
50					2	1	1							
51					1									
52					3	2								
53					2									
54														
55						1								
56														
57														
58						1						1		
59									1					
60														
61										1				
62								1						
63								1						
64						1				2				
65														
66														
67											1			
68										1	2			
69										1				
70														
71											1		1	
72														1
73														
74														
75														
76														
77														
78													1	
79											1			
80														
81														
82														
83														1

TABLE 6.4.6 Bass: ALK; UK; annual 1994; VIId and IVc; all trawl; unsexed.

	Age																				
Length	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
7	2																				
8	4																				
9	6																				
10	7																				
11	4	2	4																		
12	1		9																		
13	1		11																		
14	2	3	16																		
15		11	9	1																	
16		10	9	1																	
17		5	9	1																	
18		11	6	8																	
19		4	13	8																	
20		1	12	12																	
21			19	10	1																
22		1	16	11	2	1															
23			20	11																	
24			14	13	2																
25			8	22	2	1															
26			3	20	9																
27			1	12	7	2															
28				17	10	4															
29			1	13	3	8															
30				11	9	11															
31				6	16	14															
32				1	21	41															
33				2	20	52															
34					17	66															
35					6	84															
36					13	143															
37					7	111	1														
38					4	91	2														
39					1	61	4														
40					2	35	4														
41						25	3														
42					1	13	6	1													
43						6	4														
44						5	1														
45						2	5	3													
46						2	3	1													
47						2	2	2													
48							1	4	1												
49						3		4	1												
50								6	1	1											
51							1	1													
52						1		1													
53							1	2				1									
54								2													
55								2													
56						1		1			1										
57													2								
58						1															
59													2								
60												2	2								
61												2									
62												1	1	1							
63												1									
64																					
65												1									
66														1							
67													2	1							
68												1									
69																1					
70																					
71																					
72																					
73																					
74																					
75																					
76																					
77																			1		
78															1						
79																			2		2
80													1						1		
81																			1		

6.5 BLACK BREAM

The black bream, *Spondyliosoma cantharus*, is the commonest of the sea breams to be found in the Channel (Wheeler, 1969). Black bream mature as females at approximately 20cm but change sex with increasing length, so that above 40cm the majority are male (Soletchnik, 1983; Perodou and Nedelec, 1980). In the Channel bream start to spawn in April, and spawning areas have been recorded around the Isle of Wight and the Sussex coast, the Channel Islands, Poole Bay, the coast of Contentin and in the Baie de Seine (Soletchnik, 1983). Black bream are demersal spawners, and the male digs a nest in gravel where he defends and cares for the eggs (Wilson, 1958). During the winter months concentrations of prespawning adults are found in the south-western Channel in waters from 50-100m depth. In the spring these fish migrate eastwards and disperse in shallow coastal waters, where they are caught from April until late summer. In autumn there is a return migration by the new recruits and adults to the overwintering areas (Soletchnik, 1983). Length-weight parameters and von Bertalanffy growth parameters are available for bream from the western Channel and the northern Bay of Biscay in quarters 1 and 4, with growth being consistently faster in the Bay of Biscay than in the Channel (Perodou and Nedelec, 1982). Current management consists of a minimum landing size of 23cm.

THE FISHERY

The UK and French métiers for black bream were similar in terms of their seasonality and gear. Most bream were caught in the eastern Channel and around the Channel

Islands during the spring and summer, mainly by trawl métiers U1.2 and F1.2, and in the western Channel during the winter almost entirely by the pelagic trawl métier F3.1 (Table 6.5.1) The landings of bream recorded in U1.2 were almost entirely from demersal pair trawlers, and this fishery appeared to exploit the spring spawning concentrations found in the eastern Channel. French pelagic trawl métiers (F3.1 and F3.2) also appeared to exploit spring spawning concentrations.

In the eastern Channel, the French length data were not adequate for data raising by quarter, but were adequate when both years data were aggregated by quarter and commercial category. In the western Channel length data were adequate for the pelagic trawl (F3.1, 1995 only) and longline métiers (F7.2) in the second quarter (Table 6.5.2), and annually for F1.1 and F1.3. Length samples were adequate for data raising from U1.2 in quarters 2 and 3, and U2.2 in quarter 1 (Table 6.5.2), but UK landings for the remainder of the year were so small that collecting adequate length samples was not possible (e.g. U1.1, Table 6.5.2).

Age samples from fish larger than 34cm (UK) or 38cm (France) were difficult to obtain, but this reflected the length distribution of the samples from the fishery. The larger fish were caught seasonally at the start of the pair trawl (U1.2) fishery and by the French longline fishery (F7.2). Bream landed by the UK gill nets were not identified at the ports sampled, so no sampling was possible, however anecdotal evidence suggests many larger bream are caught by this métier.

The UK fishery for black bream was dominated by the presence of strong year classes, particularly 1989 and 1991. In the French fisheries, these year classes were also large, but not so pronounced. Consequently, sampling of these year classes was better than the other year classes, (Table 6.5.3).

The age data collected (Table 6.5.4) were not adequate to produce quarterly age data for any of the métiers under study. On a quarterly basis, the CVa's were adequate for the more abundant year classes, but poor for the others, (Table 6.5.3). When aggregated six monthly the overall CVa's for the UK data were better. When aggregated annually the overall CVa was worse, and did not reach the desired level except for the 1989 year class. On the basis of the CVa the UK quarterly or six-monthly data are better than the annual data, although the small number of samples in the quarterly data may prohibit confident data raising (Table 6.5.5 - 6.5.6).

The UK age samples were not random but maintained the target level of 3 fish per 1cm length group (Appendix II), and ideally the quarterly data should therefore not be aggregated. Annual aggregation of the UK age data has been carried out to produce ALK's, despite the bias that is introduced (Table 6.5.5-6.5.6). Annual aggregation of data is also recommended for the French data (Table 6.5.3; Table 6.5.7), where the sampling has approximated to random sampling. To decrease the French annual CVa across all ages to acceptable levels would require an approximately four fold increase in the number of samples achieved (approximately 800 samples per annum), and to decrease the UK annual CVa to acceptable levels would require a nine-fold increase in samples (approximately 900 samples per annum; Appendix III).

When UK data are aggregated annually the variance of the estimates of numbers at age due to length sampling is equal or greater than the variance due to age sampling, and as a result the CV is higher than the CVa (Table 6.5.8). From these data, in order to lower the CV to acceptable levels would require a sixteen-fold increase in age samples (approximately 1600 samples per annum).

The bream fishery is very seasonal, and so it was not possible to collect adequate data during all quarters. Combining the French and UK data is not recommended, as the stock integrity in the Channel has yet to be established (Anon, 1993). However, in the future it may be possible to collect adequate length and age data for every quarter from French pelagic trawl métiers (F3.1, F3.2) as new data suggests that these métiers are less seasonal and catch bream all year (Y. Morizur, pers. comm.). As the bream are abundant in the UK fishery when in season, it would be easy to improve age data with an increase in the age sample targets.

TABLE 6.5.1 Métier Sampling Summary - BLACK BREAM

Sampled Métier	Total landings first year[1] (tonnes)	Sampled Weight first year[1] (tonnes)	(%)	Number of Fish Sampled	Number of Vessels Sampled	Mean number of Fish Sampled per Boat	Months of peak fishing activity	Most important sampled ports
F1.2	543.8	0.698	0.13				Jan-Feb & Jul-Aug	Port en Bessin
F3.2	156.8	0.698	0.44				Apr & Aug-Sep	Port en Bessin
F.other	9.0	0.698	7.75				N/A	Port en Bessin
Total	**709.6**	**0.698**	**0.01**	**1688**	**10**	**169**		
F3.1	1000.0	0		0	0		Dec-Jan & Jun-Jul	Lorient
F1.1	30.0	0.2417	0.81	442	6	74	Dec-Jan	Saint-Malo; Saint-Quay
F1.3	30.0	0.0467	0.16	567	13	44	Unknown	Saint-Quay
F7.2	20.0	0.1836	0.92	4	1	4	Jun-Oct	Roscoff
F5.2	10.0	0		0	0		Unknown	Roscoff
F.other	10.0	0		0	0		N/A	
Total	**1100.0**	**2.6473**	**0.24**	**1009**	**20**	**50**		
U1.2	247.5	0.969	0.39	392	8	49	Apr-Jun	Shoreham; Newhaven
U5.3[2]	7.4	<0.001	<0.001	1	1	1	Mar[2]	Newhaven; Littlehampton
U2.2	2.6	0.114	4.38	274	10	27	Jan-Apr	Brixham
U1.1	1.2	0.005	0.42	16	6	3	Jan-Mar	Brixham
U2.1	0.8	0.001	0.125	4	1	4	Feb-Mar	Brixham; Shoreham
U2.3	0.6	0.011	1.83	33	2	16	Feb-Mar	Brixham
U.other	1.5	0		0	0		N/A	
Total	**261.5**	**0.726**	**0.28**	**720**	**28**	**26**		
Total Landings all Métiers	2071.1							

1. Source: IFREMER (Jan - Dec 1994); MAFF (Apr 1994 - Mar 1995)
2. Approximate data.

TABLE 6.5.2 Black bream: Example length distributions.

	U1.2pair (Q2 1995)1	U1.1 (Q4 1995)	F7.2 (Q3 1995)2	F7.2 (Q2 1995)3
20		24		
21		8		
22	3	0		
23	39	102	2	
24	187	63	1	
25	259	31	0	2
26	144	8	1	3
27	261	16	2	7
28	279	31	0	17
29	206	8	3	19
30	214		3	23
31	297		1	20
32	270		1	30
33	324		1	17
34	162		1	15
35	84		0	18
36	51		1	22
37	23		1	24
38	14		0	19
39	4		0	8
40	3		0	7
41	12		1	5
42	6		1	1
43	4		1	0
44	6		0	0
45			1	2
46			1	

1. Raised to trip Sample weight 1242 kg.
2. Raised to trip. Sample weight 12.4 kg.
3. Raised to trip. Sample weight 163.5 kg.

TABLE 6.5.3 CVa for black bream samples

Age	F Q2 1994 F3.1	F Q4 1994 F1.2	F Annual 1994 F1.2	UK Q2 1994 U1.2	UK Q2+3 1994 U1.2	UK Annual 1994 U1.2
1	0	71	71	-	-	-
2	**8**	**5**	13	-	-	30
3	14	**10**	11	**4**	**3**	18
4	20	63	18	36	35	32
5	21	**10**	**9**	**3**	**8**	**10**
6	21	58	30	47	36	43
7	53	87	50	0	0	0
8	49	-	-	-	-	-
9	45	-	96	-	-	-
10	35	-	-	-	20	29
11	-	-	-	32	81	82

TABLE 6.5.8 CV for black bream; annual 1994; U1.2

Age	Catch	Variance due to age sampling	Variance due to length sampling	CVa	CV
2	17300	2.26E+07	2.63E+07	30	40
3	27700	2.29E+07	6.40E+07	18	34
4	2820	1.03E+06	1.10E+06	32	52
5	4550	7.44E+05	2.51E+06	**10**	39
6	268	2.29E+04	1.55E+07	43	1472
7	0	0	0	0	0
8	0	0	0	-	0
9	0	0	0	-	0
10	186	1.72E+04	1.55E+07	29	2125

TABLE 6.5.4 Scale Collection Summary - BLACK BREAM

IFREMER - Port en Bessin

		VIId	VIIe	VIId or VIIe	
Year	Quarter	Unsexed	Unsexed	Unsexed	**Total**
1994	1	40			**40**
1994	2				**0**
1994	3	51			**51**
1994	4	117			**117**
1995	1				**0**
1995	2	82			**82**
1995	3				**0**
1995	4	146			**146**
Total		**436**	**0**	**0**	**436**

IFREMER Brest

		VIId	VIIe	VIId or VIIe	
Year	Quarter	Unsexed	Unsexed	Unsexed	Total
1994	1				**0**
1994	2				**0**
1994	3				**0**
1994	4				**0**
1995	1				**0**
1995	2		166		**166**
1995	3				**0**
1995	4				**0**
Total		**0**	**166**	**0**	**166**

MAFF - Lowestoft

		VIId	VIIe	VIId or VIIe	
Year	Quarter	Unsexed	Unsexed	Unsexed	**Total**
1994	2	36			**36**
1994	3	32			**32**
1994	4	24			**24**
1995	1		35		**35**
1995	2	58			**58**
1995	3	31			**31**
1995	4	3			**3**
1996	1		57		**57**
Total		**184**	**92**	**0**	**276**

TABLE 6.5.5 Black bream: ALK; UK; quarter 2 1994; VIId; unsexed.

	1	2	3	4	5	6	7	8	9	10	11	12
21												
22			2									
23			1									
24			3									
25			1	1	1							
26				2	1							
27					3							
28					3							
29					3							
30					3							
31					2	1						
32					1							
33							1					
34						1						
35						1				1		
36										1		
37												
38												
39										1		1
40												
41											1	

TABLE 6.5.6 Black bream: ALK; UK; annual 1994 (quarters 2-4); VIId; unsexed.

	1	2	3	4	5	6	7	8	9	10	11	12
21		1										
22		2	3									
23		3	4									
24		3	6									
25		3	4	2	1							
26			3	4	2							
27			3		7							
28			3	1	5							
29					6							
30				3	4							
31				1	4	1						
32					1	1						
33							1					
34						1				1		
35						1				1	1	
36										1		
37										1		
38												
39										1		1
40												
41											1	

TABLE 6.5.7 Black bream: ALK; French; annual 1994 (quarters 1,3,4); VIId; unsexed.

	1	2	3	4	5	6	7	8	9	10	11	12
14	1											
15												
16	6											
17	6											
18	7											
19	3											
20	1	1										
21		8										
22		10										
23		6	6									
24		8	6									
25		3	8	1	2							
26			11	2	2							
27			5	1	2							
28			5	5	4							
29			1	6	5							
30			1	1	7							
31				4	12							
32				1	7							
33				1	9							
34				2	6	4						
35					3	2						
36					2	2	3			1		
37												
38										1		
39						1						
40										1		
41												
42									1			
43												
44											1	

6.6 BRILL

The brill, *Scophthalmus rhombus*, is distributed in north-east Atlantic shelf waters from Norway and the Orkney Islands south to the Mediterranean (Wheeler, 1969). Sexual maturity is reached at approximately 25cm for males and 33-41cm for females (Wheeler, 1969). Brill spawn between April and July in the Channel, at this time most brill are caught in the western Channel, but no precise information is available on spawning areas. Brill eggs have not been recorded in ichthyoplankton trawls, but brill postlarvae have been recorded in surface and midwater trawls off Plymouth from May to August (Clark, 1914). There are no records of brill being tagged in the Channel, and there has been no attempt to infer migration patterns from commercial catch data. Length-weight parameters and von Bertalanffy growth parameters exist for unsexed brill from the Golfe de Lion (Robert and Vianet, 1988), and from the Baie de Dournanez (Mtimet, 1993, using data from Deniel, 1981). There is no detailed information published on growth rates in northern waters, however growth rates appear to be higher in the Atlantic and the North Sea than in the Mediterranean. Females grow faster and to a larger size than males (Deniel, 1981 cited in Robert and Vianet, 1988). There is a minimum landing size of 30cm.

THE FISHERY

The greatest landings of brill came from the western Channel, as landings by both UK and French fleets in the eastern Channel were small (Table 6.6.1). Highest landings of brill were taken by the trawl métiers F1.1, F1.2, F1.3, U2.1, U2.2 and U2.3, and the tangle net métier F5.3. The western trawl métiers (F1.1, F1.3, U2.2 and U2.3), and the tangle net métier in the western Channel (F5.3), were seasonal, with the greatest landings taken during the winter and spring. In the eastern trawl métiers (F1.2 and U2.1), and the net métier in the eastern Channel (F5.3), the greatest landings were taken during the summer (Table 6.6.1).

The UK length data were adequate on a quarterly basis for U2.2 (but best for quarters 3 and 4) and also adequate for U2.3 if aggregated annually. If the length data are combined from both years, length distributions are also adequate for trawl métiers U2.1, U1.2 and U1.1.

French length data are adequate when aggregated annually for trawl métiers F1.1 and F1.3, and the net métier F5.3 (including existing data from 1991 for F1.1 and F5.3). The French data from the eastern Channel were not adequate to use the commercial category method of raising landings, and must therefore be raised by boat (as for the UK data). These data are not adequate even after aggregating all data from the two years together.

Most age samples were collected from the western Channel (Table 6.6.2). Age samples were not collected in the French eastern Channel, where the fishery is relatively small, although it was possible to collect samples in the UK eastern Channel (Table 6.6.2). None of the quarterly ALK's were adequate for data raising. The best estimates of numbers at age were given on an annual basis, with males and females combined together (Table 6.6.3-6.6.4). Although there were length stratified age sample targets in the UK (Appendix II), these targets were not always achieved, and the bias incurred by aggregating the data should be minimal. Even with both sexes combined on an annual basis the CVa's should ideally be reduced by approximately 50%, i.e. a four-fold increase in samples would be required (approximately 450 otoliths per annum; Appendix III). If stock identity could be established it may also be possible to improve the quality of the age-length data by combining French and UK samples.

The ageing of brill is a new skill for staff at both IFREMER and MAFF, and as such requires verification and checking before this species can be aged with confidence. It was also difficult to obtain sufficiently small fish (<41cm) in France, and to a lesser extend in the UK, and the large fish (>56cm) were hard to obtain in both France and England (Table 6.6.5-6.6.10). This did not present a problem when calculating the ALD's, because the length distribution of the age samples reflected the length distribution in the fishery.

In both the UK and France it would be difficult to improve the sampling with the available resources as the most important métiers and ports were covered, so improvement of the data would require extra sampling effort.

TABLE 6.6.1 Métier Sampling Summary - BRILL

Sampled Métier	Total landings first year[1] (tonnes)	Sampled Weight first year[1] (tonnes)	(%)	Number of Fish Sampled	Number of Vessels Sampled	Mean number of Fish Sampled per Boat	Months of peak fishing activity	Most important sampled ports
F1.2	33.8	0.061	0.18%	65	6	11	Jun-Aug	Port en Bessin
F2.1	18.2	0.073	0.4%	69	1	69	Aug-Sep	Port en Bessin
F4.2	15.7	0		0	0		Nov-Mar	Port en Bessin
F4.4	11.8	0		0	0		Sep-Nov	Port en Bessin
F1.4	7.7	0		0	0		Aug-Nov	Port en Bessin
F5.3	6.6	0.007	0.1%	9	1	9	Jul-Oct	Port en Bessin
F.other	3.1	0		0	0		N/A	Port en Bessin
Total	**96.9**	**141**	**0.14%**	**143**	**8**	**18**		
F5.3	50.0	0.6411	1.28	89	23	4	Feb-Jun	Roscoff
F1.1	40.0	0.4556	1.14	245	15	16	Feb-Jun	Saint-Malo; Saint-Quay
F1.3	30.0	0.3505	1.17	269	35	8	Feb-Jun	Saint-Quay
F.other	8.9	0		0	0		N/A	
Total	**128.9**	**1.4472**	**1.12**	**603**	**73**	**8**		

(cont.)

1. Source: IFREMER (Jan - Dec 1994); MAFF (Apr 1994 - Mar 1995)

TABLE 6.6.1 (cont.) Métier Sampling Summary - BRILL

Sampled Métier	Total landings first year[1] (tonnes)	Sampled Weight first year[1] (tonnes)	(%)	Number of Fish Sampled	Number of Vessels Sampled	Mean number of Fish Sampled per Boat	Months of peak fishing activity	Most important sampled ports
U2.2	48.2	2.496	5.18	979	14	51	Aug-Apr	Brixham
U2.1	38.5	0.217	0.56	143	2	70	Jul-Apr	Brixham; Shoreham
U2.3	35.2	0.693	1.97	359	7	71	Aug-Mar	Brixham
U1.1	22.1	0.117	0.53	152	35	4	Unknown	Brixham
U1.2	9.9	0.163	1.65	176	17	10	Unknown	Newhaven; Shoreham
U4.1	5.3	0.111	2.09	70	3	23	Jun-Jan	Brixham
U5.4	1.6	0.012	0.75	19	11	2	Mar-Nov	Hastings; Rye
U.other	11.9	0		0	0		N/A	
Total	**172.6**	**3.809**	**2.21**	**1898**	**89**	**21**		
Total Landings all Métiers	398.4							

1. Source: IFREMER (Jan - Dec 1994); MAFF (Apr 1994 - Mar 1995)

TABLE 6.6.2 Otolith Collection Summary - BRILL

IFREMER Port en Bessin - none

IFREMER Brest

		VIId		VIIe		VIId or VIIe		
Year	Quarter	Male	Female	Male	Female	Male	Female	**Total**
1994	1			1	3			**4**
1994	2			16	10			**26**
1994	3			2	20			**22**
1994	4							**0**
1995	1							**0**
1995	2			41	15			**56**
1995	3			4	7			**11**
1995	4							**0**
Total		**0**	**0**	**64**	**55**	**0**	**0**	**119**

MAFF Lowestoft

		VIId		VIIe		VIId or VIIe		
Year	Quarter	Male	Female	Male	Female	Male	Female	**Total**
1994	2			32	22			**54**
1994	3			27	32			**59**
1994	4					31	45	**76**
1995	1	4	8	7	12	23	9	**63**
1995	2	2	1	15	25	13	22	**78**
1995	3	24	36	16	16			**92**
1995	4	7	18	23	34			**82**
1996	1			18	25			**43**
Total		**37**	**63**	**128**	**166**	**67**	**76**	**537**

TABLE 6.6.3 CVa for brill samples

Age	F 1994 Annual F1.3 F+M	UK 1995 Q1 U2.2 F+M	UK 1995 Q1+2 U2.2 F+M	UK 1995 Annual U2.2 F	UK 1995 Annual U2.2 M	UK 1995 Annual U2.2 F+M
1	-	-	-	-	-	-
2	60	15	14	16	22	15
3	**3**	**6**	22	**9**	**10**	**7**
4	22	50	29	17	28	16
5	27	27	34	23	33	20
6	28	95	97	25	47	22
7	23	65	44	37	70	33
8	32	24	35	31	51	28
9	40	89	96	50	43	36
10	49	95	97	97	96	72

TABLE 6.6.4 CV for brill; annual 1994; U2.2; females + males

Age	Catch	Variance due to age sampling	Variance due to length sampling	CVa	CV
1	807	6.30E+04	4.46E+04	31	40
2	7330	7.87E+05	7.35E+05	12	17
3	11300	1.53E+06	8.03E+05	11	13
4	5630	1.22E+06	1.34E+05	19	21
5	3750	9.25E+05	7.14E+04	25	27
6	5130	9.91E+05	3.22E+05	19	22
7	1380	3.93E+05	1.91E+04	45	46
8	1200	3.56E+05	1.24E+04	50	50
9	0	0	0	-	0
10	365	1.11E+05	5.63E+03	91	93

TABLE 6.6.5 Brill: ALK; UK; annual 1994; VIIe; male+female.

	1	2	3	4	5	6	7	8	9	10	11	12	13
31	10	23	2										
36	3	12	13	3									
41		19	16	3	1	1							
46		2	16	6	5	3							
51			6	7	4	6	2	1					
56				1	1	6	1	2					
61				2	2		1	1		1			
66							1						

TABLE 6.6.6 Brill: ALK; UK; annual 1995; VIIe; female.

	1	2	3	4	5	6	7	8	9	10	11	12	13
31	14	2	1										
36	10	11	1										
41		23	2										
45		6	10	2	3	1							
51			6	9	5	3	2	1					
56			2	4	5	3	4		1				
61					1		2	1			1		
66													

TABLE 6.6.7 Brill: ALK; UK; annual 1995; VIIe; male.

	1	2	3	4	5	6	7	8	9	10	11	12	13
31	12	16											
36		21	6		1								
41		4	3	3	1								
46		1	1	2	2	1	3	1	1		1		1
51				1		1		2		1			1
56								1					
61													
66													

TABLE 6.6.8 Brill: ALK; French; annual 1994; VIIe; female.

	1	2	3	4	5	6	7	8	9	10	11	12	13
31													
36		2											
41		1	1										
46				1	1								
51				1			1						
56				1	3	3	2	3	1				
61						3	1	1	2	2			
66							1	1		1			

TABLE 6.6.9 Brill: ALK; French; annual 1994; VIIe; male.

	1	2	3	4	5	6	7	8	9	10	11	12	13
31													
36			1										
41		1											
46				2	1								
51				1	3	1	2	1					
56							2		1				1
61					1		1						
66													

TABLE 6.6.10 Brill: ALK; French; annual 1994; VIIe; unsexed.

	1	2	3	4	5	6	7	8	9	10	11	12	13
31													
36			5										
41		1	5										
46				6	4								
51				4	6	3	6	2					
56				2	6	7	8	6	4	1			1
61					2	7	4	2	4	4			
66							2	2		2			

6.7 CUTTLEFISH

The cuttlefish, *Sepia officinalis*, is the only species of cuttlefish commonly found in the Channel, (von Boletzky, 1983). Sexual maturity is generally completed by the winter of the second year, but under good growth conditions it may be possible for some males to reach maturity after the first winter resulting in two breeding cohorts being present in the following year (Jéon, 1982 cited in Anon 1993; von Boletzky, 1983; Le Goff and Daguzan, 1991). Cuttlefish spawn in inshore waters from early April through until July, with the peak of spawning during May. The main spawning concentrations are in waters less than 30-40m deep in Lyme Bay, the Solent, and the Baie du Mont St Michel, although spawning also occurs in the Baie de Seine, Baie de St Brieuc, Baie de Somme and less intensively along almost all of the south-east coast of England and north coast of France (Anon, 1993). Tagging experiments in the Channel suggest that juvenile cuttlefish leave the inshore nursery areas in October and migrate westward towards overwintering areas where the water depth exceeds 70m and mean water temperature exceeds 9°C (Boucaud-Camou and Biosmery, 1991). The return migration into the shallow waters is rapid; the cuttlefish begin to arrive inshore by late March, most arriving in April (Boucaud-Camou and Biosmery, 1991). Growth rates for cuttlefish are high compared to finfish species (Clarke *et al.*, 1989). Males maintain a higher growth rate in the adult phase than females, and as a consequence reach larger sizes (von Boletzky, 1983). Growth parameters exist for cuttlefish from the Bay of Biscay and the Channel (Jéon, 1982 cited in Anon, 1993; Medhioub, 1986). The adults suffer complete mortality after spawning, and the life cycle is completed after 2 years. There are no management measures for cuttlefish.

THE FISHERY

The fishery for cuttlefish was highly seasonal, there was an offshore fishery in the western Channel during the winter, followed by an inshore fishery in both the eastern and western Channel during the spring and summer. The most important métiers were the spring and autumn inshore trawl fisheries (F1.2, F1.3, U1.1 and U1.2), the winter trawl fisheries in the western Channel (U2.2, U2.3 and F1.1), and the spring potting métier (F6.5), (Arkley *et al.*, 1996), (Table 6.7.1).

Both UK and French length data were adequate for each métier whilst in season. For example, data were adequate for F6.5 and F1.3 in quarters 2 and 3, and for UK trammel nets in quarter 2 (U5.4), and also for the trawl fisheries (U2.2, U2.3 and F2.1) for quarters 4 and 1 (Table 6.7.2). There are relatively few, or no length data for each métier outside of the seasons mentioned, as none of the métiers caught significant quantities throughout all of the year. The numbers of large adult cuttlefish declined towards the end of June and July, and as a result the cuttlefish measured were larger in quarter 2 (spawning adults) than quarter 3 (juveniles only). During quarter 3 cuttlefish as small as 3cm or 5cm mantle length were caught by inshore trawl métiers F1.3 and U1.2 respectively (Table 6.7.2).

Although the data are adequate, it should be noted that it would also be easy to improve the samples, as cuttlefish are abundant in the landings whilst each fishery is in season.

TABLE 6.7.1 Métier Sampling Summary - CUTTLEFISH

Sampled Métier	Total landings first year[1] (tonnes)	Sampled Weight first year[1] (tonnes)	(%)	Number of Fish Sampled	Number of Vessels Sampled	Mean number of Fish Sampled per Boat	Months of peak fishing activity	Most important sampled ports
F1.2	1187.0	0.194	0.01				May & Sep-Nov	Port en Bessin
F6.5	152.8	0.194	0.13				May	Port en Bessin
F4.2	122.5	0.194	0.16				Oct-Dec	Port en Bessin
F1.4	75.5	0.194	0.26				Apr-May	Port en Bessin
F4.4	26.5	0.194	0.73				Apr & Sep	Port en Bessin
F5.4	29.9	0.194	0.65				Apr-May	Port en Bessin
F.other	111.7	0.194	0.17				N/A	Port en Bessin
Total	**1705.9**	**0.194**	**0.01**	**483**	**1**	**483**		
F1.1	2400	0		0	0		Sep-Dec	Existing data
F1.3	1300	0.1897	0.01	111	1	111	Jun-Aug	Existing data
F6.5	500[2]	0		0	0		Apr-May	Existing data
Total	**4204**	**0.1897**	**0.01**	**111**	**1**	**111**		

(cont.)

1. Source: IFREMER (Jan - Dec 1994); MAFF (Apr 1994 - Mar 1995)
2. Accurate data unavailable

TABLE 6.7.1 (cont.) Métier Sampling Summary - CUTTLEFISH

Sampled Métier	Total landings first year[1] (tonnes)	Sampled Weight first year[1] (tonnes)	(%)	Number of Fish Sampled	Number of Vessels Sampled	Mean number of Fish Sampled per Boat	Months of peak fishing activity	Most important sampled ports
U2.3	446.9	0.061	0.01	55	1	55	Oct-Mar	Brixham
U2.2	491.6	14.099	2.87	496	8	62	Nov-Mar	Brixham
U1.1	284.6	0.282	0.10	352	14	25	Oct-Mar	Brixham
U1.2	205.0	0.187	0.09	289	6	48	Apr-Jun & Sep	Newhaven; Shoreham
U2.1	110.7	3.274	2.96	174	2	87	Nov-Feb	Brixham; Shoreham
U5.4[3]	104.1	0.516	0.49	113	3	38	Apr-Jun	Hastings; Newhaven
U.other	1.6	0		0	0		N/A	
Total	**1644.5**	**18.419**	**1.12**	**1479**	**34**	**43**		
Total Landings all Métiers	7554.3							

1. Source: IFREMER (Jan - Dec 1994); MAFF (Apr 1994 - Mar 1995)
2. Accurate data unavailable
3. Also includes small contribution by U5.9

TABLE 6.7.2 Cuttlefish: Example length distributions

	F6.5 (Q2, 1987)	F1.3 (Q2,1987)	U1.2 (Q3, 1994)	U2.3 (Q4, 1994)
5			1242	
6			3727	
7			11181	
8			17289	
9			26295	
10			20912	
11		761	9628	1463
12	209	1677	621	2048
13	1678	12149	0	6874
14	5242	26055	0	17727
15	11416	39394	0	20740
16	20213	64096	1242	41334
17	27585	107178	0	49056
18	33223	132836	1242	36419
19	31242	109723	104	19219
20	35650	79740	0	13807
21	34427	45038	0	3423
22	32965	27960	0	1667
23	34351	13068	0	
24	26408	4019	0	
25	22255	2377	1242	
26	13695	1260		
27	6478			
28	3839			
29	406			
30	52			

6.8 JOHN DORY

The John dory, *Zeus faber*, is widely distributed in shelf waters of the Atlantic and Pacific, around the UK it is most abundant in waters to the south-west, and rare in the North Sea (Wheeler, 1969). The records of John dory in more northern waters are almost entirely of juvenile fish (Janssen, 1979; Gibson and Ezzi, 1987), the larger adult fish are rarely found in inshore waters, being most abundant at depths of 100-200m (Silva, 1992). Sexual maturity of the females is achieved at 34-38cm, the males at 25-28cm (Janssen, 1979). Spawning is thought to occur offshore from June to August in the Bay of Biscay, western Channel and in the Irish Sea (Wheeler, 1969). The eggs are large and pelagic, and although no eggs have been recorded in the Channel, post larval stages of John dory have been found in the Channel from August to October (Clark, 1914). The movements of John dory in the Channel inferred from commercial catches have not been studied. There has been no full description of ageing John dory using methods other than length frequency analysis (Silva, 1992). The opercular and hyomandibular bones have been suggested for ageing fish from the western Channel (without verification), and they suggest a length at the first winter of 9-13cm, and at the second winter 24-27cm, (Cunningham, 1892). Females grow larger than males, but no von Bertalanffy growth parameters are available for the waters in the north-east Atlantic. There are no management measures for John dory.

THE FISHERY

The John dory was found in greatest abundance in the south and west of the Channel, and was landed only during the summer and autumn months from the eastern Channel. The largest landings were made by trawl métiers in the western Channel from summer until winter (F1.1 and U1.1), and in the eastern Channel small numbers were caught in the trawl métier F1.2 during the summer and autumn (Table 6.8.1). John dory were not caught in significant numbers by any Channel métier during the spring.

Adequate quarterly length samples were collected for U1.1, and for F1.1 in quarters 2 and 3 (Table 6.8.2). Length samples from commercial categories were combined from both years to produce an adequate quarterly length distribution for F1.2 and F3.2 (Table 6.8.2). Length samples were adequate when combined annually for U2.2 and U2.3.

The John dory is relatively scarce in the Channel. In both the UK and France it would be difficult to improve the sampling with the available resources as the most important métiers and ports were covered. Any improvement of the data would require extra sampling effort, or more focusing of sampling effort on boats targeting this species.

TABLE 6.8.1 Métier Sampling Summary - JOHN DORY

Sampled Métier	Total landings first year[1] (tonnes)	Sampled Weight first year[1] (tonnes)	(%)	Number of Fish Sampled	Number of Vessels Sampled	Mean number of Fish Sampled per Boat	Months of peak fishing activity	Most important sampled ports
F1.2	30.0	0.425	1.42				Jun-Aug	Port en Bessin
F3.2	0.5	0.425	85.0				Jun-Sep	Port en Bessin
F.other	0.3	0.425	141.7				N/A	Port en Bessin
Total	**30.8**	**0.425**	**1.4**	**479**	**11**	**43**		
F1.1	200.0	0.36576	0.18	293	2	146	Unknown	Saint-Malo; Saint-Quay
F1.3	40.0	0		0	0		Unknown	Saint-Quay
F.other	2.0	0		0	0		N/A	
Total	**242**	**0.36576**	**0.18**	**293**	**2**	**146**		
U1.1	120.8	0.672	0.56	1094	35	31	Jun-Feb	Brixham; Looe
U2.2	14.5	0.404	2.78	537	15	36	Aug-Dec	Brixham
U2.3	2.8	0.136	4.86	168	6	28	Unknown	Brixham
U2.1	2.5	0.087	3.48	58	2	29	Jun-Dec	Brixham; Shoreham
U1.2	0.7	0.048	6.8	116	12	10	Jun-Nov	Shoreham; Newhaven
U4.1	0.7	0.007	1.0	27	1	27	Unknown	Brixham
U5.4	0.01	0.001	10.0	2	2	1	Jul-Nov	Hastings; Newhaven
U.other	10.8	0		0	0		N/A	
Total	**152.8**	**1.355**	**0.89**	**2002**	**73**	**27**		
Total Landings all Métiers	425.6							

1. Source: IFREMER (Jan - Dec 1994); MAFF (Apr 1994 - Mar 1995)

TABLE 6.8.2 John Dory: Example length distributions.

	F1.2 (Q2 1994)	F1.1 (Q2 1995)[1]	U1.1 (Q2 1994)
22		5	
23	8	2	429
24	31	2	674
25	54	9	1707
26	276	29	3108
27	526	35	4291
28	362	33	4763
29	775	47	4719
30	736	45	6557
31	662	37	4965
32	381	21	3248
33	428	46	2171
34	303	36	1357
35	311	50	1664
36	358	60	2382
37	295	53	1542
38	187	52	1909
39	342	54	1401
40	226	26	368
41	185	7	823
42	195	12	700
43	137	4	123
44	150	20	0
45	84	27	123
46	112	11	123
47	150	3	
48	56	3	
49	122	11	
50	76	3	
51	87	2	
52	39	6	
53	69	1	
54	39		
55	69		
56	59		
57	79		
58	20		
59	39		
60	29		
61	39		
62	10		
63	10		

1. Unraised data. Sample weight 631.6 Kg.

6.9 LEMON SOLE

The lemon sole, *Microstomus kitt*, is common in the North Sea and the western Channel (Wheeler 1969). In the western Channel lemon sole spawn from March to August, peaking during April, May and June (Anon, 1993). Ichthyoplankton samples suggest that most of the spawning in the Channel takes place in the west, as lemon sole eggs were most abundant in April in the area south and west of Cornwall (Riley *et al.*, 1986). To study migrations, ripe and running lemon sole were tagged off south Devon in 1970 (Jennings *et al.*, cited in Anon 1993). Virtually all were recaptured in areas adjacent to the release site, thus it appears that lemon sole in the western Channel undertake no extensive migrations. MAFF DFR has collected data on maturity, growth rates and mortality for lemon sole from the western Channel, but no similar data are currently available for adjacent sea areas. There is a minimum landing size of 25cm.

THE FISHERY

The main fisheries for lemon sole occurred in the western Channel during the winter and spring, and in the eastern Channel during the summer and autumn. The most important métiers in the western Channel were the winter trawl métiers F1.1, U1.1 and U2.2 (Table 6.9.1), and in the eastern Channel the summer trawl métier F1.2 , with smaller landings by the trawl métiers F2.1, U1.2 and U2.1.

The French length data for the eastern Channel are not adequate by quarter, but are adequate after length data are combined by commercial category for both years. These data are adequate for all métiers with the exception of dredging (F4.2), where no data are available for quarter 3 (as there is no fishery at this time of year). The French length data for the western Channel are adequate on a quarterly basis for F1.1, while data from F1.3 would be adequate when aggregated annually.

The UK length data are adequate for quarterly distributions to be produced for the métiers U1.1, U2.2 and U2.3. Length data are not adequate for any of the other métiers, even when all the data are aggregated.

The French age data were not adequate on a quarterly or six-monthly basis. When aggregated annually, and when both sexes are combined, the age data approached the required level of CVa (Table 6.9.2; Table 6.9.3). In order to bring the CVa for most of the age groups under the 10% level, the CVa would need to be halved, which would require a four fold increase in samples (approximately 1500 samples per annum; Appendix III).

The UK age data are also not adequate by quarter. When both sexes are aggregated on a six monthly basis, the CVa reaches, or approaches, the desired level for the first 5 age groups in the fishery (Table 6.9.2; Table 6.9.4 - 6.9.5). Although complete annual data are not available, the CVa for annual data should be below the required level for most age groups, and therefore annual data are considered adequate for the modelling purposes. However, annual aggregation of the data will introduce bias as the length stratified age sample targets were often achieved for the bulk of the length distribution (Appendix II). Aggregating the French and UK data is not recommended as there is some evidence that separate stocks may exist in the Channel (Anon, 1993).

The UK data are collected largely by the SFI, however no targets for sampling lemon sole have been set for the eastern Channel, although landings data suggests that this fishery may be significant. It was necessary to purchase lemon sole in France to collect age samples, and an expenditure of approximately 2000 FF per quarter has been necessary to achieve what was done for this study.

TABLE 6.9.1 Métier Sampling Summary - LEMON SOLE

Sampled Métier	Total landings first year[1] (tonnes)	Sampled Weight first year[1] (tonnes)	(%)	Number of Fish Sampled	Number of Vessels Sampled	Mean number of Fish Sampled per Boat	Months of peak fishing activity	Most important sampled ports
F1.2	423.6	0.147	0.03				Jun-Sep	Boulogne sur Mer
F2.1	16.7	0.147	0.88				Aug-Oct	Boulogne sur Mer
F5.4	9.1	0.147	1.61				Jul-Aug	Boulogne sur Mer
F4.4	8.6	0.147	1.71				Aug-Sep	Boulogne sur Mer
F4.2	6.9	0.147	2.13				Jan & Dec	Boulogne sur Mer
F.other	7.2	0.147	2.04				Unknown	Boulogne sur Mer
Total	**472.1**	**0.147**	**0.03**	**309**	**2**	**154**		
F1.1	190.0	2.081	1.09	1344	12	112	Unknown	Saint-Malo; Saint-Quay
F1.3	10.0	0.0307	0.31	67	10	7	Unknown	Saint-Quay
Total	**200.0**	**2.1117**	**1.06**	**1411**	**22**	**64**		
U1.1	389.3	8.637	2.22	7914	61	130	Jan-Jul	Brixham; Plymouth; Newlyn
U2.2	97.3	2.431	2.49	1876	17	110	Sep-Apr	Brixham; Plymouth; Newlyn
U2.3	40.6	0.886	2.18	583	5	117	Aug-Mar	Brixham; Plymouth; Newlyn
U.other	102.6	0		0	0		Unknown	
Total	**629.8**	**11.954**	**1.89**	**10373**	**83**	**125**		
Total Landings all Métiers	1301.9							

1. Source: IFREMER (Jan - Dec 1994); MAFF (Apr 1994 - Mar 1995)

TABLE 6.9.2 CVa for Lemon sole samples

Age	F Annual 1995 F1.1 F+M	UK Quarter 1 1994 U1.1 F	UK Quarter 1 1994 U1.1 M	UK Quarter 1+2 1994 U1.1 F	UK Quarter 1+2 1994 U1.1 M	UK Quarter 1+2 1994 U1.1 F+M
2	62	-	-	-	-	-
3	15	21	11	16	94	**10**
4	**9**	25	25	14	12	13
5	17	15	25	**10**	23	**10**
6	18	16	29	12	18	11
7	20	25	47	15	21	16
8	19	28	95	23	42	27
9	23	39	64	30	50	29
10	24	42	95	22	65	29
11	24	35	-	24	69	37
12	-	54	-	45	97	61

TABLE 6.9.3 Lemon sole; ALK; France; Annual 1995; VIIe; male+female

	Age															
Length	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17+
23			2													
24		1	7													
25	1	4	13	4	1											
26		7	6	2	1	2										
27		4	8	1	1											
28		3	3													
29	1		4	2	1			1								
30		2	8	4	6	1	1		2							
31		3	1	8	5	4		1	1	1						
32		9	7	5	5	5	1	2	1		1					
33	1	4	4	8	2	1	3	4								
34		4	2	4	5	3	4	3	2	1						
35		2	4	1	4	2	4	5	2	1		1	1			
36			2	1	4	8	2	3	1	1	2					
37		3	2	1	3	2	3	2	3	3	2	1	2	2	1	1
38				1	2	1		2	3	1	3	1				
39					2	1	3	2		2	2	2		2		1
40				1		2	3	1	2	1	2		1			
41							3	1		3		1			1	1
42									1	3	1	1				
43								1	1	1	1					
44																1
45								1		1		2				
46																
47																
48											1					

TABLE 6.9.4 Lemon sole; ALK; UK; Quarter 1+2 1994; VIIe; male

	Age															
Length	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17+
24		1		1												
25		2	2		3	1										
26		1	3	3	1		1									
27	1	4	1	2	1											
28		6	1	4	2	2	2									
29		6		4	3	1										
30		14		1	1											
31		3	2	1	4		1	1	1	1	1					
32		6	7	3		1			1				2			
33		2	1	4	3							1		1		
34		1	1	7	6											
35				5	3			1								
36			1	4	2	2		1						1		
37			1	1		1		1								
38					1											
39					1											
40																
41																
42																
43																
44																
45																
46																

TABLE 6.9.5 Lemon sole; ALK; UK; Quarter 1+2 1994; VIIe; female

	Age															
Length	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17+
24		2	2													
25		1	3		1											
26		3	6	2	1											
27		2	4	1												
28		2	5			1										
29		3	1	8	5											
30		8	1	10	5	2										
31		9		13	7	6										
32		3	3	4	5	5	2									
33		4	5	8	14	9	3	2								
34		1	3	11	8	8	4	1	1						1	
35				20	11	10	1	1	2	1	1					
36			1	14	8	8	5	2	2	2		1				
37				15	12	4	7	5	5	1	2	2				
38			1	5	6	5	6	2	6	2						
39				1	5	1	1	1	5	4		1	1	1		
40				1	3	2	3	2		3	1	1				2
41					1	1	1	2	5	3	1	1				
42									2	1	1	1				1
43						1		1	2	1		1			1	1
44									1	1						
45											1		1			
46										1						1

TABLE 6.9.6 Otolith Collection Summary - LEMON SOLE

IFREMER Port en Bessin

		VIId		VIIe		VIId or VIIe		
Year	Quarter	Male	Female	Male	Female	Male	Female	**Total**
1994	1							**0**
1994	2	28	48					**76**
1994	3							**0**
1994	4	18	73					**91**
1995	1	49	71					**120**
1995	2	35	54					**89**
1995	3							**0**
1995	4	134[1]						**134**
Total		**130**	**246**	**0**	**0**	**0**	**0**	**510**

IFREMER Brest[1]

		VIId		VIIe		VIId or VIIe		
Year	Quarter	Male	Female	Male	Female	Male	Female	**Total**
1994	1			94				**94**
1994	2			116				**116**
1994	3			69				**69**
1994	4			141				**141**
1995	1			136				**136**
1995	2			109				**109**
1995	3			93				**93**
1995	4			90[2]				**90[2]**
Total		**0**	**0**	**848[2]**		**0**	**0**	**848[2]**

MAFF Lowestoft[1]

		VIId		VIIe		VIId or VIIe		
Year	Quarter	Male	Female	Male	Female	Male	Female	**Total**
1994	1			351				**351**
1994	2			337				**337**
1994	3			324				**324**
1994	4			240				**240**
1995	1			501				**501**
1995	2			370				**370**
1995	3			352				**352**
1995	4			166[2]				**166[2]**
Total		**0**	**0**	**2641[2]**		**0**	**0**	**2641[2]**

1 Breakdown by sex not available.
2 Data incomplete: some samples collected but not processed.

6.10 RED GURNARD

The red gurnard, *Aspitrigla cuculus*, is the most abundant of four species of gurnard found in the Channel (Wheeler, 1969). The red gurnard is principally found in waters of 20-250m depth from the Orkney Islands and southern Norway south to the Mediterranean and North Africa (Wheeler, 1969). First sexual maturity occurs at approximately 25cm, with approximately 50% mature at 26-29cm at an age of three (Theret 1983, cited in Anon, 1993). Ripe and running red gurnard have been caught in the area between north Contentin and the Isle of Wight from the end of February until June, but spawning may continue later than June further east in the Channel (Theret, 1983, cited in Anon 1993; MAFF, unpublished data). Gurnard eggs and postlarvae have been collected on several occasions from the Channel, however identification to species level has not been possible as the eggs and developmental stages are difficult to separate from other gurnard species (Clark, 1914; Russell, 1976). There has been no recorded tagging exercises with red gurnard in the Channel. Red gurnards are identified in French landings data, and this information has been used to infer migrations of red gurnard (Theret, 1983, cited in Anon, 1993). Fisheries data shows that red gurnard appear in the central and western Channel during September, and in an area between Ouessant on the French coast and the Isle of Wight, particularly around the Hurd Deep, from November to January. Spawning commences in February and the spent fish appear to move west, so that by July and August most fish were caught in the western Channel. Length-weight relationships and von Bertalanffy growth parameters exist for red gurnard from the Channel (Fontaine and Theret, 1982), southern Brittany (Baron, 1985), and the Saronikos Gulf

(Greece) (Papaconstantinou, 1983), with females growing faster than males and reaching a larger maximum length. Mortality rates have only been estimated in the Saronikos Gulf (Papaconstantinou, 1983). There are no current management measures for red gurnard.

THE FISHERY

The most important fisheries for red gurnard occurred in the eastern Channel over winter, and in the western Channel from summer, through winter, until early spring. In France the red gurnard fishery was larger in the eastern Channel, where the market was more developed, but in the UK the red gurnard was generally not considered important. The most important métiers in the eastern Channel were the trawl métiers F1.1, F1.2 and U1.2, and in the western Channel the trawl métiers F1.3, U1.1 and U2.2 (Table 6.10.1).

In the UK, it was more difficult to collect samples of red gurnard in the eastern Channel (Table 6.10.2), as they were less abundant in the landings and were often out numbered by other gurnard species. The UK quarterly length data were adequate for the métiers U1.1, U2.2 and U2.3, but aggregation of quarterly data on an annual basis is recommended to produce adequate length data for U1.2.

French length data were adequate for all métiers and quarters, except F1.3 where annual data are adequate after annual aggregation. In the French eastern Channel métiers there were some regional differences in the length distributions of the commercial categories, as a result the data were raised for each area separately (the area east of, and including Dieppe; and the area west of, and including, Fécamp).

In France, it was possible to obtain age samples without difficulty throughout the year (Table 6.10.2). The CVa for the French age data for females was not adequate quarterly (Table 6.10.3; Table 6.10.5), but approached the desired level when data were aggregated on a six monthly basis, and was best when aggregated annually (Table 6.10.3; Table 6.10.6). The data for males needed to be aggregated on an annual basis to achieve the desired CVa (Table 6.10.3; Table 6.10.7).

The UK age data were not adequate on a quarterly or six monthly basis, except for the age 2 samples (Table 6.10.4). The age data were aggregated annually (Table 6.10.8; Table 6.10.9), and the sexes were combined to achieve the best overall CVa (Table 6.10.4). Even at this level of aggregation the CVa for the UK data did not achieve the acceptable level for fish aged 3 years and older, but these fish were relatively scarce in the UK fishery. However, combining the UK data introduces bias, as the specified sample targets were often achieved for the bulk of the length distribution (Appendix II).

For red gurnard, the variance due to length sampling at each age is generally greater than the variance due to age sampling, contrary to what has been suggested for other assessed species (Pope and Knights 1975; Flatman 1990; Table 6.10.10. On an annual basis the CV (with variances due to age and length sampling) approaches the desired level for UK data when aggregated annually and by sex, but only for the age groups 2 and 3 (Table 6.10.10). In order to achieve the desired level of CV for the first three age groups it would be necessary to reduce the CV by a factor of 2, i.e. a four-fold increase in age samples (approximately 2300 samples per annum; Appendix III). The stock integrity in the Channel has yet to be established, and therefore it is not recommended that the different regions are aggregated.

It is important to note that the UK landings estimates were for all species of gurnards combined, as the different species are not separated in the MAFF FAD landings statistics. Also, as red gurnard was a common pot bait species, considerable amounts did not pass through markets or auctions but were sold directly between fishermen, and these landings were not recorded. Improving UK length samples would require extra sampling effort, but better age samples could have been collected, with minimal extra effort and cost, by increasing the age sample targets (Appendix III).

TABLE 6.10.1 Métier Sampling Summary - RED GURNARD

Sampled Métier	Total landings first year[1] (tonnes)	Sampled Weight first year[1] (tonnes)	(%)	Number of Fish Sampled	Number of Vessels Sampled	Mean number of Fish Sampled per Boat	Months of peak fishing activity	Most important sampled ports
F1.2	1101.8	0.816	0.07				Oct-Jan	Port en Bessin; Dieppe
F1.4	17.3	0.816	4.72				Sep-Oct	Port en Bessin; Dieppe
F.other	15.1	0.816	5.40				N/A	Port en Bessin; Dieppe
Total	**1134.2**	**0.816**	**0.07**	**3029**	**7**	**433**		
F1.1	1152.0	0.691	0.06				Jan-Mar	Port en Bessin; Cherbourg
F.other	13.1	0.691	5.27				N/A	Port en Bessin; Cherbourg
Total	**1165.1**	**0.691**	**0.06**	**2442**	**5**	**488**		
F1.1	1500.0	5.7417	0.38	1984	10	198	Jan-Mar	Saint-Malo; Saint-Quay
F1.3	500.0	0.2889	0.06	567	20	28	Jun-Sep	Saint-Quay
F.other	140.0	0		0	0		N/A	
Total	**2140.0**	**6.0306**	**0.28**	**2511**	**30**	**84**		
U1.1	167.4[2]	0.649	0.38	1536	21	73	May-Nov	Brixham
U2.2	67.5[2]	2.488	3.68	737	10	74	Jan-Mar	Brixham
U1.2	45.9[2]	0.167	0.36	563	7	80	Jul-Nov	Newhaven; Shoreham
U2.3	36.4[2]	0.822	2.26	601	7	86	Oct-Mar	Brixham
U.other	32.6[2]	0		0	0		N/A	
Total	**349.8[2]**	**4.126**	**1.17**	**3437**	**45**	**76**		
Total Landings all Métiers	3654.9[2]							

1. Source: IFREMER (Jan - Dec 1994); MAFF (Apr 1994 - Mar 1995)
2. Data for UK landings includes all gurnard species

TABLE 6.10.2 Otolith Collection Summary - RED GURNARD

IFREMER Port en Bessin

		VIId		VIIe		VIId or VIIe		
Year	Quarter	Male	Female	Male	Female	Male	Female	**Total**
1994	1	67	137	107	173			**484**
1994	2	66	156	67	176			**465**
1994	3	32	101	29	117			**279**
1994	4	48	137	68	136			**389**
1995	1	56	125	59	137			**377**
1995	2	44	137	40	138			**359**
1995	3	49	177	64	128			**418**
1995	4	91	154	29	140			**414**
Total		**453**	**1124**	**463**	**1145**	**0**	**0**	**3185**

IFREMER Brest - none

MAFF Lowestoft

		VIId		VIIe		VIId or VIIe		
Year	Quarter	Male	Female	Male	Female	Male	Female	**Total**
1994	2			24	56			**80**
1994	3			13	39			**52**
1994	4			18	33			**51**
1995	1			19	60			**79**
1995	2			4	40			**44**
1995	3	32	77	3	29			**141**
1995	4			18	71			**89**
1996	1			11	31			**42**
Total		**32**	**77**	**110**	**359**	**0**	**0**	**578**

TABLE 6.10.3 CVa for French red gurnard samples

Age	F 1994 Q1 F1.1 M	F 1994 Q1 F1.1 F	F 1994 Q1 F1.2 M	F 1994 Q1 F1.2 F	F 1994 Q1+2 F1.2 M	F 1994 Q1+2 F1.2 F	F 1994 Annual F1.2 M	F 1994 Annual F1.2 F	F 1994 Annual F1.2 M+F
1	-	-	-	-	-	-	18	**6**	**8**
2	29	25	-	97	**9**	**9**	**8**	**10**	**7**
3	11	**6**	49	**1**	18	**9**	18	**10**	**10**
4	24	14	24	16	21	14	20	13	12
5	21	13	35	14	22	11	17	**10**	**9**
6	25	20	**1**	21	40	15	36	14	17
7	27	39	32	34	35	19	38	36	22
8	42	41	64	64	73	42	65	38	36
9	53	59	59	48	63	38	59	53	37
10	86	95	66	55	74	57	74	66	57
11	-	-	-	89	-	60	-	-	-

TABLE 6.10.4 CVa for UK red gurnard samples

Age	UK 1994 Q2 U1.1 F	UK 1994 Q2 U1.1 M	UK 1994 Q2 U1.1 F+M	UK 1994 Q2+3 U1.1 F+M	UK 1994 Annual U1.1 F	UK 1994 Annual U1.1 M	UK 1994 Annual U1.1 F+M
1	-	-	-	26	**8**	**6**	**9**
2	**4**	**8**	**4**	**6**	**7**	**7**	**7**
3	27	35	24	17	14	32	18
4	45	0	38	40	35	54	30
5	33	-	31	44	36	-	32
6	35	0	44	25	48	71	52
7	-	-	89	71	95	-	86
8	-	-	-	-	-	-	-
9	-	-	89	-	95	-	86

TABLE 6. 10.10 CV for red gurnard: annual 1994; U1.1; male + female.

Age	Catch	Variance due to age sampling	Variance due to length sampling	CVa	CV
1	365000	1.17E+09	2.10E+09	**9**	15
2	518000	1.47E+09	1.67E+09	**7**	11
3	101000	3.41E+08	1.40E+08	18	22
4	12500	1.46E+07	1.73E+07	30	45
5	9240	8.81E+06	1.71E+07	32	55
6	1850	9.44E+05	2.95E+06	52	107
7	120	1.07E+04	2.84E+04	86	165
8	0	0	0	-	0
9	120	1.07E+04	2.84E+04	86	165

TABLE 6.10.5 Red Gurnard: ALK; French; Quarter 1 1994; VIId; Female

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
22			2													
23																
24			3													
25			3													
26			1	2												
27			2	1												
28				3	1											
29				7	2	2										
30			1	7	7	2	1									
31				1	4	5										
32					4	5										
33				1	9	7	2	1								
34					2	5	2		1							
35					3	7	4	2	1							
36					1	1	4	2								
37							4	3		1						
38							1			1						
39							1		1							
40										2	2	1				
41										2			2			
42																1
43									1	1						
44									1		1					
45												1				

TABLE 6.10.6 Red Gurnard: ALK; French; Annual 1994; VIId; Female

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
13	1															
14																
15																
16																
17																
18																
19		5														
20		6														
21		5														
22		9	2													
23		6														
24		8	3													
25		14	6													
26		13	4	5												
27		8	7	3	2											
28			12	13	1											
29			17	15	5	3										
30			18	12	8	2	1									
31			11	9	9	6										
32			19	10	8	12	3									
33			7	9	13	14	4	1								
34			2	4	8	19	7	2	1			1				
35			3	4	6	11	8	7	1							
36			1	1	3	10	10	5		1						
37				1	1	2	12	5	2	1						
38					1	4	2	2	1	1	1	1				
39						2	1	4	2	1						
40						1		2		2	2	1				
41									1	2			2			
42								1								1
43									1	1						
44									1		1					
45												1				

TABLE 6.10.7 Red Gurnard; ALK; French; Annual 1994; VIId; male

	1	2	3	4	5	6	7	8	9	10
17	1									
18										
19	1									
20	4	1								
21	6									
22	3	6								
23	1	12	2	1						
24	2	10	3							
25	6	6	4							
26	4	8	4	3	1	2				
27	1	6	5		2					
28		11	4	8	2					
29		5	4	6	7	1	1			
30		3	1	2	4					
31		1	3	4	8		1			
32		1		1	5	4		1		
33				1	1	2	1			1
34			1		3	1	3		1	
35							1	1		
36									1	
37				1						1

TABLE 6.10.8 Red Gurnard: ALK; UK; 1994 annual; VIIe; female.

	1	2	3	4	5	6	7	8	9
17	4								
18	1								
19		1							
20	5	2							
21	7	3							
22	4	5							
23	12	6							
24	6	5							
25	3	8	1						
26		5	2						
27		6	1						
28		8	3						
29		3							
30		3	2						
31			5		1				
32		2	5	2	1				
33			3	1					
34			2						
35				2	3				
36				2	2				
37				1					
38				1	1	1			
39									
40					1				1
41				1		1			
42						1	1		

TABLE 6.10.9 Red Gurnard: ALK; UK; 1994 annual; VIIe; male.

	1	2	3	4	5	6	7	8	9
18	3								
19	1								
20	4	2							
21	2	3							
22	5	3							
23	1								
24		1	1						
25		5							
26		4							
27		5							
28		2							
29		1	2						
30		1	1						
31		1		1					
32		2							
33									
34		1				1			
35									
36									
37				1					

6.11 RED MULLET

The red mullet, *Mullus surmuletus*, is distributed from the Canaries in the south, throughout the Mediterranean Sea to Norway and the Orkney Islands in the north, where they occur most abundantly in depths less than 50m (Wheeler, 1969). In the Mediterranean first sexual maturity is attained at a length of 13-15cm, at age 1-2 years, and males may mature earlier than females (Sanchez *et al.*, 1983). Spawning areas have not been described for the Channel, but both pelagic and demersal stages have been recorded in the waters around Plymouth in August (Clark, 1914), and in September demersal 0-group red mullet have been recorded in coastal waters at depths of 5-15m, in the Solent and Poole Bay (MAFF, unpublished data). In October and November both juveniles and adults move offshore into deeper waters of 46-55m, and a return migration occurs in June (Wheeler, 1969). Red mullet have been aged using otoliths, and on the Catalan coast (Mediterranean) red mullet reach 23cm after a minimum of 5 years, (Sanchez *et al.*, 1983). Von Bertalanffy growth parameters and length-weight parameters exist for red mullet from the Catalan coast (Sanchez *et al.*, 1983), but not for the Channel. There is a minimum landing size for red mullet of 15cm.

THE FISHERY

The most important métiers were the trawl métiers F1.1, F1.2, F1.3 and U1.1, and the French fishery was also considerably larger than the UK fishery (Table 6.11.1). Red mullet were landed in the eastern Channel during the winter by the trawl métier F1.2, and in the autumn and summer by U1.1. The greatest landings in the western Channel were over winter by the trawl métiers F1.1 and U2.2. However, it was difficult to obtain accurate landings from F1.1 as red mullet was often mixed with other species.

In the UK adequate length data for VIId métiers, (almost entirely from the trawl métier U1.2) could only be produced by aggregating data from both years. Data were also adequate quarterly for the less seasonal métiers U1.1 and U2.2.

Although the fisheries in the eastern Channel were seasonal, the data collected were adequate to produce length distributions on a quarterly basis for all the French VIId métiers after aggregating data from equivalent quarters from the two years (Table 6.11.2). The fisheries in the western Channel were less seasonal and adequate quarterly length data were provided for F1.1 (Table 6.11.2).

In both the UK and France it would be difficult to improve the sampling with the available resources as the most important métiers and ports have been covered, so improvement of the data would require extra sampling effort.

TABLE 6.11.1 Métier Sampling Summary - RED MULLET

Sampled Métier	Total landings first year[1] (tonnes)	Sampled Weight first year[1] (tonnes)	(%)	Number of Fish Sampled	Number of Vessels Sampled	Mean number of Fish Sampled per Boat	Months of peak fishing activity	Most important sampled ports
F1.2	227.6	0.291	0.13				Nov-Jan	Port en Bessin
F3.2	5.5	0.291	5.29				Nov-Dec	Port en Bessin
F.other	5.8	0.291	5.02				N/A	Port en Bessin
Total	**238.9**	**0.291**	**0.12**	**801**	**8**	**100**		
F1.1	170.0	0.2034	0.12	208	3	69	Oct-Mar	Saint-Malo; Saint-Quay
F1.3	30.0	0.002	<0.01	10	1	10	Unknown	Saint-Quay
F5.2	10.0	<0.01	<0.01	13	1	13	Unknown	Roscoff
Total	**210.0**	**0.2054**	**0.10**	**231**	**4**	**58**		
U1.1	23.4	0.280	1.19	581	16	36	Jul-Nov	Brixham; Looe
U2.2	14.1	0.605	4.29	1080	14	77	Sep-Mar	Brixham
U2.3	6.2	0.112	1.81	365	6	61	Oct-Mar	Brixham
U1.2	5.6	0.076	1.35	162	13	12	Sep-Nov	Newhaven; Shoreham
U5.4	0.06	<0.001	0.3	1	1	1	Unknown	Hastings
U.other	11.3	0		0	0		N/A	
Total	**60.7**	**1.073**	**1.77**	**2139**	**50**	**43**		
Total Landings all Métiers	503.8							

1. Source: IFREMER (Jan - Dec 1994); MAFF (Apr 1994 - Mar 1995)

TABLE 6.11.2 Red Mullet: Example length distributions

	U1.1 (Q3 1994)	U2.2 (Q3 1994)	F1.2 (Q3 1994)
18			463
19	218		4735
20	53		4479
21	428		3553
22	1344		1840
23	2056	82	5189
24	3191	204	5812
25	3834	266	1260
26	3739	674	6575
27	1957	633	2532
28	951	776	7374
29	233	1011	9299
30	233	705	8725
31	154	1062	6542
32	0	786	4405
33	0	327	3783
34	0	225	1703
35	26	286	1943
36		204	966
37		102	804
38		102	660
39		20	201
40		0	86
41		0	86
42		0	0
43		0	29
44		20	0
45			29

6.12 SCALLOP

The scallop, *Pecten maximus*, is widely distributed in north-east Atlantic shelf waters from Iceland and Norway south to the Iberian peninsula and the Canaries, where they are most abundant at depths of 15-75 metres (Mason, 1983). Scallops are fully mature at approximately 3 years old (85mm) (Franklin *et al.*, 1980). The spawning period lasts from April until September, but with considerable variation in timing, and as they are sedentary the spawning areas correspond to the adult distribution (Paulet and Fifas, 1989). The appearance of 0-group scallops, called 'spat', is unpredictable and some year classes are often absent from a population (Franklin *et al.*, 1980). It also appears that whilst in some areas scallops are self-recruiting, in others they rely on passive immigration of larvae (Darby and Durance, 1989). There is considerable variation in growth rates of scallops between different areas and within those areas between years (Anon, 1993). The von Bertalanffy growth parameters exist for scallops from a range of grounds in the Channel (Dare and Deith, 1991; Paulet and Fifas, 1989). There is a minimum landing shell width of 10cm (biological samples measure shell height).

THE FISHERY

The only important métiers for scallop are the dredging métiers, U4.2 and F4.2 in the eastern Channel during the winter, and U4.1 and F4.1 in the western Channel during the summer (Table 6.12.1).

The length data from the French landings of métiers F4.1 and F4.2 were adequate by quarter whilst the fishery is in season (Quarters 1,2 and 4 - no data for quarter 3; e.g. F4.2, Table 6.12.1). In France some existing length data were also used. The UK length data are poor, and not suitable for raising, although better in the second year of sampling (Table 6.12.2). There is evidence for separate stocks existing in the Channel (Anon, 1993), and therefore combining data from different regions is not recommended.

It was difficult to get scallop samples in the UK, as almost all scallop landings go directly to merchants and are not available for sampling at the markets. The scallops are sold rapidly at the merchants, so it was also difficult to find samples that were complete. Some sampling of scallops was possible at the auction in Brixham, but in the eastern Channel all scallops passed directly to the merchants. Sampling of the UK scallop métiers is therefore best carried out at sea but this technique was considered too time consuming with the manpower available to this project.

TABLE 6.12.1 Métier Sampling Summary - SCALLOPS

Sampled Métier	Total landings first year[1] (tonnes)	Sampled Weight first year[1] (tonnes)	(%)	Number of Fish Sampled	Number of Vessels Sampled	Mean number of Fish Sampled per Boat	Months of peak fishing activity	Most important sampled ports
F4.2	4785.7	0.410	0.008				Nov-Mar	Port en Bessin & Grancamp
F.other	42.9	0.410	0.96				N/A	Port en Bessin & Grancamp
Total	**4828.6**	**0.410**	**0.008**	**1796**	**14**	**128**		
		(*)						
F4.1	6750	47.873	0.71	6000	90	67	Nov-Mar	St Quay, Paimpol
Total	**6750**	**47.873**	**0.71**	**6000**	**90**	**67**		
U4.1	3482.0	2.060	0.06	120	1	120	May-Aug	Brixham
U4.2	780.0	0.060	0.01	49	1	49	Jan-May	Portsmouth
U.other	298.0	0		0	0		N/A	
Total	**4560.0**	**2.120**	**0.05**	**169**	**2**	**84**		
Total Landings all Métiers	16138.6							

1. Source: IFREMER (Jan - Dec 1994); MAFF (Apr 1994 - Mar 1995)

(*) [illegible]

TABLE 6.12.2 Scallop: Example length distributions; UK

mm	U4.1 (Q4 1994)	U4.1 (Q2 1995)
85		7781
86		2594
87		5187
88		10375
89		2594
90		7904
91		7904
92		28653
93		12968
94		15685
95		14449
96		27417
97		10743
98	1494	17166
99	4482	22353
100	1494	18278
101	2988	23588
102	1494	11979
103	8964	22476
104	0	13583
105	10459	11979
106	5976	22353
107	7470	18401
108	4482	14572
109	1494	14449
110	4482	11979
111	1494	11979
112	2988	10620
113	5976	9262
114	1494	18524
115	1494	2717
116	0	13214
117	1494	6668
118	0	5310
119	1494	1358
120	1494	5310
121		5310
122		3952
123		2594

TABLE 6.12.3 Scallop: Example length distributions; French

cm	F4.2 (Q2 1995)
9	21046
9.5	105232
10	512127
10.5	659452
11	961116
11.5	470035
12	336741
12.5	28062
13	28062

6.13 SPIDER CRAB

The spider crab, *Maia squinado*, is distributed from Scotland and the southern North Sea south to the Mediterranean, where it is most abundant at depths of 0-70m (Anon, 1993). In the Channel, mature females are all carrying eggs by June, the eggs begin to hatch in July and have all hatched by November (Anon, 1993). Some females may produce two batches of eggs in a season (de Kergariou, 1975). Hatching takes place in inshore waters generally less than 20m deep, and the larvae are then pelagic for 2-3 weeks (de Kergariou, 1983). The juveniles remain in the nursery areas until they reach maturity at the end of their second year, and after maturity tagging exercises have shown that adult spider crabs leave the inshore waters from September to January and migrate to overwintering areas in waters deeper than 50m (Latrouite and Le Foll, 1989). In April and June the mature spider crabs return inshore, although not necessarily to their original nursery areas. There are also some longer-term migrations westwards in the Channel (Edwards, 1980). Males grow larger and faster than females, although maturity occurs at the same age (Anon, 1993). Growth parameters for the Channel have not yet been published. However, adults size is reached after the terminal moult, at approximately 2 years of age and 8 to 20 cm carapace length (Le Foll, 1993), after which no further growth occurs. In the Channel spider crabs have a minimum landing size of 12cm carapace height.

THE FISHERY

The most important métiers were the net métier, F5.6, during winter and spring, and the pot métiers U6.1, U6.2, F6.1 and F6.2 (Table 6.13.1). The pot métiers landed spider crabs throughout the year, but the greatest landings were during spring and summer.

The French quarterly length data were only adequate for F5.6 (Table 6.13.2), and F6.2 in quarters 2 and 4. However, the relatively poor sampling is not a serious problem for métiers which exploit the adult crabs, which have reached their terminal size. The UK length data were adequate for all quarters and métiers (e.g. U6.2, Table 6.13.2), except for the netting métier U5.4.

The sampling of spider crab in France was effort intensive, because the data had to be collected at sea. In the UK, in addition to length samples collected by staff directly involved with this project, samples were also collected by the SFI staff. It is not recommended that the data for different regions are combined, as there is evidence that separate stocks exist for the French and UK sides of the Channel (Anon, 1993). In both the UK and France it was difficult to improve the sampling with the available resources as the most important métiers and ports were covered, so improvement of the data would require extra sampling effort.

TABLE 6.13.1 Métier Sampling Summary - SPIDER CRAB

Sampled Métier	Total landings first year[1] (tonnes)	Sampled Weight first year[1] (tonnes)	(%)	Number of Fish Sampled	Number of Vessels Sampled	Number of Fish Sampled per Boat	Months of peak fishing activity	Most important sampled ports
F4.2	11.1	0		0	0		Feb-Mar	None
F1.2	4.2	0		0	0		Mar-Aug	None
F1.4	3.6	0		0	0		Jul-Aug	None
F5.5	1.6	0		0	0		Jan-May	None
F6.2	0.6	0		0	0		May & Oct	None
F.other	1.0	0		0	0		N/A	None
Total	**22.1**	**0**		**0**	**0**			
F1.3	100.0	0		0	0		Nov-Aug	Sampled At Sea
F5.6	2000.0	1.721	0.08	432	1	432	Nov-May	Sampled At Sea
F6.1	300.0	0		0	0		Nov-Aug	Sampled At Sea
F6.2	1400.0	0.309	0.02	345	2	172	Nov-Aug	Sampled At Sea
Total	**3800.0[2]**	**2.03**	**0.05**	**777**	**3**	**259**		
U6.1	714.0	1.726	0.24	754	6	126	Apr-Dec[2]	Salcombe; Coverak
U6.2	360.4	5.028	1.39	1993	26	77	Mar-Dec[2]	Eastbourne; Shoreham
U5.4	0.04	0.066	(165)	77	1	77	Unknown	Worthing
U5.7	3.2	1.431	44.7	409	4	102	Dec-May	Coverak; Helford River
U.other	22.4	0		0	0		N/A	
Total	**1100.0**	**8.251**	**0.75**	**3233**	**37**	**87**		
Total Landings all Métiers	5122.2							

1. Source: IFREMER (Jan - Dec 1994); MAFF (Apr 1994 - Mar 1995)
2. Approximate data.

TABLE 6.13.2 Spider Crab: Example length distributions (raised to trip); France

cm	F5.6 (Q4 1994) Male	F5.6 (Q4 1994) Female
12	41	48
12.5	136	95
13	170	82
13.5	142	110
14	171	147
14.5	181	72
15	107	22
15.5	90	1
16	32	0
16.5	41	1
17	25	
17.5	8	
18	0	
18.5	0	
19	8	
Weight[1]	1189	534

1. Weight sampled (kg).

TABLE 6.13.3 Spider Crab: Example length distributions (raised to trip); UK

cm	U6.2 (Q4 1994)[2]
11	13
12	117
13	143
14	116
15	53
16	29
17	6
Weight[1]	394

1. Weight sampled (kg).

6.14 TURBOT

The turbot, *Scophthalmus maximus*, is distributed from the Mediterranean northwards to the British Isles and Norway and as far north as Faroe, Iceland and Rockall (Wheeler, 1969). There are no detailed maturity data for the Channel, but in the North Sea the average size at first maturity for females is 46cm, and males appear to be mature by 30cm (Jones, 1974). Spawning lasts from April until September in the Channel, and turbot eggs have been found in ichthyoplankton trawls in the eastern Channel, particularly the Baie de Seine, from April to June reaching a peak in June (MAFF, unpublished data). In June, larvae have been found west of a line drawn from the Isle of Wight to Cherbourg, and post-larval turbot have also been recorded in the waters around Plymouth in July (Clark, 1914). There have been no tagging exercises using turbot in the Channel, and the migration patterns inferred by commercial catch data have not been studied. There are considerable data on growth rates of turbot as a result of interest in the aquaculture of this species (Weber, 1979; Fernandez-Pato *et al.*, 1990; Paulsen 1989). Length-weight parameters and von Bertalanffy growth parameters exist for the North Sea and the Golfe de Lion, where females grow faster than males and achieve a greater maximum size. Estimates of total mortality exist for the North Sea (Weber, 1979; Robert and Vianet, 1988). There is a minimum landing size of 30cm.

THE FISHERY

The fishery for turbot was concentrated in the western Channel, where the largest landings occurred in the winter and summer. In the eastern Channel small landings occurred throughout the year, with no clear seasonality. The most important métiers were the tangle nets (F5.3 and U5.7) and offshore trawls (U2.2, F1.1, F1.2 and F2.1) (Table 6.14.1). The tangle net métiers F5.3 and U5.7 and the trawl métiers F1.1, F1.2 and F2.1 were all summer fisheries, and the trawl métier U2.2 was a winter fishery.

Length data were adequate quarterly for the métiers U2.2 and U2.3 (Table 6.14.2). Length data were also adequate for U5.7 and F5.3, during the periods of highest landings (Table 6.14.2). It was not possible to collect adequate quarterly data for any of the other métiers in the western Channel, (e.g. F1.3; Table 6.14.2), as only small numbers of turbot were landed per trip (Table 6.14.1). The length data collected for all eastern Channel métiers were not adequate quarterly or annually (e.g. U1.2, Table 6.14.2). Some data from 1991 were also provided for F5.3 and F1.3, and similar data exists for 1993, but needs to be reworked by quarter.

It was difficult to collect adequate numbers of turbot for age samples (Table 6.14.3). ALK's were not adequate for quarterly use (Table 6.14.4 - 6.14.6). The French ALK's were missing samples from the small length groups, (<41cm) (Table 6.14.5), as these fish were landed mostly by the inshore trawl métiers, but only in small numbers. In the UK it was easier to find these smaller fish, but conversely it was harder to find large fish (>61cm) (Table 6.14.8). However, the size range of age samples reflected the length distribution in the main fishery in each country, i.e. métiers F5.3 in France and U2.2 in the UK. The ageing of turbot represents a new skill for staff at MAFF and IFREMER, and as such requires verification and checking before this species can be aged with confidence.

It was not possible to raise the French age data with any confidence, even on an annual basis (Table 6.14.9). With male and female age data combined annually the ALK may be used, but the length data are insufficient for confident raising for all métiers except F5.3 (Table 6.14.2). In order to reduce the CVa to acceptable levels across most age groups would require a nine-fold increase in age samples, (approximately 1500 samples per annum, Appendix III).

The UK age data were not adequate quarterly, when aggregated annually and when sexes were combined the target CVa is nearly achieved for ages 2,3 and 4 (Table 6.14.9). As the UK sample targets by length group were not achieved, the sampling approximated to random sampling, eliminating some of the bias that would be incurred when aggregating the data. In order to lower the CV (including the variances due to age and length sampling) to acceptable levels across the first 3 year classes in the fishery, would require decreasing the CV by a factor of 2 (Table 6.14.10). This would require a four-fold increase in age samples, (approximately 1600 samples per annum, Appendix III).

The stock integrity in the Channel is unknown, so aggregating the data from different regions is not recommended. In France it was difficult to improve the sampling with the available resources as the most important métiers and ports have been covered, so improvement of the data would require extra sampling effort. However, a remanagement of the sampling effort may be sufficient to improve data for F5.3, where the landings are concentrated in quarters 2 and 3. In the UK, sampling of métier U5.7 could be increased and may help to provide the larger fish missing in the UK ALK's. To improve the sampling of the other métiers would require extra effort.

TABLE 6.14.1 Métier Sampling Summary - TURBOT

Sampled Métier	Total landings first year[1] (tonnes)	Sampled Weight first year[1] (tonnes)	(%)	Number of Fish Sampled	Number of Vessels Sampled	Mean number of Fish Sampled per Boat	Months of peak fishing activity	Most important sampled ports
F1.2	33.6	0.138	0.41	53	6	9	May-Aug	Port en Bessin
F5.3	32.0	0.045	0.14	32	2	16	Jun-Sep	Port en Bessin
F2.1	31.7	0		0	0		Aug-Oct	Port en Bessin
F4.4	23.7	0		0	0		Apr-Jun	Port en Bessin
F4.2	23.1	0		0	0		Nov-Feb	Port en Bessin
F1.4	9.2	0.030	0.32	11	1	11	Jun-Jul	Port en Bessin
F5.4	6.5	0		0	0		Oct-Nov	Port en Bessin
F other	0.4	0		0	0		N/A	Port en Bessin
Total	**160.4**	**0.213**	**0.13**	**96**	**9**	**11**		
F1.1	30.0	0.0957	0.32	39	6	6	May-Jul	Saint-Malo; Saint-Quay
F1.3	10.0	0.1276	1.3	50	22	2	May-Jul	Saint-Quay
F5.3	80.0	0.416	0.52	17	20	1	May-Jul	Roscoff
Total	**120.0**	**0.6393**	**0.5**	**106**	**48**	**2**		

(cont.)

1. Source: IFREMER (Jan - Dec 1994); MAFF (Apr 1994 - Mar 1995)

TABLE 6.14.1 (cont.) Métier Sampling Summary - TURBOT

Sampled Métier	Total landings first year[1] (tonnes)	Sampled Weight first year[1] (tonnes)	(%)	Number of Fish Sampled	Number of Vessels Sampled	Mean number of Fish Sampled per Boat	Months of peak fishing activity	Most important sampled ports
U2.2	51.5	1.455	2.8	543	20	27	Jan-Apr	Brixham
U2.3	18.9	1.235	6.5	387	11	35	Oct-Mar	Brixham
U5.7	16.8	0.207	1.2	60	1	60	Apr-Jul	Looe
U2.1	16.3	0.302	1.8	91	3	30	Sep-Feb	Brixham; Shoreham
U4.1	14.7	0.093	0.6	27	2	13	Dec-May[2]	Brixham
U1.1	11.4	0.045	0.4	33	19	2	May-Nov	Brixham; Looe
U1.2	6.5	0.068	1.0	51	19	3	Jan-Dec[2]	Newhaven; Shoreham
U5.4	1.2	0.016	1.3	10	10	1	Sep-Dec[2]	Hastings; Rye
U.other	23.1	0		0	0		N/A	
Total	**160.4**	**3.421**	**2.13**	**1202**	**85**	**14**		
Total Landings all Métiers	443.8							

1. Source: IFREMER (Jan - Dec 1994); MAFF (Apr 1994 - Mar 1995)
2. Approximate data.

TABLE 6.14.2 Turbot: Example length distributions.

	U2.3 (Q1 1995)	F1.3 (Annual 1995)$_1$	F5.3 (Q2 1994)$_2$
26		3	
31	13	9	1
36	169	13	11
41	313	3	12
46	247	5	2
51	273	4	0
56	234	2	1
61	169	1	
66	65	1	
71	52	2	
76	13		

1. Raised to trip. Sample weight 50.3 kg.
2. Sample weight 45.0 kg.

TABLE 6.14.4 Turbot: ALK; French; Q2 1995; VIIe; male+female.

	2	3	4	5	6	7	8	9	10	11	12	13	14	15
31														
36														
41			4	2										
46		5	13	13	3	3								
51		2	11	12	6									
56			5	4	4	2								
61				5	4	1								
66				1	1	1								
71														
76							1							

TABLE 6.14.5 Turbot: ALK; French; Annual 1995; male+female.

	2	3	4	5	6	7	8	9	10	11	12	13	14	15
31														
36		1												
41		2	5	3	1									
46		6	16	15	3	3								
51		3	16	15	8									
56			7	7	7	5								
61				6	6	1	3	1	1					
66				2	1	3		3	1	2				
71						3	2	5		2	1			
76							2		1			1		

TABLE 6.14.3 Otolith Collection Summary - TURBOT

IFREMER Port en Bessin - none

IFREMER Brest

		VIId		VIIe		VIId or VIIe		
Year	Quarter	Male	Female	Male	Female	Male	Female	**Total**
1994	1							**0**
1994	2			10	2			**12**
1994	3			8	28			**36**
1994	4							**0**
1995	1							**0**
1995	2			75	27			**102**
1995	3			23	44			**67**
1995	4							**0**
Total		**0**	**0**	**116**	**101**	**0**	**0**	**217**

MAFF Lowestoft

		VIId		VIIe		VIId or VIIe		
Year	Quarter	Male	Female	Male	Female	Male	Female	**Total**
1994	2			29	30			**59**
1994	3			30	32			**62**
1994	4	4	4	19	20			**47**
1995	1			9	20			**29**
1995	2			21	28			**49**
1995	3					31	37	**68**
1995	4	8	11	21	17			**57**
1996	1			17[1]	11[1]			**28**[1]
Total		**12**	**15**	**146**[1]	**158**[1]	**31**	**37**	**399**[1]

1 Data incomplete: samples collected but not processed.

TABLE 6.14.6 Turbot: ALK; UK; Quarter 1 1995; male+female.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16															
21															
26															
31		1	1												
36			4												
41			5	2											
46			2	1											
51				2	1	1									
56					1	1	2								
61						1							1		
66								1							1
71												1			
76															

TABLE 6.14.7 Turbot: ALK; UK; Annual 1995; male.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	1														
21															
26	1	1													
31		6													
36		10	16	1											
41		6	8	6	2										
46		2	6	4											
51				3	3	4	2	1							
56							2	1							
61						1									
66															
71															
76															

TABLE 6.14.8 Turbot: ALK; UK; Annual 1995; male+female.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	3														
21	1														
26	2	2													
31		13	2												
36		17	18	1											
41		9	17	8	2										
46		5	15	10	2										
51			6	10	5	4	2	1							
56				12	5	1	4	2							
61					5	4		1					1		
66					1			2							1
71												1			
76														1	

TABLE 6.14.9 CVa for turbot samples

Age	F 1995 Annual F5.3 F+M	UK 1995 Q1 U2.2 F	UK 1995 Q1 U2.2 M	UK 1995 Q1 U2.2 F+M	UK 1995 Q1+2 U2.2 F+M	UK 1995 Annual U2.2 F	UK 1995 Annual U2.2 M	UK 1995 Annual U2.2 F+M
2	-	-	0	71	26	23	20	15
3	34	15	26	16	14	14	15	11
4	14	39	54	36	19	15	23	13
5	16	62	-	65	36	22	41	20
6	24	57	0	53	44	43	35	30
7	32	50	-	50	62	67	42	39
8	48	71	-	71	49	43	65	37
9	29	-	-	-	-	-	-	-
10	82	-	-	-	-	-	-	-
11	47	-	-	-	-	-	-	-

TABLE 6.14.10 CV for turbot: annual 1994; U2.2; female + male

Age	Catch at age	Variance due to age sampling	Variance due to length sampling	CVa	CV
2	2230	1.78E+05	9.07E+04	19	23
3	7070	4.22E+05	6.65E+05	**9**	15
4	7990	9.11E+05	4.97E+05	12	15
5	2170	5.49E+05	3.98E+04	34	35
6	1230	2.71E+05	3.84E+04	42	45
7	1020	1.69E+05	2.68E+04	40	43
8	247	4.06E+04	4.48E+03	81	86

7. SAMPLING EFFORT

It is difficult to estimate the total time spent on each stage of the project because of the variety of tasks involved. Estimates of the total time taken for collecting length and age samples by country and quarter have been prepared (Tables 7.1-7.3). This effort summary is intended to help estimate the time needed to collect length samples and age samples for future work, although future work may be more efficient as a result of this report.

An estimated total of 327 man-days has been spent collecting length and age data, equally divided between the three participating laboratories. The time spent collecting samples depended on the method used. For example, samples collected at sea were of good quality but data collection was usually slow. Length samples taken at merchants could be incomplete if the fish were sold before measurement, and métier allocation of samples was sometimes difficult as landings from different vessels were mixed together, but age samples were generally easy to collect provided the origin of the fish was known. In all cases sampling at merchants required the consent of the merchant. Auctions allowed easy access for sampling before the fish were sold, and the landings were generally complete. However, not all samples passed through auctions, and no auctions exist in the UK between Hastings in the east and Brixham in the west. In this region sampling could only be carried out at sea or at merchants. The time available to work on a species at an auction was also limited by the sale and removal of the fish, but this varied depending on the species and the size of the market, and only affected the total numbers of fish sampled.

In addition to length and age sampling at ports and at sea, a considerable amount of time was spent collecting age samples from fish that had been purchased and returned to the laboratory (e.g. 67 days at Port en Bessin). The time spent ageing otoliths and scales was variable and difficult to estimate, and is not included in Tables 7.1-7.3. Turbot and brill have not been aged regularly by staff at IFREMER or MAFF and as a result extra time was spent on these species. As the techniques and experience of the readers increased, the time spent reading correspondingly decreased. The time spent reading any scale or otolith will depend on the species, the technique, the age of the fish and also the individual person reading, so between 2 and 25 otoliths were prepared and read per hour.

An important consideration when designing a biological sampling programme is the time taken in travelling to the sample sites. From Lowestoft the travelling time to the main ports serving the south-western Channel was approximately seven hours in each direction. Thus sampling could not be carried out on a daily basis but had to be planned in terms of several consecutive days of sampling. This travelling time is not included in the summary table.

All sampling work was determined by the pattern of landings, and so was affected by the same factors influencing fishing activity. Weather was important as it greatly influenced the activity of the fishing boats, particularly the smaller inshore boats. On several occasions bad weather and the corresponding lack of fish curtailed sampling trips. The seasonal abundance of target species also affected the sampling success, although considerable effort was initially spent attempting to take non-seasonal samples from seasonal landings.

Data were collected from the most important métiers for all of the species in the study, so that the data covered more than 75% of the landings of any species (Table 7.4). The samples taken of bass and lemon sole were broadly comparable with the samples taken for some TAC species (Table 7.4), but largely by virtue of the good sampling in the UK. The number of length samples taken (as number measured per 1000 tonnes landed), was affected not only by the availability of the landings and abundance of the fish, but also the number of métiers to be sampled and the sample targets themselves. Additional sampling effort would be required for most species to make the sampling comparable to the levels required for TAC species.

TABLE 7.1 Sampling Effort Summary - PORT EN BESSIN

Table 7.1.1 Port en Bessin. Time spent taking age and length samples at markets.

Year	Quarter	Number of Man-Days	Total number of fish Measured	Mean fish measured per man - day	Total number of scales taken	Mean number of scales taken per man - day
1994	1	5	2414	483	107	21
1994	2	8	2333	292	91	11
1994	3	4	3312	828	51	13
1994	4	9	4172	463	215	24
1995	1	5	4596	919	125	125
1995	2	5	3871	774	127	63
1995	3	4	3079	770	0	0
1995	4	7	2922	417	239	34
Total		**47**	**26699**	**568**	**955**	**20**

Table 7.1.2 Port en Bessin. Time spend taking otoliths in laboratory (from purchased fish).

Year	Quarter	Number of Man-Days	Total number of otoliths taken	Mean number of otoliths taken per man - day
1994	1	8	484	60
1994	2	9	541	60
1994	3	6	279	46
1994	4	9	480	53
1995	1	9	497	55
1995	2	9	448	50
1995	3	8	418	52
1995	4	9	548	61
Total		**67**	**3695**	**55**

TABLE 7.2 Sampling Effort Summary - BREST

Time spent collecting length and age samples at markets and at sea.

Year	Quarter	Number of Man-Days	Total number of fish Measured	Mean fish measured per man - day	Total number of otoliths taken	Mean number of otoliths taken per man - day
1994	1	7	3894	556	131	19
1994	2	19	5970	314	241	13
1994	3	21	1112	53	171	8
1994	4	15	5051	337	141	9
1995	1	12	1398	116	136	11
1995	2	22	435	20	686	31
1995	3	11	365	33	242	22
1995	4	12	3473	289	90	7
Total		**119**	**21698**	**182**	**1838**	**15**

TABLE 7.3 Sampling Effort Summary - LOWESTOFT

Time spent collecting length and age samples at markets and at sea (does not include SFI staff samples or effort).

Year	Quarter	Number of Man-Days	Total number of fish Measured	Fish measured per man - day	Total number of otoliths taken	Number of scales taken per man - day
1994	2	14	2854	204	229	16
1994	3	14	3213	229	205	15
1994	4	17	5148	303	224	13
1995	1	13	2763	212	223	17
1995	2	14	5236	374	229	16
1995	3	12	2586	215	332	28
1995	4	10	3148	315	233	23
1996	1	7	2769	395	168	24
Total		**101**	**27717**	**274**	**1798**	**18**

TABLE 7.4 Sampling efficiency for the first full year of sampling (France, Jan 1994-Dec 1994; UK, Apr 1994-Mar 1995). Estimates for non-quota species are UK and France combined; estimates for TAC species are UK samples only.

Species	Estimated landings (tonnes)	Numbers of métiers sampled	Percentage of landings covered by sampling	Important métiers not sampled	Number measured per 1000 tonnes landed
Bass	831.1	23	87		8914
Black bream	2071.1	12	50	F3.1 (100t)[1]	1649
Brill	398.4	13	85		6636
Cuttlefish	7554.3	13	62		274
John dory	425.6	11	88	F1.1, F6.5 (2900t)[2]	6517
Lemon sole	1301.9	11	92		9289
Red gurnard	3654.9	10	95		3124
Red mullet	503.8	11	98		6294
Scallop	16138.6	5	98		493
Spider crab	5122.2	6	91		783
Turbot	443.8	14	75	U.other, F2.1, F4.4, F4.2 (101.6t)	3163
UK cod	618.1	11	97		5412
UK plaice	1986.3	9	97		8898
UK sole	1245.1	13	97		21534

1. Successfully sampled during 1995 (98% coverage in 1995).
2. Existing data available for these métiers from 1987 (99.9% coverage when including these data).

8. CONCLUSION

Each species has been described in terms of the seasonality and regionality of the most important métiers. All of the non-quota species sampled during this project have seasonal fisheries, and this is largely the result of seasonal changes in their distribution. The extent of this movement is variable between species, and has affected the sampling success. For example, all the métiers for lemon sole in the western Channel can be sampled easily throughout the year, because the fish remain in the region throughout the year. Conversely, the sampling of black bream is made difficult by their seasonal migrations, and as a result it is not possible to get adequate samples from any one métier for the whole of the year, as samples are only available during the seasonal 'windows'. When a fishery is seasonal to such a degree that adequate data cannot be collected throughout the year, annual aggregation of data seems more realistic. This is recommended for most of the species in this study, despite the bias that can be introduced. With hindsight it is clear that the targets for length-stratified age sampling were largely inappropriate, but with the new data collected during this project more suitable targets could be created.

Métiers in the UK and France may exploit one species in a similar pattern, for example the tangle nets métiers for turbot, F5.3 and U5.7 or the inshore trawl métiers for John dory, F1.3 and U1.1. Other species are exploited by different métiers, for example there is currently no equivalent established UK métier for the French cuttlefish pot métier, F6.5 (Anon, 1996b; Arkley *et al.*, 1996). The samples taken in this study have illustrated the different exploitation patterns imposed on a single species by the different métiers. Thus, a true picture of the exploitation pattern in the Channel would require samples from both countries.

The quality of the data after raising depends largely on the estimates of total landings by each métier. The data are better for species which are landed by vessels which land through monitored auctions and merchants, but for métiers whose landings do not pass through monitored auctions or merchants the recorded landings data do not give a true estimate. For example, the independent estimate of total UK landings of bass from the Channel in 1994 was approximately 1500 tonnes (Pickett, pers comm), although the MAFF FAD estimate was approximately 300 tonnes. This level of under-reporting has overestimated the degree to which many of the bass métiers have been sampled. This may also be true for other species and métiers in the Channel.

Another problem to be considered before any stock assessment is carried out is estimating the number of fish discarded at sea (Armstrong *et al.*, 1995). There are no published detailed studies on discards of non-quota species, however, it is known that there are high discarding rates for red gurnard, and in France for black bream (Y. Morizur, pers. comm.). Conversely the discard rate for turbot and brill in the UK appears to be low. In the UK the discard rate for species such as cuttlefish appears to be highly variable depending on the métier considered (Arkley *et al.*, 1996). The problem of discards needs to be considered before any rational management measures can be considered.

For most of the species in this study it was not possible to improve the sampling within the effort constraints. However, for some species sampling could be improved considerably with minimal additional effort, for example the red mullet, black bream and cuttlefish, because these species are landed in abundance when in season. For other species greater sampling effort would not have been able to significantly improve the data, for example John dory, and most turbot and brill métiers. These species are not landed in sufficient quantities at any time of year to significantly improve the length or age data through additional sampling effort. As a result of this report, all species could now be more efficiently sampled, largely by taking into account the seasonal patterns of the fishery, and targeting samples accordingly.

Although the data collected during this study are adequate for tentative conclusions to be made about the stocks, extra biological work is needed for many of the species before any management is imposed. In particular, knowledge of the biology of John dory and red mullet in the Channel is poor, and the reading of the turbot and brill otoliths also needs to be validated and checked. Before management based on analytical assessments is undertaken, continued sampling is normally required to produce a long time series of biological data, and thus establish base line information on stock characteristics and status. For most species, if continued sampling is intended, it would be desirable either to modify the sampling strategy from that described in this programme, and/or to increase the sampling targets.

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APPENDIX I

Métier Codes and Descriptions

This tables presents a brief summary of the métiers described in the text and tables. A total of 74 métiers have recently been described in the EC report *International Catalogue of Fishing Fleet Activity in the English Channel* (Tétard *et al.*,1995); a more detailed description of the métiers involved in this study is available in this report.

Métier Code	Gear	Region	Main Target Species
UK			
U1.1	Otter trawl	7e	Gadoids; flatfish; angler; skate; cuttle
U1.2	Otter trawl	7d	Gadoids; flatfish; cuttle; pelagics; bass
U2.1	Beam trawl	7d offshore	Flatfish; cuttle; angler; skate; gurnards; gadoids
U2.2	Beam trawl	7e offshore	Flatfish; angler; cuttle; skate; gurnards; gadoids
U2.3	Beam trawl	7e inshore	Flatfish; angler; cuttle; skate; gadoids; scallop
U3.1	Midwater trawl	7e	Pelagic species
U3.2	Midwater trawl	7d	Pelagic species; bass
U4.1	Scallop dredge	7e	Scallop; flatfish; angler
U4.2	Scallop dredge	7d	Scallop; flatfish
U5.2	Gill net	7e	Bass; grey mullet
U5.3	Gill/trammel net	7d	Bass; grey mullet
U5.4	Trammel net	7d	Sole; plaice; cod; cuttle
U5.7	Tangle net	7d and 7e	Skate; angler; turbot
U5.8	Drift net	7d and 7e	Bass; cod; grey mullet
U5.9	Gill net	7d	Sole; plaice
U6.1	Mixed pots	7d and 7e offshore	Brown crab; spider crab;lobster
U6.2	Mixed pots	7d and 7d inshore	Brown crab; spider crab;lobster
U7.1	Longline	7d inshore	Cod; dogfish; bass
U7.2	Longline	7e	Conger; hake
U8.1	Handline	7d and 7e	Bass; mackerel; pollock
France			
F1.1	Otter trawl	7e offshore	Flatfish; cuttle; angler; gurnards; skate; gadoids
F1.2	Otter trawl	7d offshore	Gadoids; mackerel; plaice; gurnards; cuttle
F1.3	Otter trawl	7e inshore	Cuttle; skate; angler; gurnards; flatfish; gadoids
F1.4	Otter trawl	7d inshore	Cuttle; mackerel; cod; whiting
F2.1	Beam trawl	7d and 7e offshore	Sole; plaice; turbot; dab; scallop
F3.1	Midwater trawl	7e	Bass; mackerel; bream
F3.2	Midwater trawl	7d	Pelagic species
F4.1	Dredge	7e	Scallop; flatfish; spider crab
F4.2	Dredge	7d	Scallop; flatfish
F4.4	Dredge	7d and 7e	Sole; flatfish
F5.2	Gill/trammel net	7e	Pollock; sole; bass; red mullet; bib; plaice
F5.3	Tangle net	7d and 7e	Angler; turbot; rays
F5.4	Trammel net	7d and 7e	Sole; plaice; cuttle
F5.5	Gill net	7d	Cod; whiting; plaice; brown crab; spider crab
F5.6	Tangle net	7e	Spider crab; brown crab
F6.2	Mixed pots	7d and 7e inshore	Brown crab; spider crab; lobster
F6.5	Cuttle pots	7d and 7e	Cuttle
F7.2	Longline	7d and 7e	Bass; gadoids; mackerel; skate; ling; dogfish

APPENDIX II

Bass

UK quarterly targets for length samples and otoliths

Métier/gear	Division	Length sample unit	No. length samples per quarter	Ports
Multimethod inshore (Trawls, lines and nets)	7e	n Boats	2	Ports from Brixham to Newlyn.
Offshore trawl	7e	n Boats	2	Brixham, Plymouth, Looe.
Offshore trawl	7d	n Boats	2	Ports from Poole to Rye.
Multimethod inshore	7d	n Boats	2	Ports from Poole to Rye.

Scale specification:

Existing data plus some new data. 25 aged fish per 5cm length class (total of 200 fish). No specification on sex. Only sample scales from fish caught by unknown gear if the overall quarterly target might otherwise not be reached.

French quarterly targets for length samples and otoliths

Métier/gear	Division	Length sample unit	No. length samples per quarter	Port
Offshore trawl (inshore trawl)	7d	1 box in each commercial categories	2	Port-en-Bessin
Pelagic trawl	7e	1 box in each commercial category	1 at quarter 1-2	Granville
Longlines, inshore trawl	7e	1 boat	2 in quarters 2,3,4 0 in quarter 1	Brest, Paimpol

Scale specification:

Constant allocation of 3 fish every 1cm (total of 130 fish) by division. No specification on sex.

Black Bream

UK quarterly targets for length samples and scales

Métier/gear	Division	Length sample unit	No. length samples per quarter	Port
Offshore trawl	7d	n Boats	1	Ports from Poole to Rye.
Offshore trawl	7e	n Boats	1	Ports from Weymouth to Newlyn.

Scale specification:

Fixed allocation (3 fish per 1cm). No sex differentiation.

French quarterly targets for length samples and scales

Métier/gear	Division	Length sample unit	No. length samples per quarter	Port
Offshore trawl	7d	One box in each market category	1	Port-en-Bessin
Pelagic trawl	7e	One box in each commercial category	quarter 1 or 2 only	Granville

Scale specification:

Fixed allocation (3 fish per 1cm). No sex differentiation.

Length sample:

Quarterly length compositions can be obtained with annual length samples in each market category by using landings in each market category.

Brill

UK quarterly targets for length samples and otoliths

Métier/gear	Division	Length sample unit	No. length samples per quarter	Ports
Inshore trawl	7e	n Boats	2	Ports from Weymouth to Newlyn.
Offshore trawl	7e	n Boats	2	Ports from Weymouth. to Newlyn.
Large mesh net	7e	n Boats	1	Ports from Weymouth to Looe.
Offshore trawl (inshore trawl)	7d	n Boats	As available	Ports from Poole to Rye

Otolith specification:

Specification per length required from landings. Sex and where possible maturity recorded. Otoliths removed where possible from under gill covers hence no need to purchase fish. Initial specification per sex for each length class have been combined.

Length group	Number required
26-30	10
31-35	12
36-40	12
41-45	10
46-50	7
51-55	5
56-60	5
61-65	2
66+	2
Total	65

French quarterly targets for length samples and otoliths

Métier/gear	Division	Length sample unit	No. length samples per quarter	Port
Large mesh net	7e(+7h)	1 boat	2	Le Conquet, Roscoff
Inshore trawl	7e	n boats	2	Saint-Brieuc
Offshore trawl	7e(+7f)	Commercial categories	<=2	Saint-Malo
....	7d		nothing	

Otolith specification:

Sampling anywhere and anytime. No specification per sex per length. Several samples will be requested. Buying fish is too expensive. Otoliths can be taken under the gill cover for small fish.

Cuttlefish

UK quarterly targets for length samples and ageing

Métier/gear	Division	Length sample unit	No. length samples per quarter	Port
Offshore trawl	7e	n Boats	1	Ports from Brixham to Looe
Inshore trawl	7e	n Boats	1	Ports from Brixham to Looe
Offshore trawl (inshore trawl)	7d	n Boats	1	Ports from Rye to Poole
All nets	7d	n Boats	1 in quarter 2 only	Ports from Rye to Poole.

Ageing specification:

None

French quarterly targets for length samples and ageing

Métier/gear	Division	Length sample unit	No. length samples per quarter	Port
Offshore trawl	7e	Existing data		Saint-Brieuc
Offshore trawl	7d	Nothing, only market categories	Nothing	All

Ageing specification:

None

Length sample:

Market categories would allow us to separate in weight small and larger cuttlefish (7d). Quarterly length compositions can be obtained with existing data (annual length sample in each market category) by using landings in each market category.

John Dory

UK quarterly targets for length samples and otoliths

Métier/gear	Division	Length sample unit	No. length samples per quarter	Port
Inshore trawl	7e	n Boats	1	Ports from Weymouth to Newlyn.
Offshore trawl	7e	n Boats	1	Ports from Weymouth to Newlyn.
Inshore trawl	7d	n Boats	As available	Ports from Poole to Rye.

Otolith specification:

None.

French quarterly targets for length samples and otoliths

Métier/gear	Division	Length sample unit	No. length samples per quarter	Port
Inshore trawl	7e	Existing data		Saint-Brieuc
	7d	None	None	None

Otolith specification:

None.

Length sample:

Nothing in 7d. Existing and maybe new data on market categories would allow us to know the quarterly length compositions in 7e.

Lemon Sole

UK quarterly targets for length samples and otoliths*

Métier/gear	Division	Length sample unit	No. length samples per quarter	Port
Offshore trawl (inshore trawl)	7d	n Boats	None	All
Trawl	7e	n Boats	18	All

Length and Otolith samples*:

Sex and, where possible, maturity recorded. Otoliths removed from under gill cover so no need to purchase fish. No specification by sex.

Length group	Number required
23-24	9
25-26	15
27-28	15
29-30	24
31-32	27
33-34	27
35-36	30
37-38	30
39-40	27
41-42	15
43-44	15
45+	6
Total	240

* SFI targets. Additional sampling in 7d when available.

French quarterly targets for samples and otoliths

Métier/gear	Division	Length sample unit	No. length samples in the quarter	Port
Offshore trawl (inshore trawl)	7d	2 boxes for cat 10/1 for cat 20/1 for cat 30.	2	Boulogne
Offshore trawl	7e(+7f)	3 commercial categories	2	Saint-Malo
Inshore trawl	7e	n boats	2	Saint-Brieuc

Otolith specification:

Buying of fish. Fixed maximum allocation (10/cm). Sex determined on aged fish. If possible maturity (mature or immature) for each aged fish. No ageing of fish from 7e inshore trawl. DFR to read all otoliths.

Red Gurnard

UK quarterly targets for length samples and otoliths

Métier/gear	Division	Length sample unit	No. length samples per quarter	Ports
Offshore trawl	7d	n Boats	2	Ports from Poole to Rye.
Inshore trawl	7d	n Boats	2	Ports from Poole to Rye.
Offshore trawl	7e	n Boats	2	Ports from Weymouth to Newlyn.
Inshore trawl	7e	n Boats	2	Ports from Weymouth to Newlyn.

Otolith specification:

Buying of fish to satisfy length specification. Two otoliths taken from each fish. Record total length, weight, and if possible maturity (mature or immature) for each fish. IFREMER to read otoliths.

Length group	No. required per sample
15-16	2
17-18	3
19-20	5
21-22	5
23-24	6
25-26	6
27-28	6
29-30	6
31-32	5
33-34	3
35-36	2
37+	1
Total	50

French quarterly targets for length samples and otoliths

Métier/gear	Division	Length sample unit	No. length samples per quarter	Port
Offshore trawl (inshore trawl)	7d	Boxes in each commercial category	2	Boulogne, Port-en-Bessin Dieppe
Offshore trawl	7e	Boxes in each commercial category	2	Port-en-Bessin Cherbourg
Inshore trawl	7e	Boats	2	Saint-Brieuc

Otolith specification:

Buying of fish at Port-en-Bessin separately from 7d and 7e, (15 to 40 kg per commercial category). Two otoliths per fish, record length, weight and if possible maturity (mature or immature) for each fish.

Red Mullet

UK quarterly targets for length samples and otoliths

Métier/gear	Division	Length sample unit	No. length samples per quarter	Port
Offshore trawl (inshore trawl)	7d	n Boats	1	Ports from Poole to Rye.
Offshore trawl	7e	n Boats	1	Ports from Weymouth to Newlyn.
Inshore trawl	7e	n Boats	1	Ports from Weymouth to Newlyn.

Otolith specification:

No otoliths to be taken.

French targets for quarterly length samples and otoliths

Métier/gear	Division	Length sample unit	No. length samples per quarter	Port
Offshore trawl	7d	One box in each market category	1	Port-en-Bessin
Inshore trawl	7e	One box in each commercial category	1 in the year	Saint-Brieuc
Offshore trawl	7e	Boxes in each commercial category	Existing annual data +new data?	Saint-Malo

Otolith specification:

No otoliths taken.

Length sample:

Quarterly length compositions can be obtained with annual length samples in each market category by using the landings for each commercial category (7e).

Scallop

UK quarterly targets for length samples and ageing

Métier/gear	Division	Length sample unit	No. length samples per quarter	Port
Dredge	7e	n Boats	2 in quarters 2 and 3	Brixham, Plymouth Looe
Dredge	7d	n Boats	2 in quarters 1 and 4	Newhaven

Ageing specification:

None.

French quarterly targets for length samples and ageing

Existing data only.

Spider Crab

UK quarterly targets for length samples and ageing

Métier/gear	Division	Length sample unit	No. length samples per quarter	Port
Pots	7e	n Boats	2	All
Pots	7d	n Boats	2	All

Ageing specification:

None

French quarterly targets for length samples and otoliths

Existing data only

Turbot

UK quarterly targets for length samples and otoliths

Métier/gear	Division	Length sample unit	No. length samples per quarter	Port
Offshore trawl	7e	n Boats	2	Weymouth to Newlyn
Inshore trawl	7e	n Boats	2	Weymouth to Newlyn
Large mesh net	7e	n Boats	1	Weymouth to Newlyn
Offshore trawl (inshore trawl)	7d	n Boats	As available	Poole to Rye

Otolith specification:

Specification by length but not sex. Both otoliths taken where possible from underneath the gill cover hence no purchase of fish is required. Sex and maturity also recorded for each fish. Initial specification per sex for each length class length have been combined.

Length group	No. required per sample
<30	7
31-35	10
36-40	12
41-45	10
46-50	7
51-55	5
56-60	5
61-65	3
66-70	2
71-75	2
76+	2
Total	65

French quarterly targets for length samples and otoliths

Métier/gear	Division	Length sample unit	No length samples per quarter	Port
Large mesh net	7e(+7h)	1 boat	2	Le Conquet, Roscoff
Inshore trawl	7e	n boats	2	Saint-Brieuc
Offshore trawl	7e(+7f)	Commercial categories	<=2	Saint-Malo
....	7d		nothing	

Otolith specification:

Sampling anywhere and anytime. No specification per sex per length. Several samples will be requested. Buying fish is too expensive. Otoliths can be taken under the gill cover for small fish.

APPENDIX III

Estimate and variance of numbers at age

Estimated number at age:

$$N_i = \sum_{j} N_j P_{ij}$$

Variance of the estimate:

$$Var(N_i) = \sum_{j} (N_j)^2 Var(P_{ij}) + \sum_{j} Var(N_j)(P_{ij})^2 + \sum_{j} 2Cov(N_j P_{ij})$$

Where:

j = length group
N_j = total number of fish in length group 'j'
P_{ij} = proportion of fish age 'a' in length group 'j'

The final covariance factor is ignored and an approximation is therefore given by:

$$Var(N_i) = \underbrace{\sum_{j} (N_j)^2 Var(P_{ij})}_{\text{Variance due to age sampling}} + \underbrace{\sum_{j} Var(N_j)(P_{ij})^2}_{\text{Variance due to length sampling}}$$

Variance of P_{ij}:

$$Var(P_{ij}) = P_{ij}(1 - P_{ij}) / n_j$$

where n_j = number of otoliths in length group j

Variance of N_j:

$Var(N_j)$ is independent of the number of otoliths:

$$Var(N_j) = Var(n'_j) * (\sum_{b} W_v^2) (\sum_{B} W_v)^2 / (\sum_{b} W_v)^2$$

Where:

W_v = weight landed by sampled vessel 'v'
b = number of vessels sampled

B = number of vessels in the fleet

and $Var(n'_j)$ = variance of the estimated mean number per unit weight

To calculate $Var(n'_j)$:

Let n_{vj} = estimated number of fish per unit weight in length group 'j' for vessel 'v':

$$n_{vj} = 1/W_v \; [\sum_c (n_{cvj} \; W_{cv} / w_{cv})]$$

Where:

c = category
W_{cv} = weight landed in category 'c' for vessel 'v'
w_{cv} = weight sampled in category 'c' for vessel 'v'

Then the estimated mean number per unit weight (n'_j):

$$n'_j = \sum_b n_{vj} \, (W_v / \sum_b W_v)$$

And the variance of the estimate:

$$Var(n'_j) = 1 / b - 1 \; \sum_b (n_{vj} - n'_j)^2$$

The coefficient of variation of the numbers at age (CV_i)

$$CV_i = \sqrt{[Var(\text{due to age sampling})_i + Var(\text{due to length sampling})_i]} \; / \text{ number at age}_i$$

Relationship of CV_i with the number of otoliths sampled

In order to determine the approximate effect of the numbers of otoliths on the CV_i we need to examine the component of the covariance due to age sampling, (after Flatman 1990). If we assume, for one age, that the total numbers of fish in a length group (N_j) is similar for each length group, and so $N_j = N$:

$$Var(N_i) = N^2 \sum_j P_{ij} \, (1 - P_{ij}) / n_j$$

If we also assume that for all length groups the probability that [fish in group j = age i] is the same, then:

$$\mathrm{Var}(N_i) = N^2 P_i (1 - P_i) \sum_j 1/n_j$$

If the number of otoliths in each length group is the same then:

$$\mathrm{Var}(N_i) = N^2 P_i(1 - P_i) \; J / n_j$$

Where:

J = number of length groups, and n_j is now a constant.

So: $\mathrm{Var}(N_i) = \mathrm{CONSTANT} * 1 / n_j$

This means, within the assumptions, that the component of the CV_i due to age sampling (referred to as CVa in the text) is proportional to $1/n_j$, and therefore the CV_i is proportional to $1/\sqrt{n_j}$.

This can be used as a basic guide to the relative level of sampling required to bring the CV_i below the agreed level of 10% (Flatman, 1990). However, in practice it will be difficult to bring the CV_i below 10% across all cohorts, as the less abundant or partially recruited year classes will always be sampled less completely.