Resource Management Committee

ICES CM 2001/D:05
Ref: ACFM

REPORT OF THE

INTERNATIONAL BOTTOM TRAWL SURVEYS WORKING GROUP

ICES Headquarters
2–5 April 2001

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

Palægade 2–4 DK–1261 Copenhagen K Denmark

TABLE OF CONTENTS

1 TERMS OF REFERENCE AND PARTICIPATION

The following resolution was passed at the ICES Annual Science Conference in Brugges, Belgium in September 2000.

The International Bottom Trawl Survey Working Group [IBTSWG] (Chair: A.W. Newton, UK) will meet 2-5 April 2001 at ICES HQ to:

a) review and comment upon specifications for extending the ICES IBTS data base. This expansion shall include data from the beam trawl survey in the North Sea and bottom trawl surveys in western and southern divisions.

This database shall continue to be held at the ICES Secretariat;

b) agree on procedures on how to validate the integrity of the data in the IBTS database;

c) define the necessary steps to develop a new standard gear for the IBTS surveys in the western divisions

d) evaluate comparative fishing trials during the IBTS in the western Division between France, Ireland and Scotland;

e) encourage further exchange of valid tow positions between all participating institutes;

f) consider the implications of the conclusions of Theme Session K (Incorporation of external factors in Marine Resource Surveys) of the ASC in Bruges;

g) evaluate the new standard indices and the implications in using the new indices in assessments in collaboration with relevant assessment working groups;

h) examine the gear parameters extracted by ICES from the IBTS database and analyse net performance;

i) examine, in conjunction with members of the WGOH and SGGOOS, those aspects of the IBTS which may form an ICES contribution to GOOS and what changes might be necessary to conform to the requirements of GOOS;

j) review the co-ordination of surveys in the three divisions including development of survey manuals.

IBTSWG will report to ACFM before its October 2001 meeting, to ACME and to the Resource Management and Living Resources Committees at the 89th Statutory Meeting.

The meeting was attended by:

Sarah Adlerstein	Germany
Trevor Boon	UK(England)
Henrik Degel	Denmark
Jorgen Dalskov	Denmark
Siegfried Ehrich	Germany
Brian Harley	UK(England)
Henk Heessen	Netherlands
Lena Larsen	ICES Secretariat
Jean-Claude Mahe	France
Johan Modin	Sweden
Andrew Newton (Chair)	UK(Scotland)
Rick Officer	Ireland
Gerjan Piet	Netherlands
Dave Reid	UK(Scotland)
Francisco Sanchez	Spain
Odd Smedstad	Norway
Henrik Sparholt	ICES Secretariat
David Stokes	Ireland
Yves Verin	France

Fatima Cardador (Portugal) and Mike Armstrong (UK-N Ireland) were unable to attend.

2 INTRODUCTION

The International Bottom Trawl Working Group (IBTSWG) has its origin in the North Sea, the Skagerrak and the Kattegat where co-ordinated surveys have occurred since 1965. Initially these surveys only took place during the first quarter of the year, but between 1991 and 1996 co-ordinated surveys took place in all four quarters of the year. Pressure on ship time caused the number of surveys to be reduced and currently co-ordinated surveys in the North Sea are only undertaken in the first and third quarters.

The IBTSWG assumed responsibility for co-ordinating western and southern division surveys in 1994. Initially progress in co-ordination was slow but in the last few years there has been a marked improvement and whilst data exchange etc. is not at the level of that enjoyed in the North Sea, there is excellent co-operation between the participating institutes. Much of this co-operation stems from two EU funded projects – SESITS, co-ordinated by IEO and reported in ICES CM1999/D:2 and IPROST (Standardized Trawl Surveys in NW Europe) led by IFREMER. A section in this report is devoted to some of the results achieved in the latter project.

The original ICES database was created in an era when there were restrictions on computer memory etc and ever since the data have been held in a format that is restrictive for both accessing data and adding new fields, especially as the data acquisition process is expanded. This problem has been acknowledged for a number of years but there has been no apparent way of resolving this dilemma given staff and financial constraints within ICES. At the same time we now live in times which expect a wider distribution of aggregated data acquired during the surveys. These problems must be addressed. Section 3 discusses the submission of a 5th Framework proposal that is currently being evaluated by the European Commission and, hopefully, will solve a large number of these problems.

The co-ordination of such a large number of surveys on such a wide geographical area will always generate a number of points that have to be discussed at committee level. This year is no exception. A large number of topics were discussed and the view of the WG was that, given the volume of problems to be resolved, that the WG should re-convene in 2002. A digest of viewpoints can be found in the appropriate sections that follow.

3 5TH FRAMEWORK PROPOSAL

Tor a) Review and comment upon specifications for extending the ICES IBTS database. This expansion shall include data from the beamtrawl survey in the North Sea and bottom trawl surveys in western and southern divisions. This database shall be held at the ICES Secretariat.

In February 2001 a proposal (DATRAS, DAtabase TRawl Surveys) was submitted for the 5th Framework "support for research infrastructures" call with the following objectives:

1) Establish an international database of trawl survey data at the ICES HQ including:

- IBTS North Sea, Skagerrak, Kattegat: 1st quarter 1965-present, other quarters (1991-present)
- IBTS western and southern divisions
- BTS North Sea, Channel and Irish Sea: 3rd quarter 1985-present.
- BITS Baltic Sea 1990-present:

The database should be updated annually, formats of database and exchange files should follow the concepts developed by the IBTS and BITS databases

2) Standardised input and quality assurance of the survey data through:

- Expansion of the survey manual and further standardization of procedures among participants
- Availability of species identification sheets and agreement on nomenclature and level of identification
- Definition of the data quality checks required prior to incorporation of data in the database
- Development of software for quality control
- Agreement on exchange format and workplan for loading data onto the database

The standardisation should not only be pursued within each survey among participating laboratories but also between surveys.

3) Improved access to the survey data through:

- User's guide containing description of the contents of the database
- Development of standardised data extractions depending on user-specific demands
- Availability on the web of aggregated data, standard tables and figures that are annually updated
- Web facilities that allow access through the same database front-end.

The participants in this project are:

- ICES responsible for the design of the database, development of software for data input, quality control, extraction and a web application that allows access to the data including a user's guide.

- RIVO (Netherlands) responsible for the co-ordination, preparation of data sets for inclusion in database, checking of errors, quality control and development of survey manuals

- MARLAB (UK) responsible for preparation of data sets for inclusion in database, quality control and development of survey manuals

- IFREMER (France) responsible for preparation of data sets for inclusion in database, quality control and development of survey manuals

In the working group concern was expressed with regard to the availability of data for inclusion in the database and the regulation of access to the data. In the database the data will be stored according to the format developed for IBTS and BITS which is on a haul-by-haul basis. The working group put forward that:

- there should be an agreement between ICES and all the nations involved with regard to the access to data in relation to the level of aggregation of the data

- access to disaggregated data should only be allowed to institutes involved in the survey

- different levels of access to data at different levels of aggregation may be regulated through passwords

- there should be agreement with regard to the purposes the data are allowed to be used for

- together the above measures should convince the fisheries institutes involved to deliver the survey data present at the respective national databases

In effect these points are covered by the ICES policy (ICES, 1994) for access to the IBTS database and should therefore also apply to the new database. This policy states that:

- data are available without restrictions for all usage in connection with ICES working groups or research projects within the ICES work programme. For other use there is an important distinction between raw and aggregated data

- For raw data applicants have to fill in a request stating the reasons why the request was made, the level of aggregation or disaggregation, title and description of the project for which the data are to be used, for whom the project is conducted and particularly whether the project is under contract. Once the form is filled in and signed by the applicant and the undertakings on the form effectively agreed upon by the applicant, it will be sent to the national contact person of the countries responsible for supplying the data. A deadline for response will be given. Objections or specific requirements, when arising, will be handled by referring the applicant to the country which had objected

- Aggregated data down to the level of statistical rectangle (but without identification of the country or haul) which is already available in the public domain via ICES publications. All requests should go through the national contact persons to secure proper use of the data and guidance of the user. Until this has been accepted, all requests are referred by the Secretariat to the national contact persons.

Considering the commitment of ICES to deliver data for GOOS it should be noted that the above policy also applies for the extended database at ICES in relation to GOOS. This implies that only data at a level of aggregation that allows public access will be available for GOOS. (REMOVE)

Further the working group recommended that consequences of the development of this database pertaining to:

- data quality and correction of mistakes
- database design, exchange format
- development of survey manuals including species identification
- standard output

should be extensively communicated for the attention and consideration by the relevant working groups (IBTS, BEAM, BITS) to the institutes/ nations involved.

Recommendations for the database that were put forward by the working group:

- actual catches will be reported together with the duration of the haul, the catch will not be raised to the standard number per hour trawling
- position registrations should be in sufficient decimals to allow use for determination of valid tow positions
- the format of the new database should not be changed too radically since this might involve changes in the national institutes' databases.

4 VALIDATING THE INTEGRITY OF THE IBTS DATABASE

Data from the IBTS data-base have in the past mainly been used to derive recruitment indices for a limited number of target species, and are used for tuning the VPA. Increasingly, however, the data are also being used in studies, which analyse e.g. biodiversity of the North Sea fish fauna. In the instance of studies concerning the major commercial species, small errors in the data are unlikely to have a major influence on the results of the analysis. However, when IBTS data are used for the analysis of rare species, for example as in Daan (2001), 'small errors' can lead to major mistakes. Especially when these data are used to study the occurrence of rare species, proper species identification is essential. In the case a species is not properly identified this will affect estimates of abundance of two species.

In a working document, Daan lists a number of possible errors he encountered in IBTS data for the period 1965 up to and including the first quarter data of 1998 (WD 1). The author states that, while it is often clear that there must be a mistake in the data, it is not always obvious how to correct the data. Moreover, two independent analyses of the same IBTS data may give different results if expert judgement differs. Daan checked all problems he encountered with Dutch data against the original data sheets, but was of course unable to verify errors he observed in the data from the other nations.

Although the analysis presented in WD1 does not pretend to give a comprehensive account of all existing problems, it quite likely gives a fairly complete overview of most possible errors. These errors could be input errors, or real mis-identifications. Daan describes at least five different types of error:

1. Redundant codes. Some catches have been reported as genus and/or family. If a genus is represented by more species, or a family by more than one species, and if the responsible scientist felt unable to identify the species, there is a good reason to do this. If, however, there is only one species per genus present in the North Sea (or one genus per family), the higher codes are redundant, because they imply effectively the same species or genus. In all, 16 such codes were found. Although the use of these may not be considered a real mistake, it means that any analysis requires additional pre-processing of the data to get rid of redundant codes and to narrow down the number of taxa reported.

2. Rare species. In a number of cases, records of extremely rare species can be expected to be the result of input errors. The electronic input from the original data sheets is often done by people who have little or no idea of the data they are entering. Especially, the combination of recorded length (unusually small or extremely big) and species code, points at input errors.

3. 'Undersized species'. Because of the use of a 20mm cod-end liner in the standard IBTS trawl, the catch of fish as small as 1 cm is highly unlikely. All such records should be checked for errors.

4. ‘Oversized species’. All records were checked against the maximum length according to Wheeeler (1978). Sometimes the L max mentioned in Wheeler has appeared to be too low and could be adjusted on the basis of records which have been verified with the original data sheets. In several other cases, however, it is likely that the species is wrongly identified or wrongly recorded.

One example of such a problem is that some countries mainly record bull-routs (*Myoxocephalus scorpius*), whereas another country only records sea scorpions (*Taurulus bubalis*) from the same area, but which have the same (too big) length as bull-rout.

Another example concerns the catches of different species of dragonets (*Callionymus lyra*, *C. reticulatus* and *C. maculatus*), which have quite different values for L max and different distributions in the North Sea, and for which it is obvious that mistakes in identification, or recording must have been made.

5. Other problems. Problems in this category are more difficult to spot, and even more difficult to ‘repair’. Examples are the erroneous records of mainly *Mustelus mustelus* in one year, and mainly *M. asterias* in other years. This could be the result of a biological phenomenon, but also hint at identification problems.

Another example concerns the records of *Alosa alosa* and *Alosa fallax*, with some countries reporting mainly or only one species, and other countries only reporting the other species.

Daan (WD 1) reaches the following conclusions:

1. The historic data must be scrutinised by the responsible national laboratories, under the auspices of the IBTS WG, so that the database at ICES Headquarters contains only trustworthy information and can be used for comprehensive analyses;

2. The IBTS Working Group must ensure the collection of reliable information for all species during future surveys; this requires a re-investment in taxonomic knowledge and exchange of scientists among ships. Only intercalibration among participants will remove the existing discrepancies.

The WG extensively discussed Daan’s Working Document and possible ways to improve the quality of the data in the IBTS database. The WG agreed with the conclusions drawn from the performed analysis.

All countries should check the problems described in WD1 and report any changes to ICES at the earliest possible occasion. When a new database is developed, it should be considered to include a field on each record, that allows the inclusion of a comment providing details on the possible verification of the information.

Another step would be to improve the quality of the existing ICES IBTS checking programme. This should be done by:

- including a check against minimum and maximum lengths for all species, and giving a warning if this length is exceeded by more than 10 %;

- listing records in which only the genus or family is recorded (with the exception of a few major genera/families such as Ammodytidae, *Pomatoschistus* sp.);

- listing any ‘rare’ species recorded;

- including a check of the reported weight, using a species-specific L-W relation and the reported length frequency distribution.

In some laboratories (e.g. in Santander, Lowestoft and IJmuiden), people have started to make a collection of photographs of fish, macro-benthos species and maturity stages. If possible special emphasis should be given in such photographs to the distinguishing features. Exchange of such photo-collections, preferably in a computerized format, is strongly recommended. *Such an exchange could be co-ordinated through the 5th frame-work proposal for a new ICES survey database (see section 3).*

Furthermore the exchange of scientists between vessels is strongly recommended.

Recommendations

The IBTS WG recommends that all countries check the problems described in WD1 and report any changes made in the IBTS data at the earliest possible occasion to the ICES Secretariat.

ICES should improve the quality of the IBTS data checking programme by including in this programme:

- a check against minimum and maximum lengths for all species, and giving a warning if this length is exceeded by more than 10 %;

- the listing of records in which only the genus or family is recorded (with the exception of a few major genera/families such as Ammodytidae, *Pomatoschistus* sp.);

- the listing of any 'rare' species recorded;

- including a check of the reported weight, using a species-specific L-W relation and the reported length frequency distribution.

The IBTS WG recommends that laboratories which possess a collection of photographs of fish, macro-benthos species and maturity stages, exchange such photo-collections (if possible in a computerized format), in order to improve species identification and maturity staging.

The IBTS WG further recommends the exchange of scientists between vessels.

5 NEW STANDARD GEAR

ToR c) define the necessary steps to develop a new standard gear for the IBTS surveys in the western divisions

The problem

The WG has identified the problems encountered in using the GOV trawl in some parts of the western and southern areas. Large parts of these areas are characterised by extremely hard and rough seabeds, e.g. the area west and North of the Hebrides, the area west of Ireland and substantial parts of the western English Channel. The GOV was also tested in Iberian waters and was rejected as unsuitable for the conditions encountered. The GOV is generally considered as being a fragile net, and even with heavy ground gear it is not suitable for deployment on rough seabeds.

At present, all western GOV trawls are carried out on surveyed "clear tows". By their nature, these are mostly on soft ground. Given that there is no trawling on the harder ground the results from the soft ground are implicitly interpolated into the, un-surveyed hard ground when the data are aggregated to calculate area indices. It is unclear whether fish assemblages from soft ground can be considered as representative of those on the harder ground.

What is required?

The requirement is to be able to extend our western bottom trawl surveys into all areas where fish are found and also fished. This requires a gear, which can be deployed effectively in all the ground conditions likely to be encountered. Additionally, this gear would have to be extensively calibrated against the GOV to allow the maintenance of time series.

Effective deployment

Comprehensive surveying of the western divisions will require trawling in deeper water and over rougher bottom using heavier ground gear. The IBTS WG agreed that these requirements have implications for vessel design:

- In the case of large catches, damage is known to occur to fish contained in the codend if the codend is hauled over square transoms or stern rollers.

- The fact that smaller fish are particularly effected compromises the accurate assessment of the abundance of smaller fish.

- Getting a large catch over a square stern will often require that the codend will need to be split in the water. This practice will:

- result in loss of small fish from the net and further diminish the accuracy of assessment, and,

- introduce delays in getting the entire catch aboard, reducing the time available to fish and, consequently, reducing the cost effectiveness of the vessel.

- There will be logistical problems in recovering very heavy ground gear by vessels equipped solely with a square transom and a roller.

The IBTS WG therefore strongly suggests that vessels incorporating stern ramps will be best suited to extend the survey coverage in the Western Division. The IBTS WG recognises that stern ramps may complicate the deployment of some pelagic gears and therefore suggests that multi-tasking vessels be adaptable to incorporate stern ramps when required and alternative stern arrangements to facilitate towing operations not requiring a stern ramp.

The solution?

Two possible directions could be taken to the development and use of a new standard gear:

- Co-operation with gear specialists to design and test a new, robust and generally applicable gear. This has the advantage that the gear could be standardised and it's parameters and performance could be determined during development. The disadvantages are that this would take a considerable amount of time, and would be unlikely to occur without external funding support.

- Investigate the gear currently used by commercial fishermen who work in all type of grounds, and select the best available for our purposes. This has the advantage that the gear should be obtainable quickly, and should be relatively cheap. It would also mean that the surveys were being carried out with similar gear to the fishery. The disadvantage is that standardisation may be difficult, and gear performance will initially be unknown. An alternative to sourcing from commercial fishing operations would be to investigate other gears already available in the fisheries research community.

It is not clear at present that a gear is available that would work well on all bottom types but this should be investigated. It would be possible to have different gears for different seabeds, but this would be entail difficulties for index calculation.

Progression

Approaches have been made to WGFTFB for collaboration on this matter. While the members of that group felt that this was the type of work they should be involved in, it was felt that no progress could be made without external (probably EU) funding. No individual was willing to act as a co-ordinator for such a project and so no progress has been made.

By default, this would suggest that the second option (above) should be considered. It is suggested that institutes involved in the western surveys initiate investigation into both the commercial and survey gears which may be possible candidates. Where possible pilot surveys should be carried out.

Recommendation

The WG recommends that the choice and design of a new standard gear for the western and southern be formally presented to WGFTFB and included in it's terms of reference.

6 IPROST PROJECT

The International Program of Standardised Bottom Trawl Surveys off North Western Europe (IPROSTS – EU contract 98-057) officially started on 1st of April 1999 and ended on the 31st of March 2001. This project aims to conduct surveys in 1999 and 2000 and pursue the standardisation process already started in the North Sea and in the south-western Europe to the North and will involve France (IFREMER) for Divisions VIIg,h,j and VIIIa,b , Ireland (Marine Institute) and Scotland (MARLAB) for Divisions VI and VII. Integrated surveys were conducted during November of 1999 and 2000. The research vessels *Celtic Voyager*, *Scotia* and *Thalassa* were deployed in the area of study and half-hour tows using a GOV trawl were made according to a standardised stratification scheme taking into account the IBTS working group recommendations. Intercalibration was carried between the RV SCOTIA and RV CELTIC VOYAGER in 1999 and between the R/V THALASSA and R/V CELTIC VOYAGER in 2000. Studies were conducted on gear performance and ageing sampling strategies.

6.1 Intercalibration

As part of the IPROSTS EU Project on bottom trawl survey standardisation a series of inter-vessel calibration exercises were required under sub-task 3. In November 1999 20 comparative tows were completed between the R.V. Scotia III (MARLAB) and the R.V. Celtic Voyager (Marine Institute) in the western Irish Sea (see Fig.1.). Similarly, in November 2000, a second inter-calibration exercise was carried out between the R.V. Thalassa (IFREMER) and R.V. Celtic Voyager. This second inter-calaibration added an extra 12 stations to the original twenty tow positions from 1999, but also extended the exercise into the northern Celtic Sea resulting in a total of 32 paired hauls in 2000.

The three vessels involved in the inter-calibration project are of varying capacities (see Table.6.1.1) and tow gears of different geometry. Thalassa and Scotia III both tow *standard* GOV trawls, while the Celtic Voyager, due to it's smaller size and reduced horse-power, deploys a scaled down version of the same GOV design (see Table.6.1.2).

Table 6.1.1. General characteristics of the three vessels

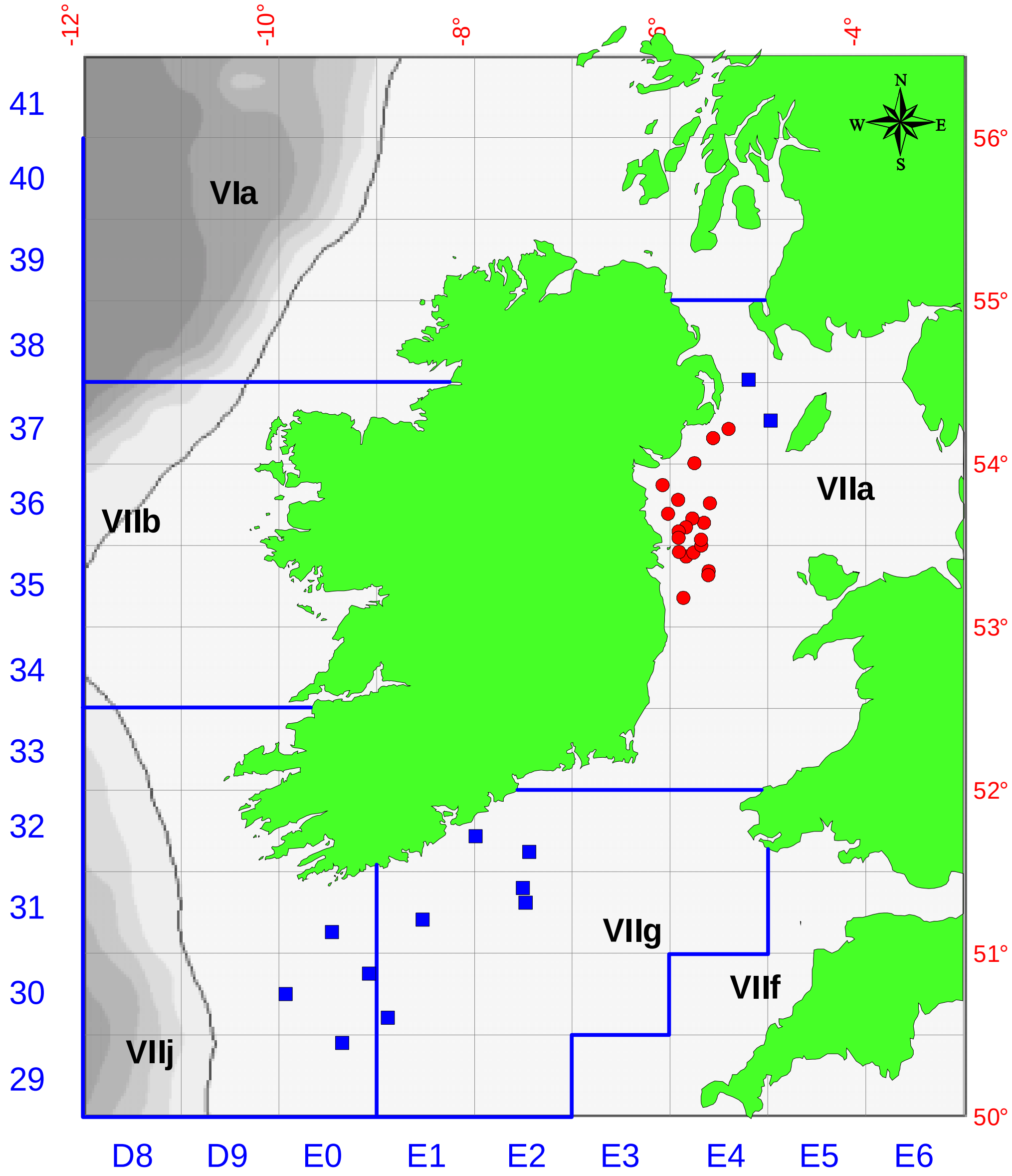
	RV Thalassa	*FRV Scotia*	*RV Celtic Voyager*
Year Built:	1996	1998	1997
Length:	73.65m	68.6m	31.4m
Draught:	6.1m	5.65m	4.3m
Net Ton:	840t	785t	340t
Cruise speed:	11knots	11 knots	8 knots
Engine:	4,512kw	4,455kW	626kW

Table 6.1.2 Average net parameters at 25m, taken from Reid *et. al*. (ICES K.28)

	RV Thalassa	*FRV Scotia*	*RV Celtic Voyager*
Headline:	4.45m	5m	5.29m
Door Sp:	64.63m	73.34m	50.50m
Wing Sp:	17.22m	16.13m	na
Flotation:	Floats	Kite	Kite
Gear Area:	287.6m sq	366.7m sq	267.1m sq

Catches were sorted and, where necessary, sub-sampled according to standard protocols laid down by each institute, based on the procedures outlined in the IBTS manual.

Figure 6.1.1. Map of station positions for IPROSTS inter-calibration. Squares indicate stations added in 2000 trial.



Tow duration was 30min and net monitoring was by means of SCANMAR on each vessel, with the exception that wingspread data was not available for the Celtic Voyager.

Overall catches during both inter-calibration exercises were highly variable and showed no particular pattern as regards one vessel over another.

It was felt that analysis of the data should take at several approaches in order that information at several levels could be visualised.

1. at the macro scale we wished to investigate whether the catch composition from each vessel was indicating a significantly different community assemblage or abundance

2. general correlation in the paired catches was explored using principal component analysis

3. finally, at the species level, an analysis of the relative catch rate of each boat by length class for a given species was investigated to contrast the information on population structure coming from each vessel.

Results

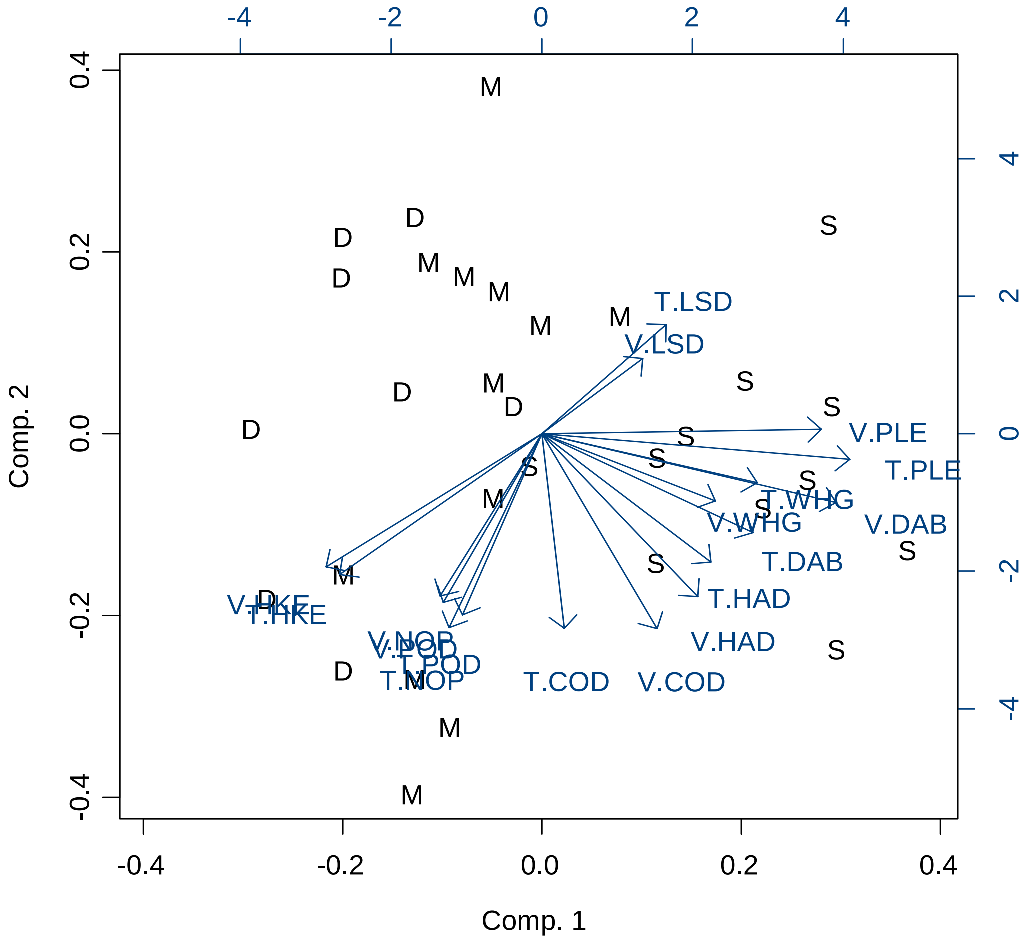
1.Analyis of species abundance and richness was investigated using paired t-tests and Mann-Whitney U tests. Both analyses failed to reject the null hypotheses that there were significant differences in taxa richness or abundance between the vessels involved

Principal component analysis (PCA) is a useful analytic tool for exploring correlations in multivariate data and reducing "noise" in the data. PCA biplots (Fig.6.1.2) indicated a high correlation between species (variables) from each boat, indicated by the narrow angle between variables. That is, haddock catches on the Celtic Voyager (V.HAD) are closely associated with the haddock catches on the Thalassa (T.HAD).

Stations (samples), as might be expected, also showed a reasonable degree of clustering according to depth. There was also visible correlation between deeper water stations and species such as hake and Norway pout which would again fit what might be expected intuitively.

The length of vector representing each variable broadly indicates the proportion of variance explained by this particular construction of the biplot for this variable. The cumulative variance explained by the first three components of each biplot varied from 62% to 81% and should be borne in mind when interpreting the output.

Figure 6.1.2 PCA biplot of 2000 inter-calibration data (Station Depth: `S= <50m; M= 50-100m; D= >100m`)



The length frequency analysis was carried out by applying the model developed at the Marine Laboratory, Aberdeen (Fryer *et al*, internal report: 03/01) for the inter-calibration exercise between Scotia II and Scotia III. The model is analogous to a gear selectivity trial and essentially constructs a smoothed catch rate at each station for one vessel (Fig.6.1.3), here the Celtic Voyager, relative to the second vessel, Scotia III in 1999, and Thalassa in 2000. Following on from this, information across hauls is combined by taking a weighted average of these smoothed curves to attempt to produce a reasonable, average, of relative catch rate for boat A at each length class, compared to boat B. The 95% confidence intervals are constructed by bootstrapping (n=1000) (see Figure 6.1.4).

Results from this analysis would tend to suggest that there is a significant amount of variation within and between hauls. When data is then combined over hauls the relative catch rate for the Celtic Voyager tends to centre in or around the 0.5 level for haddock for example. That is to say, when compared to either the Scotia III or Thalassa for a haddock at a given length class, the Celtic Voyager is tending to account for approximately 50% of the total catch. Confidence intervals indicate that there is a reasonably broad range of possible conversion factors that could be used to compare the catch from one boat with another, from c. 0.4 – 0.6 for 25cm haddock in 2000 for instance. This frustrates the conclusion of a single conversion factor with confidence. Notwithstanding, there does appear to be good stability in the model across the range of length classes in which there is greater than 15-20 paired hauls included in the analysis.

In summary, analysis of the inter-calibration data indicates that there is no significant deviation in the community structure being presented from each boat during these pair-wise comparisons. In addition there is good correlation between paired catches in both years.

While conclusion of a single conversion factor for these vessels is difficult at this stage there is work in progress at MARLAB on the model to address the influence that “outliers” at the extremes of the length distribution appear to be having. It is also evident that there is a dramatic reduction in noise in the model as the number of paired stations increases. It is hoped that, as the model is dependent only on relative catch rate, it should be possible to add further data to the analysis in the future where surveys naturally overlap.

Figure 6.1.3 Relative catch rates at length for Celtic Voyager to Thalassa for whiting for the 2000 trial

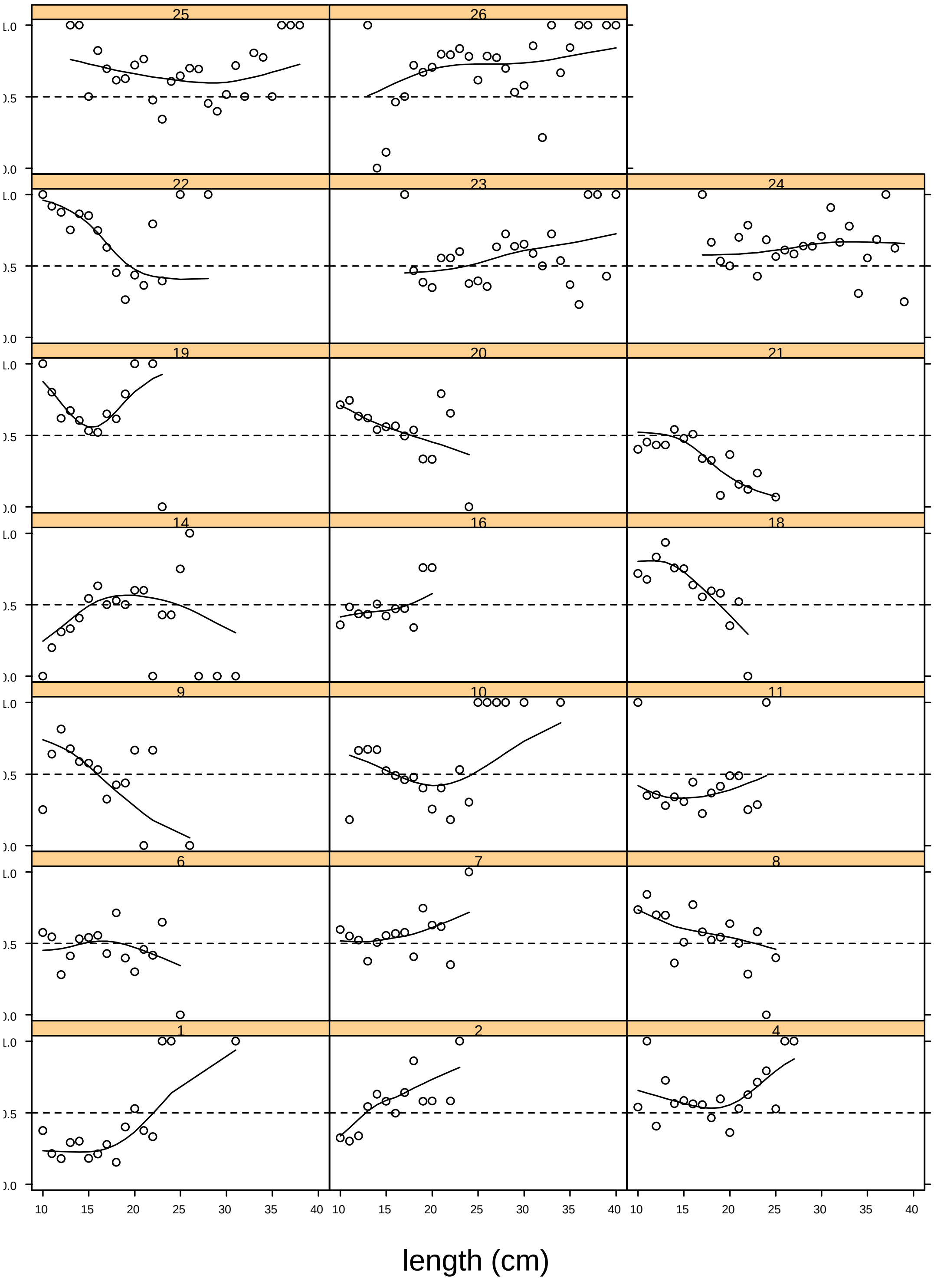
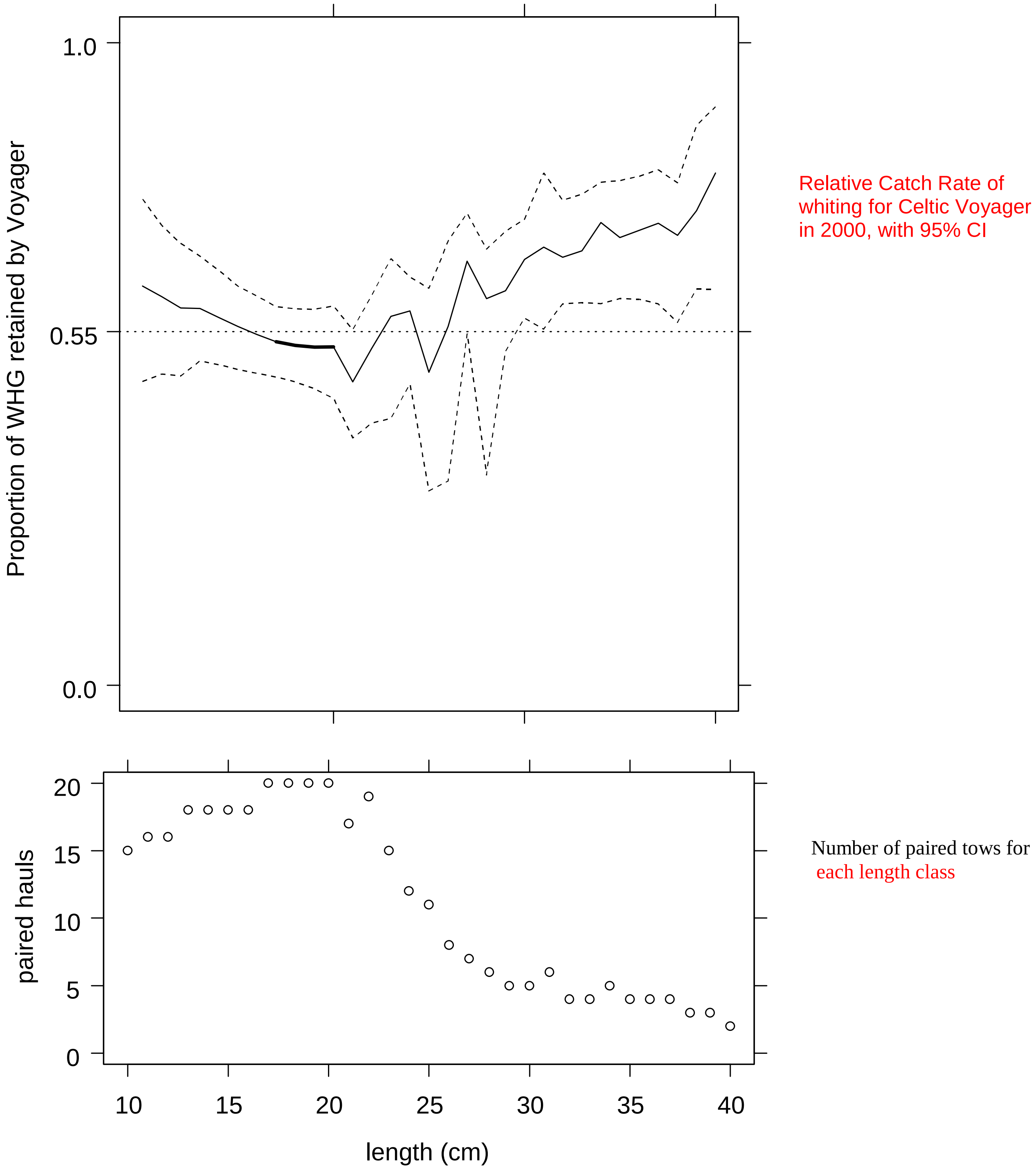


Figure 6.1.4. Relative catch rate over combined over hauls hauls, weighted by station, showing 95% bootstrapped confidence intervals.



6.2 Comparison of ageing sampling strategies

Abundance indices at age from research surveys provide unbiased time series of prime importance in the process of stock assessment. Sampling strategies used for computation should insure the estimates are of best possible precision. In the IBTS manual, the recommendations concerning ageing material sampling include minimum number of otoliths per length class and that sex and maturity data may be reported for each species for which age data are collected. For some species however, stratification by sex of length and age composition could increase substantially the precision of the abundance at age indices with only a small increase of effort. In order to provide evidence to support or not this statement, different sampling strategies were tested on two species (whiting and megrim) during the 1999 French EVHOE surveys. The results of the relative gain of precision obtained for different strategies relative to a reference strategy of otolith sampling (1otolith/cm/station) are given for whiting and megrim in Tables 6.2.1and 6.2.2. Conclusions are that while for whiting, increase in precision is achieved only with an important increase of sampling but independent on the stratification by sex, for megrim a clear improvement in precision is obtained by stratification by sex with no significant increase in the total number of otoliths taken.

Table 6.2.1 – Summary of relative gain in precision obtain with different whiting otolith sampling strategy compared to the reference strategy.

Reference : 1 otolith/cm/station - Nb otoliths : 325					
	Proportional 1/5, Sexes separated	Proportional 1/5, Sexes combined	Proportional 1/10, Sexes separated	Proportional 1/10, Sexes combined	Stratified 5/cm, Sexes separated
Age	Gain % CV	Gain % CV	Gain % CV	Gain % CV	Gain % CV
0	-7	0	-7	0	-0
1	14	6	10	1	0
2	25	21	13	11	0
3	27	26	9	8	-0
4	7	7	1	2	-0
5	11	8	1	0	0
6	7	9	3	3	-0
7	-6	-1	-2	0	-0
8	4	0	4	0	0
Nb otoliths	605	605	418	418	233

Table 6.2.2 - Summary of relative gain in precision obtain with different megrim otolith sampling strategy compared to the reference strategy.

	Reference : 1 otolithe/cm /station	Stratified 5/cm, Sexes separated		Stratified 10+/cm, Sexes separated	
Age	Nb oto.	Nb oto.	Gain (% CV)	Nb oto.	Gain (% CV)
0	6	8	14	8	14
1	18	23	22	26	33
2	27	41	10	73	24
3	6	9	24	13	26
4	17	25	38	50	55
5	49	52	21	92	37
6	39	41	25	57	36
7	30	30	-38	37	-10
8	22	23	3	25	10
9	21	20	-2	22	1
10	12	13	4	13	5
Total	250	288		419	

7 VALID TOWS

The exchange of valid tow positions from surveys in the North Sea has again become rather fragmented. The value of exchanging this information was discussed in terms of savings in time and expensive net damage, when there is a need to find replacement fishing grounds. Also the quarter 1 survey in 2001 saw the return of a long absent participant (England). Urgent communications had to be made with selected institutes to obtain safe fishing positions for this participant to use. It was also noted that positional data reported to ICES in exchange format does not provide the necessary precision and that some data on haul position are missing. CEFAS (UK) has renewed an offer to collect, collate and return clear tow position information. It is recommended that all institutes, including those taking part in westerly and southerly surveys, should provide shooting and hauling positions for valid tows, for at least the preceding year, according to the format detailed in the IBTS North Sea manual (Version VI).

8 IMPLICATIONS OF THE CONCLUSIONS OF THE THEME SESSION K ON "INCORPORATION OF EXTERNAL FACTORS IN MARINE RESOURCE SURVEYS"

This section reviews papers presented to the Annual Science Conference in Bruges in September 2000. Part 1 is a summary as presented by the convenors to ICES, followed by a list of the papers presented. Part 2 is an analysis of each paper as prepared by Adlerstein and Ehrich and presented to the Working Group. Part 3 summaries the views of this Working Group for the relevant papers.

Part 1: Summary of theme session K presented to ICES by the convenors

THEME SESSION ON INCORPORATION OF EXTERNAL FACTORS IN MARINE RESOURCE SURVEYS (K)

Co-Conveners: E.J. Simmonds (UK), P. Petitgas (France), and S. Walsh (Canada)

Many external factors have various degrees of impact on marine resource surveys and can be summarised into three broad categories:

Fish behaviour: aggregation and distribution; vessel avoidance; reaction to gear.

Environment: weather: water movements; sea temperature; visibility; light.

Sampling gear characteristics: tow duration; towing speed; gear size; ground contact; mesh sizes.

Most of these factors are not addressed in the design and conduct of surveys, nor are they incorporated in the analysis of results. There is a need to address such issues to improve both the quality of surveys and the analyses of data. Ideally the collection of survey data should be optimised according to the variables available and the analysis methods that will be applied.

The aim of the Theme Session was to provide a forum for discussion of methods and presentation of results that take into account the multivariate nature of survey data and/or combine variability sampled at different space-time scales. 30 papers were received all of which were relevant to the Session, 11 of these were displayed as posters and presented in summary in the session; 19 were presented orally.

Presentation of papers

The Session opened with an invited review of uses of surveys for fisheries management, independently from catch at age models (Doc. K:24). Examples of North East Arctic cod and Namibian hake were shown where the surveys indicated different stock trajectories from the catch-at-age matrix method of assessment.

The Session then considered papers dealing with examples of the external factors which influence survey catch rates in bottom trawl surveys. The catching efficiency of the net is affected by the geometry of the trawl which varies with depth. Generally the effective swept area/volume is unknown and hence an average value is used. This assumes that between surveys the distribution of the fish does not change. When it does the survey will over- or under-estimate the population size. It was clear that in addition to fishing gear effects, vessel effects can play a role in variation in abundance indices possibly through vessel noise emissions. Many marine fish species are associated with specific topographical features of the seabed, which influences their distribution and aggregation patterns. This feature along with such covariates as time of day, spatial scale, school size, location and day and night activity levels are external factors which can affect the precision and accuracy of survey estimates if not accounted for. Because sources of variability occur in a multi-dimensional space, extracting and partitioning of this variability among the covariates is often difficult. Marine trawl surveys are coarse in scale relative to the variability that is often high. Therefore estimates of abundance are generally imprecise. This effect also makes it more difficult to establish the influence of individual factors. Sampling precision of biological features was also investigated and shown to be seriously affected by within sample correlation. This indicates that large measured numbers may not be helpful but increased numbers of samples is much more effective.

Model-based approaches such as generalised linear models (GLM) and generalised additive models (GAM) were shown to be good tools for modelling spatial data both from trawl and egg surveys and these models can easily incorporate covariate data in its formulation to derive new abundance indices with improved precision. Both categorical and continuous variables were included and models are fitted with model selection being best when a mixture of common sense complimented by information theory was used. The models allow highly informative temporal and spatial illustrative cartoons. Explicit relationships can be obtained and the precision of these estimated through bootstrap. Geostatistics, in this case kriging with external drift, allows correction for external spatially variable factors without the need for coefficients, the variable being estimated is guided between the observations by the shape of the external variable. Improvement in the fit between the modelled indices and independent assessments were demonstrated. For bottom trawl surveys, logbook data were used with the survey data to analyse the biological life cycle in space and time. Shifts in the spatial pattern of spawning were related to a decadal increase in temperature.

For pelagic fish, swimming migratory behaviour of schools, school characteristics and spatial clustering of schools were related to environmental parameters and strongly consistent latitudinal effects were observed. While schools' characteristics did not show any relation with local environment nor with local biomass, migratory and clustering patterns could be related to general regional ecological conditions.

Discussion

The Session concluded with a useful discussion, which highlighted a number of important points for future consideration.

Survey data was regressed on covariates relating to the many potential sources of variability using multivariate analysis techniques. Confounding effects between covariates are often observed and if the modelling is to assign variability appropriately an even sampling of all the multivariate space (time of day, location, vessel and gear) is required. This in turn requires appropriate survey design.

Data collection could be increased or in some cases diverted and dedicated to two types of complementary studies:

small scale directed experiments which focus on analysing the processes of catch variation; leading to site specific determination of relationships,

sampling more evenly the multidimensional space of catch variation and statistically identifying the confounding effects throughout the data set. In multi-vessel surveys there is a need to construct overlapping coverage with different vessels. This second method may not clarify the processes affecting catch rate but will provide appropriate survey specific corrections which should provide improvements in the survey performance.

Two kinds of covariates have been found useful:

those that increase precision because they enable better characterisation of the structural relationships such as depth,

those that increase the dimensionality of the data set, for instance, the time of day (and behavioural covariates), vessel and gear variables. Increasing the dimensionality to better understand the data and account for these sources of variability will add extra variance terms which may not diminish the overall variance but will provide a greater insight and a more realistic estimate of precision.

In particular a day/night affect was thought to be a continuous function influencing catch rates even during daytime. To account for this there may therefore be a need for surveys that collect only day data to require night samples to better characterise the time of day effect. Externally derived correction factors were not perceived as a solution to this problem, however, removal of confounding effects have been proposed using GAM or Geostatistics.

In addition to direct stock indices, surveys also allow monitoring of biodiversity and biological parameters. Optimisation of survey design, sample placement and tow duration should be considered at the design stage when possible. However, some changes can be made to improve survey efficiency. Additional instrumentation can be added to existing surveys to measure fishing gear and fish behaviour with the aim of monitoring and optimising performance. For example the inclusion of bottom contact sensors should be mandatory for bottom trawl surveys. More understanding of the processes at work in the relationships between fish behaviour and surveys was stressed. The interest in experiments as well as in the use of new technology such as remote vehicles and sonar observation was noted.

The ability of the survey data alone to show clearly the trends in population abundance was clearly demonstrated. The models presented provided great insights and the potential for improvement in estimating survey abundance indices and the development of survey based stock management models was particularly stressed.

Documents presented

K:01	S. Adlerstein and S. Ehrich	Effect of deviation from vessel target speed over ground, trawl speed through water and time of day on catch rates of several fish species in North Sea surveys.
K:02	D.J. Beare, D.G. Reid, and P. Petitgas	Spatio-temporal patterns in herring (*Clupea harengus* L.) school abundance and size in the NW North Sea: Modelling space time dependencies to allow examination of the impact of local school abundance on school size.
K:03	D.J. Beare, D.G. Reid, P. Petitgas, P. Carrera, S. Georgakarakos, J. Haramlambous, M. Iglesias, B. Liorzou, J. Masse, and R. Muino	Spatio-temporal patterns in pelagic fish school abundance and size: a study of pelagic fish aggregation using acoustic surveys from Senegal to Shetland.
K:04	D.J. Beare and D.G. Reid	Investigating the complexity of spatio-temporal patterns evidenced in the triennial mackerel and horse-mackerel egg survey data.
K:05 Poster	N. Bez and J. Rivoirard	Collocation indices to compare spatial distributions of populations.
K:07	P. Brehmer, F. Gerlotto, and B. Sam	Measuring fish school avoidance during acoustic surveys.
K:09	L. Clarke, D. Stahl and J. Simmonds	Spatio-temporal models of North Sea Herring.
K:10 Poster	J. Coetzee, O.A. Misund, and D. Boyer	Survey vessel avoidance reaction of Sardinella off Angola.
K:11	T.R. Hammond, and C.M. O'Brien	Persistence of acoustically observed fish biomass in a 220 km survey region.
K:14	C. Kvamme, L. Nøttestad, B. Axelsen, A. Dommasnes, A. Fernö, and O.A. Misund	A sonar study of the migration pattern of Norwegian spring-spawning herring (*Clupea harengus* L.) in July
K:15	O.M. Lapshin, Y.V. Gerasimov, Y.G. Izumov, and I.G. Istomin	The influence of polymorphic characteristics on the Alaska Pollack (*Theragra chalcogramma*) fishing efficiency.
K:16 Poster	R.B. Mitson	Fish avoidance: the vessel noise factor.
K:17	R. Muiño, and P. Carrera	Sardine (*Sardina pilchardus* Walbaum) characterisation off the Spanish Atlantic coast.
K:18	C.M. O'Brien and J.C. Fox	Incorporating temporal information in ichtyoplankton surveys using a model-based approach: cod: (*Gadus morhua* L.) in the Irish Sea.
K:19	C.M. O'Brien, S. Adlerstein, and S. Ehrich:	Accounting for spatial-scale in research surveys: analyses of 2-year old cod from English, German and international groundfish surveys in the North Sea.
K:20	R.P. Oeberst, P. Ernst, and C.C. Friess	Inter-calibrations between German demersal gears HG 20/25 and TV3 520 as well as between the gears TV3 520 and TV3 930.

K:21	R. Oeberst	Proposal for the stratification of the Baltic Sea for the Baltic International Trawl Survey.
K:23	M. Pennington, L. Burmeister and V. Hjellvik	Assessing trawl-survey estimates of freqency distributions.
K:24	M. Pennington	Survey-based stock assessments: Are they more reliable than catch-based assessments?
K:25	P. Petitgas	On the clustering of fish schools at two scales and their relation with meso-scale physical structures.
K:26	G.A. Petrakis, D.N. MacLennan, and A.W. Newton	North Sea trawls surveys: Diel and depth effects on the catch rates.
K:27	G. Piet	Evaluation of the incorporation of external information using GAM on the catch-at-age index estimation for North Sea plaice and sole.
K:28	D.G. Reid, D.J. Beare, J-C Mahe, P. Connolly, C.G. Davis, and A. Newton	Quantifying variability in Gear Performance on IBTS surveys: Swept area and volume with depth.
K:29	D.G. Reid	The relationship of herring school size to seabed structure and local school abundance in the NW North Sea.
K:30	J. Rivoirard	Testing the effects of vessel, gear and daylight on catch data from the International bottom trawl survey in the North Sea.
K:31	J. Rivoirard and K. Wieland	Correcting daylight effect in the estimation of fish abundance using kriging with external drift, with an application to juvenile haddock in North Sea.
K:32	J. Simmonds and J. Rivoirard	Vessel, and day/night effects in the estimation of herring abundance and distribution from the IBTS surveys in North Sea.
K:33	D. Somerton and K. Weinberg	The effect of water speed on bottom contact and escapement under the footrope of a survey trawl.
K:34	B.K. Stensholt, K. Michalsen, and O.R. Godø	Behavioural rhythm of cod during migration in the Barents Sea.
K:36	M. Verdoit and D. Pelletier	Characterizing the spatial and seasonal dynamics of the whiting population in the Celtic Sea from the analysis of commercial catch and effort data and scientific surveys data.
K:37	C.W. West and J. R. Wallace	Measurements of distance fished during the trawl retrieval period.
K:39	E.J. Simmonds, E. Toresen, E. Torstensen, C. Zimmermann, E. Götze, D.G. Reid, and A.S. Couperus	1999 ICES Coordinated acoustic survey of ICES Division IIIa, IVa, IVb and VIa (north).

Part 2: Summaries of papers relevant to the Working Group

1. Papers dealing with environmental effects and fish behaviour (time of day effects)

K:01

Effect of deviation from vessel target speed over ground, trawl speed through water and time of day on catch rates of several fish species in North Sea surveys.

The problem: Catches of several species are known to fluctuate within 24 hr.

Method: Generalized Additive Models on catch rates using time of day as a nonparametric continuous variable. Data from a fishing experiment.

Application: Norway pout, haddock (under and over 20 cm), whiting (under and over 20 cm), dab, and grey gurnad from small area in northern North Sea collected in 5 days in November 1997.

Results: Rates except for adult whiting varied with time of day typically within twofold between day and night and the variation is non necessarily symmetrical within 24 hr. Rates of Norway pout and small and large haddock were higher during the day and rates of dab, grey gurnard and small whiting were higher at night. Fluctuation is also within day time.

Recommendations: Limit survey within day time. There is a need for fine scale fishing experiments to investigate effect of time of day in different circumstances

Discussion: Results are from reduced spatial-temporal experiment and need to be repeated to test the generality. Making data corrections without appropriate knowledge could bring more problems than using raw data.

K:26

North Sea trawl surveys: diel and depth effects on the catch rates.

The problem: Catch rates of some fish are higher during day time, others are higher at night and this can be affected by depth.

Method: Hauls were classified as day and night time hauls and to two depth zones.

Application: Catch data for juvenile and adult herring, haddock, whiting, and common dab from Scottish surveys from 1976 to 1993, 1st quarter.

Results: Rates of common dab were higher at night. All rates higher at shallow stations. For herring rates were also higher at night and juvenile rates were higher in shallow stations while for adults there were higher in deep stations. For haddock rates were higher during day time, but they were always more abundant in deep stations. Juvenile whiting were mostly higher at night, but did fluctuate for adults. Juvenile rates were higher in shallow stations and adults rates in deep stations.

Recommendation: Conduct the surveys in identical circumstances with regard to for example time of day and area distribution of fishing.

Discussion: Catch indices based on single averages of catch rates without regard to extraneous causes of variability are liable to be biased. Clearly there is a need of more sophisticated models of the capture process to remove unwanted variability from the catch indices revealed by trawl surveys.

K:27

Evaluation of the incorporation of external information using GAM on the catch-at-age index estimation for North Sea plaice and sole.

The problem: Need of improving abundance indices from surveys.

Method: Presence/absence and nonzero catches modelled separately with GAMs. Results are compared with assessment output and their internal consistency investigated.

Application: North Sea plaice and sole from Beam Trawl Survey from 1995 to 1999.

Results: Modelling catch rates incorporating external variables depth, time of day, latitude, longitude, day of year, and median grain-size improve the indices provided by BTS survey

Recommendation: No recommendation

Discussion: Incorporating biotic variables (species composition) hardly affected the calculated abundance indices. Temperature did not tested significant but does not imply that the hypothesis that increase in temperature caused the fish to avoid shallow waters.

K:30

Testing the effects of vessel, gear and daylight on catch data from the International Bottom Trawl Survey in the North Sea.

The problem: Standard abundance indices are routinely calculated in a way that does not account for differences in catchability between vessels or in catch rates between day and night.

Method: Selection of neighbouring pairs of stations from the same vessel. Student test to test if night catches are different and for example lower than day catches.

Application: Cod, haddock, whiting and herring at ages 1, 2 and 3+ in 1st quarter, 1983 to 1997 and 3rd quarter 1991 to 1996.

Results: Significant correlation found with sun elevation was assessed. Positive effect of day light on haddock and herring all ages and on cod 2 and 3+. Day/night effect was tested significant for haddock and herring all ages and cod 2 and 3+. No effect for cod 1 and whiting all ages.

Recommendation: No recommendation

Discussion: No clear response of catch on time of day and sun elevation. The data selection is problematic to provide basis to analyse the effect in isolation of other factors.

K:31

Correcting daylight effect in the estimation of fish abundance using kriging with external drift, with an application to juvenile haddock in North Sea

The problem: Substantial number of hauls are taken outside daylight period (up to 33% of selected hauls). Standard indices do not account for potential bias due to differences between day and night catches. Uneven distribution of the time.

Method: Geostatistical method. Used because it is argued that response to catch rates to light levels are difficult to quantify. Assumes that level of catch varies as a cosine function of time or day/night. Results are compared to IBTS standard indices and ICES assessment.

Application: Haddock age 1, 2 nd 3 haddock, 1st quarter IBTS 1983-1997

Results: External drift kriging with time of day resulted in higher indices than IBTS. Day/night and cosine function gave similar results. Difference more pronounced for age 1 haddock (21%). The differences vary by year.

Recommendation: Use external drift with day/night indicator but preferably with time of day for compensating for effects.

Discussion: The effect is assumed. So the result means when the effect exist and day/night or it has the cosine shape (symmetrical). Although the assumption of the temporal variation is weak and the level nor amplitude of the cosine do not need to be known.

K:32

Vessel and Day/Night effect in the estimation of herring abundance and distribution from IBTS surveys in North Sea

The Problem: The hauls were carried out preferentially during the day but the proportion of night hauls changes over time from about 14% over the first years to 20% over the last years.

Method: Use of day and night indicator and function of time of day (cosine centred on midday). Kriging with external drift to show differences between daylight and darkness. Results from kriging with external drift are compared to arithmetic mean and ordinary kriging. All data analysed because arguments of no strong relationship between spatial sampling and time of day. Performance was assessed by comparing the chosen functions to cohort estimation and to herring assessment excluding IBTS.

Application: Data herring 1 to 5+from 1983-1997 IBTS

Results: There is evidence that time of day affect catch rates. Small improvement for the day night indicator when estimated at ages 1, 2 and 3.

Recommendations: The effects of vessel need to be taken into account, but more work is required in particular to determine the best method for incorporating effects..

K:34

Behavioural rhythm of cod during migration in the Barents Sea

The problem: Fish assessment by surveys requires understanding behaviour (i.e. vertical migrations).

Method: Data storage tags used to collect data and conduct statistical method to extract information on migration patterns in relation to temperature over time.

Application: Adult Northeast Arctic cod from 19 DST from the Barents Sea

Results: Rhythmic behaviour occurred in 12 of the tags, most commonly over 24 hrs: 11 over 12 tags diel migration, 7 over 8 where semidiurnal tidal cycles in depth and temperature

Recommendation: Understanding factors that induce systematic rhythmic vertical movements can be useful in correcting bias introduced by this behaviour**.**

Discussion: Diurnal rhythms were detected but the results are not consistent and no general principle can be concluded. The vertical migration can cause bias in bottom trawl and acoustic stock estimates.

2. Papers dealing with vessel effects and vessel performance

K:01

Effect of deviation from vessel target speed over ground, trawl speed through water and time of day on catch rates of several fish species in North Sea surveys.

The problem: Effort in IBTS is standardised by 30 hauls at 4 knots over ground but deviations are common. Also, speed through water varies.

Method: Generalized Additive Models on catch rates using speed over ground and through water as continuous variables and accounting for time and accounting for time of day effect. Data from a fishing experiment.

Application: Norway pout, haddock (under and over 20 cm), whiting (under and over 20 cm), dab, and grey gurnad from small area in northern North Sea collected in 5 days in November 1997.

Results: Catch rates of fish closely related with the seabed increased with speed over ground and rates of more pelagic fish increased with speed through water except for large haddock. Most affected were small haddock and whiting.

Recommendation: Make efforts to maintain the target speed. Select data within reasonable range to calculate abundance indices.

Discussion: There is danger in applying unique correction factors to raw data as the effects can be species and size specific. Further investigation is needed to corroborate the generality of the results.

K:16

Fish avoidance: The vessel noise factor

The problem: A reminder of the vessel avoidance factor and the recommendation on maximum underwater noise levels. Most currently operated vessels have the potential of cause fish avoidance whether trawl or acoustics.

Method: Not applicable

Application: Vessels in current use for IBTS

Results:Not applicable

Recommendation: Suggestions for taking into account the noise factor and on suitable propulsion methods.

Discussion: Magnitude and directionality of the noise depend on vessel speed and other factors.

K:30

Testing the effects of vessel, gear and daylight on catch data from the International Bottom Trawl Survey in the North Sea.

The problem: Standard abundance indices are routinely calculated in a way that does not account for differences in catchability between vessels or in catch rates between day and night.

Method: Comparison of catches between pairs of vessels that are overlapping in space. Student t-test performed on duplicate differences to see if their means is significantly different from 0.

Application: Cod, haddock, whiting and herring at ages 1, 2 and 3+ in 1st quarter, 1983 to 1997 and 3rd quarter 1991 to 1996.

Results: Difference in catch rates levels for Scotia in relation to other vessels operating in the North Sea in quarter 3 (lower for cod and haddock).

Recommendation: No recommendation

Discussion: Vessel difference is likely to be due to use of different gears.

K:32

Vessel and Day/Night effect in the estimation of herring abundance and distribution from IBTS surveys in North Sea

The problem: 17 vessels have been used over the study period with only one vessel operating over the whole study period.

Method: Paired observations from vessels were compared. The spatial distribution of sampling is non-representative, each vessel covering ¼ to 1/3 of the area and the allocation changes little over years. The areas overlap but there is compounded spatial and vessel effects.1) Student t test, 2) differences between pairs were examined using bootstrap, 3) GLM by age class, later pooled. Correction factor applied.

Application: Data herring 1 to 5+from 1983-1997 IBTS

Results: Difference between vessels were found. Useful catch rate corrections as large as a factor of 6 need to be applied.

Recommendation: More work is required to determine the best method of incorporating the vessel effects observed particularly where the factors are poorly defined. Methods that use not just point estimates but the range of correction factors give more robust results

Disc

K:33

The effect of water speed and bottom contact and escapement under the footrope of a survey trawl.

The problem: Towing speed over ground is designated to standardise bottom trawl surveys but speed through water can be more influential. Speed affects trawl geometry and interact with swimming speed. Escapement under the trawl footrope, occurring mostly at the centre of the trawl can affect capture efficiency.

Method: 2 phase experiment to investigate relationship between footrope contact and STW monitoring with a bottom contact sensor and the effect of STW on the capture efficiency attaching an auxiliary net under the trawl.

Application: Experiments conducted by commercial stern trawlers using a Poly Nor` eastern trawl used by NMFS 1) in September 1999 off the coast of Washington at 77 and 146 m and 2) in July 2000 south of the Pribiloff Islands.

Results: Distance off-bottom increased with STW, the effect on wind spread increased or decreased depending on the STW. Capture efficiency as a function of STW varied by species and length group. No effect for cod and walleye pollock and Pacific halibut and decrease in capture efficiency for skates with increasing STW.

Recommendation: In areas subject to strong current, standardisation should be based on TSW rather SOG.

Discussion: The study is for escapement under the net only and does not provide information on the effect of STW in getting the fish in the net or the escapement over the net.

K:37

Measurements of distance fished during the trawl retrieval period

The problem: Controlling and quantifying tow duration/tow distance is necessary to standardise effort. Tow duration is defined as the period between the trawl is in stable fishing configuration until the end of some fixed, predetermined sampling period when trawl winches are started to retrieve the gear. But, trawls might be continuing to fish during the retrieval period, before coming off bottom.

Method: Measurement to estimate distance along the bottom that the gear swept during the retrieval period and speed at which the trawl moved over the seabed.

Application: 1998 and 1999 NMFS West Coast slope survey for groundfish off Washington, Oregon and California, 4 vessels using 15-minute tows at 2.2 knots.

Results: Distances swept were substantial and increased with the depth of the tow. Effective speed approached or exceed the speed in the survey protocols and among vessels.

Recommendation: Use survey protocols which relied on real-time observations of the gear performance to determine the beginning and endpoints of each haul.

Discussion: These effects can increase the impact of depth-related bias and inter-vessel variability of surveys. The effects increase when the surveys standard nominal tow duration decreases.

K:28

Quantifying variability in gear performance on IBTS surveys: swept area and volume with depth.

The problem: There is substantial variability in headline height, wing spread, door spread, swept area and headline height and good evidence that swept area and volume varies systematically with depth.

Method: Implication of the variation on catch rates investigated using linear modelling.

Application: Vessel surveillance and whiting and haddock catch data from 1) 1998 and 1999 Scottish survey from November carried out on FRV Scotia on the West Coast Scottish shelf, 2) 1999 EVHOE survey from Bay of Biscay and Celtic Sea carried out on the Thalassa, 3) 1999 Celtic Sea Groundfish survey carried out on the Celtic Voyager.

Results: Gear performance varies with depth. Variation of headline height has an impact on catch rates.

Recommendation: Follow the IBTS protocols in using the 50 and 100m sweep depths depending on depth. Repeat the analysis with IBTS in the North Sea

Discussion: Net performance parameters are correlated with depth.

3. Papers dealing with distribution

K:02

Spatio-temporal patterns in herring (Clupea harengus) school abundance and size in the NW North Sea: Modelling space time dependencies to allow examination of the impact of local school abundance on school size.

The problem: Hypothesis: small herring schools size in a particular location is caused by high counts of nearby herring schools.

Method: Relationship between school descriptors and external variables examined by multiple regression models.

Application: Herring schools in NW North Sea

Results: Strong non-linear dependency on time of day and water depth. The number of schools per nmi tend to be high during the middle of the day and lower at dawn and dusk, but the relationship changes with location.

Recommendation:

Discussion: Some of the fish detected acoustically in the larger schools are not detected in the smaller more numerous schools.

K:07

Measuring fish school avoidance during acoustic surveys

The problem: Fish avoidance is know as a major source of bias and errors in assessment of stock abundance. Reaction has been measured in two dimensions but it occurs in three and can start a long distance from the vessel (>100).

Method: Routine in situ measurements using adapted acoustic devices. Bias is calculated from the avoidance speed and the average position of the schools at several distances and depth from the vessel.

Application: Sardinella aurita in western Venezuela, Catalan Sea and Senegal.

Results: Avoidance reactions present significant differences between areas and a species can have difference avoidance strategies in terms of swimming speed and direction. Higher during day. Other factors are depth of the school and the sea bottom, temperature, vessel speed (higher noise at 3-4 knots), trawling).

Recommendation: It is impossible to have a general model for correcting results from surveys. Routine in situ measurements of avoidance that allow to remove the bias for each single species.

Discussion: Technical improvements of acoustic devices are in development to provide precise evaluation of avoidance.

K:11

Persistence of acoustically observed fish biomass in a 220 km2 survey region.

The problem: Short term refuges assume persistence of fish in harvest area.

Method: Generalized Additive Models and visual data analysis techniques. Complementation of trawl and acoustic data. Acoustic data from 0.5 to 5 m above the seabed. During day sampling to assess proportion of cod in acoustic data.

Application: Juvenile (cod) from acoustic survey over 220km off the coast of Yorkshire. The application has shortcomings because of the difficulties in identifying species and cannot follow fish schools.

Results: The biomass varies as much as 50% in the area in a period of 3 days.

Discussion: Variability of the abundance (not catch rates) can be very high within a reduced area.

K:25

On the clustering of fish schools at two scales and their relation with meso-scale physical structures

The problem: Aggregation generates in fisheries survey data correlation between values at a scale of a few kms and trends at the scale of tens of km. Pelagic fish aggregate in schools which themselves occur in clusters of schools.

Method: Pair correlation function and Matern point process along acoustic transects. Physical variables are river plume, vertical water stratification and upwelling events.

Application: Bay of Biscay French pelagic acoustic survey, 1997, targeted at the spawning anchovy in spring.

Results: Trends are better explained by river plume but no relationship with environment at small scale.

Recommendation: 2 stage model for school occurrence in fishery surveys, 1) parent events, inhomogeneous Poisson process with functional link with environment parameters 2) cluster process around parent event.

Discussion: Clustering of schools of few kilometers is related to behavioural schooling dynamics but meso scale aggregation at tens of kms is related to meso-scale physical structures and the food chain they support.

K:29

The relationship of herring school size and local school abundance in the NW North Sea

The problem: Demersal fish tend to aggregate on or over seabed with specific characteristics and anecdotal evidence indicates that also herring show preference to aggregate in areas with rapid change in depth and where seabed is hard.

Method: Simple nonparametric analysis.

Application: Data from 1993 to 1997 ICES herring acoustic surveys in July.

Results: Herring schools tend to be larger and denser over complex sea beds. Also they were larger when far from other schools.

Recommendation: No recommendation

Discussion: Herring is a substrate spawner and in the study area they spawn in autumn. The survey is designed to survey pre-spawning aggregations which might occur in advance.

4. Others

K:23

Assessing trawl-survey estimates of frequency distribution

The problem: Effective sample size from estimates of the frequency distribution of a population can be much smaller than the number of fish sampled during a survey.

Method: Calculation of effective sample size necessary to sample at random to achieve the same information in length contained in the cluster samples. Simulations.

Application: Trawl survey in the Barents Sea, Namibia and South Africa

Results:. Effective size of cod and haddock in the Barents Sea survey is around one. In Namibia it was around 0.5 hake per tow and in South Africa 1.3 hake per tow.

Recommendation: To increase the precision the tow duration should be reduced and sampling should be performed at more stations.

Discussion: More fish than necessary are measured at each station

K:19

Accounting for spatial-scale in research surveys: analysis of 2-year old cod from English, German and International groundfish surveys in the North Sea.

The problem: Estimates from coarse scale surveys do not account for variation occurring at finer scales.

Method: Value of using high-resolution spatial scale catch data and environmental information to improve model-based estimates is investigated with statistical methods including GLMs and GAMs to test and quantify the relationship of catch rates with covariates (windspeed and time of sampling). Also, spatial indices are calculated.

Application: 2 year old North Sea cod from 3 surveys (coarse, and fine) third quarter 1995 in selected area in central north sea.

Results: Mean rates are similar for the three surveys but variances are different. Use of a negative binomial distribution is suitable to describe the catch distribution at different spatial scales considered. When covariates are incorporated in fine-scale analysis the distribution follows a poisson.

Recommendation: The need to decide whether catch data follow a particular distribution can be replaced by a general assumption about mixing processes, through the use of the negative binomial distribution. Further fine-scale surveys would be helpful to understand aggregation processes and improve design of surveys and calculation of abundance indices.

Discussion: The negative binomial distribution represents one type of general process of aggregation and different parameter estimates were obtained for it in the data from different spatial resolution surveys.

K:36

Characterising the spatial and seasonal dynamics of the whiting population in the Celtic Sea from the analysis of commercial catch and effort data and scientific surveys data.

The problem: Scientific surveys do not provide sufficient seasonal coverage to help delineating the periods that characterise the main demographic stages.

Method: Use CPUE from survey information computed at the spatial resolution of ICES rectangles for spatial/temporal information on recruitment and commercial data for spawning stock through maps and multivariate descriptive methods.

Application: Whiting from the Celtic Sea.

Results: Surveys indicate that most age groups are caught in the same area in northern Celtic Sea while commercial data indicate a wide spread distribution.

Recommendation:

Discussion: Further analysis is needed to discriminate between the survey and commercial data.

Part 3: Recommendations from the Working Group

3.1 Environmental effects and fish behaviour (time of day effects)

3.1.1 Summary from papers K01, K26, K27, K30, K31, K32, K34

Differences were found in catch rates from day and night hauls, except for large whiting. Variation also occurs within day time hours. A unique correction function is not recommendable because patterns vary with species, age, and areas and between years.

3.1.2 Recommendation from the WG:

The Working Group recognises that there is a day-night variation in catch rates that could cause bias in calculated abundance indices. Thus the sampling period recommended in the manual is restricted to daytime only.

It is proposed that when possible to measure and record additionally the light conditions (radiation). Before having sufficient information to correct data for variation caused by time of day effect the WG recommends further meso-scale experiments in different areas and seasons.

3.2 Vessel effect/vessel performance

Summaries from papers K01, K16, K30, K07, K32, K33

Noise

3.2.1 Summary from papers K16, K07

Vessels are characterised by different noise emission profiles. These can potentially cause fish avoidance. This can then be seen as a vessel effect. Previous experimental work has shown that fish reaction to vessel noise can vary widely even within a species, or across small areas. The subject of vessel noise and fish avoidance has been examined extensively by WGFAST (Working Group on Fisheries Acoustic Science and Technology). This work is ongoing and is the subject of a theme session at the 2001 meeting of WGFAST in Seattle in April.

1.2.2. Recommendations from the WG.

The Working Group recommends that this work should continue and that WGFAST should consider the subject in relation to fish avoidance to a vessel while bottom trawling as well as at survey speeds. WGFAST is requested to keep this WG informed of progress in this area

Vessel effect

3.2.3 Summary from papers K32, K30

No difference were found for cod, haddock, whiting and herring in vessels operating in quarter 1 in 1983 to 1997 and quarter 3 in 1991-1996 in the IBTS except Scotia that used a different gear. Another study finds important differences for herring for the same survey.

The actual results show no or very little vessel effect in the catch data of bottom fish species.

3.2.4 Recommendation from the WG. The WG recommends to make further comparison fishing experiments to clarify this issue. Even when the vessel effect is believed to be unimportant the current allocation of areas covered by vessels in the survey should be maintained to assure the overall coverage in the case of a ship breakdown.

Vessel performance

Bottom contact and escapement

3.2.5 Summary from paper K33.

There is a problem in areas of strong currents by fishing against the current the gear can loose contact with the bottom and the fish will then escape under the fishing line. In the IBTS database there is no information on bottom contact to evaluate the magnitude of the problem.

3.2.6 Recommendations from the WG: The WG recommends to investigate this effect. Some participating institutes have agreed to investigate the use of a bottom contact measuring device developed in Canada.

Area or volume swept

3.2.7 Summary from papers K01, K28, K37

Speed over ground has an effect on demersal fish and speed through water on more pelagic species (area/volume swept). Effect is more important for small juvenile gadoids (speed). The effect is species dependent. Further, head line height and swept area depends on bottom depth which affects catch rates. Last, the distance fished during trawl retrieval is also a potential problem. The problem is particularly significant for short trawl duration (15 min).

3.2.8 Recommendation from the Working Group

The WG emphasis the importance to follow the protocols as closely as possible, to stress the importance of reporting and standardise the way of measuring speed over ground, through water and distance trawled, make the haul position available to the users, analyse available information to propose models to correct for this bias. At the moment the results are restricted to particular areas and species and the experiments should be extended to allow generalisation.

Discussion in reference to alternatives to keep the gear geometry as constant as possible included the use of a constrained rope and was disregarded as it was considered too dangerous in bad weather conditions.

With respect to trawl retrieval the problem seems to be minor in the North Sea where the sea bottom is fairly flat, depth is mostly less than 100 m and 30 min hauls are performed. It might be a mayor problem in other areas where fishing depth range is greater. When present the problem can be minimised if the skippers follow the same hauling procedure. For each vessel shooting and hauling procedures should be described to assure standardisation. This description should also include the procedure for procession the catch on each participating vessel to avoid another possible source of variation in the catch data.

Distribution

Clustering

3.2.9 Summary from papers K02, K19, K25

For anchovy clustering is related to behaviour and at meso scale is related to physical structures and food prey (river plume). Herring schools tend to be larger over complex sea beds and when far from other schools. Number of herring school was highest in the middle of the day, but the dependency varies in space. For cod the need of information on aggregative processes to correct calculation of the variance is stressed. Negative binomial distribution with very different parameters were found appropriate to model the distribution of catch rates from coarse and fine scale surveys.

3.2.10 Recommendation from the Working Group

For the IBTS survey we recommend acoustics and trawl survey investigation on meso spatial scale to characterise clustering and understand the mechanisms.

9 NEW STANDARD INDICES

The IBTS standard areas used for the calculation of abundance indices were established in order to incorporate all the statistical rectangles regularly fished, excluding regions which are of limited or no significance for a given species (ICES CM 1981/H:1). The areas for cod, haddock, whiting and Norway pout are species-specific and cover the main distribution of these species in the North Sea. For cod, three rectangles from the western Skagerrak (44F8, 44F9 and 43F8) are included. The areas for haddock, whiting and Norway pout covers an additional rectangle (43F9) in the eastern Skagerrak which, however, has never been fished (ICES CM 1998/D:4).

The standard area for cod was identical to that used for whiting until 1980, but since then five rectangles, of which four are located in the coastal region of the German Bight, have been excluded because they introduced an increased variability of the survey index for the 1-group, and further, a decreased correspondence with VPA estimates for the years 1969 to 1979 (ICES CM 1983/G:62). The IBTS was extended in the 1980's to the Skagerrak and Kattegat (Heessen et al. 1997) where at times high abundance of, in particular age 1 and 2, cod can be found (ICES CM 1998/D:4, Wieland 1998). The existing standard areas have, however, not been changed accordingly, and separate indices were given for age 1 and 2 cod in the Skagerrak and the Kattegat based on a length splitting (e.g. ICES CM 1999/D:8).

The Working Group on the assessment of demersal stocks in the North Sea and Skagerrak, which is one of the major user of IBTS results, applies the following stock entities since 1996 (ICES CM 1998/Assess:7):

- Cod: eastern Channel (Div. VIId), North Sea (Sub-area IV) and Skagerrak

- Whiting: eastern Channel and North Sea

- Haddock and Norway pout: North Sea (Sub-area IV) and Skagerrak/Kattegat (Div. IIIA).

The recent change of the assessment units, the extension of the IBTS survey area and the high importance of the Skagerrak/Kattegat as nursery areas in some cases provided the background for the recommendation by the Study Group on the Evaluation of the quarterly IBTS surveys for a re-definition of the IBTS species-specific standard areas (ICES CM 1998/D:4). The IBTS Working Group redefined the new areas (ICES CM 1999/D:2) and asked the ICES Secretariat to carry out the new calculations so that the new indices could be evaluated during 2000 (a correspondence year) with a report being made during the Copenhagen 2001 meeting. Unfortunately due to pressure from other topics ICES was unable to re-compile these indices and the request was repeated for the 2001 meeting. Again there were problems in the re-compilation and this term of reference remains unfulfilled. This term of reference is repeated, for the third time, in the list suggested for the meeting in 2002.

10 GEAR PARAMETERS

ToR “h” tasked the WG to “examine the gear parameters extracted by ICES from the IBTS database and analyse net performance”. No data extraction has been made from the ICES database. This was because much of the required data were not entered into the main database and remain as separate files. However, some work has been possible using data obtained directly from institutes. This has been used to examine gear performance in the western area on three Quarter 4 IBTS surveys.

A full report of this work was presented at the ICES ASC in Bruges, Belgium in September 2000 as part of theme session K on incorporation of external factors in marine resource surveys, entitled “Quantifying variability in Gear Performance on IBTS surveys: Swept area and volume with depth”- K:28. A copy is attached to this report as an appendix 2. So only a brief summary is presented here.

Gear performance parameters normally available from routine IBTS surveys include:

- Headline height (distance from headline to seabed)
- Wing spread (distance between wing ends)
- Door spread (distance between doors)
- Distance towed (over the ground)

Measures of swept area, and swept volume, for both net and gear are also usually available, although the precise basis for the calculation of these parameters may not be consistent between institutes.

The study was based on surveys by three institutes (FRS-MLA, MI-Dublin and IFREMER). The results are summarised in table 10.1-4 for each institute. The main finding was that the behaviour of the gear varied dramatically with depth. For example, in the Scottish data headline height dropped by around 40% over a 175m depth range, while wing and door spread increased by around 25%. Swept area also increased by between 25 and 32% for the net and the full gear respectively

Table 10.1. Summary of trawl surveillance data for the two Scottish surveys (pooled data).

Parameter	R^2	Slope	Value at 25m	Value at 200m	Change	Change %
Headline Height	0.210	-0.008	5.00	3.58	1.42	39.7
Wing Spread	0.444	0.035	16.13	22.25	6.12	27.5
Door Spread	0.293	0.145	73.34	98.72	25.38	25.7
Net Swept Area	0.362	108.74	56450	75480	19030	25.2
Gear Swept Area	0.192	465.91	258433	339966	81533	31.55

The accepted method for controlling these depth related changes is to use different sweep lengths in different depth ranges. The IBTS manual recommends short sweeps (60m including back strops) in depths less than 70m and long sweeps (110m) in greater depths. This is for Q1 North Sea IBTS, for other surveys a sweep length of 60m is considered adequate. IFREMER use these sweep lengths in the western area but change over at 125m. A summary of the French data with this rigging is presented in table 10.2.

Table 10.2. Summary of trawl surveillance data for the French survey.

Parameter	R^2	Slope	Value at 25m	Value at 125m	Change	Change %
	Short sweeps – depths < 125m					
Headline Height	0.184	-0.01	4.45	3.45	1.00	28.99
Wing Spread	0329	0.043	17.22	21.52	4.30	19.98
Door Spread	0.731	0.245	64.63	89.08	24.45	27.45
Net Swept Area	.0344	195.07	59381	78888	19507	24.73
Gear Swept Area	na	na	na	na	na	na
	R^2	**Slope**	**Value at 125m**	**Value at 200m**	**Change**	**Change %**
	Long sweeps – depths > 125m					
Headline Height	.001	0.001	3.64	3.66	0.02	0.55
Wing Spread	0.069	0.003	20.58	20.82	0.24	1.15
Door Spread	0.349	0.037	100.93	103.88	2.95	2.84
Net Swept Area	0.044	15.15	74092	75304	1212	1.61
Gear Swept Area	na	na	na	na	na	na

Using the short sweeps, the same depth dependence was seen as in the Scottish surveys, with changes in the order of 25% over the 100m depth range. In deeper waters, and with the longer sweeps, the gear performance was much more consistent.

Using data collected during the French EVHOE 1999 survey, a comparison was made between the performances of the three different trawls used. The characteristics of each trawl had been checked by the maker before the survey, and it was concluded that the three trawls were identical. Theoretically, the performance of these trawls should have been identical. In fact, variations were observed, mainly in values of headline height and wing spread between trawls (table 10.3). The reasons for these differences in performance cannot currently be explained.

Table 10.3 Summary of trawl surveillance data for three different trawls for the French survey

Trawl No.	Sweep length	Headline height	s.e.	Wing spread	s.e.	Door spread	s.e.	Nb Stations
1	100	3.1	0.3	19.6	0.9	104.9	7.9	5
2	100	4.1	0.3	21.5	0.9	104.1	3.6	17
3	100	3.6	0.6	20.6	1.6	102.3	9.2	53
2	50	4.3	0.2	21.5*	na	88.3	3.7	2
3	50	3.8	0.7	19.7	2.3	79.8	8.3	43

* one station only

The net used in the Irish survey is not a GOV, but was designed as a small boat version of the GOV. Trawl surveillance data for this net are presented in table 10.4. The operating depth range was less than for the other two vessels and only short sweeps were used. There was no major change in headline height over this depth range, but strangely, there was a substantial increase in door spread of around 35%, with a concomitant increase in swept area.

Table 10.4. Summary of trawl surveillance data for the Irish survey.

Parameter	R^2	Slope	Value at 25m	Value at 125m	Change	Change %
Headline Height	0.015	0.004	5.29	5.73	0.44	7.68
Wing Spread	na	Na	na	na	Na	Na
Door Spread	0.661	0.267	50.50	77.15	26.65	34.54
Net Swept Area	na	Na	na	na	Na	Na
Gear Swept Area	0.480	854.06	157874	243280	85406	35.11

Conclusions

A number of major areas for concern can be identified:

- All surveys produced major depth related changes in gear performance.
- The deployment of the gear on the three surveys led to major differences in gear performance between vessels.

It is strongly recommended for all institutes to report all trawl surveillance collected during a survey.

The IBTS surveys are not designed explicitly as swept area surveys. They are considered as repeat station surveys designed to produce a relative abundance (CPUE) index. Depth changes in gear performance could therefore be considered as of minor importance, as they would be expected to be consistent between years for the same vessel/gear combination. However, this will only be true if there are no major changes in depth distribution of the target species, and that the gear performance is consistent between years. The first assumption is unlikely to be true, and the second is definitely false; gear performance on Scotia was different in two consecutive years, and on Thallasa between different nets on the same survey.

While the IBTS are not explicitly swept area surveys, it can be assumed that the design is predicated on the principle of a fixed swept area. The stations are meant to comprise a 30 minute tow, at a speed of 4 knots using a standard gear. If gear performance remained constant, these stipulations would deliver a fixed swept area.

Additionally, while the IBTS are used for relative abundance index calculation they are also used to produce abundance maps. These are widely used in management and international negotiation, and are likely to be biased by the depth related performance of the gear.

The impact of these depth related gear performance changes on the catch rates in the surveys is presently unclear. An analysis of this was attempted for the Scottish surveys. However, there was considerable confounding of both gear and catch parameters with depth, and modelling efforts were usually dominated by the depth signal. Using reduced depth ranges ameliorated this but also reduced the number of data points. Notwithstanding this there were some tentative suggestions that gear parameters were linked to haddock CPUE. This will be investigated further.

The WG concluded that the investigation of depth related gear performance should be extended to other surveys, particularly those in the North Sea, and participants were encouraged to send appropriate data sets to MLA for analysis. It was agreed that gear performance was an important potential source of variability, and that this should be quantified. Participants should continue to collect the full range of trawl surveillance data:

- Headline height
- Wing spread
- Door spread
- Distance towed – over the ground (the method of calculation should be explicit)
- Speed over the ground AND through the water – where possible.

Theme session K (see section 8) also identified gear contact with the bottom as a potentially important variable. Some IBTS operatives had assumed that the Scanmar trawl surveillance gear provided this data, however this is not the case. Simple gear is available to monitor this parameter and it’s applicability should be investigated.

11 IBTS AND GOOS

At the last IBTS Working Group meeting in Lisbon (April 1999) a message was received from the ICES Hydrographer with the following information. ‘At a recent ICES Workshop on GOOS (Global Ocean Observing System) the IOC GOOS Director (Colin Summerhayes) proposed that the IBTS data base could be adopted within GOOS.’ Subsequently at a LMR GOOS Panel session in Montpellier the Panel endorsed the IBTS database as a project of the GOOS Initial Observing System. The ICES Bureau discussed the matter at its June 1999 meeting and the following is extracted from the minutes of the relevant Bureau meeting:

‘…the Bureau supported the proposal that the IBTS could be submitted as an ICES contribution towards GOOS, and noted that there was a Recommendation for the 1999 ASC establishing a GOOS Steering Group in ICES.’

This is the background to a complex area of international agreements. This section is devoted to trying to unravel some of the mysteries of these agreements and set out the role of IBTS within the context of intergovernmental organisations. A fuller explanation is provided in the Working Document submitted by Hans Lassen

Global Oceanic Observation System – GOOS)

IOC/ICES have agreed to provide a pamphlet outlining GOOS and its objectives and this information sheet should have a section on IBTS. However, this pamphlet will not be available until early 2001; in the interim the chair of IBTS WG was invited to a Steering Group (SGGOOS) and the IBTS representative at the inaugural meeting in Southampton provides the following text.

The meeting was convened in response to a recommendation made by the ICES Workshop on GOOS:

‘The Steering Group on the Global Ocean Observing System (SGGOOS) be re-established as the ICES-IOC Steering Group on GOOS (Co-Chairs ICES rep/IOC rep) and will meet in Southampton from 23–25th October 2000.’

There followed a list of 10 terms of reference. The most important one from the IBTS perspective was a) iv):

‘ develop and oversee the role of the North Sea IBTS quarterly surveys in the Initial Observing System of GOOS, and liase with and report to GOOS bodies as appropriate’

Global Ocean Observing System (GOOS) is an organisation set up under the auspices of the International Oceanographic Commission (IOC) and is based in Paris. GOOS is the parent body of a number of other organisations, as it believes in a regional approach to its charter. Logically ICES should be dealing with the regional GOOS (EuroGOOS) but although it is the European regional centre it is unlike other centres.

- EuroGOOS is based in Southampton

- It has a 3 person Secretariat (Director Nic Fleming)

- It is a closed club. You must pay to join this club and then data donated by members is free to other paid up members. External interested bodies are expected to pay for access to the data. Currently 28 national agencies from 15 countries belong to the club.

- Initially EuroGOOS was set up to deal with real time data which could be used to safeguard public safety e.g. data on weather, sea levels etc. Thus the majority of agencies are concerned with meteorology and coastal sea monitoring.

- The only fisheries institutes that belong are IMR(Norway), FIMR(Finland), IFREMER, IEO and MI(Dublin).

- At this point no fisheries data are held in EuroGOOS.

Because of the closed nature of EuroGOOS, ICES has elected to deal with the parent, GOOS. As previously stated GOOS is based in Paris and its Director is Colin Summerhayes. The concept of GOOS is that it is almost a virtual reality organisation. In itself it will not hold any data but from its website there will be portals to centres that hold data on a number of subjects e.g.

Data on Nutrients

Data on Climate

Data on Hydrography (ICES Hydrographic database)

Data on Fisheries (ICES IBTS database)

These data tend not to be real time but can be accessed some months after first acquisition by participating agencies. By linking all these data sets interested parties can construct models so that an ecosystem approach can be used in assessing the problems in the North Sea. By definition, GOOS is meant to be global but it wants to use the North Sea fisheries data has a pilot regional example so that other regions can seek to emulate the work undertaken in the North Sea. In itself submitting data to GOOS will involve participating institutes in little or no work as the GOOS portal will be to ICES in Copenhagen. However, it is apparent that the structure of the present ICES database does not lend itself easily to casual enquiries from other websites. However, if the 5th framework proposal is successful (see section 3) this would be an ideal moment to add some useful front end features e.g. spatial maps of species abundance.

Crucially there is a 'sticking point' for access to these data. GOOS has a policy of 'open access to all data'. In effect this means that all original data is freely available to everyone. This is totally against the policy that the IBTS WG has operated for a number of years. This policy is summarised in a document produced by Wim Panhorst in May 1997 from which the following is extracted:

3. IBTS data

Data from the International Bottom Trawl Survey carried out in the North Sea and Division IIIa. The data stored consist of the raw haul-by-haul data together with various levels of aggregation.

Without restrictions the data are available to all usage in connection with ICES working groups or research projects within the ICES work programme. For all other users there is an important distinction between raw data and aggregated data.

For raw haul data the following is a summary of the procedure. Applicants have to fill out a form indicating the data requested, their level of aggregation or disaggregation, the reasons why the request is made, the title and description of the project for which the data are to be used, for whom the project is conducted and particularly whether the project is done under contract. Once the form is filled in and signed by the applicant, it will be sent to the national contact person of the countries responsible for supplying the data. In order for matters to move smoothly and efficiently, deadlines for responses will be given. Objections or specific requirements, when arising, will be handled by referring the applicant to the country which had objected.

For aggregated data down to the level of statistical rectangle (but without identification of the country or haul) the IBTS working group has suggested that the data should be in the public domain but that all requests should go through *the national contact persons to secure proper use of the data and guidance of the user. Until this has been accepted, all requests are referred by the Secretariat to the national contact person.*

The above policy has served the IBTS working group well and accommodates all reservations about releasing raw data; it should be borne in mind that some of the data are sensitive and all the data were acquired at great national expense by participating nations. Thus there is great reluctance to release raw data. If IBTS is to be adopted by GOOS this problem of accessibility must be addressed. The mood of the IBTS working group was one in which requests for certain aggregated sets of data maybe allowed to be accessed by GOOS but anything below a high level of aggregation would be denied.

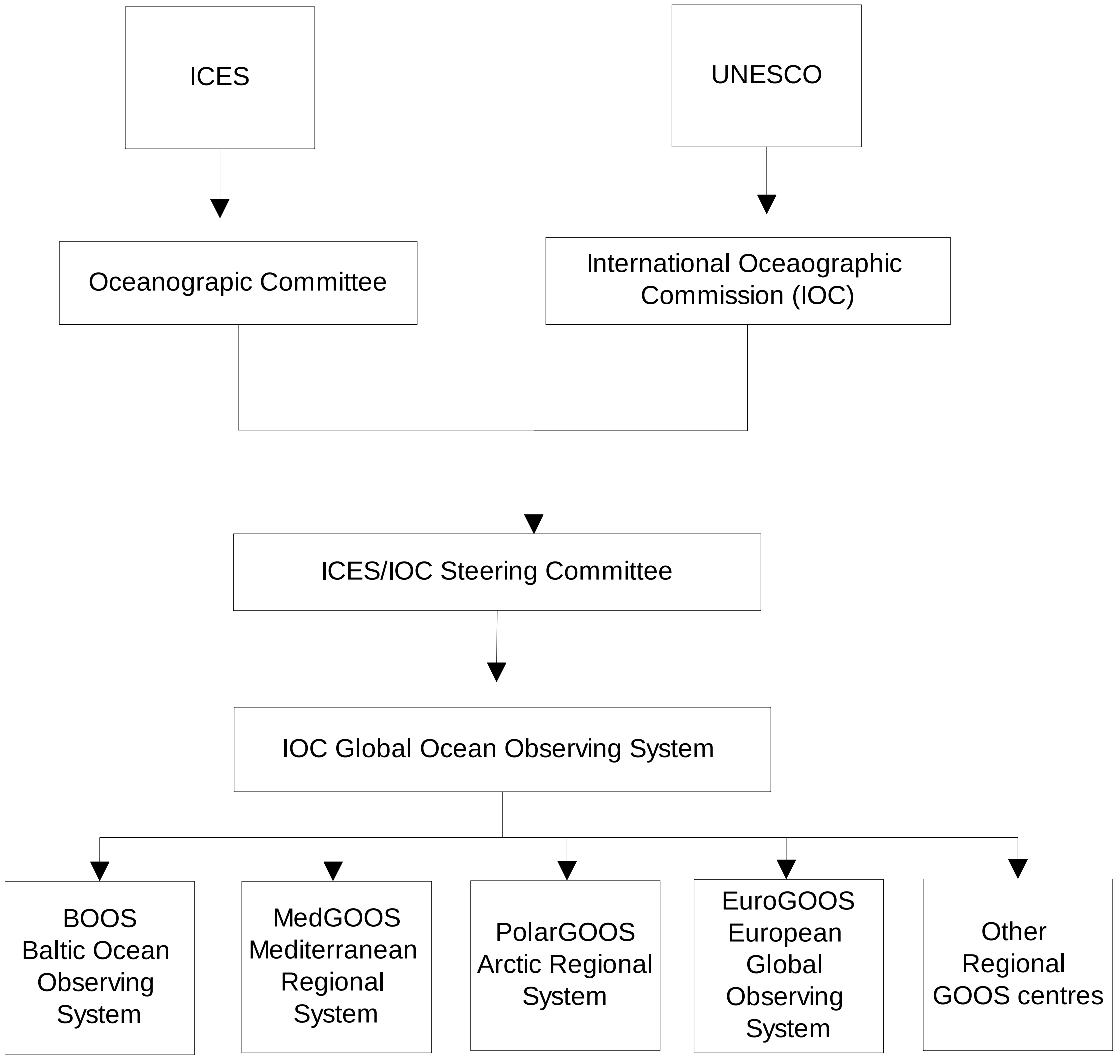


Figure 11.1 Schematic Diagram of GOOS organisation

12 REVIEW OF CO-ORDINATION

Given the wide temporal and spatial distribution of the IBT surveys it was decided that the most efficient method of co-ordinating the surveys was to establish regional co-ordinators. The current co-ordinators are:

Quarter 1 survey in the North Sea	Henk Heessen (RIVO)
Quarter 2 survey in the North Sea	Trevor Boon (CEFAS)
Western Division surveys (North of Cape Breton)	Rick Officer (MI)
Southern Division surveys (West of Cape Breton)	Francisco Sanchez (IEO)

Within the Working Group there was discussion whether the duties of the western and southern division should be merged into one unit of co-ordination. There is some scientific merit in this suggestion as the various stocks do not recognise an arbitrary boundary drawn by scientists. Merging the co-ordination could lead to an improved overview of those stocks that are encountered over the entire eastern shelf. On the other hand, it certainly significantly increases the burden on the single co-ordinator. On balance it was decided to retain the *status quo* but the situation should be reviewed at the next meeting. The division between the western and southern divisions was set at Cape Breton.

12.1 Q1 in the North Sea

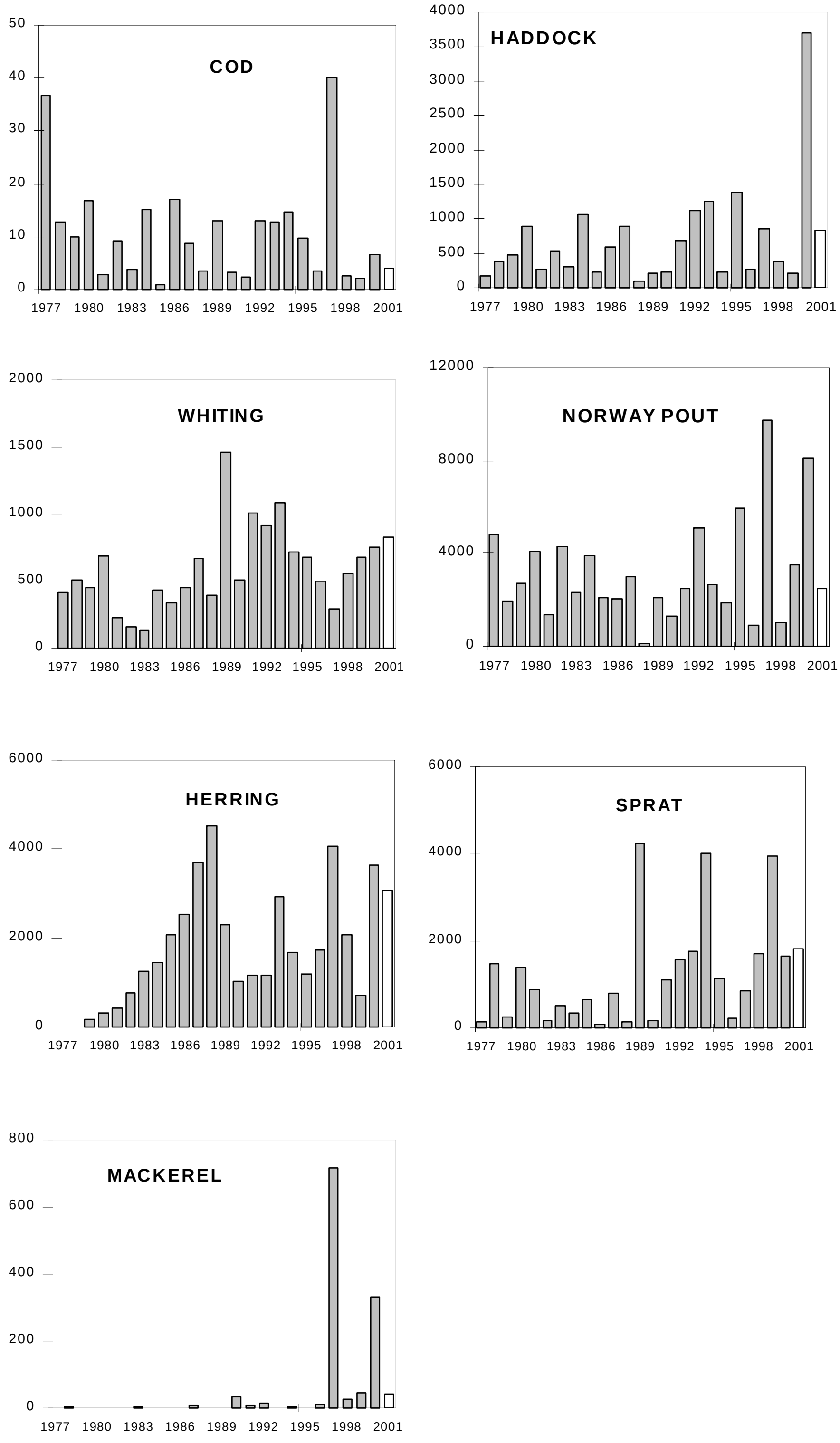
Eight vessels took part in the survey this year: “Argos”, “Dana”, “Tridens”, “Michael Sars”, “Walther Herwig III”, “Scotia”, “Cirolana” and “Thalasssa”. The coordination and the cooperation of the different vessels went fine. “Thalassa” had a break down and could not go out in time, but “Cirolana”, who joined in on the survey again after a long hault, managed to take most of the rectangles “Thalassa” should have taken. However, “Thalassa” came out later in the quarter and worked all her rectangles. The coverage was very good this year. All rectangles were covered with GOV, and the total number of hauls was 430. A total number of 464 MIK hauls were taken, and according to the preliminary data, only four rectangles were not sampled.

The preliminary indices for age 1 in 2001 based on length only are shown in the text table below:

	Cod	Haddock	Whiting	N. Pout.	Herring	Sprat	Mackerel
Index	4.0	836	835	2486	3075	1822	43
% of av. 78 – 00	40%	119%	141%	79%	165%	144%	82%

It must be mentioned that the very rich 1999 year class of haddock seams to have had a low growth, and that the index of haddock also contain some of this year class. The time series of the indices are shown in Figure 12.1.

Figure 12.1 Preliminary 1-group indices as average N/hour fishing.



12.2 Q3 in North Sea

The North Sea, Skagerrak and Kattegat quarter 3 survey has now completed 10 years in its co-ordinated form. Table 12.2.1 shows the effort ascribed to this survey over the time series. Good coverage of the area had continued until 2000 when, unfortunately Sweden withdrew their vessel at very short notice. As a consequence the Skagerrak and Kattegat were not surveyed that year. Data from this survey have been used each year in the North Sea Demersal Working Group, which meets in October, shortly after the survey is completed. In recent years efforts have been made to provide age based indices for the entire survey to that working group and the preliminary reports for the survey have not been produced. Although the data are used it was felt that some form of report on the survey is desirable and that the preliminary report provided for that requirement. It is recommended that the preliminary report for quarter three surveys should be produced in future and retrospectively for 1999 and 2000.

Table 12.2.1 Number of valid hauls and days at sea per country for quarter 3 surveys 1991 - 2000 and number of days proposed for 2001

	1991		1992		1993		1994		1995		1996		1997		1998		1999		2000		2001
	Hauls	Days	Hauls	Days	Hauls	Days	Hauls	Days	Hauls	Days	Hauls	Days	Hauls	Days	Hauls	Days	Hauls	Days	Hauls	Days	Days
Denmark															51	14	54	15	62	15	18
France			61	17	70	19	55	19			56	32									
Germany			48	12							33	8	32	8	28	8	31	9	26	7	8
Netherlands	73	19	32	11	65	17	42	10	34	9	17	5	18	8							
Norway																	77	26	71	21	28
Sweden	52	15	53	15	53	15	53	15	53	15	53	15	46	15	48	15	48	15			15
UK(England)	87	27	72	31	71	27	73	23	74	30	79	27	74	26	74	28	74	28	75	28	32
UK(Scotland)	90	20	87	20	87	20	89	20	89	20	85	20	88	20	77	18	79	21	80	18	23
Total	302	81	353	106	346	98	312	87	250	74	323	107	258	77	278	83	363	114	314	89	124

12.3 Western Division Q4 Groundfish Surveys 2000 Report

Table 12.3.1. Summary of surveys undertaken in Western Division in 2000.

Country	Ship and Institute	Dates	Area	Days	No. of Hauls
UK (Scotland)	*Scotia*, MARLAB	12 November - 4 December	West coast of Scotland	23	75
France	*Thalassa*, IFREMER	19 October - 1 December	Bay of Biscay and the Celtic Sea	45	121
Ireland	*Celtic Voyager*, MI	11 November - 2 December	Irish Sea and Celtic Sea	20	65
Ireland	*Marliona*, MI	9-19 November	West of Ireland	16	68

NATIONAL SURVEYS

Scottish Surveys

A total of 39 valid half hour tows were conducted in ICES area VIa, 5 in VIIb and a further 11 tows were undertaken in the Irish Sea (VIIa). *Scotia* deployed the GOV trawl fitted with heavy ground gear (gear C) on the trawling stations to the west of Scotland. The fishing gear was monitored continuously by Scanmar equipment for headline height, wing spread, door spread and net speed through the water. Additionally a number of navigational parameters were also monitored. The catches were sampled and analysed according to established Scottish principles which, in turn, are based on recommendations from the IBTS working Group (Addendum to ICES CM1996/H:1).

One of the main objectives of this survey is to provide indices of abundance for the relevant ICES working groups e.g. Northern Shelf Demersal Assessment WG.

French surveys

117 valid hauls were realised in the strata covered traditionally since 1997 and 4 extra hauls in depth from 400-600 m were also realised following a recommendation from the IBTS working group. The sampling strategy has remained unchanged and is of a stratified random selection of stations.

The gear used is a GOV 36/47 without the kite but with extra buoyancy added. Gear performance was monitored during each set through Scanmar and Pacha instrumentation.

Abundance indices were computed by age and by sex for hake, whiting, megrim, cod, anglerfishes (black and white) and ling. All other species of fish, *Nephrops* and three species of *cephalopods (Illex coinditi, Lologo vulgaris, Loligo forbe*

Irish Surveys

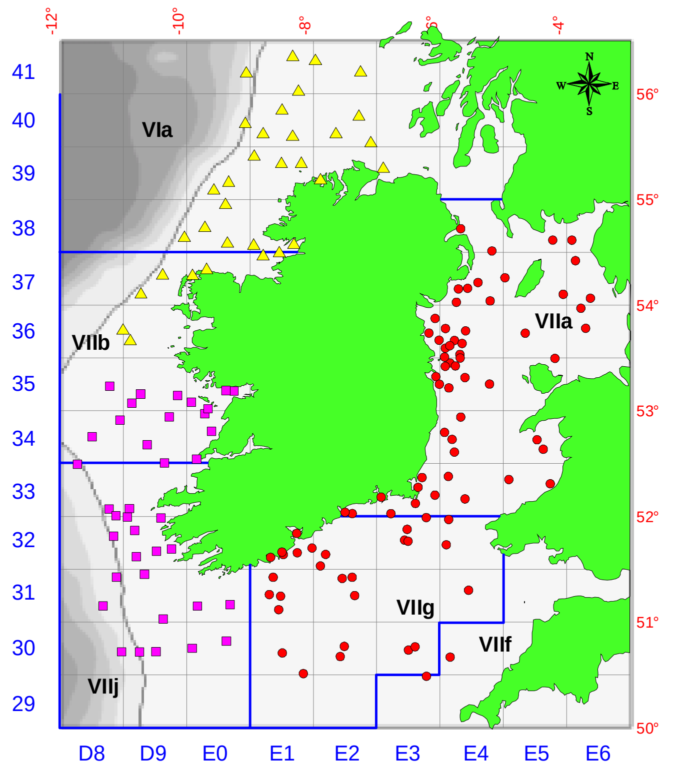
West Coast Groundfish Survey, October 2000

The West Coast Groundfish Survey is carried out in two parts: Part A fished 32 stations in ICES Division VIa (south) and VIIb (north); Part B covered 38 stations in ICES Division VIIb and VIIj. This survey is carried out on the chartered commercial fishing vessels each year. The same vessels are used each year. In 2002 these surveys will be transferred to Ireland's new 65m Research Vessel.

The Irish Sea and Celtic Sea Groundfish Survey, November 2000

The Marine Institute's Marine Fisheries Services Division conducts the ISCSGFS from the *RV Celtic Voyager*. The fishing gear used is a GOV 28.9/37.1 Trawl with Morgere Kite (0.85 by 0.85m). Morgere Polyvalent doors (Type AA4.5) are used and Gear performance is monitored throughout the survey using the SCANMAR (RX400) net monitoring system (Headline height, Door spread). The catch is sampled and analysed according to established Irish Survey Protocols, which are based on the recommendations of the IBTS. The 2000 survey was undertaken from 11th November to 2nd December. A total of 65 valid half hour tows were completed. The present survey represents the fourth survey in the time-series. In 2002 these surveys will be transferred to Ireland's new 65m Research Vessel.

Figure 12.3.1. Irish survey trawl positions for the West Coast Groundfish surveys (Part A – triangles, Part B – squares) and Irish Sea Celtic Sea Groundfish surveys (circles).



As part of the standardisation of methodologies, the Marine Institute participated in the UK survey of western waters in March 2000 on *RV Cirolana*. Furthermore, during the comparative tow exercise between *Celtic Voyager* and *Thalassa*, scientific staff were exchanged to observe protocols used on the two research vessels.

New proposal for Spanish survey

Spain has proposed a new survey to help overcome the current lack of sampling in all areas of the IBTS Western Division. The Spanish survey will be carried out during the months of August-September 2001. The survey area proposed is the Porcupine Bank extending from longitude 12º W to 15º W and from latitude 51º N to 54º N and corresponding with a zone of western European shelf currently without standardised surveys. The new research vessel *Vizconde de Eza*, a stern trawler of 53 m and 1800 kw, will be used. The target species will be hake, anglerfishes, megrims and Norway lobster. The sampling gear used will be the Baca 44/60, which is the standard sampling gear in the Southern Division and similar to the gear used by the Spanish fleet operating in the area. This gear is proposed as no standard gear exists yet for the Western Division. Participation of Irish scientists from the Marine Institute, Dublin is anticipated in this survey.

Station allocation and depth stratification

Different strategies are in used in the surveys. France is using a depth stratified sampling strategy; Ireland and Scotland are using an ICES rectangle based strategy. The possibility of a change in sampling strategy to integrate depth was investigated for the *Scotia* survey. It was concluded that due to the particularly rough bottoms and the lack of hauls in depth more than 200 m occupied in the time series, there was no evidence to modify the current strategy. This issue will need to be revisited given the expansion of survey coverage planned in the western division.

On board sampling strategies

The effect on computation of age composition of treating species by sex or not was investigated. The results of a study carried during the French survey on megrim and whiting are presented under section 6.2.

Gear performance monitoring

From the results of the preliminary gear monitoring data analysis, it was agreed that gear monitoring should be conducted on a systematic basis. Standardised positioning of the Scanmar element on the trawl gear has to be defined.

Computation of abundance indices

Taking into consideration the different techniques used in the computation of abundance indices, it appeared that the average value per basic unit (rectangle or stratum) weighted by its area should be used. In the case of a rectangle which includes land or area of depth not intended to be covered initially (e.g. > 200 m in the Irish and Scottish surveys) those areas have to be excluded from the computation of the rectangle area.

Environmental data

CTDs were carried after each tow during the French survey (a total of 119 stations). Water temperature was recorded during each tow by mean of a mini-logger attached to the net during the UK Scotland survey. Surface temperature and salinity was continuously recorded during the survey. CTD data were collected during the ISCSGS (Ireland) in 2000. However, there were problems with the electronic equipment and the data are sporadic. No environmental data are recorded on the WCGS (

Inter-Calibration

8 days of inter calibration (32 hauls) between the *RV Thalassa* and *RV Celtic Voyager* were completed in the Irish and Celtic Seas in November 2000. This work was conducted under the IPROSTS project. A preliminary report on the project is given elsewhere in this report.

Co-ordination meetings

A meeting was held in Paris in October 2000 to plan the inter-calibration between the *RV Thalassa* and the *RV Celtic Voyager*.

A meeting of scientists involved in groundfish surveys in the Western Division is planned after the 2001 surveys. This meeting will be particularly timely given that Spain will have commenced a survey west of Ireland on the Porcupine bank and Ireland will soon have extended capacity to conduct surveys following the delivery of a new 65m research vessel. A report will be made to the full IBTS Working Group in April 2002.

12.4 Overview of Southern Division Surveys 2000

The series of 4th quarter bottom trawl surveys were accomplished and 284 valid hauls were realised. The surveys were performed from 25 September until 20 November 2000. The European Atlantic shelf from 48º of latitude to the Strait of Gibraltar was sampled (ICES Divisions VIIIa, b and c and IXa). All the area was stratified according to 11 main geographical sectors (Figure 12.4.1) and depth strata.

French survey in the Bay of Biscay

63 valid hauls were realised in the Bay of Biscay (geographic sectors GN and GS, figure 12.4.2). The sampling strategy and methodology are defined in the previous section (Western Division Surveys).

Spanish surveys

Two surveys were conducted in the 4th quarter of 2000, one on the northern Spanish shelf (ICES Division VIIIc and IXa) and other in the Gulf of Cadiz (ICES Division IXa) and one in the 1st quarter (only in the Gulf of Cadiz). All surveys were accomplished following stratified random sampling protocols with the R/V *Cornide de Saavedra* and using the Baca 44/60 trawl gear with a 20 mm codend mesh size. The mean headline height was 2.0 m and the mean wing spread and door spread were 21.2 m and 125.2 m, respectively. The duration of each haul was 30 minutes in the northern survey and of 1 hour in the southern one, carried out during daylight at a towing mean speed of 3.0 knots.

In the North of Spain a total of 113 valid half-hour tows were conducted (table 12.4.1 and figure 12.4.2). In addition 8 extra hauls were carried out outside the standard sampling area, in shallow and deeper depths (less than 80 m and more than 500 m depth). Gear performance was monitored by Scanmar equipment. Also, 134 CTDs sampling stations were carried out.

Abundance indices were computed by age and by sex for hake, blue whiting, four-spot megrim, megrim, anglerfishes (black and white), horse mackerel, and mackerel. All other species of fish and invertebrates (only commercial species) were measured. At present abundance indices by age are being processed. The biomass and abundance indices resulting from this survey for the major commercial species are in the table 12.4.2.

During 2000 two groundfish surveys were conducted in the Gulf of Cadiz, in the Spring and in the Autumn. In the Spring survey a total of 38 valid one-hour tows were achieved, including 23 CTDs sampling stations. The surveyed area covered depths ranging between 15 and 700 m (figure 12.4.2). The main objectives of the Autumn survey were focused in the calibration of the Baca 44/60 and GOC 73 (MEDITS-E surveys) trawl gears. Nevertheless, the sampling scheme followed in this calibration experience was similar to that of the standard surveys. In this survey, a total of 30 1-hour valid hauls were carried out with the Baca 44/60 gear, which were restricted to depths shallower than 500 m depth due to the ship-time available. Additionally, 25 CTDs stations were also carried out in this survey.

Biomass indices (kg per hour) for the whole area were computed for the main commercial species: hake, horse mackerel, blue whiting, mackerel and Spanish mackerel, octopus (*Octopus vulgaris*), cuttlefish (*Sepia officinalis*), rose shrimp (*Parapenaeus longirostris*) and Norway lobster. Results are shown in the table 12.4.2.

Portuguese surveys

During 2000 two Portuguese groundfish surveys were conducted, in summer and autumn, covering Division IXa in Portuguese waters. The area surveyed extends from latitude 41°20' N to 36°30' N, and from 20 to 750 meters depth (figures 12.4.1 and 12.4.2; table 12.4.1). In summer (July) and autumn (October-November) 2000 surveys a total of 88 and 78 valid hauls were realised (figure 12.4.3), and 178 and 158 CTDs sampling stations took place, respectively.

The sampling strategy was unchanged from the previous surveys and is a fixed station sampling scheme. A total of 97 fixed stations were planned, spread over 12 sectors. Each sector is subdivided into 4 depth ranges: 20-100, 101-200, 201-500 and 501-750 m (figure 12.4.2) with a total of 48 strata. The duration of each tow was 60 minutes, carried out during daylight at a towing mean speed of 3.5 knots.

The Portuguese surveys were carried out with the R/V *Noruega*. The fishing gear used was a bottom trawl (type Norwegian Campell Trawl 1800/96 NCT) with a 20 mm codend mesh size. The mean vertical opening was 4.6 m and the mean horizontal openings between wings and doors were 15.1 m and 45.7 m, respectively. CTD sampling stations were homogeneously distributed all over the study area, avoiding leaving large extensions uncovered.

The catch was sorted by species, counted and weighted. All fish and commercial cephalopods and crustacean species were measured. Biological parameters (length, weight, status of maturity among others) and hard structures (otoliths and *illicia*) were collected. Abundance indices (number per hour) and biomass indices (kg per hour) for the whole area were computed for the main commercial species: hake, horse mackerel, blue whiting, mackerel and Spanish mackerel, megrims, anglerfish and rose (*Parapenaeus longirostris*) and red (*Aristeus antennatus*) shrimps and Norway lobster. Results are shown in the table 2. At present abundance indices by age are being processed.

More information on Portuguese surveys is provided in a Working Document presented to this WG (Cardador, 2001).

In the whole Southern Division hake present a wide distribution with local patches corresponding to the nursery areas (figure 2.4.3). The highest biomass indices were observed on the Portuguese shelf (figure 12.4.4). The low abundance index of this year reflects the scarce level of recruits (0 class).

Table 12.4.1. Sampling areas, valid hauls and coverage per sector in 4th quarter of 2000 on IBTS Southern Division surveys.

Zone	Geographic sector		Survey 2000	
	Name	km²	Valid hauls	Hauls/1000 km²
Bay of Biscay	GN	56820	48	0.84
	GS	14470	15	1.04
Cantabrian Sea	AB	2460	13	5.28
	PA	4614	24	5.20
	EP	5352	21	3.92
Galicia	FE	7774	36	4.63
	MF	4139	19	5.07
Portugal	NO	11245	25	2.22
	SW	5837	30	5.14
	SO	7296	23	3.15
Gulf of Cádiz	CA	6774	30	5.50
Whole area		**126781**	**284**	**2.24**

Table 12.4.2. Standardised indices of abundance in the 4th quarter of 2000 from Southern Division.

Species	French Bay of Biscay		Spain North		Portugal		Spain South	
	Kg/hour	N/hour	Kg/hour	N/hour	Kg/hour	N/hour	Kg/hour	N/hour
Hake	9.76	204.16	6.02	133.8	10.9	91	2.03	25.1
Four-spot megrim	0.06	0.42	3.78	66	0.1	0.8	0	0
Megrim	0.5	1.4	3.5	38	0.02	0.1	-	-
Black anglerfish	0.6	0.42	1.32	0.8	0.13	0.1	0.48	0.9
White anglerfish	0.8	0.74	1.14	1.8	0	0	0.04	0.1
Blue whiting	205.96	8510.04	152.38	6054.2	95.6	2951.5	10.82	358.3
Horse mackerel	177.48	4214.96	48.54	399.6	6.8	78	1.74	69
Mackerel	39.1	308.5	5.08	59.8	2.4	25.8	0.14	0.4
Spanish mackerel	1.56	29	-	-	0.1	0.3	0.1	0.6
Norway lobster	0.64	40.1	0.14	3	0.4	10.2	0.41	14
Rose shrimp	-	-	-	-	2.5	215.9	1.66	419.9
Red shrimp	-	-	-	-	0.2	10.7	-	-

Figure 1. General geographic stratification of the bottom trawl surveys included in the Southern Division.

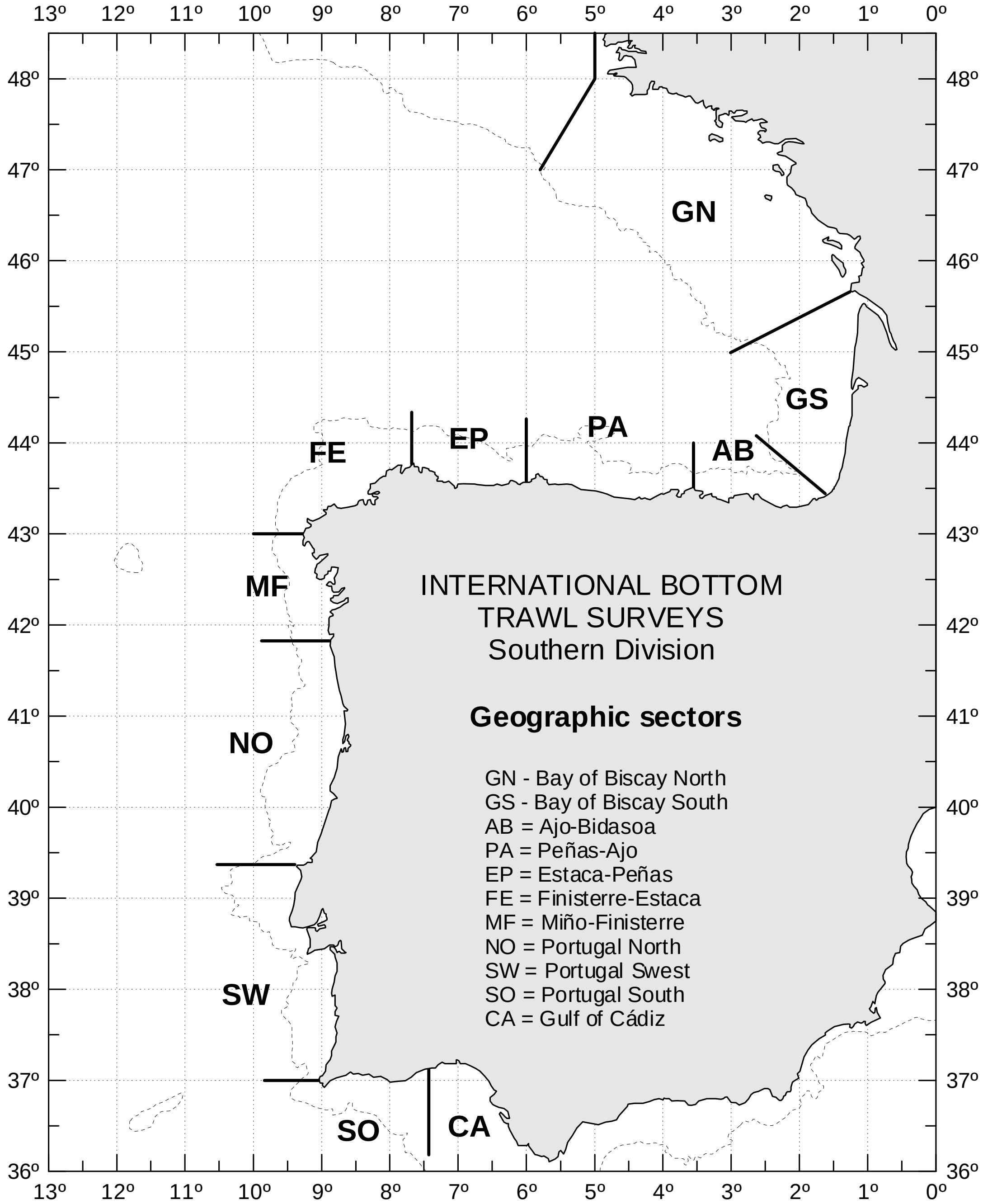


Figure 2. IBTS Southern Division. Location of hauls in 4th quarter bottom trawl surveys.

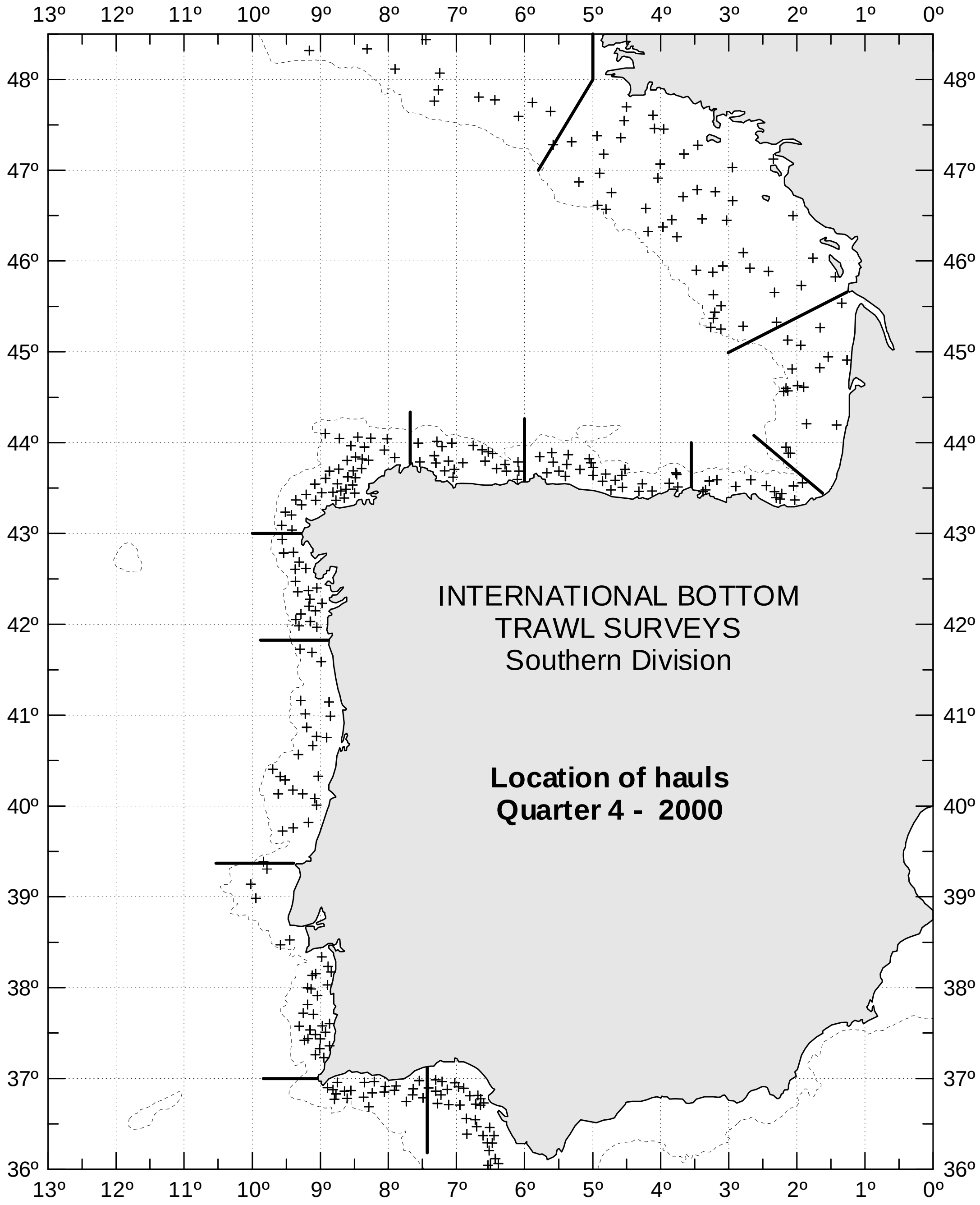


Figure 3. Standardised abundance indices (n/hour) of hake in Southern Division.

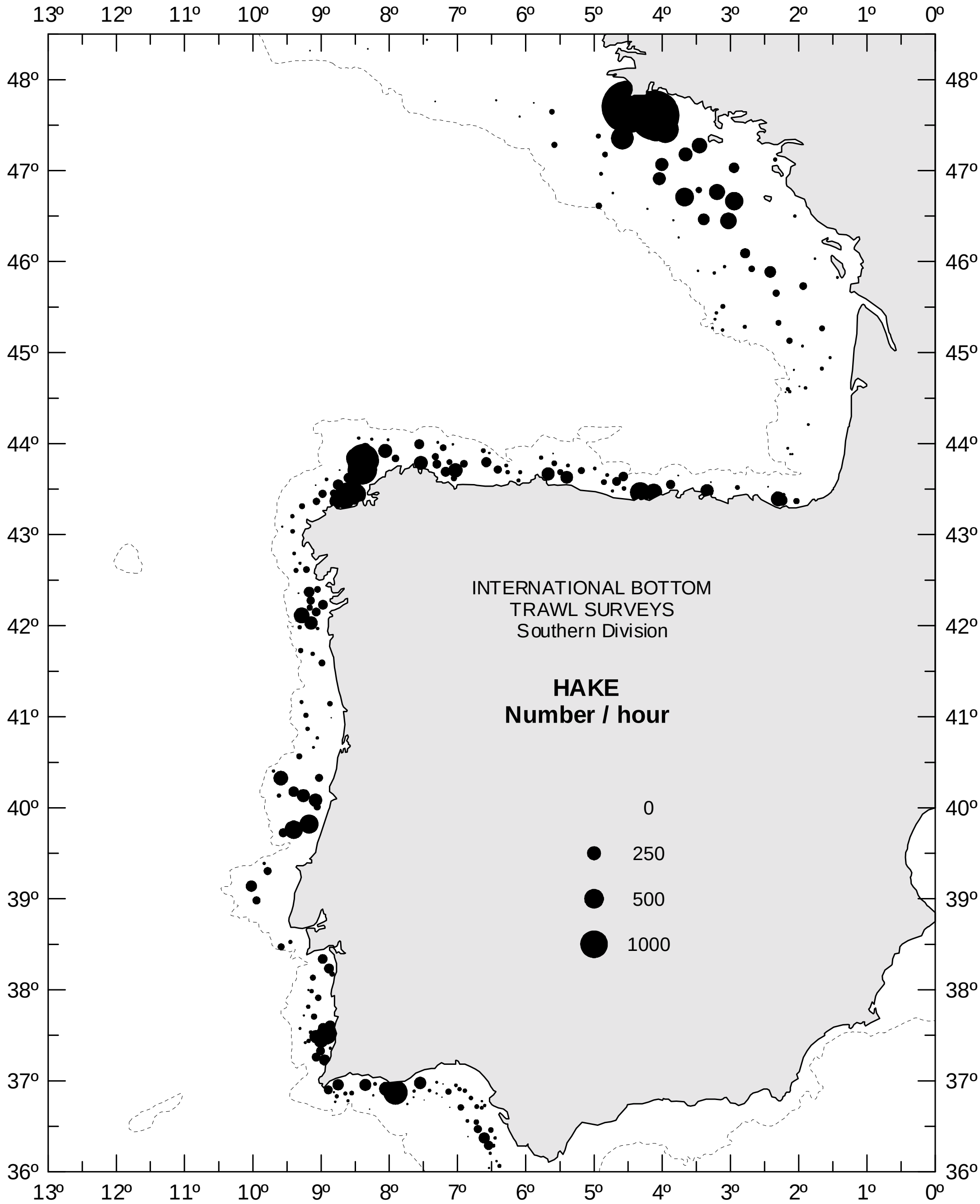
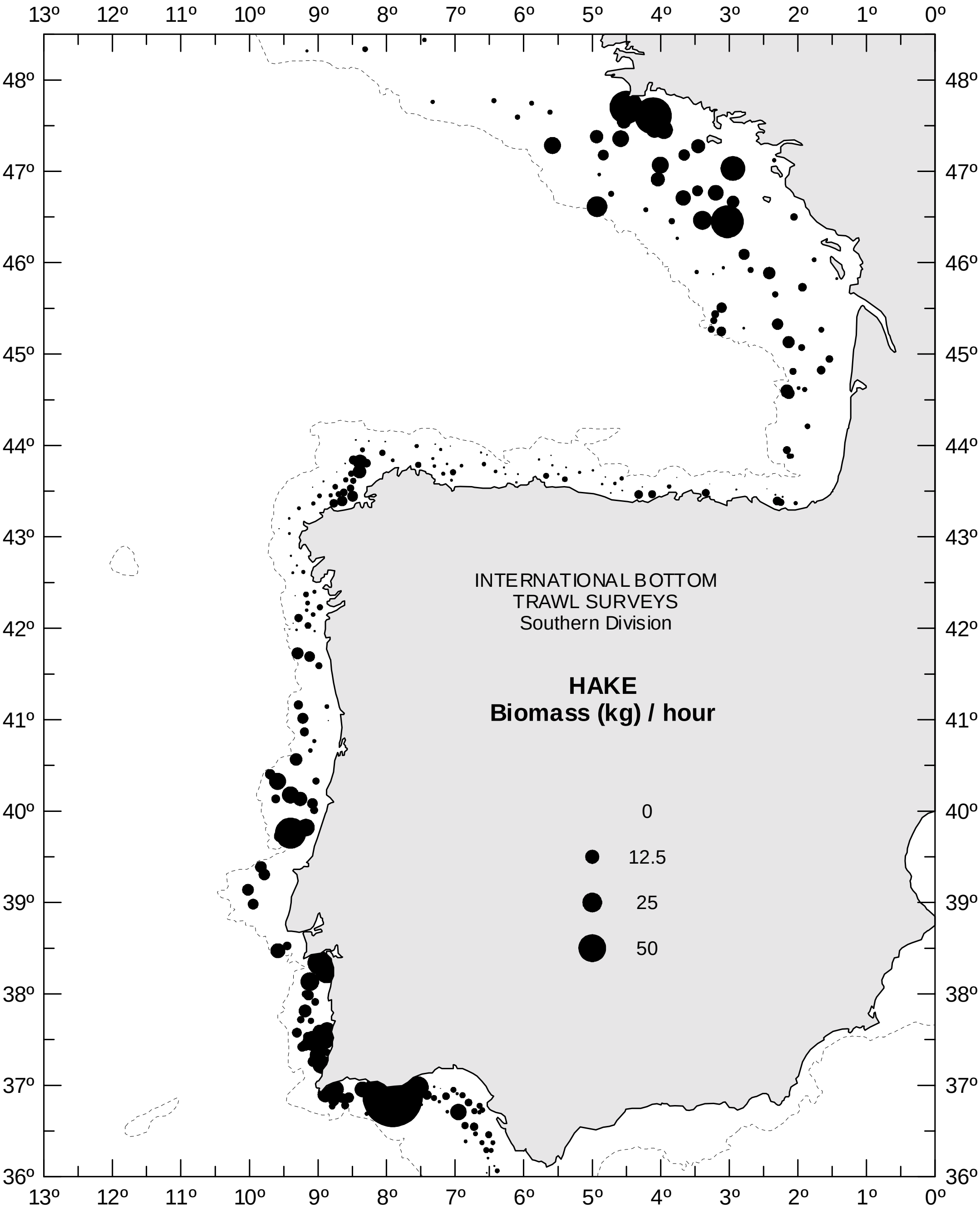


Figure 4. Standardised biomass indices (kg/hour) of hake in Southern Division.



13 RESULTS OF COD INDICES FROM Q1 2001

The preliminary index for cod, age 1, in 2001 was only 40 % of the average for the period 1978 – 2000. This index is based on length only (all fish less than 25 cm), and a very preliminary age/length key indicates that the index may be even lower. All year classes after 1996 have been well below average, which means that the SSB is likely to stay at a low level in the near future.

Reports from the individual cruise leaders and from the survey co-ordinator indicate that the survey was conducted in the usual manner with no unusual factors that may have corrupted the survey data. Thus it is likely that the cod index reported is a reflection on the current state of the cod stock.

14 GENERAL

14.1 MIK hauls

At the last IBTS Working Group meeting held in Lisbon, April 1999, a request was received from the Herring Assessment Working Group to increase the number of Methot Issac Kidd samples from an area south of 52º 30' N. The Group agreed to try to respond to this request by undertaking an additional 27 hauls in the area. However, after some practical experience of the additional work it has been decided that the IBTS will have to revert to the standard number of hauls in each statistical rectangle as it was proving impossible to meet all the targets assigned to the vessels involved. If extra ship time becomes available additional MIK hauls may be undertaken.

14.2 Sprat Otoliths

The problem of the level of sprat otolith sampling was re-visited. In April 1999, after an approach from the Herring Assessment WG, the recommended level of otolith sampling was raised to either 12 or 16 otoliths per 0.5 cm (depending on the length class). At the time it was pointed out that this increased level of sampling had an impact on the amount of time required for age determination in each institute. Two year's experience has indicated that this is a problem and no institute has been able to reach the level of sampling requested.

14.3 Mapping of species on the eastern Atlantic.

Improved co-ordination in the western and southern divisions has unveiled the possibility of a more coherent approach to the publication of data acquired from these surveys. As a first approach it has been agreed that the relevant institutes will provide data in an agreed format for the following species:

Mackerel (Numbers of abundance for 0, 1, 2 and 3+ year classes)
Hake (0, 1, and 2+)
Blue whiting (Total abundance)
Horse mackerel (Total abundance)

Dave Reid of MARLAB will co-ordinate the data exchange and produce maps which can be loaded onto an appropriate web site, for example ICES, in order to ensure a wider distribution of the data. Initially data from the Q4 surveys in 2000 will be used.

14.4 Web sites

The Working Group is concerned that the format of the current IBTS database at ICES is too restrictive to allow any information to be displayed on the web. Presentations were made of Canadian and UK (CEFAS) examples of simple methods of displaying aggregated data for groundfish surveys. Hans Lassen of ICES was involved in the discussions and it was agreed that this would become a priority as soon as staff and financial resources allowed. There is a related link to section 14.2.

15 RECOMMENDATIONS

1. If the 5th Framework proposal is successful the co-ordinator should maintain continuous and open dialogue with the appropriate Working Groups in designing the format of the database, the exchange files and the various outputs

2. If the 5th Framework falls, which implies that the IBTS database will not be re-created, then the ICES Secretariat must review the current weaknesses in the database. Many of these are documented within the IBTSWG and by comments from other WGs which use the IBTS database

3. There should be mandatory reporting of gear parameter data that is currently recorded on surveys.

4. Depth stratification should be applied in the western and southern divisions

5. Sampling of megrim for abundance indices at age should be carried out by sex.

6. Valid tow positions should be reported to CEFAS

7. The IBTS WG recommends that all countries check the problems described in WD1 and report any changes made in the IBTS data at the earliest possible occasion to the ICES Secretariat.

8. ICES should improve the quality of the IBTS data checking programme by including in this programme:

   - a check against minimum and maximum lengths for all species, and giving a warning if this length is exceeded by more than 10%;
   - the listing of records in which only the genus or family is recorded (with the exception of a few major genera/families such as Ammodytidae, *Pomatoschistus* sp.);
   - the listing of any ‘rare’ species recorded.

9. The IBTS WG recommends that laboratories which possess a collection of photographs of fish, macro-benthos species and maturity stages, exchange such photo-collections (if possible in a computerized format), in order to improve species and maturity identification.

10. The IBTS WG recommend the exchange of scientists between vessels.

11. Participants are requested to report data that correspond to the format type 1A. These data should be added to the IBTS database

12. Due to the heavy workload facing the Group in the next year it is recommended that a meeting is held 8-11th April 2002. The Irish institute has offered to host this meeting in Dublin.

13. The WG recommends that participants in North Sea Quarter 1 survey forward gear performance parameters to Dave Reid of MARLAB.

14. All survey co-ordinators should produced preliminary reports similar to that produced by the Q1 N sea survey and they should be circulated to all members of the WG.

15. All fisheries survey data reported to ICES must carry the correct hydrographic station number when such data are available.

16. All Participating institutes review their catch sampling strategies in order to achieve optimisation of sampling for each species.

16 SUGGESTED TERMS OF REFERENCE

a) to review intersessional work on stratification, sampling, gear selection and standardisation etc in the western and southern divisions

b) to critically review the format and quality of gear parameters supplied to ICES as described in the IBTS Manual

c) to review the recommendations arising from the IPROST (EU Contract 98/057 – International Program of Standardized Bottom Trawl Surveys off Northwestern Europe) project for on-going inter calibration of surveys

d) to inform ICES on the contents and outputs required from the IBTS database

e) to present and document each institute's catch processing from initial sorting to final data storage

f) to review all papers to be delivered at the next ICES ASC (theme sessions P and Q) which may have implications for IBTS surveys.

g) Evaluate the new standard indices and the implications in using new indices in assessments in collaboration with relevant assessment working groups.

h) Examine the gear parameters extracted by ICES from the IBTS database and analyse net performance

i) To review the extent of institute's collections of identification and maturity stage photographs.

j) Review the co-ordination of surveys in the three divisions including the development of survey manuals

17 LITERATURE

17.1 References

ICES 1994. Report of the international bottom trawl survey working group C.M. 1994/H:6

Wheeler, A. 1978. Key to the fishes of Northern Europe. Frederick Warne Ltd, London.

17.2 Working Documents

Adlerstein, S & Ehrich, S. Summaries of papers relevant to the Working Group presented during the theme session K (Incorporating of external factors in marine resource surveys) at the ICES Annual Meeting in 2000.

Bellail, R, Meillat, M, & Morandeau, F Preliminary Analysis of Performances of GOV 36/47 during the French EVHOE surveys in 1999 and 2000

Cardador, F. 2001. Portuguese groundfish surveys - abundance and biomass indices of the main species in Portuguese waters during 1990-2000. Working Document, IBTS WG, 8pp.

Daan, 2001. A rarity index of North Sea fish species based on survey data. ICES CM 2001/(in prep.)

Daan, N The IBTS database: a plea for quality control

Lassen, H. Global Oceanic Observing System (GOOS)

Mahe, J.C. Estimation of Abundance Indices at Age in Research Surveys (A comparison of sampling strategies)

Sanchez, F, Cardador, F, Ramos, F, & Sobrino, I. Southern Division Groundfish Surveys 2000 Report

Appendix 1

International Bottom Trawl Survey Working Group

IBTS SURVEYS MANUAL

for the Western and Southern areas

REVISION I

DRAFT VERSION based on the manual of the
SESITS Project

1. Introduction

The International Bottom Trawl Survey Working Group, has the responsibility of coordinating various research vessel surveys conducted within certain ICES areas. The first survey to be coordinated was the International Young Fish Survey (IYFS) that was conducted in the North Sea and Skagerrak/Kattegat. A procedural manual was produced for the use of scientists involved in this survey.

In 1995 the manual was revised for a fifth time in order to clarify certain aspects of the surveys in the North Sea and Skagerrak/Kattegat. At the same time the opportunity was taken to review the manual to establish whether the same procedures could be applied to Sub-Areas VI, VII and VIII and Division IXa. It was decided that some aspects of the manual applied equally to all areas but some procedures required dedicated text. These unique procedures were provided in Appendix XI as a draft.

In the 1999 IBTS Working Group meeting in Lisbon, due to the considerable difficulties in merging the protocols used in the North Sea with those used in the western and southern divisions, it was decided that two manuals should be the standard: one relating to the North Sea and the other to the western and southern areas. It was also decided that the lasted should be based on the manual produce in the SESITS project (Evaluation of demersal resources of Southwestern Europe from standardized groundfish surveys - Study contract 96-029), wich this documents refers as a 1º draft.

2 List of surveys

Scottish Surveys

- Quarter 1, Groundfish survey in ICES Division VIa (SGF6a)
- Quarter 3, Rockall Survey (SGF6b) (every second year)
- Quarter 4, Scottish Mackerel Recruit Survey (SMR)

Irish surveys

- Quarter 4, West coast Groundfish Survey (WCGS)
- Quarter 4, Irish Sea-Celtic Sea Groundfish Surveys (ISCS)

English Survey

- Quarter 1, Celtic Sea and Western Approaches Groundfish Survey (CSGF)

French surveys

- Quarter 4, French Groundfish Survey in the Eastern Channel (Division VIId) (CGF)
- Quarter 4, French Groundfish Survey in the Celtic Sea and Bay of Biscay (Divisions VIIf,g,h,j; VIIIa, b) (EVHOE)

Spanish surveys

- Quarter 4, Spanish Groundfish Survey in the Cantabrian Sea and Off Galicia (Divisions VIIIc and Northern part of IXa) (SPGFN)
- Quarter 2 and 4, Spanish survey in the Gulf of Cadiz (Southern part of division IXa) (SPGFS)

Portuguese surveys

- Quarter 3 and 4, Portuguese Bottom trawl Survey (Portuguese shelf - Division IXa) (PGF)

3. Objectives

The main objectives of the demersal surveys listed above are:

- to determine the distribution and relative abundance of all species of fish within the surveys area, particularly those of commercial importance,

- to estimate the distribution and abundance of recruits of the main commercial species to derive recruitment indices,

- to monitor changes in stocks of commercially important fish species independent of commercial fisheries data and to monitor changes in species currently not of commercial importance,
- to describe the spatial distribution pattern of all species,

- to collect data for the determination of biological including feeding, growth, maturity evolution, sex-ratio, weight,
- to analyse the effect of the environmental conditions in the species abundance distributions.

The commercial species are: cod, haddock, saithe, herring, hake, blue whiting, megrims, monkfishes, horse mackerel, mackerel, Spanish mackerel, rose and red shrimps and Norway lobster.

4. Surveyed area and season

The total area surveyed extend from Scotland till Gibraltar strait (51°40 N to 36° N), in depths between 20 to 750 m. This surveyed area covers the ICES Divisions VIa, VIIa,b,e,f,,j,g,h, VIIIa,b,c and IXa (Figure 1).

Scottish Surveys

Irish surveys

English Survey

The French demersal groundfish survey covered the ICES Divisions VIIf,g,h and VIIIa,b corresponding to Celtic Sea and Bay of Biscay. The area surveyed extends from the latitude 46°10 N to 51°40 N, and from 20 m to 400 m during the fourth quarter of the year (October – November).

The northern Spanish groundfish survey covered ICES Division VIIIc and the northern part of IXa corresponding to the Cantabrian Sea and off Galicia waters. The surveys are conducted from 35 to 700 m depths during the third and the fourth quarter (September – October).

The southern Spanish groundfish survey is conducted in the southern part of ICES Division IXa, the Gulf of Cádiz. The covered area extends from 15 m to 700 m depth, during late Winter and Autumn.

The Portuguese groundfish surveys are conducted since 1979 two times a year in Summer and Autumn, covering Division IXa in Portuguese waters. The area surveyed extends from latitude 41°20' N to 36°30' N, and from 20 to 750 meters depth.

The historical evolution of the surveys are described in section 10.

5. Sampling design

The total covered area has been stratified according to depth and geographical criteria and a stratified random sampling scheme has been adopted for France and Spain. In Portuguese surveys a fixed sampling scheme is used. The bathymetric and the geographic strata used for all the demersal surveys are presented in Figures 2 and 3. The total area covered corresponds to 286,403 Km^2 (Table I).

Table I - Surface of the geographic sectors considered during the SESITS project.

Zone	Geographic Sector	
	Name	Km²
Celtic sea	CN	35115
	CC	54535
	CS	69971
Bay of Biscay	GN	56820
	GS	14470
Cantabrian sea	AB	2460
	PA	4614
	EP	5352
Galicia	FE	7774
	MF	4139
Portugal	PN	11245
	PW	5837
	PS	7296
Gulf of Cádiz	CA	6774
Whole area		286403

Scottish Surveys

Irish surveys

English Survey

In the French surveys the whole area has been separated in 5 geographical strata or sectors: southern Bay of Biscay (GS) and northern Bay of Biscay (GN), southern Celtic Sea (CS), center Celtic sea (CC) and northern Celtic sea (CN). In each sector a stratification scheme considering depth ranges has been adopted. 6 depth ranges has been considered: 0-30m, 31 - 80 m, 81-120 m, 121 - 160 m, 161 - 200 m and 201 - 400 m (Figures 2 and 4).

The sampling design is a stratified random allocation. The number of hauls per stratum is optimised by a Neyman allocation taking into account the most important commercial species in the area (hake, monkfishes and megrims). Minimum of two stations per stratum is performed and 140 fishing stations are planned every year. This number of hauls is adjusted according to the ship time available at sea.

In the Spanish surveys the area has been stratified according to depth and geographical criteria and a stratified random sampling scheme has been adopted. In the northern surveys (Cantabrian Sea and Galician waters) three depth strata have been used (80-120, 121-200, 201-500 m) and 5 geographic sectors (Figures 2 and 5). Supplementary hauls in deeper bottoms (500 - 700 m) and shallows waters (30 – 80 m) may be conducted depending of the ship time available at sea. In the southern surveys five depth strata have been used (15-30, 31-100, 101-200, 201-500 and 501-700 m) (Figures 2 and 5).

The number of hauls per strata is proportional to the trawlable surface adjusted with the ship time available at sea. A coverage of 5.4 hauls for every 1000 Km² (120 hauls per survey) is approximately conducted in the northern area.

In the Portuguese surveys the sampling design follows a fixed station sampling scheme. A total of 97 fixed stations are planned, spread over 12 sectors. Each sector is subdivided into 4 depth ranges: 20-100m, 101-200m, 201-500m and 501-750 m (Figure 2), with a total of 48 strata (Figure 6). The positions of the 97 fixed stations were selected based on common stations made during 1981-1989 surveys and taking into account that at least two stations should be made by stratum. A maximum of 30 supplementary stations are planned, fixed in each season, to be carried out if ship time is available or to replace positions that due to particular factors are not possible to accomplish.

6 Vessels and gears

The specifications of the vessels and gears used by each country in the groundfish surveys are presented in Table II.

Table II - Sampling materials used in the groundfish surveys.

Country/Institute **Sampling material**	**Ireland** MIFRC	**UK/Scotland** MLA	**UK/England** CEFAS	**France** IFREMER	**Spain** IEO	**Portugal** IPIMAR
Research vessel	Celtic Voyager	Scotia	*Cirolana*	*Thalassa*	*Cornide de Saavedra*	*Noruega*
Type	Stern trawler					
GRT	340	N/A	1731	3022	1133	495
Kw	N/A	N/A	N/A	2200	1650	1100
Overall length (m)	32	68.6	74	73.7	67	47.5
Gear Type	GOV 28.9/37.1	GOV 36/47	PHHT	GOV 36/47	BAKA	NCT
Depth range (m)	15-200	20-200	40-600	30-400	30-700	30-750
Trawling speed (Knots)	3.5	4	4	4	3	3.5
Doors weight (kg)	500	1100	1440	1350	650	650
Doors surface (m^2)	2.99	4.5	4.5	4.5	3.58	3.75
Sweep length (m)	60	60	18.28	50 100	200	No
Diameter of Lower Bridle (mm)	20	20	20	22	No	16
Diameter of Upper Bridle (mm)	12	14	16	12	No	14
Diameter of Middle Bridle (mm)	12	14	No	12	No	14
Exocet Kite	Yes	Yes	No	No	No	No
Floats in Headline	18	20	20	18	25	80
Floats in Winglines	32	20 + 20	32+32	24 + 24	15 + 15	
Mean vertical opening (m)	6	4.6	4.4	4 4.1	2.0	4.8
Mean doors spread (m)	48	82	81.7	76.9 112.7	107.1	44.3
Mean horizontal opening (m)	N/A	19.6	N/A	18.7 20.5	18.9	15.6
Groundrope	Rubber disks	Bobbins	Rubber bobbins +Rubber disks + chain	Rubber disks and chains / Rubber and metal disks	Synthetic wrappled wire core	Bobbins

Scottish Surveys

Irish surveys

English Survey

Since 1997, the French survey is carried on the R/V *Thalassa*, a stern trawler of 73.7 m length by 14.9 m wide, gross tonnage of 3022 t. The fishing gear used is a GOV 36/47 without exocet Kite which is replaced by 6 additional floats (Figure 7). In average, the gear has a horizontal opening of 20 m and a vertical opening of 4 m. The doors are plane-oval with 1350 Kg.

All Spanish surveys were carried on with R/V *Cornide de Saavedra*. This stern trawler was transformed in 1984 from its original 56 m (LL) and 990 GRT to 67 m and 1133 GRT at present. The gear used is a Baka trawl 44/60 with a 43.6 m footrope and a 60.1 headline (Figure 8). The traditional trawl doors used are rectangular, weighting 650 Kg and 3.6 m^2 of surface (2.67*1.34 m). The diameter of warp used is 22 mm (1.9 Kg/m). The mean vertical opening is 1.8 m and the horizontal opening is 21 m. Up to 1985, a codend cover of 20 mm mesh was used, and since then, a 20 mm mesh codend liner has been adopted.

The Portuguese surveys are carried with the R/V *Noruega*, which is a stern trawler of 47.5 m length, 1500 horse power and 495 G.T.R. The fishing gear used is a bottom trawl (type Norwegian Campell Trawl 1800/96 NCT) with a 20 mm codend mesh size (Figure 9). The main characteristic of this gear is the groundrope with bobbins. The mean vertical opening is 4.6 m and the mean horizontal opening between wings and doors is 15.1 m and 45.7 m, respectively. The polyvalent trawl doors used are rectangular (2,7 m x 1,58 m) with an area of 3,75 m^2 and weighting 650 Kg.

7. Technical description of the hauls

Start time of the haul is defined as the moment when the vertical net-opening and doorspread are stable. Stop time is defined as the start of pull back.

Net monitoring should be used in all fishing operations in order to ensure the proper gear deployment. Vertical net opening and doorspread should be monitored at 30 seconds intervals and mean valid values should be reported. It is recommended that wing spread be also measured.

The hauls duration varies from 30 minutes (France and North of Spain) to 60 minutes (Portugal and South of Spain – Bay of Cádiz) and are carried during daylight at a towing mean speed from 3.0 knots (Spain) to 3.5 knots (Portugal) and 4 knots (France).

8. Biological data

The catch is sorted by species, counted and weighted. In the case of a huge catch of one dominant species, only a fraction of the catch is sorted.

Length distributions are recorded for all fish and other commercial species caught. Length is measured:

- 1 mm below for commercial crustaceans (cephalothorax length)
- 1 mm below for commercial cephalopods (mantle length)
- 0.5 cm below for herring, sprat, anchovy and sardine (total length)
- 1 cm below for all other fish species (total length).

Biological parameters (length, weight, status of maturity among others) and hard structures (otoliths and *illicia*) are collected. The specification of the sampling level of otoliths and *illicia* is described in Table III.

Table III - Specification of the sampling level of otoliths and *illicia* by country.

Species	Country	Otoliths or *illicia*
Merluccius merluccius	FR	8/cm/sex/area
		8/cm/undet./area
	SP	< 17 cm - 1 each 3 individuals
		> 17 cm - all individuals
	P	3/cm/sex/area
		>40cm - all individuals
		10/cm/undet./area
Micromessistius poutassou	SP	10/haul (random)
	P	10/cm/sex/area
Lepidorhombus whiffiagonis	FR	5/cm/sex/area
	SP	20/cm
	P	3/cm/sex/area
Lepidorhombus boscii	FR	No
	SP	10/cm
	P	3/cm/sex/area
Lophius piscatorius	all	All individuals (illicium)
Lophius budegassa	all	All individuals (illicium & 2ndfin ray)
Trachurus trachurus	SP	15/cm
	P	5/cm/sex/area
		10/cm/undet./area
Scomber scombrus	SP	10/cm/area
	P	5/cm/sex/area
Gadus morhua	FR	All individuals
Merlangius merlangus	FR	10/cm/sex/area
Solea vulgaris	FR	All individuals
Molva molva	FR	All individuals
Pollachius pollachius	FR	All individuals
Scomber japonicus	P	5/cm/sex/area

9. Environmental Data

Hydrographic data

The sampling design has to satisfy the requirements to resolve the following processes:

- Coastal Upwelling
- Ekman divergence near the capes
- Fluxes over the shelf, slope currents and circulation in the off-slope area
- Mesoscale features

CTD sampling station distribution satisfies the requirements of high resolution sampling along tracks to separate mesoscale features. The required separation between sampling points is of 10 - 15 km and the distance of the tracks off the break-shelf no major than 30-40 km. In order to detect the upwelling phenomenon, in regions where the shelf is narrow (less than 15 km), at least two sampling points are performed from the coast to the break-shelf. Homogeneous distribution of CTD stations at both sides of the most prominent capes is also conducted to evidence Ekman divergence processes. To evaluate the slope currents sample of at least three CTD casts in the following manner are done: one over the shelf, the second over the shelf-break (200 m depth) and the third off the shelf break. Equal separation distance among stations is convenient.

CTD stations outside the continental shelf are conducted during Spanish and Portuguese surveys in perpendicular profiles to the coast, with a minimum of two casts in the open ocean. In the Spanish surveys, whenever possible, information relative to the estimation of primary production is also collected. According to this, to exploit to the full the cruise, it is recommended the CTD system to have fluorometer and oxygen sensor, as well as the usage of at least a Niskin bottle (1.5 l) attached to the CTD cable at a depth of 40 m.

To avoid the aliasing effect and to improve the data analysis, CTD sampling stations are homogeneously distributed all over the study area, avoiding leaving large extensions uncovered. CTD casts sampled at stations over the shelf area cover the whole water column, from surface to bottom. When stations and CTD casts are over the slope area sample are conducted at least till 400 m depth.

Debris data

The main debris catched during the trawl operations are collected and counted by categories (plastic, wood, metal, glass, etc.).

10. Database

Scottish Surveys

Irish Surveys

English Survey

Prior to 1997, all the French data were stored on a PC format database (MDBS Knowledgeman II). A new database was installed on board the RV THALASSA in 1998. This new database is in the MS Access format and is constituted with different types of files: (i) station information files containing all information about the haul (station reference number, position, depth, etc.); (ii) weight per haul file in the form of a table (lines: stations number, column: for each species the total weight per haul); (iii) number per haul file: the same structure than before but with total number per haul; (iv) length composition file (one file in the form of a table (lines: station number, species, sex; columns: total number per length class). This database is still under development and will eventually incorporate the data prior to 1997. The hydrographic data are in text format, as processed by the CTD software (*.avg). An application developed with Arcview processes those files to give charts of temperatures at different depth levels. All intermediate information (raw data, sample ratios, and scanmar data) are kept and stored on CD-ROM in asccii files and/or MS Access.

All the Spanish survey data are processed on board using a software package specifically created for it (files in *dBase III* format). This program was designed to be straightforward and logical, and solves the greater part of the processing of data collected in the bottom trawl surveys in which a stratified sampling methodology is used. It is possible to work with the program in small computers (8086 PC) on board commercial vessels. Two master files (species and gears) and seven incidence files per survey (survey design, hauls characteristics, gear performance, catch by specie (number and weight), length distribution, age/length key and hydrography) exist. This software has the possibility to generate the file formats for records types 1, 2 and 3 of IBTS data. Data concerning fishing stations, catch composition by species in weight, in number and by length (only for all fish species and Norway lobster) are recorded since 1980.

In 1990, a Portuguese database was created at IPIMAR during the FAR project MA.1.203 using a SQL relational database in PC-DOS system (software Rbase 2.0 later upgraded to Rbase 4.0). Recently, this database was transferred to a windows environment using Microsoft Access 2.0. Six main tables are part of this database, two of which contain the log sheet (haul information, positions, etc.), two containing species sheet (catch data) and two containing sample length distribution. Maturity stages, individual weigh and otoliths are recorded in four independent tables, one for each species (megrims and monkfishes, hake, horse mackerel and blue whiting). Three accessory tables were also adopted containing scientific and common names and the three FAO letter codes for the species, fixed station information (position and depth) and information collected with the SCANMAR equipment.

11. Groundfish survey histories

Scottish Surveys

Irish Surveys

English Survey

The **French demersal surveys** began in 1987. The survey area was limited to 48°30' N in the north and to the northern margin of Gouf de Cap Breton in the south (ICES divisions VIIh, VIIIa,b,c and d). In 1990, the survey area was extended towards the north (up to 51°15' N) to cover the grounds of Celtic sea deeper than 100 meters (ICES divisions VIIe,f,g,h and j).

The survey was usually conducted in the fourth quarter (October-November) and some years in the second quarter (May-June) (Table IV). The old research vessel N/V Thalassa (a stern trawler of 66.7 m length and an engine power of 1323 kW) was used until 1995.

Table IV – French surveys: dates and number of hauls per area and year.

Year	Dates	Bay of Biscay	Celtic sea	Total
1987	30/09 - 30/10	131		131
1988	10/05 - 07/06	136		136
1988	07/10 - 04/11	134		134
1989	26/09 - 27/10	142		142
1990	25/09 - 10/11	137	56	193
1991	04/05 - 19/06	142	57	199
1992	18/09 - 30/10	107	52	159
1994	25/09 - 01/11	101		
1995	07/11 - 11/12	114		

Prior to 1997, the sampling designs were as follows :

a) In the Bay of Biscay (ICES divisions VIIh, VIIIa,b,c and d) a stratified sampling scheme was originally used. The area was divided according to latitude into 3 blocks and the hauls were distributed in seven depth zones (15-30,31-80, 81-120, 121-160, 161-200, 201-400, 401-600 m). 100 hauls were made at fixed locations and 35 at changeable stations from year to year. Since 1989, all the hauls (mean number by survey 135) are made at the same locations.

b) In the Celtic sea (ICES divisions VIIe,f,g,h and j) the sampling design was systematic, stations were located at the intersection points of a grid of lines 25 nautical miles apart both in latitude and in longitude. The mean number of sets was 56.

Catch weight and catch numbers were recorded for all species, only selected finfish and shellfish species were measured until 1990. Since 1991, all finfish and a selection of shellfish (mainly *Nephrops* and squids) are measured.

Since 1992, gear geometry is monitored using Scanmar. On the other hand, salinity and temperature by depth are also recorded at the end of each fishing from this date.

Since 1974 the **IEO** has performed **bottom trawl surveys** in the Atlantic continental shelf waters of the Iberian Peninsula (Sánchez *et al.*, 1991 ; 1995). From 1980 the fishing resources of Divisions VIIIc and IXa of ICES were monitored through surveys, with the objective of following variations in the abundance of demersal and bentic species of commercial interest by means of indices independent of fishing activity. At the same time estimations were obtained of the strength of recruitment of diverse species (principally hake) during season they occur (Autumn). The evaluations were made according to a stratified sampling protocol, maintaining other factors constant, such as time of year, ship, fishing gear, speed, trawl time, etc.

Two series of surveys have been conducted, one at Spring (April-May), starting in 1984, and the other in the Autumn (September-October) starting in 1980. The spring series ended in 1988 and the autumn one has been going on up to the present (Table V).

Table V. North of Spain surveys: dates and valid hauls per area by season and year.

Year	SPRING				AUTUMN			
	Dates	Galicia	Cantabrian Sea	Total	Dates	Galicia	Cantabrian Sea	Total
1980					05/10 - 20/10	23		23
1981					19/09 - 01/10	26		26
1982					13/09 - 25/09	34		34
1983					06/09 - 07/12	38	69	107
1984	31/05 -14/06		37	37	27/08 - 20/09	48	46	94
1985					01/09 - 26/09	50	47	97
1986	07/04 - 09/05	44	48	92	12/09 - 09/12	48	44	92
1987	11/03 - 14/05	50	56	106				
1988	07/05 - 18/05		47	47	24/09 - 20/10	47	54	101
1989					12/09 - 17/10	40	51	91
1990					10/09 - 14/10	50	70	120
1991					12/09 - 11/10	51	56	107
1992					12/09 - 17/10	53	63	116
1993					09/09 - 06/10	48	61	109
1994					21/09 - 20/10	54	64	118
1995					27/09 - 25/10	53	63	116
1996					20/09 - 22/10	54	60	114
1997	08/04 - 18/04	15	12	27	19/09 - 23/10	56	63	119
1998					17/09 - 18/10	55	59	114

Tows were of one hour duration in all surveys before 1984, and were reduced to 30 minutes thereafter. Since 1990, gear geometry is monitored using Scanmar equipment. Since 1993 hydrographic information is collected using the methodology describe in section 8.

Some changes were done in the research vessels used over the period: the engine power increase in 1983 (from 1700 Kw to 2651 Kw), the length increase in 1985 (from 56 m to 67 m), a new bridge was used in 1990 (GPS, colour Echosounder, Plotter, Doppler log, etc.). In 1989, another research vessel (N/V F. de P. Navarro) was used to conduct the survey.

Since 1993 nine groundfish surveys have been conducted in the **Gulf of Cádiz** (Spanish waters) on board of the R/V "Cornide de Saavedra" (Table VI).

Table VI. Gulf of Cádiz surveys: dates and number of valid hauls and year.

Year	Dates	Valids hauls
1993	15/03 - 25/03	34
1993	17/10 - 25/10	29
1994	28/02 - 8/03	30
1995	13/03 - 19/03	30
1996	23/03 - 29/03	31
1997	19/02 - 26/02	30
1997	30/10 - 11/11	27+9
1998	26/02 - 09/03	31+31
1998	30/10 - 09/11	34

According to Cardador *et al.* (1997), the **Portuguese groundfish surveys** have been conducted along the Portuguese continental waters since June 1979 on board of the R/V "Noruega". Initially the main objectives of the surveys were to estimate the abundance and study the distribution of the most important commercial species in the Portuguese trawl fishery: hake, horse mackerel, blue whiting, seabreams and Norway lobster. Recruitment indices of abundance and distribution for hake and horse mackerel were also evaluated in the Autumn surveys. Additionally, trawl selectivity experiments for hake and horse mackerel with 40 mm mesh size, were also conducted during 1981 surveys using the covered cod.

A stratified random sampling design was adopted during 1979-1989. The number of strata changed during this period: from 1979 to 1980 the surveyed area was divided into 15 strata and since 1981 into 36 strata. Based in the statistical analysis of the previous surveys the design was revised in order to decrease the variance within stratum. The new strata are smaller than the previous ones and can be combined to get the older ones. The aim of increasing the number of strata was to increase the probability of spreading the random sampled units in order to decrease the total variance of the mean abundance indices by species.

The boundaries of each stratum are based on depth and geographical areas. The depth ranges used during 1979-1988 were 20-100m, 101-200m and 201-500m. Each stratum was divided into units of approximately 25 nm^2, sequentially numbered. During 1979-1980 the number of random hauls per stratum was based on the previous information of the relative abundance of the target species in each geographical area and on the ship time available. During 1981-1989, when the number of strata was 36, two random units were sampled by stratum whenever possible, to become possible to estimate the standard error of the stratified mean by stratum.

The tow duration was 60 minutes during 1979-1985 at a trawling speed of 3,5 knots, changing to 30 minutes during 1986-1988, and changed again to 60 minutes since 1989, maintaining the same trawling speed. The decrease from 60 to 30 minutes was based on an analysis which has indicate that a 30 minutes tow was enough to get abundance indices for the target species (Cardador, 1983). However in the 1989 Summer survey, experiments with the two durations at the trawling speed of 3,5 knots have been performed indicating that 60 minutes tow was more adequate to sample all the structure of the horse mackerel population. The large adults of horse mackerel were not caught at a trawling speed of 3,5 knots with a duration of 30 minutes because the large pelagic fish can swim at higher speeds in front of the trawl net. It is by maintaining the trawl pursuing the fish during a longer period than 30 minutes that the larger horse mackerel looses its *stamino* and enters into the trawl net. The juveniles were well sampled with 30 minutes trawling at 3,5 knots.

Finally in Autumn 1989 a fixed station plan was established as a result of an extensive discussion on the scope of ICES Methods Working Group (ICES, 1990) about the trade on biased estimations with low variance (fixed design) or unbiased estimations with large variance (stratified design). The fixed design is more appropriate for a time series obtained for the purpose of tuning the commercial catch-at-age time series. As a result it was considered that the fixed station design is more appropriate for VPA tuning than the random allocation design. Simultaneously the survey area was extended to the 750 m bathymetric in order to sample the adult hake, and the lower distribution bound of Norway lobster and monkfish.

During 1990-1994 and under FAR project MA-1-203 the second aim of the surveys was to estimate the abundance and distribution of eggs and larvae of the commercial species. A sampling scheme with a grid of 92 stations was applied. The stations were settled at 22 east-west sampling transepts, 20 nautical miles apart, with depths varying from 20 to 1000 m. The sampling stations were placed 5´and 10´apart from each other in order to fit the bottom topography. Plankton samples were collected with a Bongo net (60 cm of mouth diameter and 335µm and 505µm mesh size), by oblique hauls from the surface to a maximum depth of 200 m or to the depth of seabed. These stations were conducted during the night. Using a CTD (Conductivity, Temperature and Depth recorder “Sea-Bird” (Model Seacat SBE 19) the temperature and salinity profiles were obtained at each plankton station. This is particular important to monitor the presence of the thermocline for sampling strategy. At its presence the eggs of mackerel and horse mackerel are distributed above the thermocline (Cardador *et al*., 1995).

During the period 1979-1997 a total of 38 surveys were carried out. The season, total fishing days and valid hauls by survey are shown in the Table XIV. In average 2 surveys per year were carried out, with 21 effective fishing days and 90 valid hauls per survey (Table VI).

Table VII. Portuguese surveys: dates and number of valid hauls by season and year.

Year	LATE WINTER / SPRING		SUMMER		AUTUMN	
	Dates	Hauls	Dates	Hauls	Dates	Hauls
1979			07/06-20/06	56	13/10-02/11	55
1980	06/03-15/03 23/05-10/06	36* 63			02/10-22/10	62
1981	07/03-30/03	67	09/06-29/06	69	20/10-13/11	111
1982	15/04-02/05	69	10/09-30/09	70	07/10-18/11	190
1983	10/03-01/04	69	17/06-06/07	68	28/10-22/11	117
1984						
1985			01/06-28/06	101	23/10-18/11	150
1986			09/06-30/06	118	05/10-29/10	117
1987					04/10-24/10	81
1988					13/10-19/11	98
1989			14/07-08/08	114	10/10-06/11	138
1990			06/07-30/07	98	27/10-06/12	123
1991			06/07-05/08	119	03/10-14/11	93
1992	14/02-20/03	88	07/07-30/07	81	15/10-5/11	59
1993	09/02-11/03	75	25/06-18/07	66	24/11-20/12	65
1994					16/10-22/11	89
1995			14/07-08/08	81	12/10-09/11	88
1996					11/10-08/11	71
1997			26/06-21/07	87	15/10-16/11	58
1998			05/07-29/07	87	09/10-10/11	96

*Southwest and South 1996 – R/V “Capricórnio”, trawl gear without bobbins

12. References

Cardador, F. (1983). Contribuição para aumentar a precisão dos indices de abundância obtidos nas campanhas portuguesas de investigação "Tipo Demersal". *Bol. INIP*. **9**:17-67.

Cardador, F.; Silva, A.; Pestana, G.; Martins, M.; Borges, M.F.; Azevedo, M.; Murta, A.; Caramelo, A.; Farinha, A.; Afonso, H. and Lopes, P. (1995) Estimation of the abundance and study of the distribution pattern of hake, horse mackerel, monkfish and megrim in ICES Div. Ixa (Portuguese waters) - Final Report Proj. FAR MA 1.203 - DGXIV of EC. 159pp.

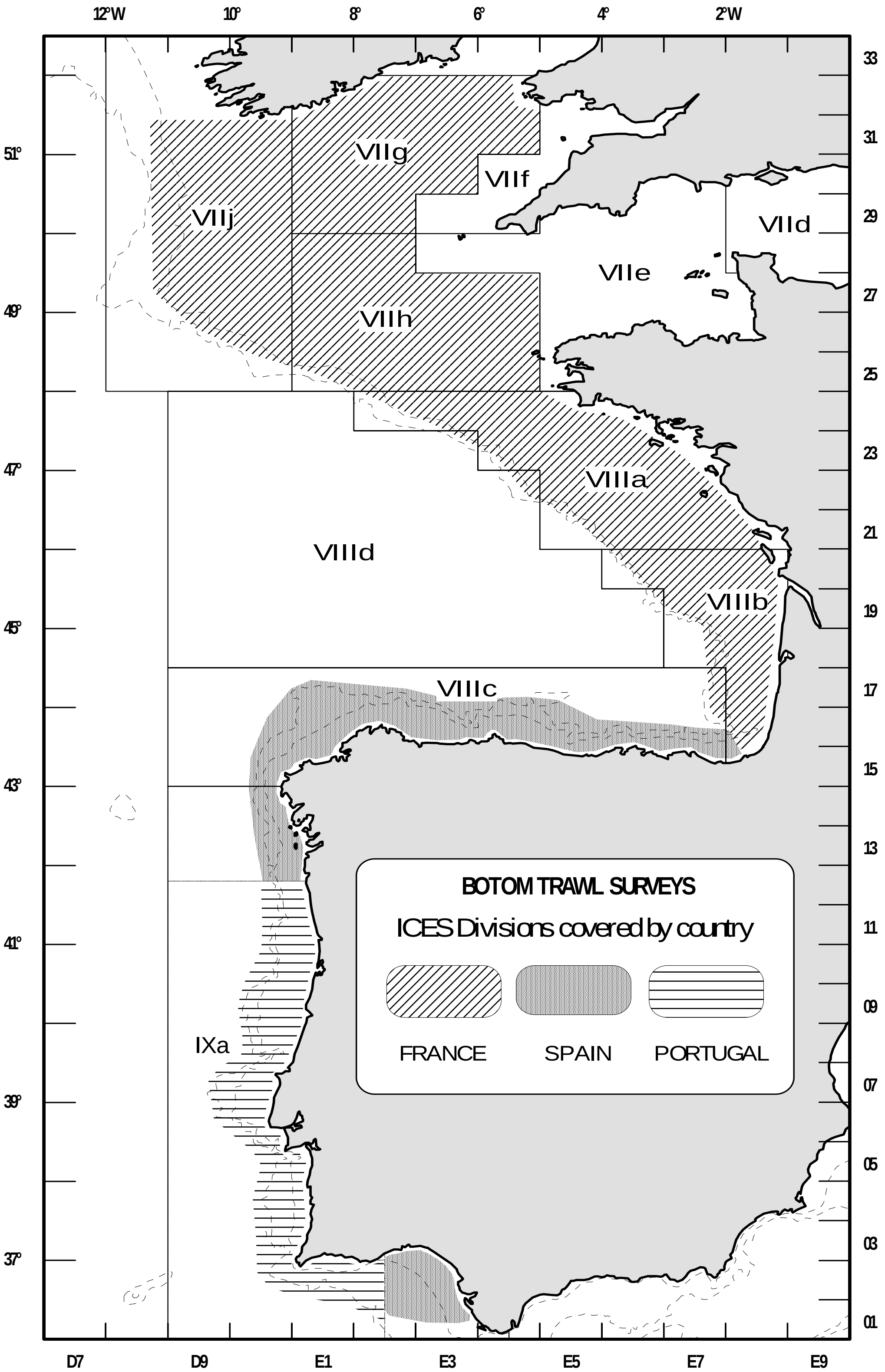
Cardador, F.; Sanches, F.; Pereiro, F.J.; Borges, M.F.; Caramelo, A.M.; Azevedo, M.; Silva, A.; Pérez, N.; Martins, M.M.; Olaso, I.; Pestana, G.; Trujillo, V. and Fenandez, A. (1997) Groundfish surveys in the Atlantic Iberian Waters (ICES divisions VIIIc and IXa): history and perspectives. ICES C. M. 1997/Y: **8**. 30pp.

ICES (1990) Report of the Working Group on Methods of Fish Stock Assessements. ICES C. M. 1990/Assess: **15**. 95pp.

Sánchez, F., F.J. Pereiro and E. Rodriguez-Marín (1991). Abundance and distribution of the main commercial fish on the northern coast of Spain (ICES Divisions VIIIc and IXa) from bottom trawl surveys. ICES CM 1991/G:53, 30 pp.

Sánchez, F., F. de la Gándara and R. Gancedo (1995). Atlas de los peces demersales de Galicia y el Cantábrico. Otoño 1991-1993. *Publ. Esp. Inst. Esp. de Oceanogr*. 20: 99 pp.

Figure 1 - Coverage of the bottom trawl surveys included in the SESITS project.



 O:\Scicom\RMC\IBTSWG\REPORTS\2001\IBTSWG01.Doc

Figure 2 - Bathymetric stratification used by each country.

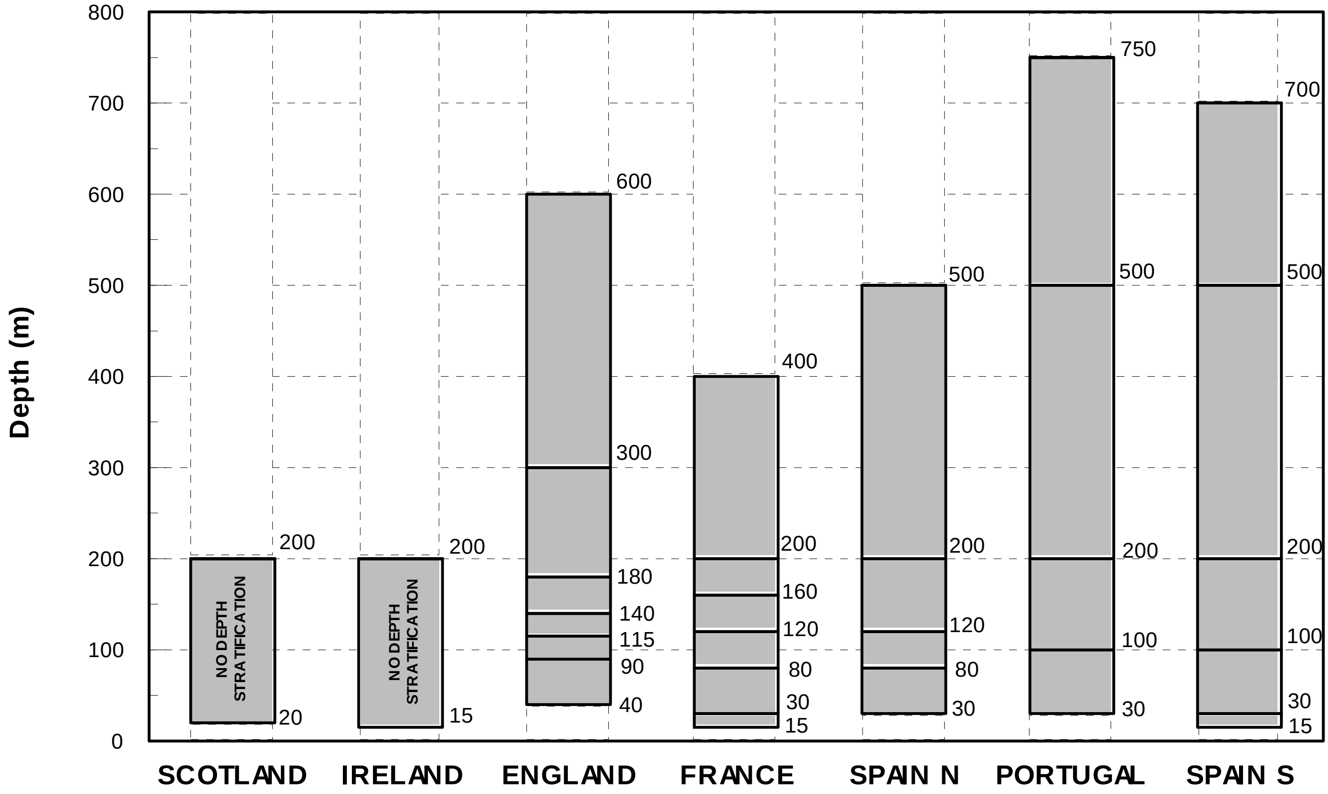


Figure 3 - General geographic stratification used.

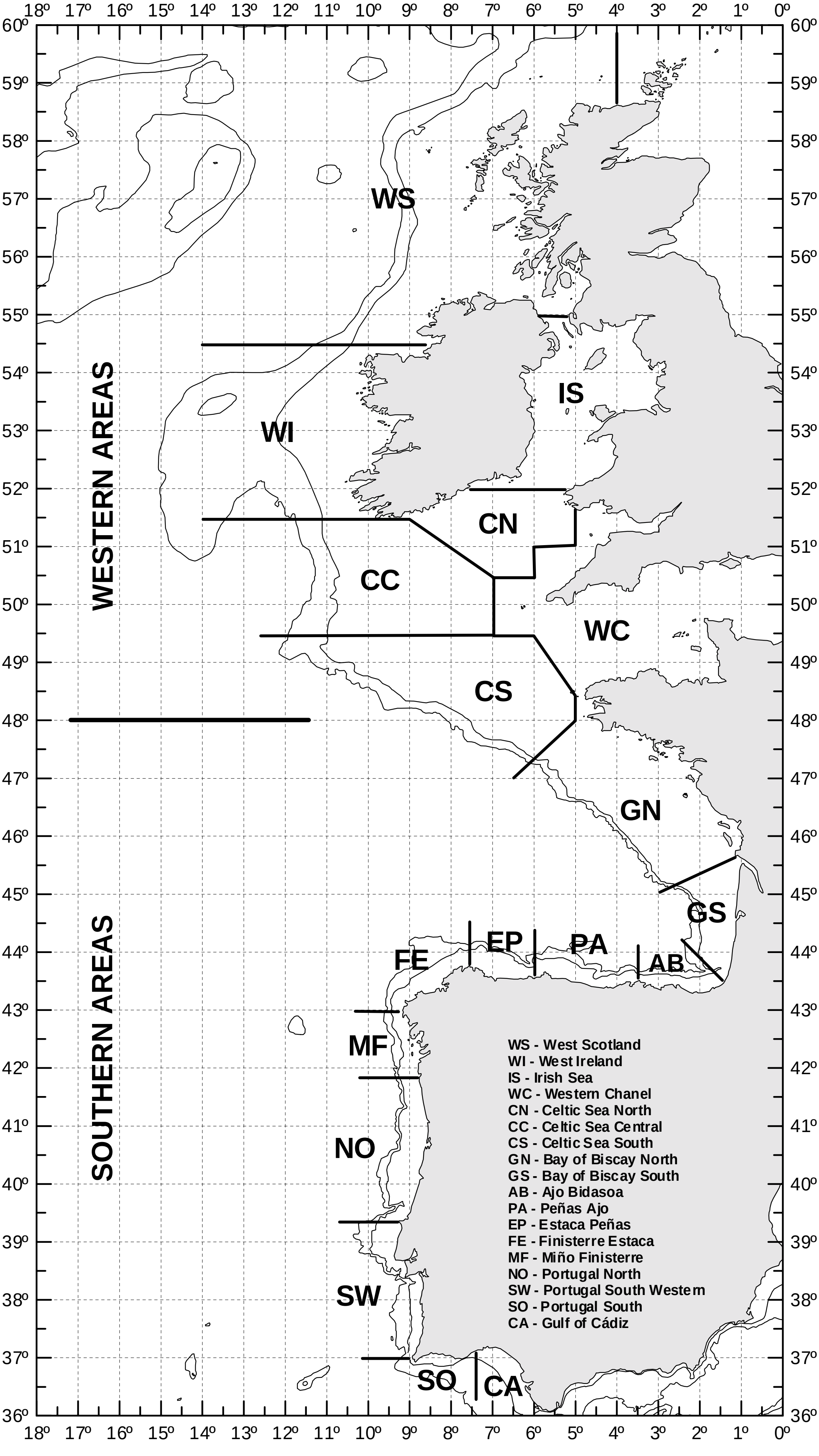


Figure 4 - Stratification used in the Bay of Biscay and in the Celtic Sea for the French surveys.

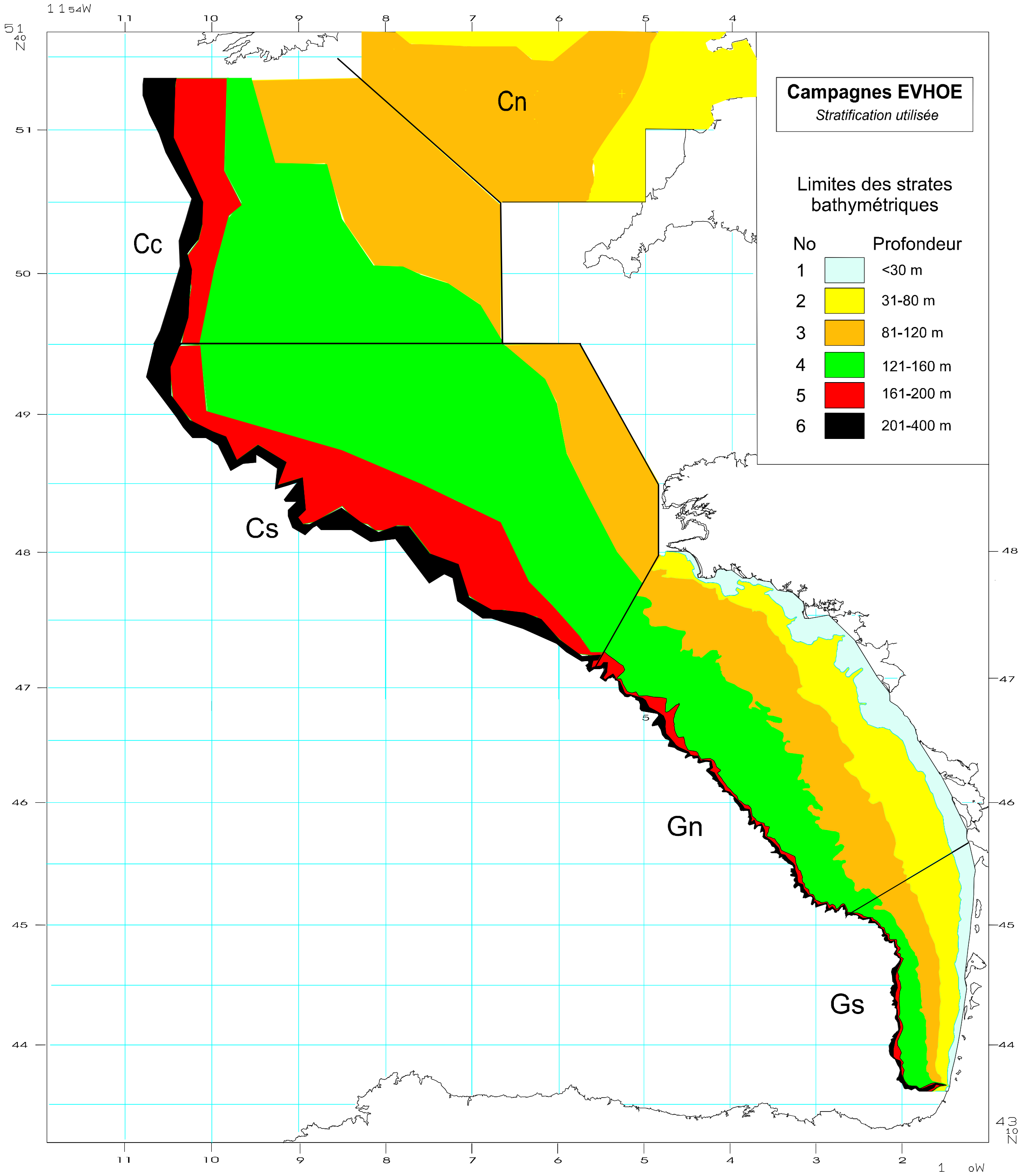


Figure 5 - Stratification used in the Spanish surveys.

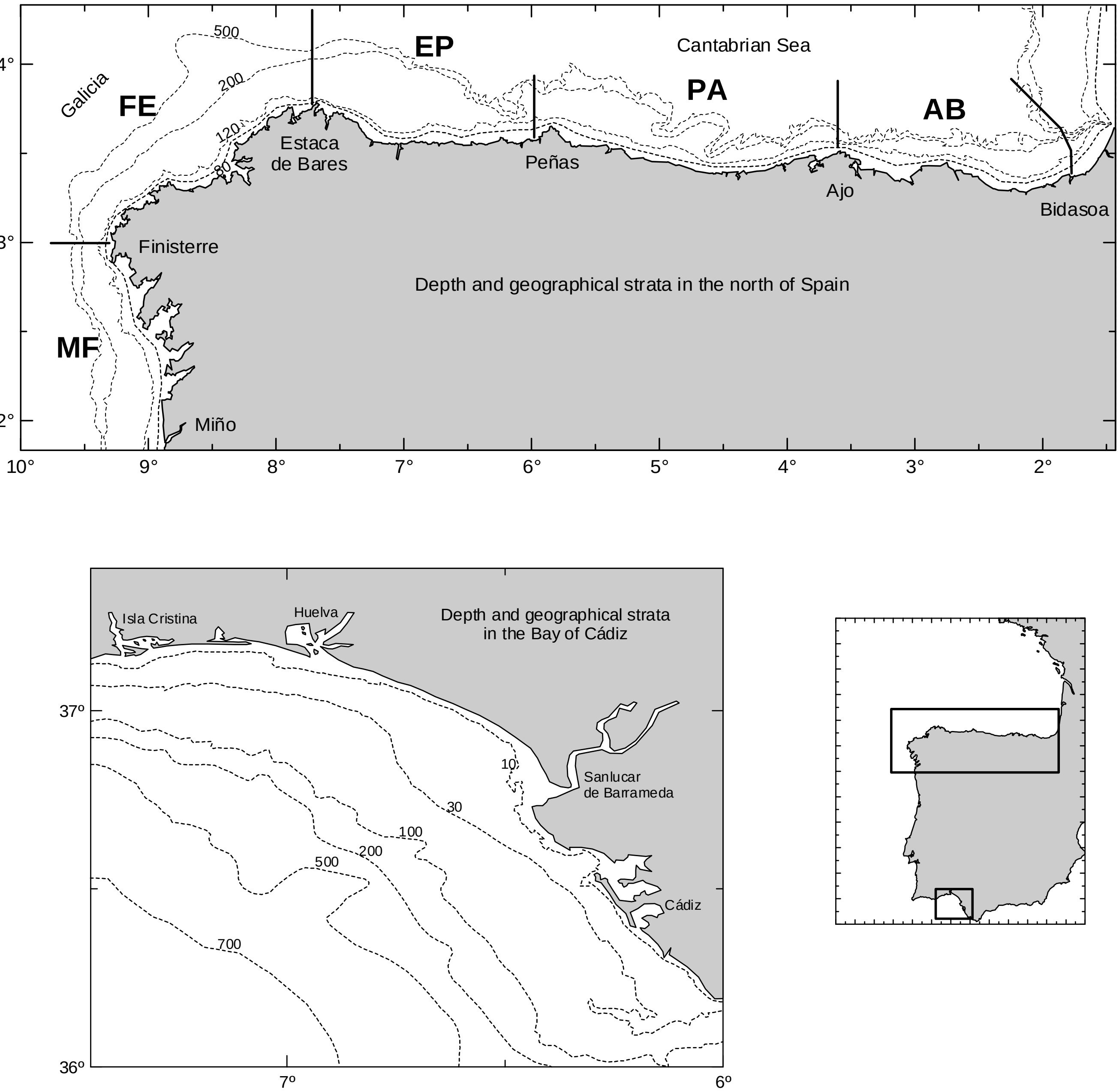


Figure 6 – Stratification used in the Portuguese surveys

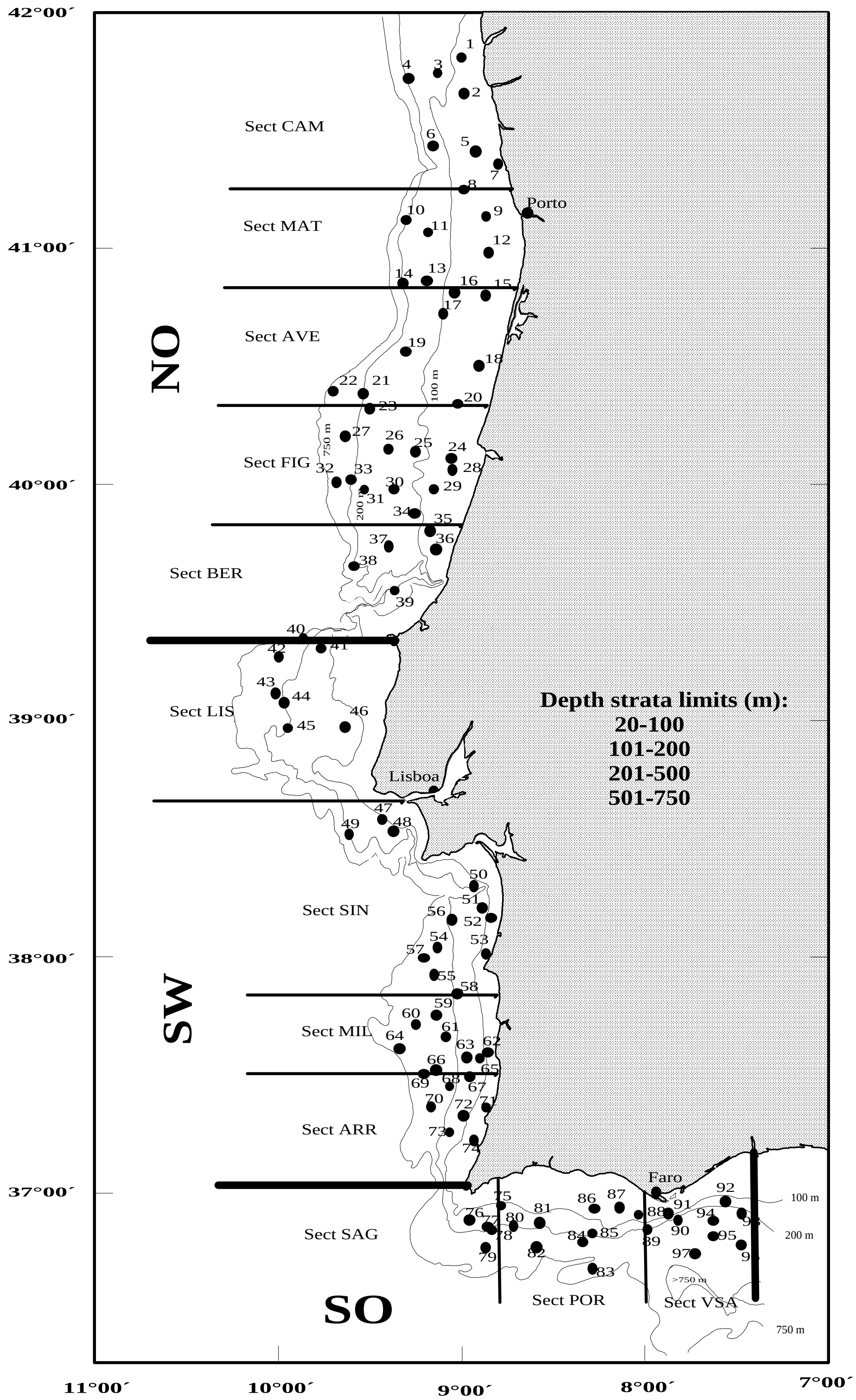


Figure 7 – Scheme of the GOV 36/47 trawl gear.

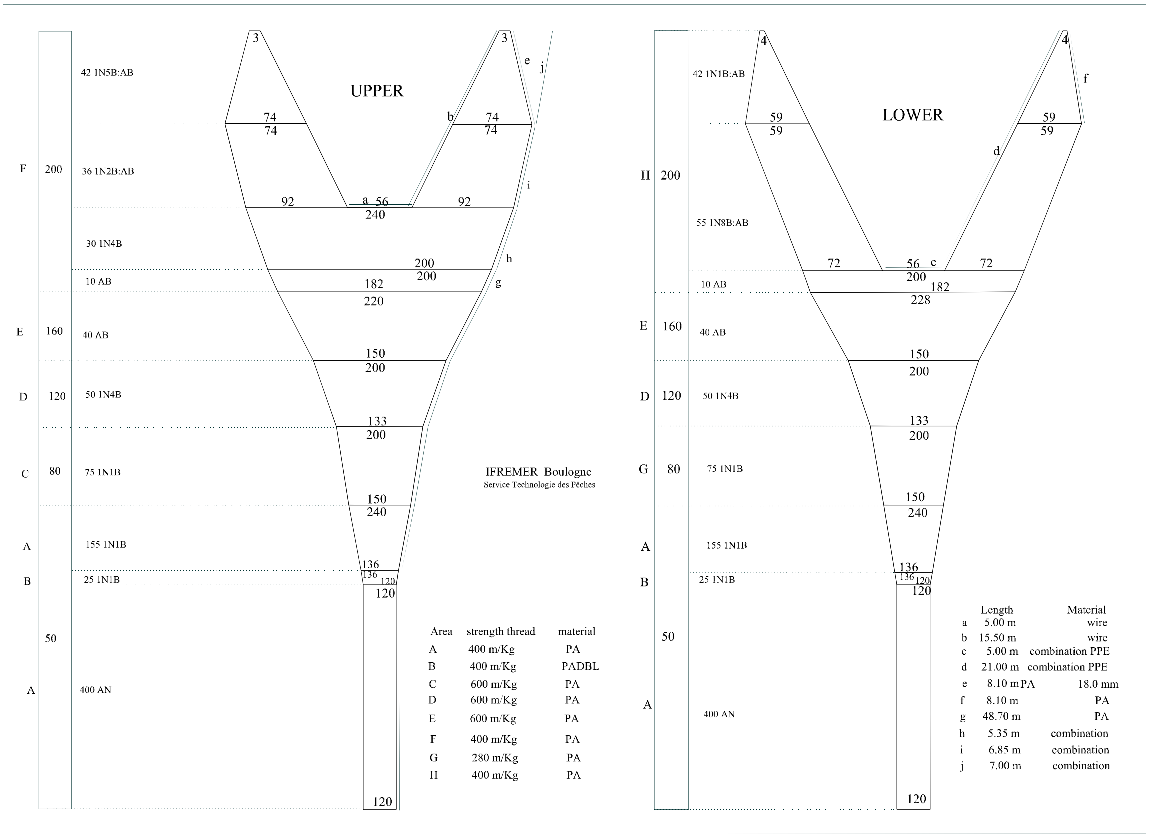


Figure 8. Scheme of the Baka 44/60 trawl gear.

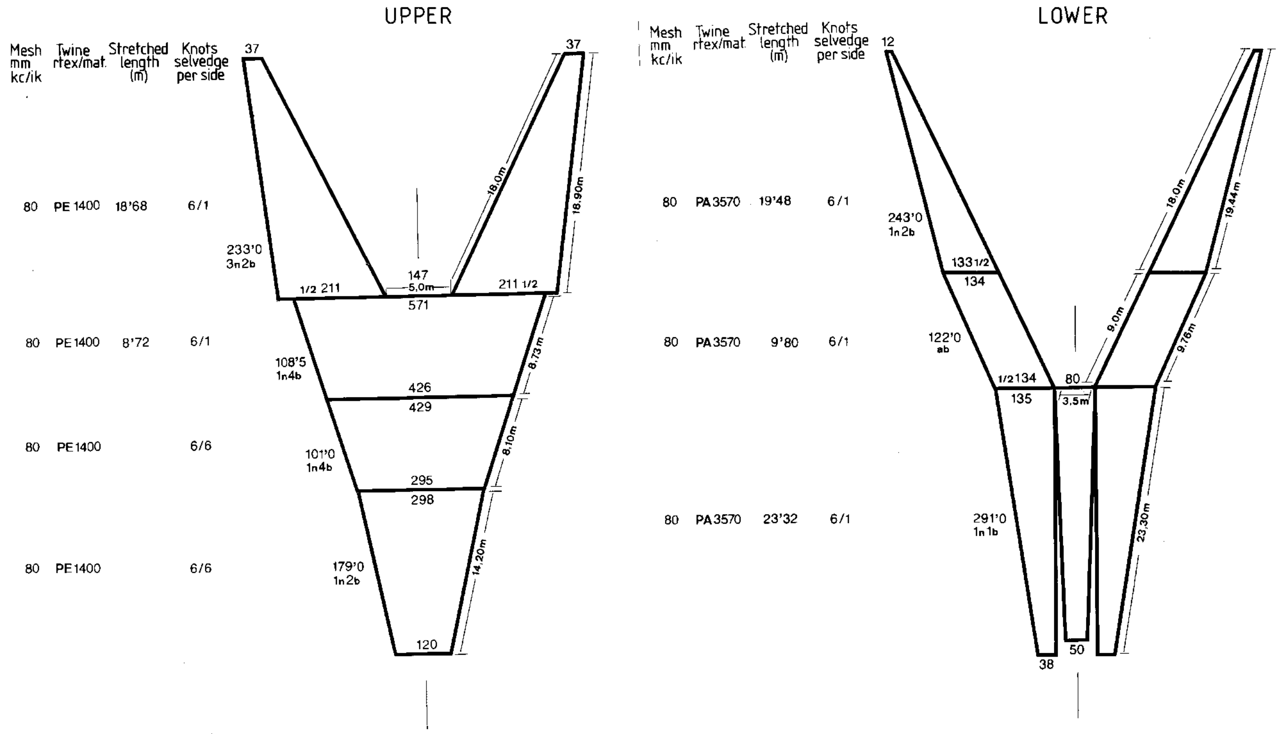
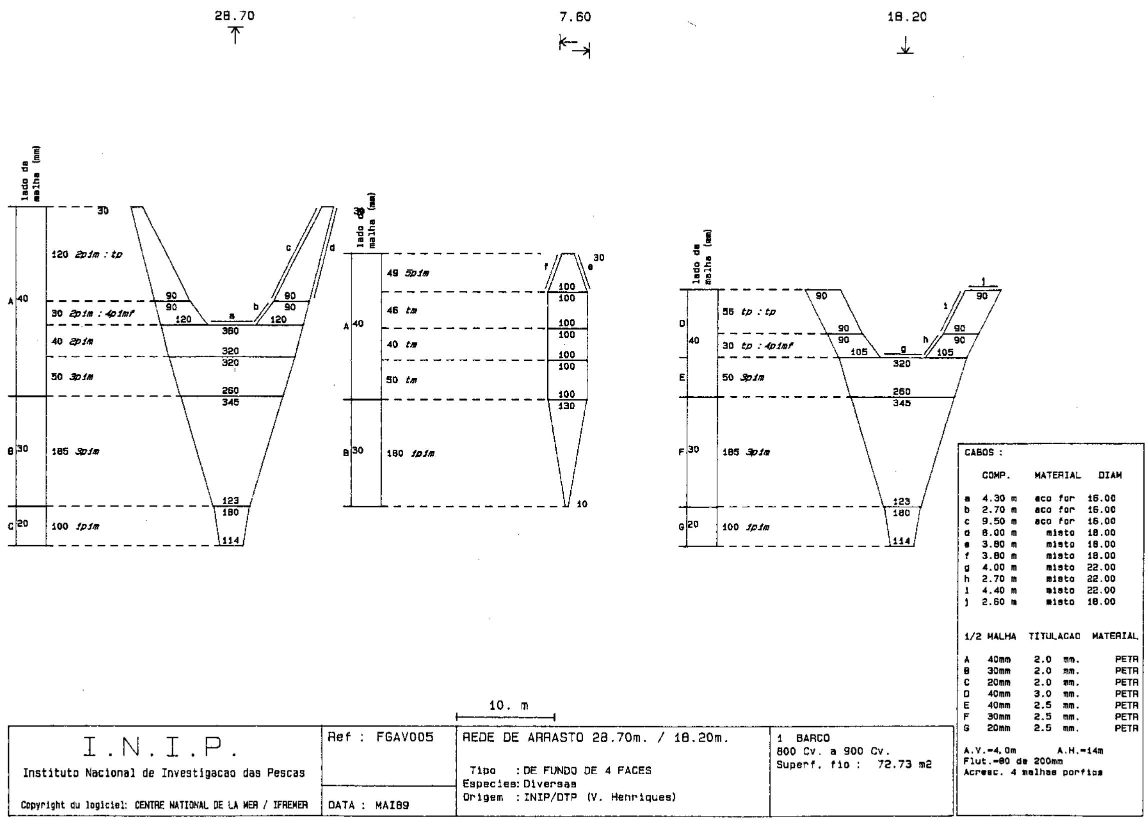


Figure 9 – Scheme of the NCT trawl gear.



APPENDIX 2

Quantifying variability in Gear Performance on IBTS surveys: Swept area and volume with depth

By: D. Reid[1], D. J. Beare[1], J-C. Mahe[2], P Connolly[3], C.G. Davis[1] & A. Newton[1]

1. Marine Laboratory Aberdeen, Victoria Road, Aberdeen, AB11 9DB, U.K.
2. IFREMER, Station de Lorient, 8 rue François Toullec, 56100 Lorient, France
3. Fisheries Research Centre, Abbotstown, Co. Dublin, Eire.

ABSTRACT

The International Bottom Trawl Surveys (IBTS) on the western shelf represent an important source of fisheries independent data on the abundance and distribution of many important commercial species. Trawl hauls on these surveys are standardised to thirty minutes and four knots. It is thus assumed that they will generally take equivalent samples. We examined trawl surveillance data on; headline height, wing spread, door spread, swept area and swept volume for recent surveys by Scotland, France and Ireland. The study showed that there was substantial variability in all these parameters, and of particular importance, swept area and headline height. There was also good evidence that both these parameters varied systematically with the depth of the trawl haul, although this varied in pattern between the three different national surveys examined.

The implications of these findings for catch rates were examined using linear modelling with haddock catches on the Scottish surveys as a test case. The analysis was complicated by the fact that both the net performance parameters and the haddock abundance appear to be well correlated with depth. This made it difficult to isolate the net parameters as sources of variance. However, the analysis clearly suggested, for this species and in this location, that variation in headline height has an impact on catch rates. The significance of these findings and of the variability in the gear performance in general is discussed.

INTRODUCTION

The major fishery independent tool for assessing demersal fish stocks is the stratified random bottom trawl survey (Pennington & Brown 1981). Such surveys are particularly important in the North Sea and adjacent areas where a series of international collaborative surveys (IBTS – ICES coordinated International Bottom Trawl Surveys) have been carried over many years (Heessen et al 1997). Considerable efforts are made to ensure that these surveys are carried out in a standard and consistent way. A manual has been produced describing the construction of the standard net (the GOV – Grande Ouverture Vertical), and standard rigging, deployment and data collection protocols are produced as an IBTS manual (Anon 1996). When new vessels are introduced into the survey, inter-calibration exercises are carried out (Pelletier 1998, Zuur & Fryer 2000). Notwithstanding these efforts, it is still necessary to make some assumptions about the way the gear actually performs.

One such assumption is that the standard trawl, towed at a standard speed for a set period will sweep a fixed area of seabed (Forrest & Minnet 1981). However, this assumption does not necessarily hold true. It is known that swept area increases with depth as a result of the greater length of warp (Carrothers 1981; Godρ & EngΔs 1989, EngΔs 1994, Rose & Nunnallee 1997). Godρ & EngΔs (1989) suggested that this might well affect the efficiency of the gear. Godρ & EngΔs showed that the increase in swept area was due to an increase in the spread of the wings and doors. As a corollary to this, the height of the headline reduced with depth, so effectively the net becomes wider and shallower with depth. It is reasonable to assume that either or both these factors (swept area or headline height) are likely to have an impact on the amounts of fish caught. Increase in swept area is likely to result in more fish captured. Decrease in headline height may reduce the amount captured, in that more may be lost over the headline.

Godρ & EngΔs (1989) examined trawl surveys in the Svalbard area off Spitsbergen, where depths varied between 20 and 600m. In the North Sea and adjacent waters the surveys are usually restricted to 200m, although in the shelf area to the west of Europe surveys go down to 500m. As part of an EU funded project (IPROSTS Study Contract) we set out to determine the variability in trawl performance with depth on a number of IBTS surveys carried out on the west coast of Scotland. In addition we examined whether there was any evidence from these surveys that any swept area differences found might have an impact on catch rate of two common fish species: haddock (*Melanogramus aeglefinus*) and whiting (*Merlangius merlangus*).

MATERIALS

The Surveys

Scotland

Trawl data from two Scottish west coast IBTS surveys were used in this analysis (November 1998 and 1999 carried out from FRV *Scotia*). These surveys were initially selected as they fell within the western area remit of IPROSTS. These surveys use the same, rectangle stratified, sampling design as the North Sea IBTS, but due to the nature of the western Scottish shelf, they tend to cover a wider depth range. Additionally, recent proposal to harmonise these surveys with those further south would require the depth limit to be extended to 500m, where the impact of gear performance changes may be even more important.

The trawl used was a standard GOV fitted with a heavy ground gear (ground gear C) to cope with the more difficult seabed found in this area. The trawl was fitted with ScanMar sensors to provide; headline height (HH), wing spread (WS) and door spread (DS). The sensors were interfaced to a PC for data logging using in-house software. For each haul, the software provide mean HH, WS & DS as well as mean swept areas between the wing ends (Net Swept Area - NSA) and the doors (Gear Swept Area - GSA). NSA and GSA were integrated from recordings of distance travelled and WS/DS every 30 seconds through the operation. Recordings were not started until the gear had settled and was fishing correctly, and were stopped as soon as the gear began to be recovered. The surveys used the current standard 30-minute tow, with the vessel speed maintained at 4 knots.

The surveillance data from 107 valid fishing operations were collected for the analysis. In approximately 5% of operations, the sensor data were corrupted or incorrect and these tows were discarded.

France

Trawl surveillance and catch data were available from the EVHOE 1999 survey by IFREMER on FRV *Thallasa*, carried out in the Bay of Biscay and Celtic Sea in November 1999. The survey design used a depth stratified approach although the stations were carried out as standard IBTS half-hour tows. The trawl used was a standard GOV, although headline floats were substituted for the standard kite. Two different sweep lengths were used; 60m from 0 to 125m depth and 110m thereafter. The trawl was fitted with ScanMar sensors to provide; headline height (HH), wing spread (WS) and door spread (DS). Swept areas were calculated from these data and from the distance towed.

The surveillance data from 105 valid fishing operations were collected for the analysis.

Ireland

Trawl surveillance and catch data were available from the Irish Sea and Celtic Sea Ground Fish Survey (ISCSGFS) carried out by the Marine Institute, Abbotstown on FRV *Celtic Voyager*, in November 1999. The survey design used a rectangle-stratified approach and the stations were carried out as standard IBTS half-hour tows. The trawl used was a modified (reduced horsepower) GOV. One sweep length of 50m was used. The trawl was fitted with ScanMar sensors to provide; headline height (HH) and door spread (DS). Swept area was calculated from these data and from the distance towed.

The surveillance data from 53 valid fishing operations were collected for the analysis.

METHODS AND RESULTS

Depth dependence in trawl performance parameters

Scotland

The basic trawl performance data for the two Scottish surveys are presented against water depth in Figures 1a to f. Calculated Regressions, R^2 values, values at 25 and 200m and differences are given in table 1.

Figure 1a shows the change in headline height. There is a clear decrease in this factor with water depth. The calculated headline height goes from 5m to 3.6m, a percentage change of 39.7%. Figure 1b & 1c show the change in wing and door spread with depth. Again there are clear changes with depth particularly in the case of wing spread. Figure 1d shows the variability in the distance towed. Most tows are between 1.8 and 2 n.mi., a variation of around 10%. These data are also used to generate the swept area values, which are shown for the net – calculated using wing spread, and for the whole gear - calculated using door spread in figures 1e and 1f respectively. In all cases there are obvious and substantial changes in gear performance with depth.

France

The French survey uses a similar GOV gear to the Scottish surveys but with differences in rigging described above

The main trawl performance data for the French survey are presented in figure 2, and the details summarised in Table 2. Using the short sweeps, the French net showed very similar patterns to the Scottish net. The calculated headline height varied from about 4.5 to 3.5m over 100m depth range. Wing spread, door spread and net swept area all varied in a similar fashion to that seen on the Scottish surveys. However, with the long sweeps there was very little change at all with depth.

Ireland

The Irish survey uses a scaled down version of the GOV suitable to a smaller vessel.

The main trawl performance data for the Irish survey are presented in figures 12 to 15, and the details are summarised in Table 3. No wing spread data and, hence, net swept area, information were available for this survey. The depth range in this survey was also less (maximum depth of 120m) than the other two surveys. The important points to note are that there was very little variation in the headline height across the depth range but that door spread varied by around 35%.

Analysis of catch rates in relation to trawl performance

It was clear from the above that there were substantial changes in the performance of the gear across the normal depth range of the surveys. The next question was whether this could be shown to have had any impact on the trawl results. We decided to concentrate on the two most abundant species encountered, haddock and whiting. For this analysis we used only numbers caught irrespective of age or length.

Firstly, haddock and whiting abundance data were log-transformed to normalise the error structure. Histograms and qq-plots confirmed there was acceptable symmetry in the log abundances.

The second step was to investigate whether there might be important variations between the two survey years. Haddock and whiting abundance were plotted against six variables (Time of day, Bottom depth, Headline Height, Net swept area, Gear swept area and Net swept volume). See Figs 1 and 2.

Haddock: 1998 survey v. 1999 survey

Haddock abundance was higher in 1999 than 1998 (Fig. 1). The range of some gear parameters, e.g., headline height and gear swept area were very different between the two surveys. In 1999 headline heights ranged between 4-5.5m whereas in 1998 they ranged between 3 and 5.25m.

Whiting: 1998 survey v. 1999 survey

The differences in average whiting catches between the two surveys were not as pronounced as for haddock (Figure 2) although the differences between years in the ranges of gear parameters are, naturally, the same.

These figures suggested that it would be better to treat the 1998 and 1999 data separately

Multiple Pair-wise plots of the 1998 and 1999 data

The next step was to determine the best approach to modelling the dependencies in the data. Figures 3 and 4 show multiple pair-wise comparisons between all the variables. They suggest broadly similar patterns of dependency for both the 1998 and 1999 datasets. Haddock abundance increased with bottom depth, gear swept area, net swept area, and net swept volume while it decreased with headline height and whiting abundance. Whiting showed almost the opposite pattern.

Separating the effects of each predictor

The variables we were most interested in (depth, headline height, net swept area, gear swept area, and net swept volume) were generally correlated with each other. For the purposes of this work we wanted to quantify the variation due to each of these variables separately. The normal way to do this would be to use multiple regression and model haddock and whiting abundances as functions of depth, headline height etc. Unfortunately, for regression coefficients to have an unambiguous interpretation, it is necessary that the covariates be uncorrelated. In Figs 3 and 4 the positive relationships between depth, net swept area and gear swept area are very clear, as is the negative correlation between depth and headline height. This correlation also means that the effects are confounded. If interest, for example, focuses on separating the effect of bottom depth and trawl headline height we need shallow-water observations at low headline heights and deep-water observations at high headline heights. The negative correlation between the two variables (Figs 3 and 4) meant that this rarely happened.

Reducing the correlation/confounding problem by sub-setting the data

Study of the raw data suggested that it would be possible to get a reasonable spread over all the covariates by using subsets of the data. This involved removing stations close to the maximum and minimum depth values, and which also had correlated values in the other net parameters. This then left us with data covering a range of depths associated with a range of, say, headline heights. The subsetted data were then re-plotted in multiple pair-wise comparisons (see Figs 5 & 6). This process reduced some of the correlation between the variables, although some remains between some of the covariates.

Investigation of the subsetted data

The next step was to determine the relationships between the net surveillance parameters and the fish abundance using linear models.

Haddock 1998

The subset of the 1998 data was produced using only data with a net swept area >60000, collected at depths of between 60m and 160m.

A range of nested linear models, using all or some of the net parameters, were then fitted to the log-transformed haddock abundance data. The most complex model to come out of this process [log(Haddock)=Depth+HLHeight+Nswarea+natural spline(Time,2)] was then passed to the S-plus function "step" to select the most economic subset. This process indicated that only depth and headline height were important as predictors of herring abundance, although headline height did not come out as significant.

Coefficients	Value	Std Error	t	P (>|t|)	Sig.
Intercept	-7.4626	5.6134	-1.3294	0.1934	
Depth	0.0287	0.0121	2.3711	0.0241	Sig.
HL Height	1.6550	1.0663	1.5521	0.1308	N Sig.
Residual standard error: 1.719 on 31 d.f.			Multiple R-Squared: 0.1594		
F-statistic: 2.938 on 2 and 31 d.f.			p-value is 0.06784 .. not significant		

Haddock 1999

The same process was followed for the 1999 data for haddock. In this case only depth was found to be important as a predictor.

Coefficients	Value	Std Error	t	P (>|t|)	Sig.
Intercept	0.2988	2.1908	0.1364	0.8931	
Depth	0.0385	0.0169	2.2751	0.0361	Sig.
HL Height	na	na	na	Na	
Residual standard error: 1.68 on 17 d.f.			Multiple R-Squared: 0.2334		
F-statistic: 5.176 on 1 and 17 d.f.			p-value is 0.03613 .. significant		

Whiting

The same process was followed for the both years for whiting. In both cases only depth was again found to be important as a predictor. No further analysis was carried out on the whiting data.

Partial Regression analysis

The final step was to investigate what dependencies remained in the data after the influence of the main factor, depth, was modelled out. This was done with the aid of partial regression plots (Figs 7 & 8). Residuals from the model (log(haddock)=Depth) for both 1998 and 1999 datasets were plotted against four of the gear parameters (net swept area, headline height, gear swept area and net swept volume). A linear model was then fitted to the data to summarise any gradient. The horizontal dotted line is the mean of the residuals. In theory, the plots summarise dependency on the other predictors after the effect of depth has been removed. Net swept area, gear swept area and net swept volume tended to have slight negative gradients. If this were a real effect, catches would be expected to increase when these parameters decrease at any given depth. Thus increase in sampling area or volume would be expected to result in a decrease in catch. This is counterintuitive, although it should be emphasised that these effects were not significant. Headline height showed the opposite effect. Greater headline height related to increased catch rates, at any given depth.

DISCUSSION

The first important point to note is that the water depth at a trawl station had a dramatic impact on the performance of the gear. This effect has been well known for some time (Carrothers 1981,Godρ & EngΔs 1989, EngΔs 1994). A number of approaches have been suggested to control this effect. One suggested remedy was to vary warp length to keep the door spread constant (Koeller 1991, Walsh & McCallum 1997). Another possibility, which has been widely adopted, is to use a rope between the warps to constrain door spread (EngΔs & Ona 1991). The IBTS manual requires the use of two different sweep lengths at different depths (50m sweeps down to 75m depths and 100m sweeps thereafter). How widely this is practiced is unknown. The data from the French surveys reported here suggests that this may go some of the way to ameliorating the situation.

The second point is, therefore, that the assumption that the standard trawl, towed at a standard speed for a set period will sweep a fixed area of seabed (Forrest & Minnet 1981) is clearly untrue. It is not unreasonable to assume that if there is a variation in the swept area there should be a variation in the catch taken. As the headline height also decreases with depth, there might be expected to be an impact of this change also. The problem we faced in determining whether this was happening was two fold.

Firstly, it is well known that the catch rates from bottom trawl surveys have a very high variability (Zuur & Fryer 2000). The potential for isolating variability due to a single factor can be limited. Zuur & Fryer were attempting to determine if there was a vessel effect between the new FRV *Scotia* and its predecessor. The data collection programme was designed to reduce as many other sources of variability as possible, however, the remaining variability made it impossible to determine any significant differences between the two vessels.

The second problem we faced was probably specific to the west of Scotland area. There was a clear pattern evident in these data of increasing haddock abundance with depth. As all the gear performance parameters also varied with depth, it became extremely difficult to isolate these from the depth signal. This confounding meant that high headlines and narrow spreads were mostly found in shallow waters and the opposite in deep waters. There were no sample data with high headlines in the deeper waters for instance. The use of subsets of the data over a restricted depth range was designed to give a more representative range of gear parameters at any given depth. However, this process itself gave rise to further problems. Firstly, the number of valid stations was reduced, and secondly, it was not possible to remove the effects of depth completely. The outcome of the analyses should be viewed in the light of these observations.

The model selection process applied to the 1998 haddock data suggested that headline height, along with depth, was an important predictor of haddock catch rate. This was borne out by the pattern of the residuals from a depth only model. Neither effect was statistically significant, but may, nonetheless, be considered as important. The model selection process did not include headline height for 1999, only depth was important. Also headline height showed only as a weak trend in the residual plots for 1999. The range of headline heights for 1999 was much less than for 1998 (4 to 5.5m in 1999 against 3 to 5.25m in 1998). Also the total number of samples in the subset was less in 1999. Either or both factors may have contributed to the failure to detect a clear signal for the 1999 data. Of course, it must be conceded that there may, in fact, be no detectable signal in 1999.

The conclusions from this study are clear. There was compelling evidence of systematic changes in gear geometry with increasing depth. Deeper tows were characterised by wider spread and lower headline height. There were indications from the analysis that headline height at least was important in one of the years as an explanatory variable for haddock abundance. This analysis represents a preliminary approach to this area of study. We used the actual calculated swept area in these analyses; however, this factor itself incorporates variability in wing spread AND distance towed. Inclusion of both these in the modelling may be more revealing. The combination of a small data set and a large depth variation militated against successful partitioning of the variance. One possibility would be to repeat this study using data from the IBTS in the North Sea where more data would be available over a wider and with less depth variation. Given the assumptions involved in swept area surveys these findings must give reason for disquiet and encourage further research.

REFERENCES

Anon 1996. Manual for the International Bottom Trawl Surveys (Revision V). Addendum to ICES CM 1996/H:1

Carrothers, P.J.G. 1981. Catch variability due to variations in groundfish otter trawl behaviour and possibilities to reduce it through instrumental fishing gear studies and improved fishing procedures. Can. Spec. Publ. Aquat. Sci., 58: 247-257.

Koeller, P.A., 1991. Approaches to improving groundfish survey abundance estimates by controlling the variability of survey gear geometry and performance. J. Northw. Atl. Fish. Sci. 11:51-58.

EngΔs, A. & Ona, E. 1991. A method to reduce survey bottom trawl variability. ICES CM 199/B:39.

Engås, A. 1994. The effect of trawl performance and fish behaviour on the catching efficiency of demersal sampling trawls. In: Fernø, A. and Olsen, Steinar, Eds. Fishing News Books, 1994.

Forrest, A. & Minnet, J.P. 1981. Abundance estimates of the trawlable resources around the Island of St Pierre and Miquelon. Can. Spec. Publ. Aquait. Sci., 58: 68-81.

Godø, O. R. and Engås, A. 1989. Swept area variation with depth and its influence on abundance indices of groundfish from trawl surveys. Journal of Northwest Atlantic Fishery Science 9, 133-139.

Heessen, H.J.L., Dalskov, J. & Cook, R.M. 1997. The International Bottom Trawl Survey in the North Sea, Skagerrak and Kattegat. ICES CM 1997/Y:31

Pelletier. D. 1998. Intercalibration of research survey vessels in fisheries: A reviwe and an application. Can. J. Fish Aquat.Sc. 55:2672-2690

Pennington, M. & Brown, B.E., 1981. Abundance estimates based on stratified random trawl surveys. Can. Spec. Publ. Aquait. Sci., 58: 149-153.

Rose, C.S. & Nunnallee, E.P. 1997. A study of changes in groundfish trawl catching efficiency due to differences in operating width, and measures to reduce width variation. Fish. Res. 36: 139-147.

Walsh, S.J. & McCallum, B.R. 1997. Observations on the varying fishing powers of Canadian survey vessels and trawls. Sci. Counc. Res. Doc. NAFO. 1997. 9pp.

Zuur, A. & Fryer, R.J. 2000 Results of comparative fishing trials between Scotia II and Scotia III. Fisheries Research Services Report (in press)

Table 1. Summary of trawl surveillance data for the two Scottish surveys (pooled data).

Parameter	R^2	Slope	Value at 25m	Value at 200m	Change	Change %
Headline Height	0.210	-0.008	5.00	3.58	1.42	39.7
Wing Spread	0.444	0.035	16.13	22.25	6.12	27.5
Door Spread	0.293	0.145	73.34	98.72	25.38	25.7
Net Swept Area	0.362	108.74	56450	75480	19030	25.2
Gear Swept Area	0.192	465.91	258433	339966	81533	31.55

Table 2. Summary of trawl surveillance data for the French survey.

Parameter	R^2	Slope	Value at 25m	Value at 125m	Change	Change %
	Short sweeps – depths < 125m					
Headline Height	0.184	-0.01	4.45	3.45	1.00	28.99
Wing Spread	0329	0.043	17.22	21.52	4.30	19.98
Door Spread	0.731	0.245	64.63	89.08	24.45	27.45
Net Swept Area	.0344	195.07	59381	78888	19507	24.73
Gear Swept Area	na	na	na	na	na	na
	R^2	**Slope**	**Value at 125m**	**Value at 200m**	**Change**	**Change %**
	Long sweeps – depths > 125m					
Headline Height	.001	0.001	3.64	3.66	0.02	0.55
Wing Spread	0.069	0.003	20.58	20.82	0.24	1.15
Door Spread	0.349	0.037	100.93	103.88	2.95	2.84
Net Swept Area	0.044	15.15	74092	75304	1212	1.61
Gear Swept Area	na	na	na	na	na	na

Table 3. Summary of trawl surveillance data for the Irish survey.

Parameter	R^2	Slope	Value at 25m	Value at 125m	Change	Change %
Headline Height	0.015	0.004	5.29	5.73	0.44	7.68
Wing Spread	na	na	na	na	na	na
Door Spread	0.661	0.267	50.50	77.15	26.65	34.54
Net Swept Area	na	na	na	na	na	na
Gear Swept Area	0.480	854.06	157874	243280	85406	35.11

APPENDIX 3

List of Participants

INTERNATIONAL BOTTOM TRAWL SURVEY WORKING GROUP

ICES, Headquarters, 2-5 April 2001

NAME	ADDRESS	TELEPHONE	FAX	E-MAIL
Andrew Newton (chair)	Fisheries Research Services Marine Laboratory P.O. Box 101 Victoria Road Aberdeen AB11 9DB United Kingdom	+44 1224 295396	+44 1224 295511	newtonaw@marlab.ac.uk
Trevor Boon	CEFAS Lowestoft Laboratory Lowestoft Suffolk NR33 0HT United Kingdom	+44 1502 524225	+44 1502 524225	t.w.boon@cefas.co.uk
Brian Harley	CEFAS Lowestoft Laboratory Lowestoft Suffolk NR33 0HT United Kingdom	+44 1502 524254	+44 1502 524254	b.f.m.harley@cefas.co.uk
Henrik Degel	Danish Institute for Fishery Research Charlottenlund Slot DK-2920 Charlottenlund Denmark	+45 33963386	+45 33963333	hd@dfu.min.dk
Dave Reid	Fisheries Research Services Marine Laboratory P.O. Box 101 Victoria Road Aberdeen AB11 9DB United Kingdom	+44 1224 295363	+44 1224 295511	reiddg@marlab.ac.uk
Odd Smedstad	Institute of Marine Research P.O. Box 1870 Nordnes N-5817 Bergen Norway	+47 55238683	+4755238687	odd.smedstad@imr.no
Jørgen Dalskov	DIFRES Danish Institute for Fishery Research Charlottenlund Slot DK-2920 Charlottenlund Denmark	+45 33 96 3380	+45 3396 3333	jd@dfu.min.dk
Lena Larsen	ICES Palægade 2-4 1261 Copenhagen K	+45 33154225	+45 33934215	lena@ices.dk
Gerjan Piet	Netherlands Institute for Fisheries Research Haringkade 1 P.O. Box 68 NL-1970 AB IJmuiden Netherlands	+31 255 564660	+31 255 564 644	g.j.piet@rivo.wag-ur.nl

NAME	ADDRESS	TELEPHONE	FAX	E-MAIL
Yves Vérin	IFREMER 150, Quai Gambetta F-62200 Boulogne-sur-Mer France	+33 321995600	+33 3995601	yves.verin@ifremer.fr
Jean Claude Mahé	IFREMER 8, rue François Toullec F-56100 Lorient France	+33 2 97 87 3818	+33 2 97873836	jcmahe@ifremer.fr
Francisco Sánchez	Instituto Español de Oceanografía Laboratorio de Santander Apdo 240 E-39080 Santander Spain	+34 942 291060	+34 942 275072	f.sanchez@st.ieo.es
Siegfried Ehrich	Bundesforschungsanstalt f. Fischerei Institut für Seefischerei Palmaille 9 D-22767 Hamburg Germany	+494038905-179	+494038905-263	ehrich.ish@bfa-fisch.de
Sara Adlerstein	Bundesforschungsanstalt f. Fischerei Institut für Seefischerei Palmaille 9 D-22767 Hamburg Germany	+49 40 38905-177	+494038905-263	adlerstein.ish@bfa-fisch.de
Johan Modin	Institute of Marine Research Box 4 SE-453 21 Lysekil Sweden	+46 523 18500	+46 523 13977	johan.modin@fiskeriverket.se
Henk. J.L. Heessen	Netherlands Institute for Fisheries Research Haringkade 1 P.O. Box 68 NL-1970 AB IJmuiden Netherlands	+31 255 564 692	+31 255 564 644	h.j.l.heessen@rivo.dlo.nl
David Stokes	The Marine Institute Fisheries Res. Centre Abbotstown Dublin 15 Ireland	+353 1 822 8200	+353 1 820 5078	david.stokes@marine.ie
Rick Officer	The Marine Institute Fisheries Res. Centre Abbotstown Dublin 15 Ireland	+353 1 822 8200	+353 1 820 5078	rick.officer@marine.ie
Henny Welleman	Netherlands Institute for Fisheries Research Haringkade 1 P.O. Box 68 NL-1970 AB IJmuiden Netherlands			henny@rivo.wag-ur.nl