ICES Advisory Committee on Fishery Management
ICES CM 2004/ACFM:13

Report of the Planning Group on Commercial Catch, Discards and Biological Sampling

2–5 March 2004
Mallorca, Spain

International Council for the Exploration of the Sea

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WORKSHOP ON DISCARD SAMPLING METHODOLOGY AND RAISING PROCEDURES

1 INTRODUCTION

1.1 Terms of reference

During the Annual Science Conference (91th Statutory Meeting) in Tallin September 2003 it was decided that an ICES Planning Group on Commercial Catch, Discards and Biological Sampling [PGCCDBS] should meet in Palma de Mallorca, 2-5 March to:

a) further regional coordination and co-operation in collecting biological data of landings of fish and shellfish;

b) develop a framework and methodology to ensure spatial / temporal coverage of sampling of biological data from the landings, taking into account the report from the Workshop on sampling and calculation methodology, the report from the Workshop on discard sampling methodology and raising procedures / techniques, the report from the age-reading workshop held in 2003 and from the various otolith exchanges;

c) identify on a regional basis the candidate stocks and species requiring improved ageing;

d) consider data delivered by fisheries inspectors and how these can be compiled in a consistent way to be used by Assessment Working Groups;

e) compare and standardise protocols for raising national catch and discard data to the international level.

1.2 List of participants

The meeting was attended by:

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1.3 Background

Fisheries advice, nationally or internationally, critically depends on the quality of data from the commercial fisheries. The quality of these data has not in all cases been satisfactory and ICES has raised this point repeatedly. Furthermore, over the latest years significant changes in the framework of the data collection has been made. In 2002, new guidelines for sampling of landings, discards and biological parameters were implemented for all EU member countries and in 2004 the EU will be enlarged by 10 new member states. This means that most of the coastal states in the North East Atlantic areas have to follow the EU data regulation directive.

Nowadays, EU member countries sampling schemes are established and operate on a national basis. No internal mechanism to ensure that internationally coordination of the sampling of fishery dependent data was established. Most of the research vessel surveys are coordinated through planning groups such as ICES PGHERS, WGBIFS and IBTSWG. The PGCCDBS was established in 2002 in order to facilitate international coordination of the sampling schemes for commercial landings, discards and biological parameters.

1.4 General introductory remarks

The majority of PGCCDBS participants represent EU member countries or countries which will be members of the EU in 2004. All these countries have to comply with EU Commission regulation 1639/2001 (referred to in this report as the Data Directive) on fisheries data collection. Therefore, this report may have more EU focused contents. Though effort has been made to facilitate possibilities of better coordination and cooperation of data collection of fisheries data in the Baltic, the North Sea, Western and Southern waters and in the Mediterranean, still significant effort have to put into further development of the international coordination and cooperation.

Some participants (Portugal) called the attention that an ICES Planning Group should not be involved in defining a structure like Regional Planning Groups (RPGs), the way it was proposed in the meeting and expressed in the present report. This is an issue of the exclusive responsibility of the European Commission, and, as such, ToRs, chairman, dates and places of meetings organized by the European Commission or Members States are not matters to be developed by the PGCCDBS. According to the understanding of those participants and the listed ToRs of the present meeting, the PGCCDBS role should be the identification of sampling problems and the coordination of theirs solutions. Those participants do not object to the division of PGCCDBS into regional sub-groups (if there is a consensus that this would facilitate the group to achieve its objectives), but it should be clear that this internal PGCCDBS structure is distinct from the Regional Planning Groups (RPGs).

2 REGIONAL COORDINATION AND CO-OPERATION IN COLLECTING BIOLOGICAL DATA OF LANDINGS OF FISH AND SHELLFISH

a) The EU Commission on establishing like Regional Planning Groups (RPG); the Baltic RPG, the North Sea RPG, the Western and Southern areas RPG and the Mediterranean RPG. The EU Commission is financially supporting costs for having these RPG meetings in order to facilitate coordination and cooperation in running the data collection according to the Data Directive (Commission Regulation (EC) No 1639/2001). The PGCCDBS agreed to split the PG into four regional sub groups so it follows the proposal made by the EU Commission with the tasks of discussing how coordination and cooperation of collection of fisheries dependent data could be established. Reports from the four Regional Groups are given separately below.

b) I other areas of the world the exact same problems in cooperation and coordination of the data collection of fisheries data exists. As an inspiration John Witzig, NOAA, USA gave a presentation on the “Coordination of Agencies and Data systems in the US”. The presentation showed that on the other side of the Atlantic Sea they are facing the exact same problems as the European countries in optimizing the data collection and maximizing the quality of the collected data. Furthermore, it was presented that many challenges have to be dealt with when many stake holders are involved in the collection of fisheries data.

2.1 Report from the Baltic Sea subgroup

The history of international cooperation between the countries fishing in the Baltic Sea is quite successful and has already contributed significantly to the standardization of the input to the assessments made for the stocks in the area. This is to a large extent due to the EU Study project; "International Baltic Sea Sampling Program (IBSSP, EU Study project 96/002 and 98/024)" that was running in the Baltic for 6 years. The aim of the project was to improve the collection of catch data from commercial fishing vessels operating in Kattegat and the Baltic Sea in order to get a complete description of the fishing pattern in the areas. The data was used as input for fish stock assessment in the areas. Further, the aim was to improve sampling and consistency of the data collected by the countries involved in the project. All countries surrounding the Baltic Sea participated in the project.

The project covered all commercial important fleets in Kattegat and The Baltic Sea. Observers collected all relevant information concerning the fishery including catch weight per species (separated into landing- and discard part), length distributions, gear and haul information, etc. The data are stored in a common database, BALTCOM (ICES, CM 2001/ACFM:26). Data are available for scientific purposes in aggregated form to all national scientific institutions on written request to the project co-ordinator. The project report includes among other things a comparison of age-length-keys obtained from different countries, gears and areas for herring and sprat.

Although the project is not running anymore, the IBSSP project has created a platform and a possible network for future cooperation within the Baltic Sea area. Another important outcome of the IBSSP project was the BALTCOM database. Today the BALTCOM (now called FishFrame) database is a very important cooperative tool for the catch sampling within the Baltic. The different counties send their disaggregated data in a standardised format to the BALTCOM. The data is then treated in an effective and consistent way, which makes it useful for the ICES Assessment working group.

There are other attempts for international cooperation and coordination within the Baltic. In order to optimise the sampling strategy and get consistent data, Sweden and Denmark have initiated work to harmonise the sampling of commercial catches of cod and salmon. One of the main tasks for regional cooperation is actually to identify areas or subjects that would benefit from regional coordination. In order to do this, data as well as sampling schemes need to be analysed. At the moment there is no obvious body doing this kind of work.

There are however areas that already could be identified to benefit from regional coordination and cooperation. Such are:

- Sampling of herring and sprat in the northern part of the Baltic.
- Definition of fisheries on a regional basis.
- Creation of a manual for sampling, maybe by refining and simplifying the old IBSSP manual.
- Organisation of sampling of vessels landing in foreign countries.
- Organization of seminars to assure maximum benefit of the common database.

The subgroup thereby recommends that a regional group is organised to handle questions concerning regional cooperation. The main aim for the regional work should be maximum consistency within data and thereby better stock assessments. In order to achieve this, the group needs to deal with planning as well as to some extent, methodologies. It should be emphasised that such a regional group should include all countries around the Baltic Sea. To enable consistency at all levels it is of importance to realise that both scientists and technicians should be included in the group. Issues to be concerned within the regional group could be raised by the STECF, ACFM, WGBFAS, other ICES working-, planning- or study groups, stock coordinators, individual countries or by the regional group itself. Besides being coordination group the regional group would then act as a data support group. It is of importance to stress that the major part of the progressive work needs to be done intercessional. The group should meet once a year with the major aim to summarise the work of the previous year, identify areas which would gain from cooperation and direct the way forward.

A possible roadmap:

A first meeting is to be held in the 1st week of May 2004. Timing of the meeting is of importance because the work of the group will be dependent on feedback from the WGBFAS, which is usually held in April. The meeting should further take place before the deadline of the application for the national programme for collection of fisheries data.

A deadline for the national institutes to nominate participants for the regional group will be in April.

The regional group should have the following general ToR:

The Baltic regional group will meet in beginning of May each year in order to:

- *Compile the intercessional regional work made since last meeting into a report.*
- *Take actions to incorporate necessary changes, identified by the intercessional regional work into the national sampling schemes.*
- *Plan the intercessional work to be done before next meeting.*
- *To consider immediately obtainable data improvements based on the WGBFAS meeting held 2 weeks before. which will infect the ongoing data collection.*
- *Identify areas or subjects that would benefit from regional coordination.*
- *Consider requests from ACFM and STECF.*
- *Consider requests from any other scientific bodies.*

First initiating meeting

The 1st regional meeting for the Baltic area will be held in the first week of May 2004 and will be chaired by Henrik Degel, DIFRES. Venue will be decided at a later stage.

2.2 Report from the North Sea subgroup

The North Sea RPG decided to the main areas where coordination and cooperation could improve the general quality of the basic fishery dependent input data for stock assessment work.

2.2.1 Use of a shared ALK

Since most of the bias in sampling comes from the Age/Length Keys (ALK) (EMAS, EU Study project 98/075), there may be advantages in combining national ALKs if this leads to an overall improvement in the level of sampling. The basic assumption for using shared ALKs is that probability of a fish at a given length being a certain age is independent of the fleet that catches the fish in that area. This assumption only holds if there are no differences in growth across the stock area. If there are, separate ALKs should be used for areas with different growth rates. In many cases, fleets are not able to sample the full length range and in these cases, combining sparse data from a number of countries can lead to overall improvements in the ALK.

The group **recommended** that shared ALKs should be considered but any changes would need to be tested statistically before being used by assessment WGs. It was suggested that pooling the data is unlikely to make the situation worse whereas using separate ALKs with various levels of bias may give more unreliable age compositions.

A separate but important problem is age reading errors between countries. In order to minimise these errors, there should be exchanges between countries to ensure intercalibration on a regular basis. Even if ALKs are not shared, there is a need to carry out otolith exchange programmes.

Since countries sample for age using different length classes, all data should be provided on a single cm basis for exchange. In order to allow exploratory analysis of the temporal and spatial variation in the data collected, countries should provide information on where and when their length and age samples were collected.

Although assessment WGs would be the most appropriate group to carry out these analyses, it was recognised that there is rarely enough time for this. Consequently, it was **recommended** that the Regional Planning Groups should take this on.

2.2.2 Collection of Biological parameters in a uniform way

The North Sea sub-group agreed that the same arguments as for ALKs apply to other biological parameters and consequently, shared data would be expected to provide improved indices. This is only appropriate if all countries are collecting data in a standard way. There was some uncertainty that this was the case and it was felt that combination of data for which there was no quality control may be of limited scientific value. For instance, one key problem is differences in interpretation of maturity stages and the time of the year used by different countries. There is a need to agree standardisation between countries and as was recommended for age, it was suggested that exchanges and or workshops should be held between countries. For maturity, the spawning period is the best time to measure maturity but this is not always possible if surveys are used to collect data as not all surveys occur at the appropriate time of the year. Another problem is the need to coordinate sampling over the tri-ennial period. There is no group dealing directly with the methodology of standardising the collection and measurement of biological parameters. The group **recommended** that the ICES SG GROMAT should take on this responsibility and this should then be included in the Quality Handbooks for each stock. The RPG should make an inventory of all standard methods for individual stocks to ensure comparability between countries. However, SG GROMAT will only meet next in 2005, in the meantime it was recommended that the IBTS standard methodology (ICES CM 1999/D:2) should be adopted.

2.2.3 Coordination of landings by foreign vessels

The only statutory requirement is to report landings by foreign vessels; this does not extend to biological sampling. Nevertheless, if there are large landings by foreign vessels countries should discuss whether these are being adequately sampled. Problems identified in the North Sea were:

- Belgian landings into the UK are rapidly transported for 1st sale in Belgium.
- Norwegian vessels land abroad and large quantities of fish are also transported to foreign markets – no evidence that these landings are being sampled.
- Large quantities of frozen fish such as herring are landed into Germany for processing but these present severe problems to sample.
- Transhipment of catches from non EU vessels.
- Non-EU landings into EU countries are a problem for biological sampling because there is no mechanism to obtain funds under the Data Regulations.

It was considered that coordination should be undertaken by the Regional Planning Group but until this group is in operation, the most effective approach is through bi-lateral contact using the list of contacts presented in the last report of PGCCDBS (ICES CM 2003/ACFM:16). In general, landings should be samples at the port of 1st sale rather than the port of landing. Once sampling arrangements have been agreed, these should be clearly stated in the National Programme proposals of both countries in order to inform the Commission and the external evaluators that this is being done.

2.2.4 Future Structure of PGCCDBS

The North Sea sub-group considered that one approach to a Regional Planning Group would be for the PGCCDBS to be split into regional groups covering the 6 regions identified as RACs. The terms of reference of the RPG would be to coordinate and plan all aspects of sampling and in the longer term survey planning and coordination. The RPG would not deal with methodological problems. These problems are common across all Regional groups and would need to be dealt with ICES WGs which could work vertically across all regions. Problems identified by the RPG would be forwarded to ICES for consideration. The terms of reference of each RPG would be the joint responsibility of the ICES Living Resources, Resources Management, Baltic Committee and ACFM. In order to avoid losing links between groups, it was suggested that the coordinators of the RPGs should meet annually to discuss common problems and make requests to ICES for advice on such issues as methodology.

First initiating meeting

The 1st regional meeting for the North Sea will be held in Lowestoft, England in September 2004 and will chaired by Dr. Richard Milner, CEFAS.

2.3 Report from the Western and Southern Waters subgroup

Establishing RPGs

The regional group for the Western and Southern areas used a third approach when discussing the ToR a and the possible implementation of the RPGs.

The group agreed that implementation of a RPG for the areas could facilitate improvement on collection of fishery dependent data. Though, it was stressed that RPGs have to be given well defined roles and tasks. Problem areas should be highlighted and these should be addressed by the RPGs. The group expressed the importance of representatives of the RPGs are represented in the ICES, PGCCDBS discussions. At least the chairman of the RPG should attend this PG meeting.

The PG should concentrate on methodology, protocols and recommendations on the areas / topics that the RPGs should look at. There was also a general consensus that it is easier to achieve things in smaller groups where all members have in depth knowledge of the regional fishery, so RPGs, in theory, could be quite successful.

RPGs should initially concentrate on problem areas (PGCCDBS should review the data collection and indicate if any problems to be dealt with) and should solve basic data issues e.g. metier descriptions and maturity age / length keys, discuss overlap of sampling areas and species etc. The group stressed that the report for 2005 on additional biological parameters should be available in due time before the next PG meeting for review.

It was argued that ToR’s should not be given for the RPGs as not all countries are members of ICES. Instead the PGCCDBS should clearly describe tasks of the RPG. Non EU countries should have the same role as EU countries in the RPG. It was proposed to split the western waters into NW shelf and SW shelf, but was rejected. It was suggested that NE arctic and the mid Atlantic ridge fisheries were incorporated into the Western group. Final decision has to be taken.

IBTSWG, BTSWG and similar groups should continue to function for the organising and planning of surveys.

Assessments

RPGs and stock assessment WG members should liaise to ensure that sampling levels, etc are correct / adequate for stock assessments purposes. The RPGs have to have access to information on sampling carried out by other countries to ensure the filling of ‘empty cells’ – to ensure spatial and temporal coverage. The RPG and the PGCCDBS should highlight if any shortcomings of the Data Directive. For example, the data requirements and the data precision level according to the Data Directive could be met, but this data aggregation level do not fulfil the data requirement for carrying out stock the assessment work.

The RPGs should try to find a way to make international age length keys feasible. The ISLDB (ICES CM 2001/ACFM:26) could be a suitable software that used by the RPGs. It will be explored whether EU Commission funding could be made available for further development of the ISLDB.

Sampling of foreign vessels

The RPGs should support and encourage bilateral agreement on the sampling of foreign vessels landings outside the flag country. A decision should be made on what should happen to biological data collected from foreign landings.

First initiating meeting

The 1st regional meeting for the Western and Southern waters will be held in Galway; Ireland in September 2004.

2.4 Report from the Mediterranean subgroup

The Mediterranean Sub-group of the PGCCDBS discussed issues such as coordination and cooperation on data collection of other related issues.

Regarding ToR a and particularly the point on whether the Mediterranean countries gain any benefit by establishing coordination and cooperation on data collection of commercial fisheries data, all agreed that both national and international coordination and cooperation is extremely important, since it’s an effective tool for the standardization of sampling methodologies and subsequent data analysis procedure used by EU countries, mainly those being in a certain region. The latter would provide better quality comparable assessments that would serve more effectively the needs of the Community and the member state for improved scientific knowledge and advice, and will thus offer the possibility to reach more efficient management decisions.

Regarding the point on whether the establishment of shared age/length keys is serving any purpose, the sub group felt that in a case of shared stocks among countries, it is necessary to work together, splitting tasks among involved member states after appropriate agreements.

Regarding the point on how it could be ensured that coordination and cooperation on sampling of vessels landing outside of the flag country, it seems that for the Mediterranean it only stands for large pelagics (tuna, swordfish) fisheries and could be achieved through close collaboration of member states, industry and scientists involved.

Regarding the point on whether we need to collect biological parameters in a uniform way, we think that it is absolutely necessary to do that on a species level. In cases that it deals with a species exploited not only in the Mediterranean but also in other areas, uniformity should be established in all areas, where the particular species is present and hence will be studied. This way, results are comparable and could contribute to the identification of possible similarities/differences among stocks of a particular species, which might need to be further clarified and/or correlated with particular aspects.

Finally, the subgroup felt that the improvement of collection of basic data of national programmes could only be achieved through regional, at least, co-ordination and co-operation and this is the way the Mediterranean countries should follow.

2.5 Summary concerning ToR a

There was a general acknowledgement of the need for establishing Regional Planning Groups dealing with coordination and planning of sampling. There was also a general agreement that regional groups need to be dynamic and flexible. At the same time it could be an advantage of being linked to the ICES "umbrella".

It was suggested that RPG could be independent from ICES but in order to ensure linkage to ICES that the RPGs should report to the PGCCDBS. There was a general consensus that a formal structure of the RPGs is needed in order to put pressure on countries to actually send people to the RPGs. It was argued that if national work would benefit from RPGs maybe internal momentum could keep them going.

There was also a discussion on topics for the RPGs. The number of topics to be dealt with is to a large extent dependant on the current level of regional cooperation. To ensure progress for coordination and cooperation it is suggested to draw up a minimum list with priorities of tasks that the RPG should handle. Besides the minimum list RPG are free to do additional work.

The PGCCDBS therefore recommends the following tasks as minimum to be dealt with by the Regional Planning Groups at there first meeting:

- Regional coordination and co-operation in collecting biological data of landings of fish and shellfish.
- Report on the main deficiencies in data collection and recommend on how these can be improved.
- Establish bilateral agreements between countries on the biological sampling (length and age) of landings by foreign flag vessels.
- Explore the possibilities of (i) task sharing between countries and (ii) setting up joint programmes for the collection of growth, sexual maturity and fecundity data for all analytically assessed fish and shellfish stocks in their region.
- Compare existing manuals for biological sampling and report on inconsistency and advice on best practice.
- Explore the possibilities of (i) task sharing between countries and (ii) setting up joint programmes for the collection of growth, sexual maturity and fecundity data for all formally assessed fish and shellfish stocks in their region.
- Collate information on existing manuals for biological sampling, in view of putting together standard manuals that could be used by all countries in the region.
- Explore the possibilities of co-funding studies that are beyond the financial capacity of single countries.

The future of the PGCCDBS in relation to the RPGs was discussion and the general opinion of the PG was that the PGCCDBS is considered as an important link between southern - northern and eastern - western countries. Furthermore, the PG found that a forum where general topics and problems could be discussed and agreed is needed and that the PGCCDBS could facilitate this.

3 DEVELOPMENT OF A FRAMEWORK AND METHODOLOGY TO ENSURE SPATIAL / TEMPORAL COVERAGE OF SAMPLING OF BIOLOGICAL DATA FROM THE LANDINGS

3.1 Summary of the Discard Workshop

The Discard Workshop was held in Charlottenlund, Denmark in the period 2-4 September 2004 with the following ToR:

a) Identify data requirements and appropriate discards sampling strategies and methods (e.g. stratification, mandatory and optional variables, selection of vessels, gears, etc.)) to collect fisheries data which fulfils requirements related to stock assessment.
b) Review the sampling strategy and methods in established discard sampling programmes and develop guidelines in order to minimise bias and maximise precision.
c) Identify raising procedures which minimise the bias and maximise the precision of estimates taking into account the sampling procedure and the use of the data.

At the discard study group the general conclusion was that currently most discard sampling programs are pilot studies: coverage of some fleets is not representative of spatial and temporal trends. As a result of this and because of short time series, discards data are not used in most assessments leading to problems (e.g. North Sea plaice). The workshop only dealt with precision levels of the data. It did not take into account that, if any of this data is to be used in near future stock assessments, uniform sampling and raising procedures have to be constructed.

For further information the entire report from the Discard Workshop is given in Annex 1.

3.2 Summary of the WKSCMFD

The WKSCMFD (Workshop on Sampling and Calculation Methodology for Fisheries Data) (ICES CM2004 /ACFM:12) met from 26 to 30, January 2004 in Nantes to address the question of standardisation of sampling methodology in the National programmes in connection with EC Regulation N°1639/2001.

General consideration

The group gives support to the STECF/SGRN alternative approach to introduce the notion of precision in the definition of sampling intensities. It is stated that the precision should be calculated on stock indicators (SSB, F, R, …) and data collection programmes adapted where the achieved precision is inadequate. Calculating precision on intermediate data (number-at-length, number-at-age, length-at-age, weight-at-age, …) implicitly tries to achieve the same objective but this raise the problems of (i) calculating precision on multidimensional data and (ii) giving precision target to countries when precision is to be calculated at the ultimate aggregate level.

EU Regulation states that sampling strategies must be at least as efficient as Simple Random Sampling. The basis behind stratification is to avoid bias and increase precision at a given cost. A review of the National programmes shows that stratification is usually done by combination of

- Time (month, quarter)
- Space (rectangle, Division, area, harbours or sets of harbours)
- Technical (Gear, fleet)

A particular attention is given to the risk of over-stratification that may occur when the number of strata is large with respect to the sampling effort.

The calculation of the precision of an estimate is not the only goal to achieve. A low CV does not guarantee an accurate estimate of the "true" parameter value. There are a few steps to consider before coming to the calculation of the precision. These steps are described in the guidelines section but do not represent a "recipe book". Expert knowledge, statistical tools and feed-back from the users will always be necessary to build the optimal sampling scheme.

ToR a – produce guidelines for routine estimation of precision in connection with national sampling programmes

Workshop gives the steps to consider before coming to the calculation of precision in the form of a questionnaire which can be decompose as follows:

- Definition of the variable to estimate
- Description of the sampling design
- Exploratory analysis
    - Bias: are samples representative of the pop. sampled
    - Precision: outliers, empty cells, …
    - Design: residuals analysis, search of patterns, …
- Description of the method used to calculate precision

ToR b – identify data requirements and appropriate sampling strategies and methods to collect fisheries data which fulfil the requirements related to stock assessment

The important question of sampling strategy has not been studied during the workshop. The improvement of a sampling scheme can only be done after primary analysis of the data and the coefficients of variation. Based on information contained in the overview tables and appropriate exploratory tools, national data should be analysed. These important issues need to be addressed specifically to another workshop.

ToR c – compile information on and review the statistical procedures implemented within the national sampling programmes

Overview tables have been produced to allow studies on similarities and discrepancies between countries in the methods in use and different approach to sampling. These tables are a starting point for future analysis of sampling strategies.

From these tables, figure 1, 2 and 3 gives a general insight of national programmes currently implemented.

ToR d – propose methods to estimate precision and design sampling stratification schemes that will minimise bias and maximise precision

	Design-based		Model-based	
	Analitical	Non-parametric bootstrap	Frequentist	Bayesian
Assumptions	Sample representative of the population, sampling scheme unbiased Strata must be a partition of the space.	Resampling unit must be independent.	Distributions and relationships between variables.	
Advantages	Explicit, identify variance due to age and due to length, can derive statistics to analyse sampling design.	Non-parametric, can deal with complex processes, simple concept, estimates covariance.	Explicit, deal with complex situations, id var comps, estimations of uncertainty, parameters can have biological interest, can include expert knowledge.	Idem frequentist model, easier to deal with missing observations, include more complex expert knowledge and different sources of data.
Disadvantages	It becomes extremely complex to apply to more than 1 strata situation, no covariance between ages.	Sensitive to low number of samples in strata which can underestimate variance or produce biased estimates due to merging of strata.	Complex assumptions, requires model testing and fitting, different sampling schemes and stocks may require different models.	Idem frequentist model, more difficult to implement, MCMC convergence problems.
Implementation	Simple	Simple, uses simulations.	Complex.	More complex, uses simulations.
Example (ref)	WD 4, 5, 6, 7 & 8			WD1

Recommendation

National programmes should be analysed in term of precision before going to another step.

- There is no recipe, no simple guideline to estimate precision for all stocks and everywhere.
- Precision should be estimated at a stock level.
- A tool need to be developed at the international level to produce estimates of precision.
- A workshop devoted exclusively on sampling design should be organised in the beginning of 2005.

The terms of reference should be

a) analyse the results of precision obtained by each country

b) advise on sampling strategies including stratification and sampling effort

Because the work to be done at this workshop must be a follow-up work with duration of 3 or 4 years, this workshop should be established as an ICES Study Group.

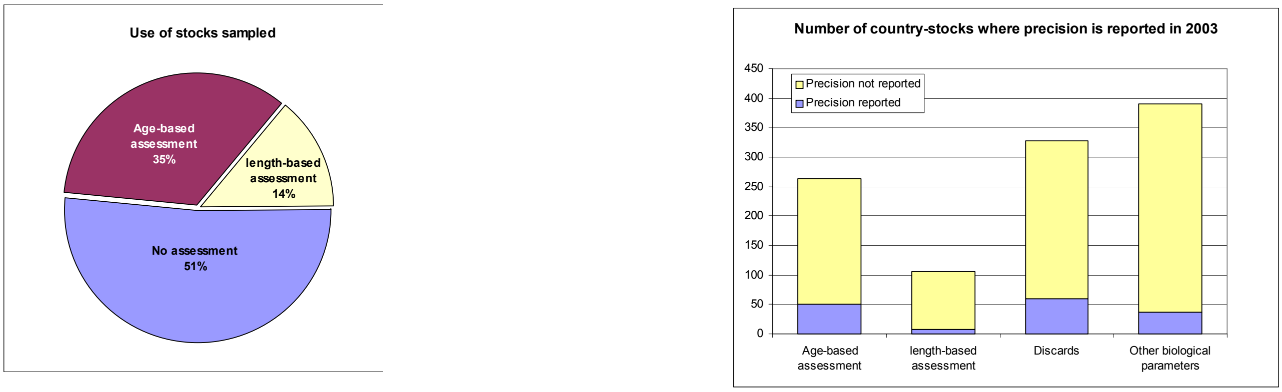

Figure 1. a) Use of stocks sampled and b) Proportion of stocks where precision will be estimated in 2003.

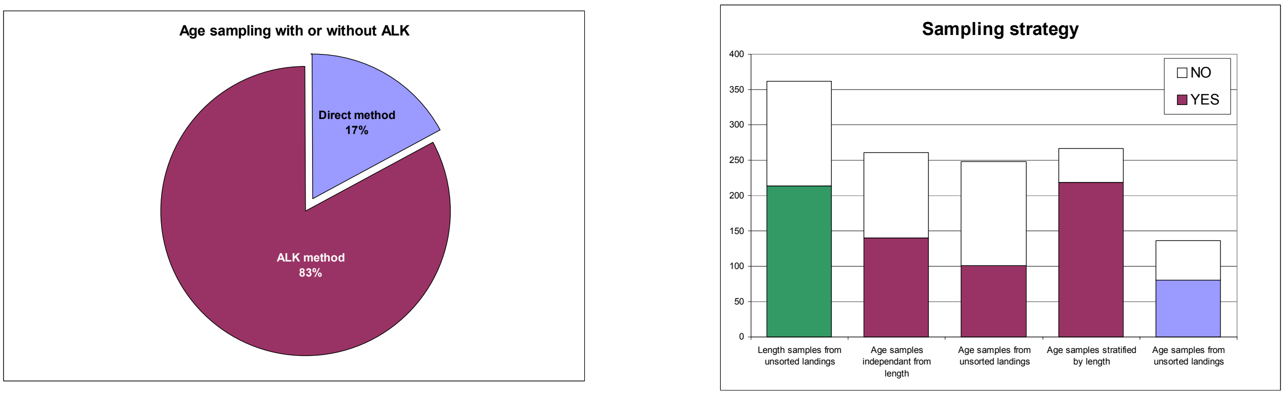

Figure 2. a) Age sampling with or without ALK and b) sampling strategy

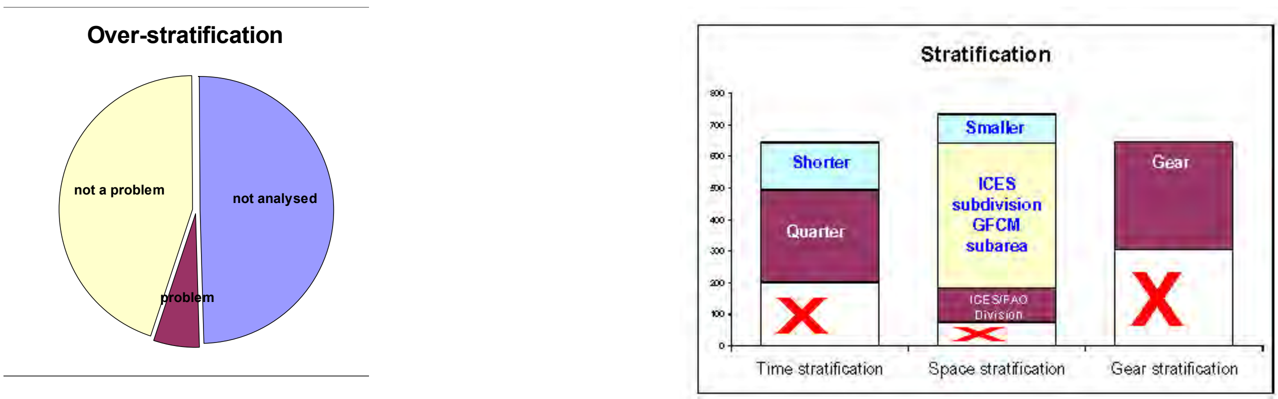

Figure 3. a) over-stratification and b) different stratification strategies

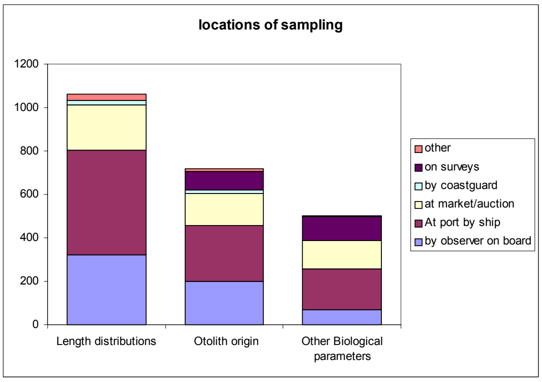

Figure 4. Location of sampling

3.3 Summaries of the discussions in the Regional Groups of ToR b

Baltic

Development of framework and methodology to ensure spatial and temporal coverage of sampling is an obvious task for the regional groups. Establishment of a homepage containing a spreadsheet with a **real time** overview of present national states in sampling level would be a simple tool enabling optimizing the spatial and temporal coverage on a regional scale. Initially there are no needs for sophisticated software as a plain spreadsheet will do.

North Sea

There is currently no information on whether there are problems with spatial and temporal coverage of biological sampling for North Sea stocks. Before requesting MS to provide details of their sampling, the group discussed whether a move to fleet based data collection would result in a improvement in the spatial and temporal coverage of sampling. It was not evident that this would occur implicitly and so this should be considered by the Regional Planning Groups when fleet based sampling is being discussed. Provided that each country examines the potential biases in their sampling programme, this should indicate whether there are problems with spatial and temporal coverage on a national basis.

Western and Southern

The Western and Southern Group suggests that the ISLDB could be used as a use software tool to ensure spatial and temporal sampling coverage. The database can easily be adjusted to include other parameters such as maturity stages. It could also contain information from discards and surveys. It would be a very useful tool for the RPGs to use. The most important thing is that all countries would need to ensure that their data submissions were completed on time.

Mediterranean

The point on whether *a framework and agree on a methodology to ensure spatial/temporal coverage of sampling* could establish was discussed. The group felt that this is of key importance and should be made in the short term, on the basis of outcomes from workshops already conducted, as well as future ones - in particular, the workshop planned for next year on the improvement of biological data collection. It is hoped this workshop will help to identify some aspects associated with biases originating from bad sampling/data stratification. This may provide a solid protocol that could be applied in the future. At this point the subgroup would like to stress the necessity of discussing sampling problems, particularly those associated with gathering small-scale fishery data. This fishery has proved to be a very complicated sector (a great number of vessels, métiers, landing ports etc), and needs to be looked into. As this problem is of great importance it is proposed that a specific Workshop on Sampling Strategies for Small Scale Fisheries should be held. It was suggested that the workshop possibly could take place in April/May 2005 (Kavala-Greece) with the following ToRs:

a) description of small scale fleets by country;

b) description of strategies used by different countries to obtain basic information for management purposes (landings, effort, catch composition by length/age, biological parameters, economic data) as requested by EC regulations 1639/2001 and 1543/2000;

c) compare sampling strategies adopted by different countries;

d) define guidelines to implement national sampling protocols.

The question on whether the Mediterranean countries *have a data collection scheme that enables ICES or other organizations to give multi-fisheries advice* was discussed. The group had the impression that there are certain "hot spots" in existing data collection schemes which need further improvement through close collaboration and exchange of knowledge/experience. This would provide more reliable data for advisory organizations.

In conclusion, the subgroup feels that through collaboration in workshops, methodological guidelines could be agreed that would ensure adequate spatial-temporal sampling in the national programmes, thus improving the data collection scheme.

3.4 Summary concerning ToR b

Data collection manuals or catalogues

At present a number of international and national manuals exist. During the EU, IBSSP-project, the SAMFISH project (EU Study project 97/059), the FIEFA project (EU Study project 95/013) data collection manuals have drawn up. A lot of work has already been done on different manuals and collecting if the existing manual with each region could be the first starting point. There was a general consensus on the usefulness of up starting the process of draw up a common data collection manual or data collection catalogue. The first draft of the manuals could be compiled by the RPGs and at a later stage reviewed by the PGCCDBS.

Assurance of adequate spatial / temporal data collection

As the data for analysing of the spatial / temporal coverage of the data sampling in an international level are made the year after the fishery and the sampling has taken place, it is not possible to take any real time actions in order to secure adequate sampling coverage. The PG agreed on trying on a regional basis to set up a system to solve this problem. If "Meta" data on the sampling carried, on a monthly basis is transmitted to all the members of the RPGs it is possible to take real time actions. Furthermore, it was agreed to try to use the present version ISLDB software as tool to get overview of the spatial / temporal sampling on a month or quarterly basis.

Small scale fisheries

I some areas the fishing fleet mainly consists of small boats but in a large amount. For this small scale fishery, especially within the Mediterranean, is very difficult to setup sampling schemes. It was suggested to establish a workshop to deal with this problem. There are two main problems when setting up sampling schemes for small scale fisheries 1) How to actually get hold of the boats and 2) Difficult to stratify on gear for example since the vessels could use a wide range of gear.

The PG suggested that this problem as a first go should be solved by setting up a random sampling scheme, unstratified on location of the fishery, on gears and on sizes of vessels. if gear is the problem. It was suggested to get experience from other sampling schemes set up for small scales fisheries such as sampling recreational fisheries. In other parts of the world such sampling schemes exists.

4 CANDIDATE STOCKS AND SPECIES REQUIRING IMPROVED AGEING

A plaice age determination exchange and workshop was held in Ostende during 13-14 may 2003 with the main focus on improvement of the accuracy of ageing between the countries reading plaice otoliths from the North Sea and to determine whether the preparation method have effect on the agreement between countries and readers.

A series of plaice otoliths consisting of both whole and sliced otoliths had been circulated between all participants prior to the workshop and parts of this was re-read after a discussion of the disagreements. Unfamiliarity by some of the participating countries with the growth patterns of the exchange sample from subarea VIId and the gap in the series between spring and fall caused some problems, but also the definition of false rings did play a major part in the disagreements.

Figures 5 and 6 shows the results from the circulation prior to the workshop, and these indicates an overall agreement of 68% with most disagreement in the older ages (8+), however, the CV% is high on age 1, which most likely is related to the unfamiliarity of the growth structures, e.g. formation of the winter ring, to some of the participants. As expected were the results of the circulation of the exchange set during improved compared to the results prior to the workshop, increasing the overall agreement after discussions of the more difficult otoliths. The preparation technique (whole versus slides of otoliths) appeared only to have an effect on the older ages (from 8+) where the rings are so narrow, that ageing performed on whole otoliths cause serious under-ageing.

Based on the workshop results it was agreed to continue exchanges of sets of otoliths from various areas of the North Sea to ensure that the agreement between countries continues to be high. The aim is to have complete exchange-sets of otoliths from all areas and throughout the seasons. Concurrently will effort be allocated to improve the agreement within the ageing laboratories and age-readers from the various laboratories will exchange digitised images of problematic otoliths in order to discuss the ageing of these.

These post-workshop actions should be considered by the coming series of ageing workshops.

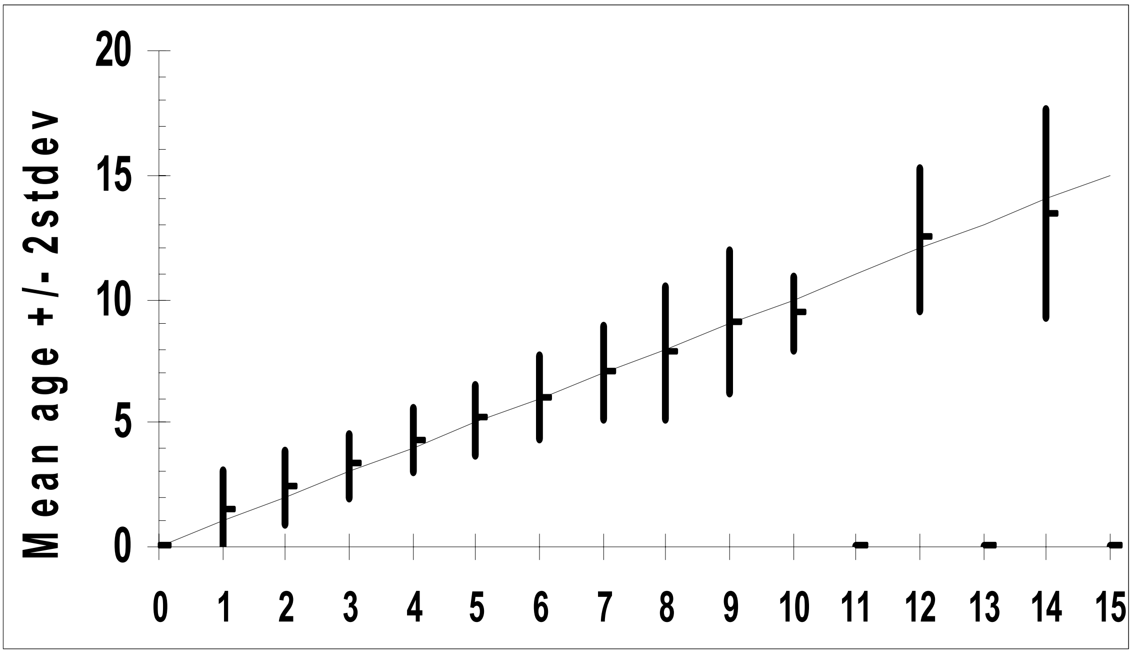

Figure 5. Shows the mean age and +/- 2 standard deviation.

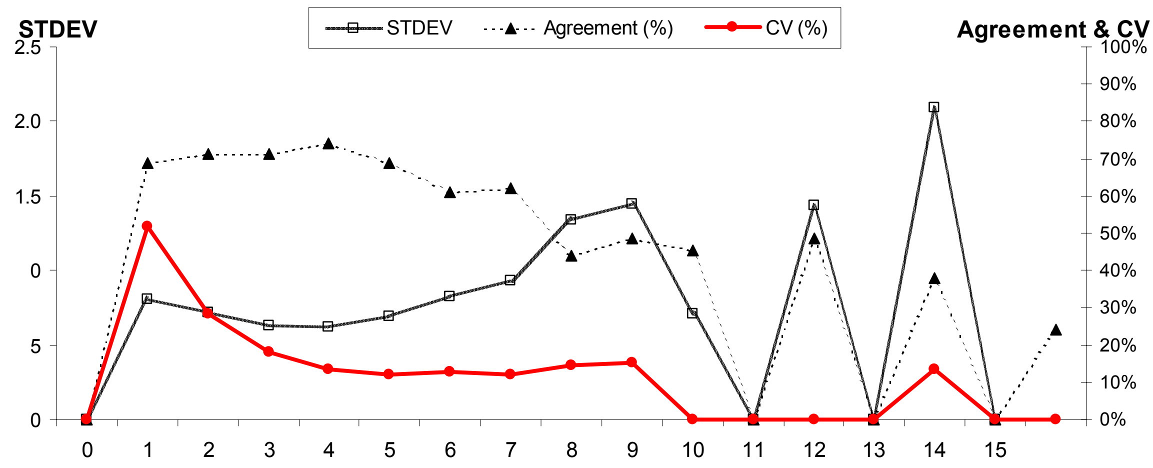

Figure 6. Coefficient of variation (CV%), percent agreement and the standard deviation (STDEV) plotted against MODAL age.

The PG discussed the present problems in age readings and agreed in carrying out otolith exchange programmes in 2004 and 2005 for a number of species. Furthermore, the PG agreed in having 4 otolith age reading workshop in 2005. The species for which otolith exchange programmes as well as age reading workshops is given in Table 1.

The PG noted, that inclusion of any other relevant ICES study groups etc. dealing with age determination is problematic, since PG has annual meeting early March and NP's are handed in by the end of May, but ICES meeting calendar is released in the autumn. Therefore, the PG recommends, that all relevant age determination groups dealing with species included in the MP should be considered eligible in EU data collection programme.

5 THE USE OF FISHERIES INSPECTORS DATA BY ASSESSMENT WORKING GROUPS

Considerations on Commission Fishery Inspectors legal functions

Commission Fishery Inspectors are acting under the terms of two Council Regulations:

Council Regulation (EC) Nº 2371/2002 of 20 December 2002 on the conservation and sustainable development of fisheries resources under the Common Fisheries Policy[1]. Recital number (24) of this regulation states that "*The Commission should be provided with appropriate powers to carry out its obligations to control and evaluate the implementation of the Common Fisheries Policy"*. Those powers are specify in Article 26.1 of this regulation (responsibilities of the Commission) provides that "*the Commission shall evaluate and control the application of the rules of the Common Fisheries Policy by the Member States, and facilitate coordination and cooperation between them"* . Furthermore, Article 27 of this regulation (Evaluation and control by the Commission) provides that *"the Commission may, of its own accord and by its own means, initiate and carry out audits, enquiries, verifications and inspections concerning the application of the rules of the Common Fisheries Policy by Member States. It may in particular verify:*

the implementation and application of those rules by Member States and their competent authorities;

the conformity of national administrative practices and inspection and surveillance activities with the rules;

the existence of the required documents and their concordance with the applicable rules;

the circumstances in which control and enforcement activities *are carried out by Member States.*

[1] O.J. L358; 31.12.2002, p 59

Council Regulation (EC) Nº 2347/93 of 12 October 1993 establishing a control system applicable to the common fisheries policy[2] as last amended by Council Reg. (EC) Nº 1954/2003 of 4 November 2003[3]. Recital number (28) of this regulation states that *"it is necessary to establish general rules to allow Community inspectors appointed by the Commission to ensure the uniform application of Community rules and to verify the control carried out by the competent authorities of Member States"*. Those general rules are specified in Title VII (Application and verification of monitoring) and particularly in Article 29 which provides that : *"The Commission shall verify the application of this regulation by the Member States by means of examination of documents and by conducting on-the-spot visits"*

Taking into consideration the above mentioned legal texts, Commission Fishery inspectors are entitled to check (verifications, audits, inspections, enquiries…) the implementation of the CFP rules by MS. It is true that in order to assess the level of implementation some checks in terms of compliance (usually accompanying MS inspectors, but not always) could be done. Nevertheless, to check compliance by individual vessels it is not the first priority of Commission Fishery inspectors. The evaluation of the compliance is of the entire responsibility of the competent authorities of the member States. Article 24 of Reg. (EC) 2371/2003 (Inspection and enforcement) provides clearly the responsibilities of MS: *"Member states shall take the inspection and enforcement measures necessary to ensure compliance with the rules of the Common Fisheries Policy on their territory or in the waters subject to their sovereignty or jurisdiction. They shall also take enforcement measures relating with fishing activities outside Community waters of Community fishing vessels flying their flag."*

Protocol of data transmission signed between ICES and the DG-FISH

In June 2003 a protocol was signed between ICES and DG-Fish in order to make available data compiled and recorded by Commission Fishery Inspectors in the context of verification programmes when visiting MS.

It was agreed to transmit those data in an Excel-format. Commission Fishery inspectors shall take all necessary measures so that primary data collected under this protocol shall be codified in before to be transmitted to ICES in order to guarantee confidentiality of individual vessel identification.

Files transmitted should contain the following information:

Clear indication if the vessel' trip has been physically inspected and quantities duly verified or not.
Quantities landed in Kg of all species landed;
Gear category
ICES zone
Mesh size or number of hooks
Days at sea and hours fishing
Engine power
Vessel identification (codified)
Flag MS identification (codified)
MS where landing took place (codified)

Results

During 2002 we have collected data from 331 trips of 204 individual vessels of which we have accompanied national inspectors verifying catches in 121 cases.

During 2003 we have collected data from 419 trips of 92 individual vessels of which we have accompanied national inspectors verifying catches in 183 cases.

Use of these data by Commission Fishery inspectors

These compilation of data as been used by Commission Fishery inspectors to assess the reliability of landing data transmitted by MS to the Commission particularly in the context of verification programs for certain stocks, namely cod stocks in the North Sea and West of Scotland and northern hake stock in Western waters.

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[2] O.J. L261; 20.10.93, p.1
[3] O.J. L289; 7.11.2003, p. 1

We are aware that such limited number of data could not be considered a “prove” of unreliable data. Nevertheless, by comparing inspected and non-inspected trips of the same vessels fishing in the same area and season we have been able to identify a high level of variability between “inspected” and “non-inspected” landings. As a matter of example we have come across of a certain number of vessels in a particular port that when inspected their catch composition were 8-10 tons of a quota specie “A” and 0 tons of a non-quota specie “B”. Analyzing logbook entries of previous trips (non-inspected trips) by the same vessels the catch composition change so dramatically as declared 0 tons of quota species “A” and 8-10 tons of non-quota species “B”.

Assumptions of unreliable data are not easy to prove by using this “ad hoc” method (due particularly to the limited number of samples and the absence of a system in place to audit the quality data compiled), but if we add up some other considerations as, for example, absence or limited cross-check data verification[4] and in particular between VMS and logbook information[5], lower coverage (in terms of inspection intensity), of physical inspections and low quality of inspection procedures observed[6], there is room to believe that logbook data collected is highly unreliable in a series of fisheries.

Inspection priorities for 2004

Under Article 27.2 of Reg. (EC) Nº 2371/2002 *“Inspection reports shall be made available to the member State concerned”*. This particular legal obligation and the decision by the DG-Fish hierarchy to give publicity (an make available in the net) the contents of the Commission Fishery inspectors reports have obliged to reconsider the structure and contents of the verification programmes. Due to that, inspection priorities and verification programmes have not been approved yet. Nevertheless and in clear synergy with priorities in terms of conservation it is possible to anticipate that stocks under recovery, notably cod stocks in ICES zones defined in Annex V of Council Regulation 2287/2003 (TAC and quotas regulation) will constitute one of the priorities of the DG-Fish inspectorate.

Due to the complexity of the legislation to be verified and the number of MS concerned by cod fisheries it will be rather difficult that DG-Fish inspectorate could provide data for areas 2 and 3, except the data compiled in the verification programme on the implementation of Annex V of the above mentioned regulation establishing a fishing effort limitation and additional conditions in the context of the recovery of certain fish stocks (notably cod and associated species).

In this context, DG-Fish inspectorate will be in a position to transmit at the beginning of 2005 all data collected under the ICES-DG-Fish protocol signed in 2003. Interim data compiled maybe transmitted to the relevant working groups during 2004 if necessary.

Collection of landing data in the context of the cod recovery plan

Purpose

The purpose of the program is to create a database from different sources, in order to provide information on under or non-reporting catches of cod and mis-reporting by declaring cod as another species.

The aim of this kind of inspection is to collect official data furnished by the fishermen (logbooks, landing declarations), auctions (sales notes) and other structures involved in this fishery (VMS data from the National Administrations). At the same time, EU inspectors will collect information on the quantity of cod landed from a sample of boats in the relevant ports.

The fleets of eight MS are involved: United Kingdom, Denmark, France, Netherlands, Belgium, Germany, Ireland and Sweden.

During 2004, the aim will be to perform two missions in each MS, the first one in March and the second in September. During each mission, logbooks, landing declarations, VMS data and sale notes will be collected for a predefined sample of boats. Data will concern a period of two weeks before the mission and the week in which the mission will be carried

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[4] As provide by Article 19 0f the Reg. (EC) Nº 2847/93

[5] As provided by Article 19k of the Reg. (EC) Nº 2847/93

[6] As provided by Article 2 of Reg. (EC) Nº 2847/93

out. In order to obtain an independent picture of cod landings, during the mission EU inspectors will check directly the landings of the sample of boats for which official data have been collected (missions will be unannounced), randomly changing the ports each day. This strategy will be adopted in order to minimise the risk that fishermen correctly fill in the logbooks only as consequence of the presence of the EU inspectors at the port.

Definition of the fleets to be analysed

The vessels targeted will be composed of vessels over 10 m in length, operating in the geographical areas defined in the point 2. of Annex V of EU Reg. 2287/2003 with the gears listed in point 4. of the same EU Regulation.

Two missions per year will be performed in each relevant MS. In the United Kingdom and Denmark, the number of boats constituting the sample will be higher than those of the other MS, as a consequence of the high levels of landings of cod occurring in those two countries.

The number of vessels for each MS on which official data will be collected by the EU inspectors, is listed in the following table. In each MS the vessels will be chosen from more than one designed port. On the same vessels or some of them, EU inspectors will perform landing inspection during the week of mission. The same vessels composing the sample of the mission in March should be inspected again during the second mission of the year.

For each MS, the vessels will be chosen according to the characteristics of the fleet fishing cod. The most important factor to consider will be the gear used. For each MS, the number of vessels using a certain gear to be used in the sample will be proportional to the importance of that gear in respect to the total fleet fishing cod.

Member State	Sample (number) of boats
United Kingdom	20
Denmark	20
France	10
Netherlands	10
Belgium	10
Germany	10
Ireland	10
Sweden	10
Total	100

Data analysis

Collected data will be transformed in Landing per Unit of Effort (LPUE). Data will be standardised in different manners, according to the type of gear:

- Demersal Trawl, Seines and Beam trawl: kg (or tons) of cod landed/boat/fishing day
- Static Demersal Nets: kg (or tons) of cod landed/boat/fishing day/1000 m of net
- Demersal long-lines: kg (or tons) of cod landed/boat/fishing day/1000 hooks

The mean LPUE values obtained from different official sources will be compared with each other and with LPUE values coming directly from the sampling carried out by EU Inspectors.

Available data will be:

1) Mean LPUE computed from the data registered in the logbooks;
2) Mean LPUE computed from the landing declarations;
3) Mean LPUE computed from the quantities registered in the sale notes;
4) Mean LPUE computed from the representative samples (at least 20% of the landing in a port) weighed in presence of national inspectors (Annex V EC Reg. 2287/2003);
5) Mean LPUE computed from the sample collected by the EU Inspectors.

The first analysis is aimed to compare official data in order to underline possible discrepancies among the different data sources. A comparison will be performed also to compare VMS information and data on the fishing areas reported in the logbooks collected during the missions.

A statistical analysis will be carried out in order to compare official data of landing with the observations performed by EU Inspectors directly at the landing points.

Starting from the sample collected by EU inspectors, it is impossible estimate the "real mean LPUE" of the port. On the other hand, it is possible calculate the "confidence interval", in which the probability of containing the real mean LPUE value is high.

Normally, for statistical purposes, a probability of 95% is chosen (95% probability that the real mean LPUE value lies within the confidence interval).

If m and s_m are respectively the mean LPUE and the standard error of a sample randomly extracted from the data set, there is 0.95 probability in favour of the hypothesis that the real mean LPUE of the population will lie between m–$t_{0.05}$ and m+$t_{0.05}$.

In other words, the real mean LPUE of the data set will lie between:

$$m - (1.96 * sd/\sqrt{n}) < \text{Real mean LPUE} < m + (1.96 * sd/\sqrt{n})$$

Where:

m = mean LPUE of the sample;
1.96 = t (from Student table) value for 95% of probability;
sd = standard deviation of the sample;
√n = square root of the number of observations (boats checked) carried out during the sampling.

Therefore, the range of the confidence interval will be narrower reducing the variability of the data - sd - (choosing a more homogeneous set of vessels) and/or increasing the size of the sample (number of vessels inspected).

In practice, a larger size of the sample needs great availability in terms of human resources, time and money. So, in our specific case, for a better estimation of the parameters and their differences it is preferable to reduce the variability of the sample defining a more homogeneous subgroup of vessels (stratified sampling system).

For each subgroup of vessels a confidence interval for the real LPUE will be estimated starting from the LPUE observed by the EU Inspectors. Therefore, the LPUE computed from logbooks, landing declarations and sales notes should be compared with the confidence interval and if they lie inside it, can be considered reliable.

It is possible also to estimate a confidence interval of cod landing per group of vessels for the week in which the sampling was carried out. This estimation could be computed simply by multiplying the values of the confidence limits by the total number of fishing days carried out by the group of vessels during the week of sampling:

The confidence interval of cod landing will be:

$$\text{Days} * [m - (1.96 * sd/\sqrt{n})] < \text{Cod Landing} < \text{Days} *[m + (1.96 * sd/\sqrt{n})]$$

Where:

Days = total number of fishing days carried out by the subgroup of boats during the week of sampling;
m = mean LPUE of the sample;
1.96 = t (Student) value for 95% of probability;
sd = standard deviation of the sample;
√n = square root of the number of observations (boats checked) carried out during the sampling.

Landing data coming from official data (landing declarations, sales notes) should be compared with the confidence interval and if they lie inside it, can be considered reliable.

6 RAISING PROCEDURES OF NATIONAL CATCH AND DISCARD DATA TO THE INTERNATIONAL LEVEL

Introduction

To be able to compare, discuss and evaluate the different methods for raising sampling data to total catch it was agreed that every country should give a presentation of the methods used. Most of the have prepared a presentation and in addition provided a description of the method used. These descriptions by country are given below.

6.1 Belgium

Landings

Sampling procedure

In Belgium, as a rule, all fish and shellfish are auctioned in market categories (except when the quantities landed are very small, in which case they are sold all sizes mixed). The same market categories as also used in the database with the official landing statistics, held by the Sea Fisheries Office. All landing records are based on sale-slips.

Port sampling by the Sea Fisheries Department is done by species and stock, and for each species and stock by market category. Sampling is on a quarterly basis and targets a pre-set number of samplings (anything between 1 and 6 samples per quarter, depending on the total volume of the landings of the species and stock concerned). In the auction, full boxes are picked *ad random* from all market categories of a single vessel's landings, and from each box, a fixed number of animals are taken (from top to bottom, to avoid biases due to the presentation of the boxes) for length (and age) measurement. Sample sizes range from 20 to 300 animals, depending on the species and the type of measurements (length only, or length and age). All sampling data are recorded by vessel and market category, and stored in a central database.

Raising procedure

The entire raising procedure is based on market categories, and follows the steps given below:

1) For each vessel sampled, the length frequency data (LFD) of the market samples are first raised to the total volume of the landings by market category. Raising factor used: total weight landed by market category over sample weight.
2) For each quarter, these raised LFDs are then summed across vessels (keeping the market categories separate). The datasets thus obtained comprise the LFDs by market category for all vessels sampled in each quarter.
3) Next, the LFDs are raised to total fleet, again by market category. Raising factor used: total landings by market category by the whole fleet in that particular quarter over total landings by market category by the vessels sampled.
4) The quarterly LFDs of the landings as a whole (i.e. for all vessels and all market classes combined) are then obtained by summing the LFDs calculated in step 3 across market categories.
5) In the final step, the quarterly LFDs are summed to yearly totals.

Discards

Sampling procedure

Discard sampling in the Belgian sea fisheries is done either by sea-going observers (flatfish directed beam trawl fisheries in the English Channel, the Irish Sea, the Celtic Sea and the Bay of Biscay) or through a system of self-sampling (*Nephrops* directed fishery in the southern North Sea).

Discard (and other) data collected during these programmes include:

1. Routine estimates of the quantities discarded for all Appendix XII species and some Appendix XIII species in EU Regulation 1639-2001.
2. Length (and age) measurements on the discards and the retained catches, c.q. landings of cod, haddock, whiting, hake, gurnards, red mullet, plaice, dab, lemon sole, sole and *Nephrops*, in all fisheries where these species occur in sensible numbers (in the discards, in the landings or in both).

Raising procedure

The Sea Fisheries Department does not yet have an established raising procedure for its discard data. Different approaches are currently under investigation, but it is clear that the procedure will have to take into account aspects such as fleet behaviour and the peculiarities of the sampling programme, and hence, that it may depart from the general rule that was suggested by the Workshop on Discard Sampling Methodology, viz. to use fishing voyages as the standard unit in the raising procedure. Belgian fishing vessels often shift between areas during the same voyage, and therefore another standard unit (such as days or hours fishing) will be required, to get a closer match between the spatial and temporal distribution of the landings and the associated discard data.

6.2 Denmark

Commercial sampling

The information used for estimating the total catch at age in numbers comes from three different data sources. The sales notes, the logbooks and from collection of biological information of commercial landings (market sampling). From the logbooks we used the information about where the catch has been taken, we combine this with the sales note information to split the catch weight into size grades by species and then we use the marked samplings to divide each size category into age groups.

Market samples are stratified by year, quarter and geographic area (harbours or ICES squares), and the collection of biological information is made in a way to insure that both the geographic area and the hole quarter is cowered by samples. For some areas the sampling is further subdivided into gear types.

Raising procedure

First step in the raising procedure is to elevate landed weight from the samples of gutted fish to live fish weight using a conversion factor. Then the number of individuals pr. kg in a size sorting is calculated and a sorting by age key is made. With the number of individuals pr kg in a sorting, the catch weight in a stratum, can be converted to numbers of individuals in the different size sorting groups. By using the sorting-age key, the numbers of individuals can be split into age groups to produce to numbers at age in each sorting. Numbers pr age can then be summed over size grading and the total numbers at age can been calculated for all stratums by adding them together.

Landing that is not sorted is divided over the sorted landing in the same proportions as the sorted landings.

Not all sales notes can be matched with a logbook sheet. It is not always possible to match trips and sales notes and vessels less that 10 meters, are exempted from keeping a logbook, provided they submit a declaration giving the area in which they are fishing.

For the catch that have not been match, a scaling value is calculated between the match landing weight and the total value, the numbers a age is raised be this scaling value.

The mean weight at age is calculated using weighted means, but the numbers in each sorting is being calculated by numbers in weights of a standard box, that means that the total numbers calculated at age times the mean weight at age(the so called SOP, sum of products) is higher that the official landing weight. The reason for the discrepancy is that the standard boxes often contain a little overweight.

If there is no samples for a particular stratum when going through the raising procedure, a similar strata will be chose to represent this strata. This could be a nearby area or the pervious quarter, or the same quarter from the pervious year.

Before the start of a new year, an initial sampling scheme is made by DIFRES based on last years fishing pattern and changes known to come in the fishing activities. During the year the fishery is continuously monitored based on the national landing statistics and other sources. Each month each local office of the Fishery Inspection reports to DIFRES the number of samples collected from each stratum. The reports are collected and a feedback is given to the local office if more or less samples according to the initial planning are to be collected.

Steps in the raising procedure:

- Average number of specimens per box in each stratum is calculated.

- The total number of specimens landed in a stratum is calculated by dividing the number of boxes landed by the average number in each box.

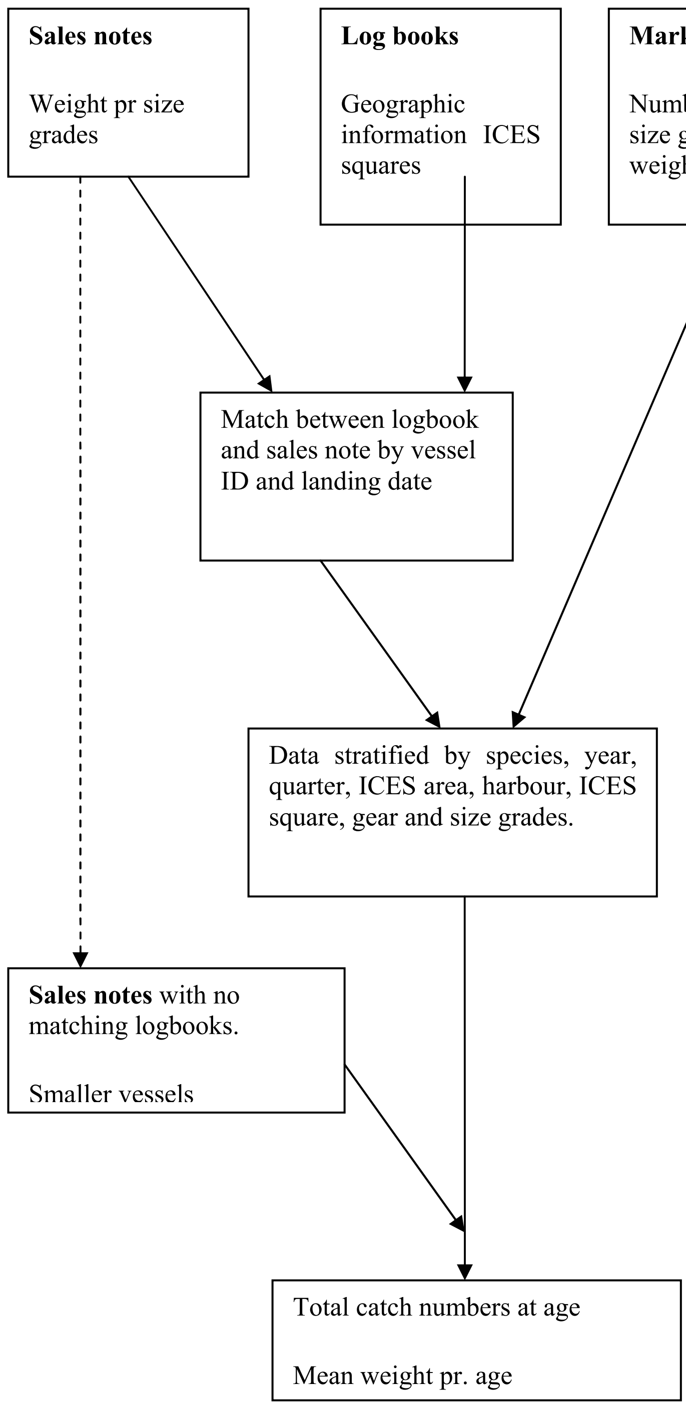
- Based on the samples, the age distribution in each stratum is calculated. No weighting procedure is applied.

- The age distribution is applied on the number of specimens landed per stratum.

- The individual mean weights per stratum are calculated parallel during the raising procedure by using weighed means.

- The number and individual mean weight per age group is aggregated on year, quarter, species and areas relevant for the given species.

If some gabs are identified (marginal landings where no biological information are available, biological information are extrapolated from adjacent area or quarter. In each case a expert judgement define the most suitable extrapolation.


Sales notes
Weight pr size grades
Log books
Geographic information ICES squares
Market samples
Numbers pr age pr size grades mean weight pr age
Match between logbook and sales note by vessel ID and landing date
Data stratified by species, year, quarter, ICES area, harbour, ICES square, gear and size grades.
Sales notes with no matching logbooks.
Smaller vessels
Total catch numbers at age
Mean weight pr. age

6.3 England

Commercial sampling

The English commercial samples are stratified by time, area and gear. Approximately 40 fleets are sampled. A sample consists of around 40 fish pr commercial category and up to 200 specimens for category 5. Length is measured to cm below for most species (pelagics to half cm, shellfish to mm).

Raising procedure

Length distributions are raised to vessel and thereafter raised to area (or port) landings, then to month and to quarter within each administrative district. Information on landing mainly comes from log books for vessels >10m. For smaller vessels information comes from sales notes. Length distributions are combined by quarter across district to give quarterly distributions.

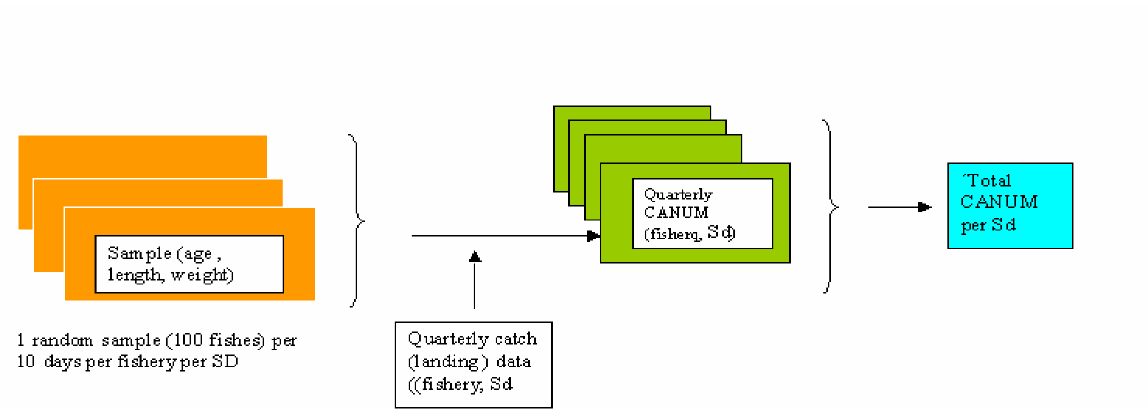
Age length keys(ALK) are stratified by time and area but not by gear. Strategies for length stratification of otolith samples vary for different species. Monthly samples are combine to quarterly ALK. The quarterly ALK are combined with the quarterly length distribution and finally the annual age compositions can be made by combining the quarterly results.

6.4 Estonia

The fishing areas include Sub-divisions 28 (incl. the Gulf of Riga, 29S and 32. The biggest fishery id herring and sprat trawl fishery, performed by pelagic trawls. The part of herring landings comes from coastal trap-net fishery during the spawning period in 2 quarter. The vast majority of catch are landed in 7 harbours. The discarding is not permitted.

The coastal fishery of flounder, migratory and freshwater species (perch, pike-perch, whitefish, salmon, sea trout, smelt etc) form another segment of Estonian fishery.

The herring and sprat fishery are sampled for analytical assessment. The direct random sampling is performed on monthly basis; all fisheries and sub-divisions are covered in fishing periods. In general, one random sample (100 fish) is analyzed (age, length weight, sex, maturity stage) every 10 days per fishery and Sub-division in order to obtain age composition and mean weight at age. The data are aggregated on quarterly basis and used to calculate CANUM. The quarterly CANUM data are used to obtain total CANUM per Sub-division (see chart below).



6.5 Finland

Baltic herring and sprat: distribution, fisheries and sampling framework

Most of the herring (95 %) and practically all the sprat are caught in the herring trawl fishery (pelagic & demersal) or mixed trawl fishery for both species, and approximately 5 % of the annual herring catches come from trap-net fishery in spawning time. Finnish trawl fishery is conducted mainly on ICES sub-divisions 29-32 and trap-net fishery exclusively on these areas. The length on annual fishing season depends very much on the wintertime weather conditions (ice cover) and these, as well as spawning time for herring, vary spatially according to e.g. latitude.

Finnish (herring) fishery exploits three different herring stocks: Bothnian Bay herring in ICES subdivision 31, Bothnian Sea herring in ICES subdivision 30 and the "combined" herring stock (assessment unit) in Baltic main basin (ICES subdivisions 25-29 and 32).

The distribution of sprat is more southerly than herring's. The share of sprat in mixed catches diminishes gradually towards north in the Gulf of Bothnia, and in the northern half of Bothnian Bay area there is practically no sprat at all. However, in northern Baltic main basin, Åland and Archipelago Seas as well as in the Gulf of Finland, sprat is common in trawl catches, but it's share in the catches vary lots depending on e.g. season.

The sampling of these species is stratified according to ICES sub-divisions, seasons (year-quarters) and fishing gears (demersal- and pelagic trawls for herring and sprat, and trap-nets for herring). The biological herring data collected from these fisheries (or regional fleets) has also been used regularly in tuning of XSA in the assessment of the two herring stocks in the Gulf of Bothnia.

Catch in numbers

The basis for calculations of catches in numbers for both species are year-quarterly combined gear-specific information on landings and corresponding sampling data from each ICES sub-division in the Finnish fishing zone. There are no discards in Finnish herring and sprat fisheries, because all catches are sold either for human consumption or for fodder markets.

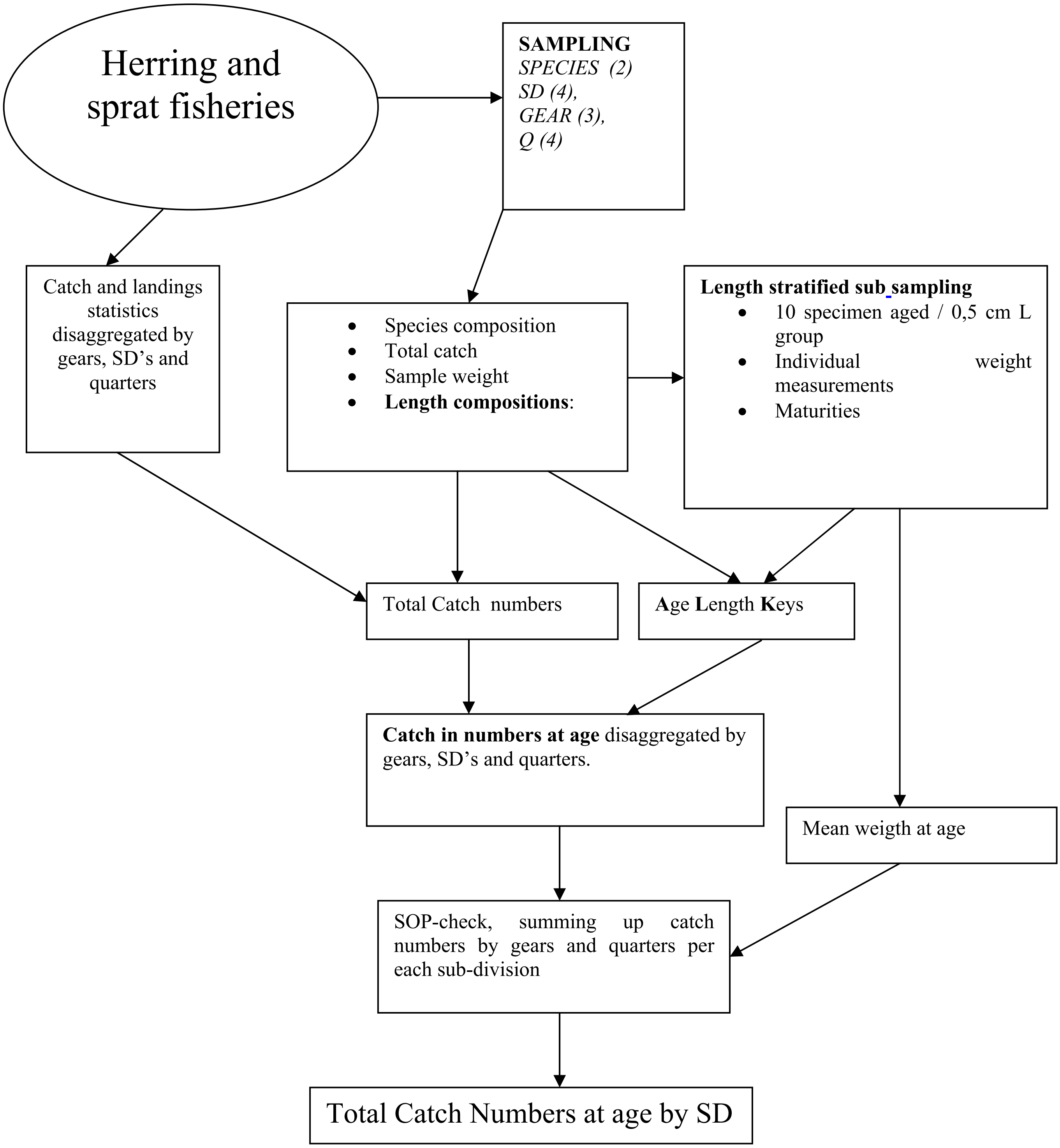
Catch estimations are based on mandatory log-book information on landings, which are cross-checked with the sales declarations, both nationally and internationally. The sampling is conducted regularly by FGFRI from all active fisheries and notable fishing ports all the year.

Age compositions (Age-Length-Keys) of the catches are estimated by length-stratified sub-sampling scheme. From existing 0,5 cm length-classes 10 specimens are aged per year quarter and sub-division. These specimens are also individually measured by mm and weighed by g, and also checked for maturity before spawning time.

The mean weights at age are derived from the specimen sub-sampled for age. The Numbers at age and MW at age are checked by sum product and fitted quarterly to match the gear disaggregated landings data. The catch numbers at age /gear are summed up seasonally for national annual total CN at age for each SD, and later on internationally combined sub-divisionally for assessment purposes.

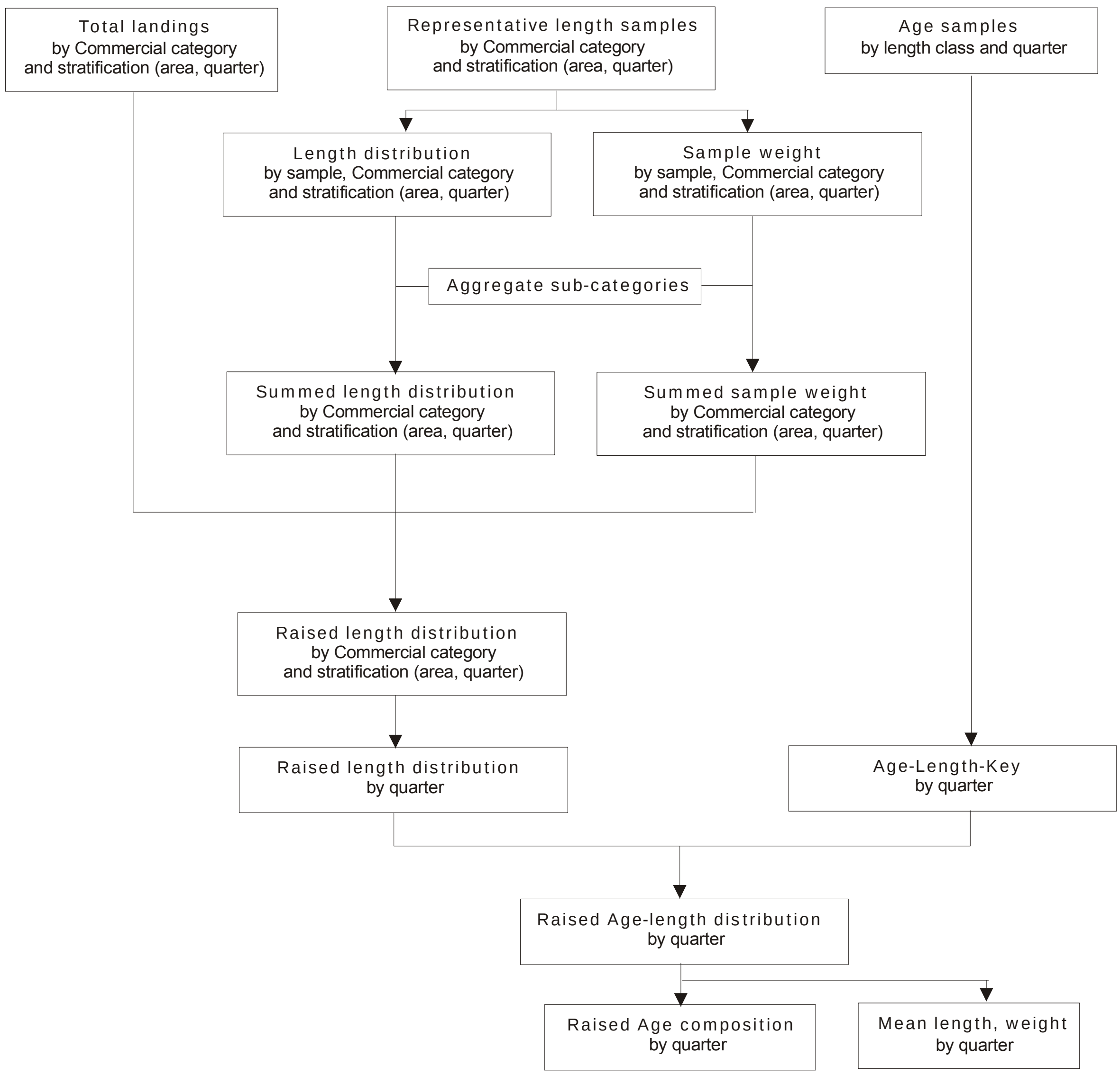
Missing values

Sometimes sampling may miss a stratum (SD, Q, G) due to low catches, low activities in a certain fishery or if the (sampling-) target species is a minor bycatch in a certain fishery. In these situations missing values are predominantly replaced by information from another gear in the same time and area (e.g. gill-net replaced by the value from trap-net, or pelagic trawl replaced by demersal trawl), but sometimes also by values from adjacent SD or year quarter.

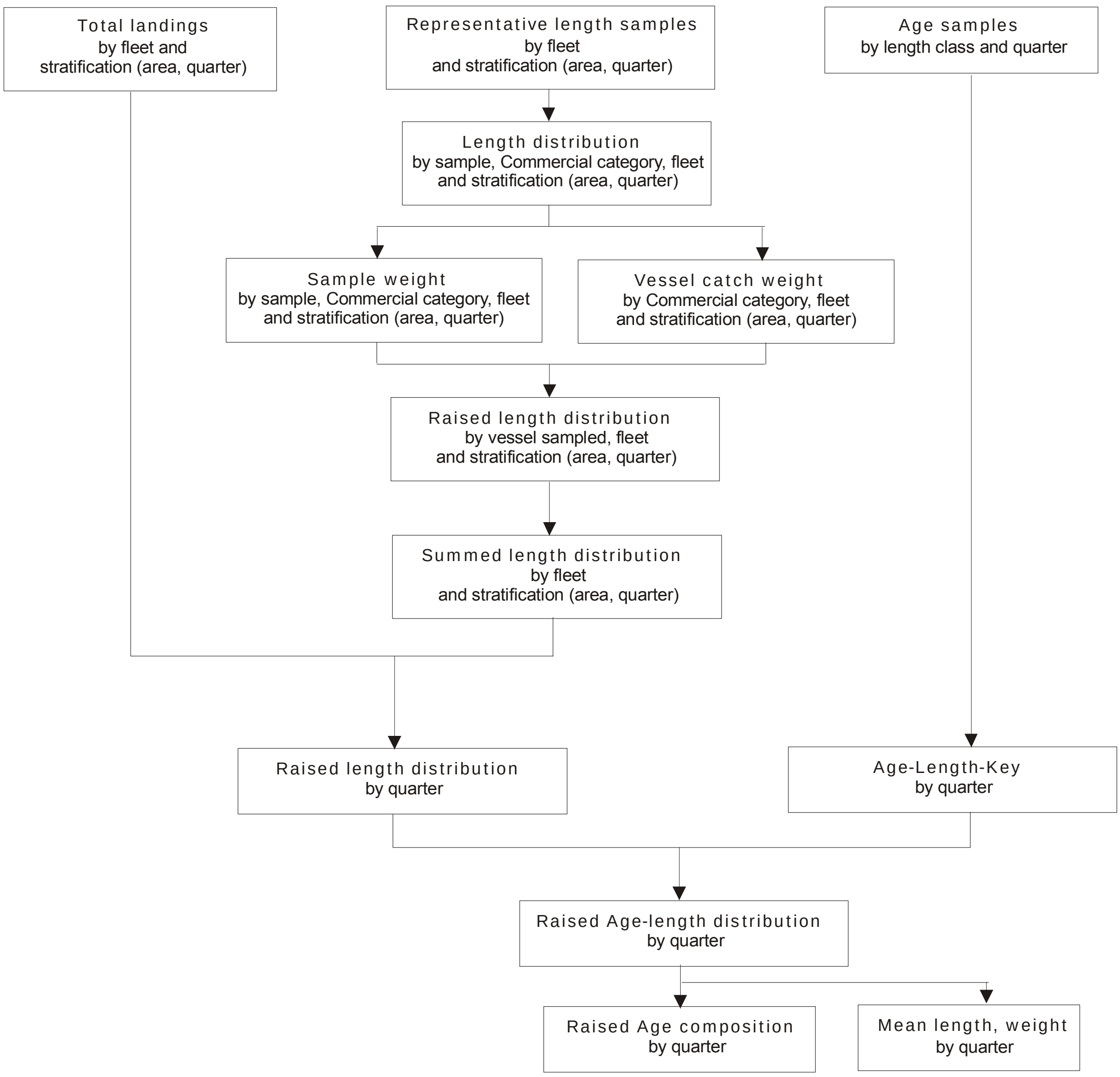

Herring and sprat fisheries
SAMPLING
SPECIES (2)
SD (4),
GEAR (3),
Q (4)
Catch and landings statistics disaggregated by gears, SD's and quarters
Species composition
Total catch
Sample weight
Length compositions:
Length stratified sub sampling
10 specimen aged / 0,5 cm L group
Individual weight measurements
Maturities
Total Catch numbers
Age Length Keys
Catch in numbers at age disaggregated by gears, SD's and quarters.
Mean weigth at age
SOP-check, summing up catch numbers by gears and quarters per each sub-division
Total Catch Numbers at age by SD

6.6 France

French raising procedure for Commercial category sampling



French raising procedure for fleet sampling



6.7 Germany

Sampling procedure

After the catch of a fishing vessel belonging to a certain fleet segment has been separated by species samples are taken from the retained part of the species catch of a haul and the part to be discarded. The sum of both parts in terms of weight and numbers is the sample of the species catch. The way to do this is dependent on the type of the vessel and it's processing method. A description of the general sampling procedure is shown in Figure METH01.

Besides the weighing and counting of the sample otoliths are taken and individual fish weights are measured in order to gain age length keys and length weight relationships. Total numbers in the sampled catch are calculated by the product of the sample numbers and the ratio of catch weight to sample weight.

Raising procedure

The total numbers of a species landed by a certain fleet segment in a certain division/quarter is raised by the product of the sum of numbers of the sampled hauls times the ratio of the landed weight and the sum of the weight of sampled hauls.

The sum of numbers in samples in Division D is:

$$NSC_{q,f} = \sum_{j} N_j \qquad (1)$$

with q the index for the quarter, f the index for a fleet segment and j the number of samples in division D. The raised total number in division D is:

$$N_{q,f} = NSC_{q,f} \frac{WL_{q,f}}{WSC_{q,f}} \qquad (2)$$

with $WL_{q,f}$ landings weight in division D and $WSC_{q,f}$ sum of the weight of samples in division D.

The last step is the summing up over quarters and fleet segments in order to get the national catch in numbers at age of a species in a division.

The raised national total number in division D then is:

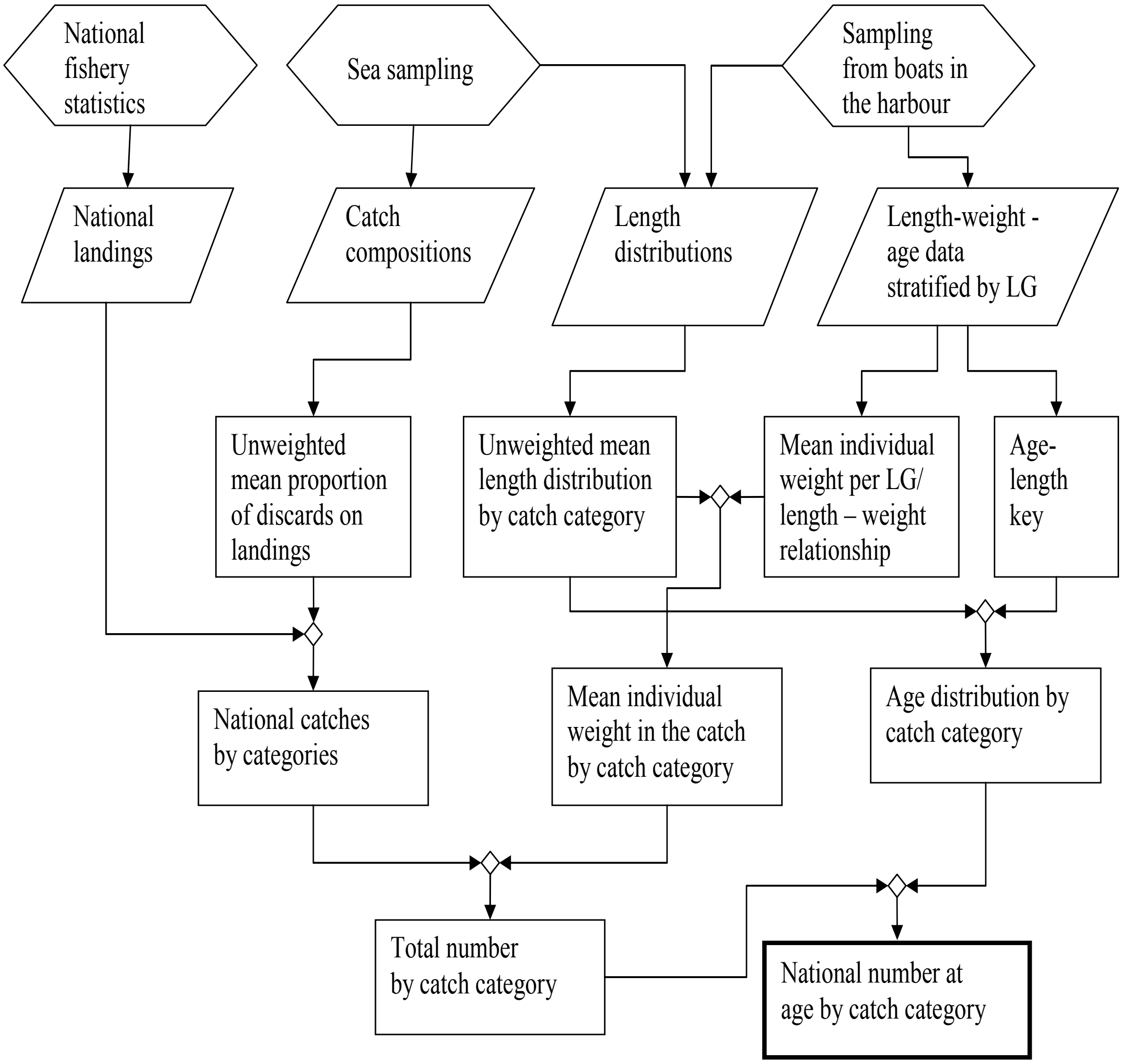
$$N_D = \sum_{q} \sum_{f} N_{q,f} \qquad (3)$$

Length and age compositions of the aggregated sampled catches are used to calculate the length and age compositions of the total catch/landings/discards in the respective quarter/division and total fleet.

In the case when landings are reliable raising of discards is done by the ratio of discard weight to landed weight from the samples. When landings are not reliable or in the case of species not under TAC control discards are raised by the ratio of effort in terms of fishing hours of the relevant fleet segment in a division/quarter to the sum of hours fished of the sampled hauls.

According to the method developed in the frame of the EU-Project IBSSP II, for Baltic cod for each stratum (sub-division, quarter, fishery (gear),year and country) the total weight of cod discarded is calculated from the total landing using the ratio between the retained (landed) and the discarded part of the catch estimated from sampling data. Length, age and individual weight data of the corresponding stratum are used to calculate the catch in number at age of discards and landings, respectively. Finally the results are summarized on stock basis.

This procedure corresponds to the method used to estimate the catch in number at age of discards for the assessment of the cod stocks in the Baltic Sea using the international BaltCom database where the national sampling data of all countries fishing in the Baltic Sea are included.


National fishery statistics
Sea sampling
Sampling from boats in the harbour
National landings
Catch compositions
Length distributions
Length-weight - age data stratified by LG
Unweighted mean proportion of discards on landings
Unweighted mean length distribution by catch category
Mean individual weight per LG/ length – weight relationship
Age-length key
National catches by categories
Mean individual weight in the catch by catch category
Age distribution by catch category
Total number by catch category
National number at age by catch category

6.8 Greece

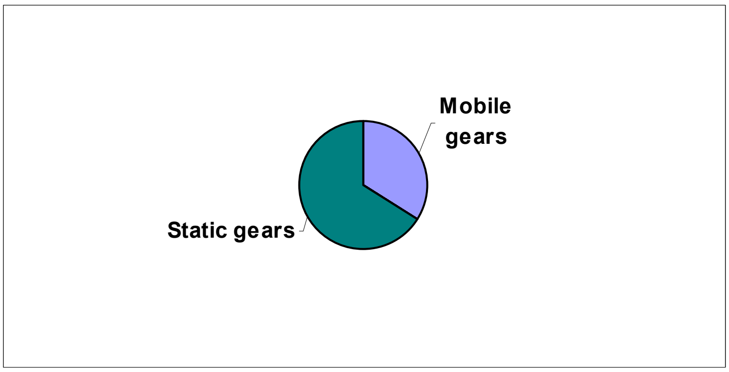
Discards sampling in Greek Waters are conducted by the Hellenic Center for Marine Research, Institute of Fisheries Research.

The Greek fishing fleet are distributed on the following types of fishing techniques:

1) Trawlers 1.2%, purse-seiners 1.7% and polyvalent 0.7% in total 3.6% for mobile gears.

2) Static Nets 95.5 %, Hooks 1.0% in total 96.5% for static gears.

Percentage of catches distributed by mobile and static gears in Greek waters



Sampling

Data collection is stratified by area, vessel category (Trawlers, purse-seiners, coastal fisheries), vessel length (>12m, 12-24m, 24-40m) and by season.

The primary unit of measurements is by day: The total catch, total landing, total discard and fishing effort. From a random sample of specimens per species, both retained and discarded, lengths and weights are recorded and the otoliths are extracted.

Raising procedure

Estimation of total discards per species and its variance is based on records of total landings per stratum. Optimum allocation of strata for raising estimates is based on annual values.

6.9 Italy

No information was available for Italy.

6.10 Netherlands

Dutch market sampling raising procedures

Roundfish species

Length distributions by gear, and stratified age samples are obtained from the fish markets by market category by quarter and ICES Division.

Raising procedure: raising factors are obtained by dividing national catch weight per market category, quarter and ICES Division by the market category weights of available length samples for corresponding areas and periods. Length distributions per market category, ICES Division and quarter are raised to the national catch per market category for corresponding ICES Divisions and quarters. Quarterly ALK's by ICES Division are applied to obtain catch numbers at age for concerning quarters and ICES Divisons. Mean weight at age is calculated by quarter and ICES Division.

Pelagic species (no market size categories)

A sample of 20 kg of unsorted catch is collected on board of freezer trawlers and the length distribution is estimated from all fish in this sample. Age samples are obtained by reduction to 25 fish that are still representative for the original length distribution (random sample). Data on length, weight, sex and maturity of all these 25 fish are collected.

Raising procedure: raising factors are obtained by dividing national catch weight per month/quarter and ICES Division by the total weight of the available samples. Catch numbers at age per month/quarter and ICES Division are obtained from the raising factor and the age composition of the concerning samples. Mean weight at age per month/quarter and ICES Division is directly calculated from the available samples for the area and period.

The raising procedures are carried out by month for mackerel and herring, because fast changes in age composition and mean weights can occur due to migration. Quarterly catch numbers are obtained by combining respective months and the mean weights at age by quarter, corresponding to the weighted mean weight in the catch.

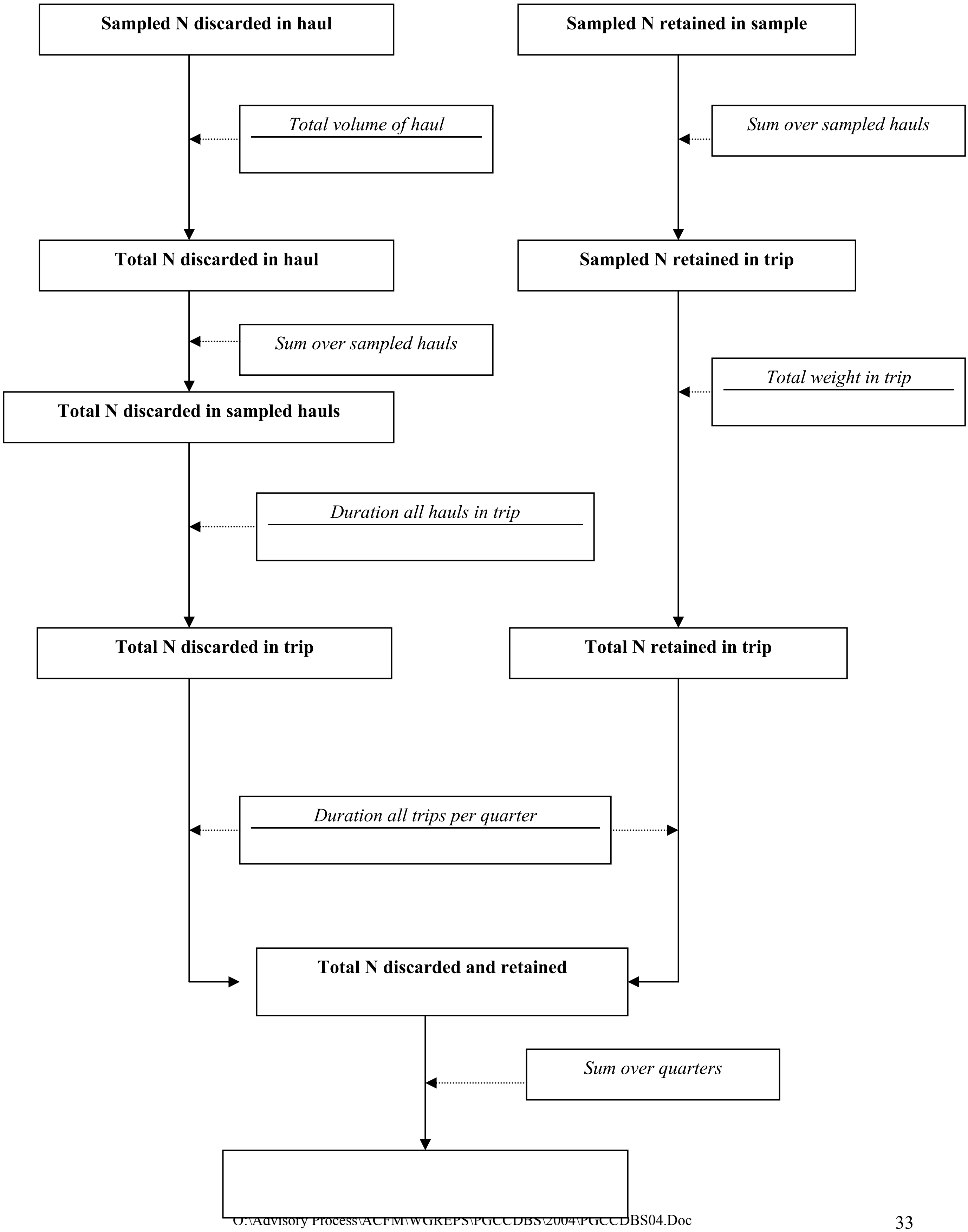
Flatfish species (market size categories)

Representative age samples per market category (corresponding to random sampling within a market category) are obtained from the fish market. One age sample consists of a specified number of fish per market category to be randomly taken within each market category. Data on length, weight, sex, maturity and gonad weight of all these fish are collected.

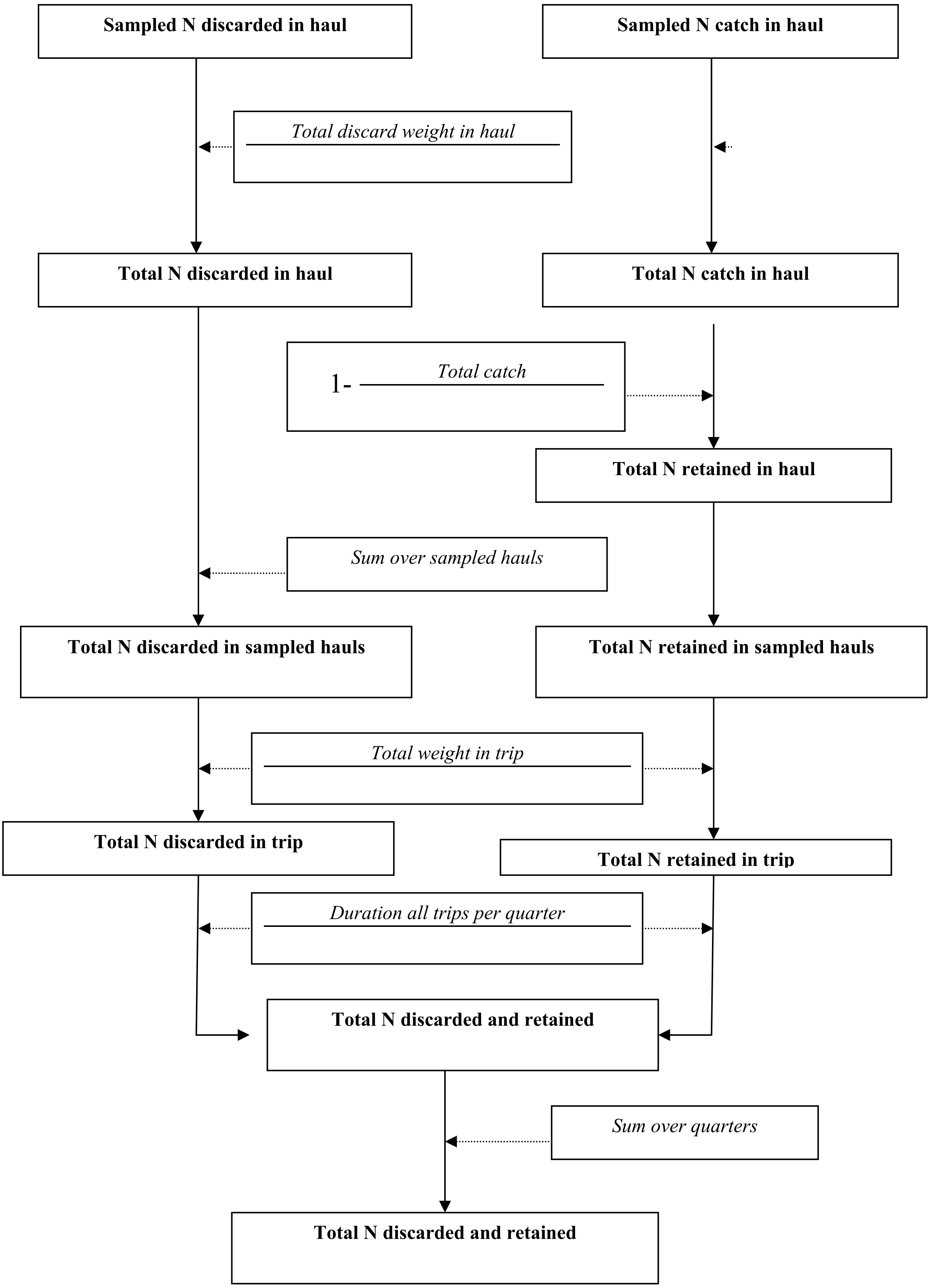
Raising procedure: raising factors are obtained by dividing the national catch per market category, quarter and ICES Division by the weights of the available age samples for the corresponding market categories, areas and periods. Catch numbers at age per month/quarter and ICES Division are obtained from the raising factor per market category and the age composition of each market category of the concerning samples. Mean weights at age by month/quarter and ICES Division are directly calculated from the available samples for concerning area and period (weighted by category catch weight).

DUTCH DISCARDS SAMPLING RAISING PROCEDURES

DEMERSAL FLEET DISCARD SAMPLING



DUTCH DISCARDS SAMPLING RAISING PROCEDURES
PELAGIC FLEET DISCARD SAMPLING



6.11 Norway

Sampling

In Norway, sampling of the commercial fishery by the Institute of Marine Research (IMR) is conducted from several different platforms. Technicians are travelling by hired boat from port to port sampling for 6 weeks in each quarter. This sampling covers mainly the coastal demersal fishery. At 3 ports for demersal and 5 ports for pelagic landing, stationary sampling staff are collecting from the landings. At sea, the coast-guard are sampling during inspections. A special arrangement is set up with 8 commercial vessels, the so-called reference-fleet, where the crew is collecting at sea from the catch.

A staff of 15 observers from the Directorates of Fisheries collect samples on board vessels. Approximately 10% of the landing form the industrial fishery is sampled by control staff also from the Directorate. Further, arrangements are made with 4 pelagic freezing vessels collecting samples at sea.

Raising Procedure

Data for the raising procedure comes from the sales note database, stratified by species, area, gear and quarter. Except for trawlers, where the area information is taken from the logbooks. On a quarterly basis, a length-weight relationship is used on all gears and sub-areas.

- One data cell = species, quarter, area, gear.
- Allocate an Age-Length key and length distribution to each cell.
- Use the species-quarter length-weight relation to estimate the mean individual fish weight which then is used to convert catch in tons to catch in numbers.
- No weighing of samples, but finally CANUM for all the cells are simply added to get the total Norwegian CANUM.
- In the assessment, total WECA is achieved by a weighted (by national catch-in-numbers) addition of the national data.

Discard Sampling

Norway has a discard ban on the following species:

- Cod
- Haddock
- Saithe
- Redfish
- Mackerel
- Herring
  - Norwegian. Spring spawning
  - Tronheimfjord herring
  - North Sea
- Argentine (Argentina silus)

- Capelin
- Greenland halibut
- Whiting
- Blue whiting
- Anglerfish

Even with the ban on discard there are small amounts of discard in the Norwegian fisheries. The amounts by fishery have been quantified in Valdemarsen and Nakken (2002). Norway has a discard sampling program on juvenile cod as by-catch in the shrimp fishery in the Barens Sea / Svalbard area.

6.12 Poland

Discard sampling programme

In 1995-2001 Poland sampled systematically discard data in Polish bottom and to lesser extent pelagic fisheries in the Baltic. The sampling in this period was supported by UE founded projects. Next, the discard monitoring was continued with lower intensity (being constrained to cod) as only national financial support was available. All Polish catch data sampled during discard sampling in the Baltic Sea are included in the international database: BALTCOM.

The only species to be included in yearly discard estimates in the Baltic is cod. In 2005 Polish discard sampling effort will be approximately proportional to catches by strata (quarters, sub-divisions, and fleets) and will achieve the minimum levels given in Appendix XII of Commission Regulation (EC) No. 1639/2001. The number of samples will be approximately equal to number of samples for biological monitoring of catches as the later monitoring will be conducted mainly at sea. Polish discard sampling will cover the area IIId. Vessels to be monitored will be selected among a large number of vessels >12 m. At beginning of 2006 the discard by strata will be estimated and in the next years discard sampling will be proportional to discard levels in the strata, differently than planned for 2005 sampling proportional to the catches.

Until 2003 and in 2004 evaluation of discards is performed using the procedure raising by landings. Sampling strata are as follows:

1. sub-division (24, 25, 26)
2. quarter
3. and fleet (gear) - bottom trawl
    - bottom pair trawl
    - pelagic pair trawl
    - pelagic trawl
    - gill-nets
    - hooks

This stratification is a general desegregation of landings by fleet and is not an optimal stratification in respect to discard pattern. For some strata no discard information is available and therefore extrapolations are made. The extrapolations are made taking into account the following priorities:

1. same quarter, adjacent sub-division
2. same gear, adjacent sub-division

Observers on board commercial fishing vessels are collecting data during normal fishery trip. All relevant biological information and information concerning the catch are recorded. The catch of cod is sorted by the fishermen for discards and landing. In case of big catches subsample of the catch are biologically sampled including length, age, individual mass and maturity. From the samples the average ratio in weight discard/landing for a given stratum is obtained. To estimate the weight of discarded fish the raising factor obtained for a given stratum from samples is applied to landing statistics in the stratum. Next, the weight of discarded fish is disaggregated by age using age length key obtained from biological sampling of discards. Estimates of all strata are summarized to give the estimation of total discards in cod fishery.

There is no possibility (at the moment) to do random sampling because of backwardness of fishermen and lack of the funds. At the moment 2 to 4 observers sampled a small set of co-operative bottom and pelagic trawlers (~ 4 vessels). As a result coverage of a fleet is poor and variances could not be estimated.

There is no quality control of the data at national level except analysis of outliers (e.g. at age/length key).

6.13 Portugal

IPIMAR conducts two different sampling schemes for length and age. Length information is collected following a stratified random sampling scheme (SRS) by gear, zone and quarter, with vessel as the sampling unit. Age sampling is also collected following a SRS, applied by zone and length, with the individual fish as the sampling unit. The basic information collected is:

- Length: number of individuals per length l, vessel v and strata s, n_{lvs}

- Age: number of individuals per length l and age a, n_{la}

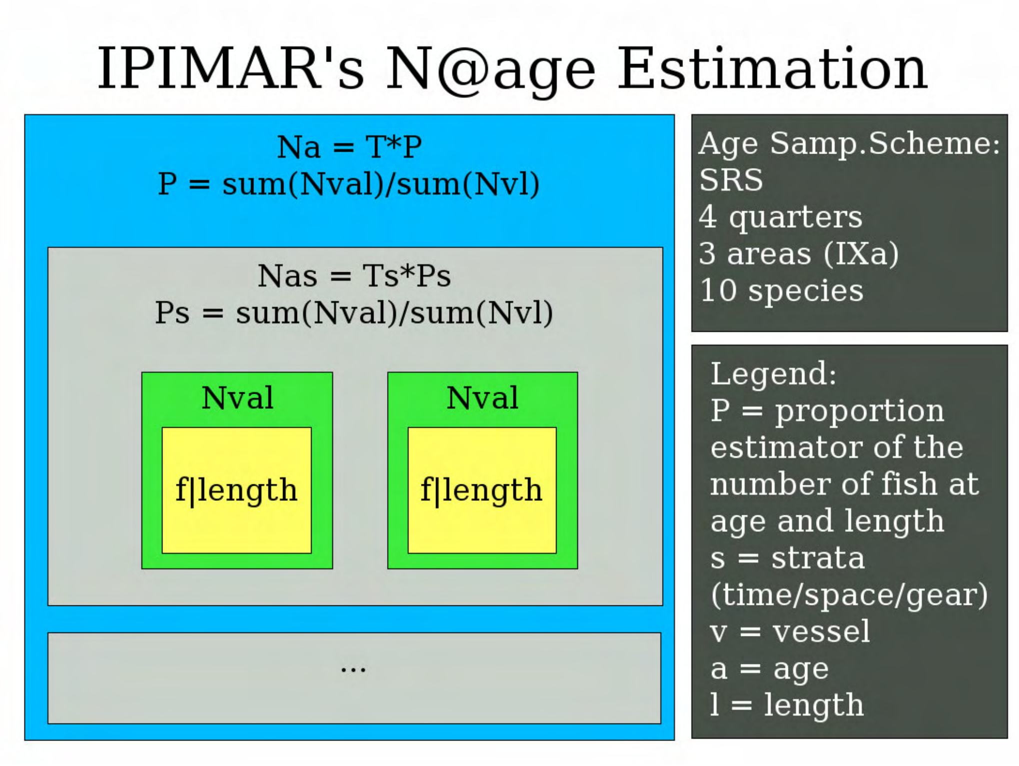
with $l = 1, \ldots, L$; $v = 1, \ldots, V$; $s = 1, \ldots, S$; and $a = 1, \ldots, A$.

The numbers-at-age estimator is

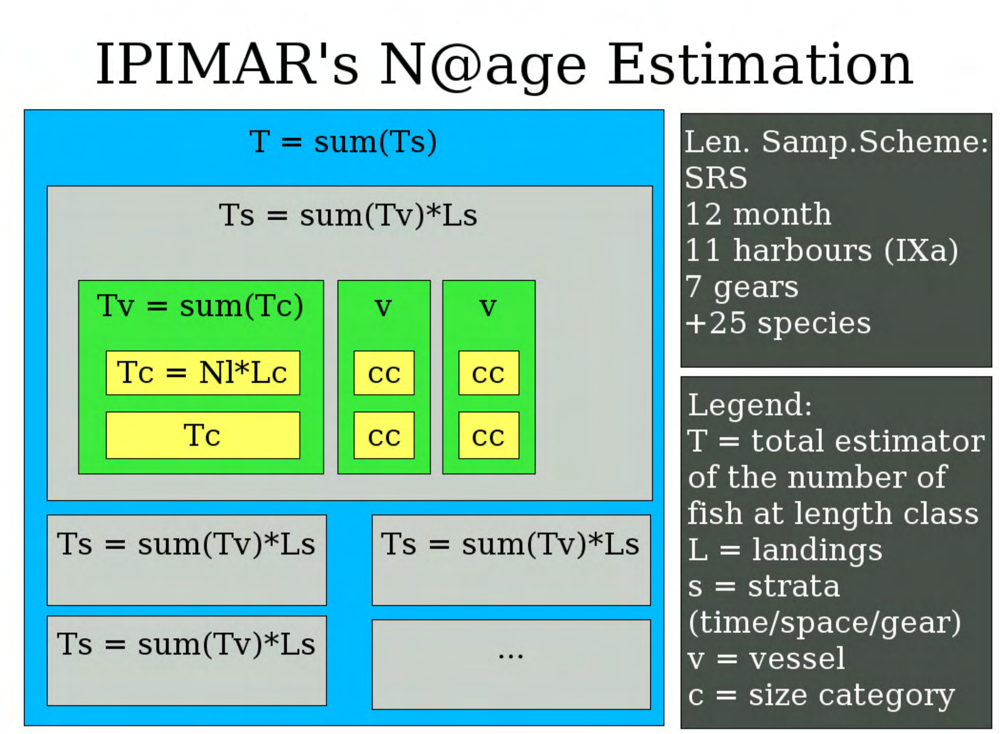
$$\hat{N}_a = \sum_{l=1}^{L} \hat{P}_{la} \times \hat{N}_l \qquad a = 1, \ldots, A \tag{1}$$

where $\hat{N}_l$ is the estimator of the number of individual fish per length, based on the stratified estimator for the population (Thompson, 1992) applied to n_{lvs}, with variance $\hat{var}(\hat{N}_l)$, and $\hat{P}_{la}$ is the estimator of the percentage of individuals of age a and length l, based on the proportion estimator (Cochran, 1960) applied to n_{la}, with variance $\hat{var}(\hat{P}_{la})$.

Figures show the length and age sampling and estimation process used at IPIMAR on the continental waters.



Length sampling scheme and length composition estimation processes at IPIMAR for Portuguese continental waters.



Age sampling scheme and age-length key estimation processes at IPIMAR for Portuguese continental waters.

6.14 Scotland

Introduction

Throughout the year, personnel from FRS' Fisheries Management Programme collect biological data (eg length and age data) on fish and shellfish species caught by Scottish fishing vessels. This involves sampling both the landed and the discarded components of the catch. Sampling is conducted at markets and on-board fishing vessels and is stratified on the basis of fishing area, fishing gear and time of year.

The biological data on the principal fish stocks are used in conjunction with information on quantities of fish landed, collected by the Scottish Fishery Protection Agency ($\mathbf{SF}_{pa}$), to characterise the catch. This is achieved using a number of computer programmes and raising procedures developed and applied to data within FRS. A new database is being developed to handle all data sets.

Important outputs from the programmes are estimates of the numbers and lengths and weights at age of fish landed and, in some cases, fish discarded by the Scottish fleet. These are provided to ICES assessment WG data co-ordinators and form part of the international data sets used by ICES stock assessment working groups. In addition, biological data on crabs, lobsters and scallops are collected for use in in-house assessments.

The market and discard sampling programmes are run as separate but parallel projects.

Market sampling of landings

Shore-based sampling of demersal, pelagic and shellfish species is operated as a single integrated scheme, and involves staff from across the FMP sampling a range of species at all the major Scottish fishing ports each month of the year.

The sampling strategy and targets vary according to species. For demersal species, market sampling is stratified on the basis of fishing area, fishing gear and time of year. Currently, samples are obtained for heavy trawl, light trawl, seine net, Nephrops trawl and pair trawl, in each month of the year. Each combination of area / gear / time is referred to as a stratum or cell.

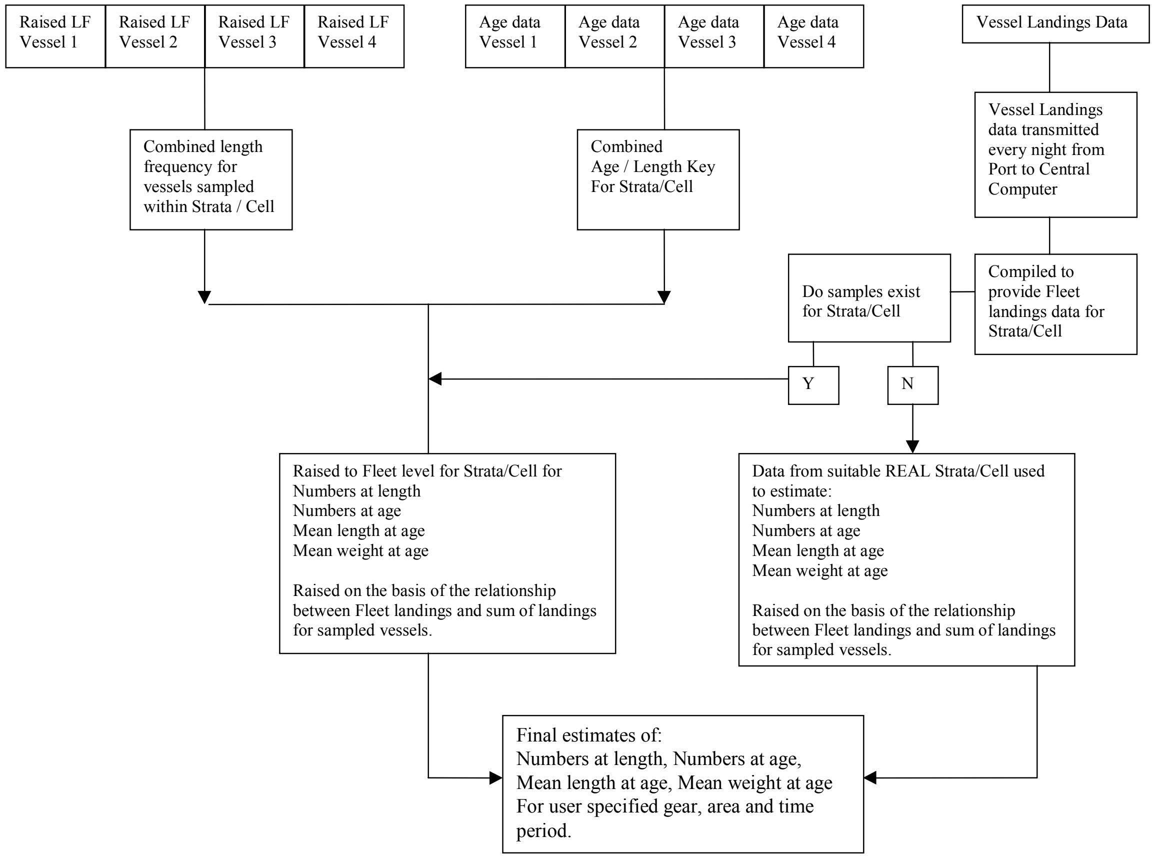
The objective is to measure landings from four different vessels within a cell, and to measure at least 50 kgs of each size category (or grade) of fish landed by a particular vessel. Each fish is measured for total length, the total weight landed for each grade is ascertained and sample numbers are raised to boat level. Identical procedures are applied to any other vessels sampled within a cell and the results are aggregated. Information on the quantities of fish landed, by sampling area and by gear, available to FRS through SEERAD's Fisheries Information Network (FIN), is extracted on a regular basis. These data are combined with sampling data to estimate numbers of fish and length frequencies of landings for the Fleet for the cell. Data is raised to Fleet level based on the relationship between landed weight for sampled vessels and landed weight for Fleet.

Age determination: Otoliths for age determination are taken from a sub-set of the fish measured. For haddock, saithe and whiting, the target is 5 per cm over the length range per area per gear per month; for cod it is 3 per cm. For megrim and angler it is one per cm per month per ICES area. Otoliths are read by trained readers within the laboratory. The age length keys constructed are applied to monthly length frequency data to obtain estimates of numbers at age per cell.

It is not possible to sample all strata. Data for missing cells are derived from 'real' data according to a set of rules incorporated in the processing programmes. These rules define criteria for finding real data that are most likely to be representative. They are based on accumulated experience and knowledge of the fisheries and differ according to gear. In some cases the user may be required to specify data which are used to 'fill in' missing cells.

A suite of market sampling programmes, developed by FRS is used to aggregate the data and allow the operatives to extract catch information. An appropriate monthly weight length relationship is applied to the relevant data set. The data can be extracted using a menu which the user to specify the level of data aggregation, from the lowest level eg per cell per month to higher level, an annual summary for ICES sub-Area or division.

FRS, Scotland, UK – Market Sampling Data



6.15 Spain

Landings

Spanish Program in ICES Areas

The Spanish fisheries deployed in Subareas I, II, VI, VII, VIII, IX and XII using trawls, lines, purse seines and gillnets. Some of these fleets are mixed fisheries and the others target species as anchovy, sardine, mackerel, horse mackerel, blue whiting, hake, megrim, anglerfish, Norway lobster, etc. In Divisions VIIIc and IXa the coastal artisanal fleets have a relevant importance, caught species as cephalopods, crustaceans, etc in a mixed fisheries.

IEO and AZTI supports a sampling program in the main fishing ports of the Spanish Atlantic coast of the Iberian Peninsula, mainly for stock assessment purposes in the relevant ICES areas. This sampling program covers more than 50 species for landings and 15 main species for length and age purposes. This species belong from 24 stocks assessed landed into 28 different ports and fished by 11 different main gears. In addition of these ports, in order to have total landings by fleet for each stocks, data will be collected for 45 minor ports in Spain.

The target species, stocks and gears for the sampling programme were selected taking into consideration the economic and management importance for the different Spanish fleets in terms of individual value or tonnage. Data are obtained on a monthly basis.

Raising procedure

The landing information is summarising by IEO and AZTI, and came from sale notes. The sampling program is designed to obtain the length and age composition of the landings for the most important species by areas.

The length sampling intensity by species is proportional to the landings of the harbor and fishing area. Length samples are taken in the market usually when the boat has landed. In some cases (megrim and anglerfish) two species are included in the total landings, in these cases landings by species are estimated on the basis of their relative weight in the samples. The sample technique used is stratified sampling by geographical area, time and gear, and in some pelagic species commercial categories. The sampling unit is in all cases the vessel. Below, the statistical raising method used is simplistically explained.

Let:

W_{ij} = Weight landed from ith vessel sampled and jth category.
w_{ij} = weight sampled from ith vessel and jth category.
W_{landed} = Total landed weight.
N_{il} = Number landed from ith vessel and lth length.
n_{ijl} = numbers sampled at lth length in jth category from ith vessel.

Then:

Number at length l from vessel i: $N_{il} = \sum_{j=1} n_{ijl} * \frac{W_{ij}}{w_{ij}}$

Weight landed by ith vessel sampled: $W_i = \sum_{j=1} W_{ij}$

Number landed at length l: $N_l = \frac{W_{landed}}{\sum_{i=1} W_i} * \sum_{i=1} N_{il}$

Otoliths are obtained from market samplings and surveys. The technique used is stratified sampling by geographical area, time and length. ALK's turned into proportional ALK's by Stock. Subsequently a proper ALK is applied to the length frequency to turn the length frequency into numbers at age.

Discards

ICES Area

Spain started sampling discards on board commercial vessels in 1987 for two years consecutively. The following studies devoted to discard were carried out in 1993, 1994, and 1997. Sampling discards continued during 1999, 2000 and 2001 (not the whole year). Since 2002, under the Community Sampling Fishery Program Spain continues sampling discards on board.

The initially ideal random vessel sampling was not possible to be carried out in most cases due to different facts. Nevertheless, a large group of vessels are being used (quasi-random).

The discard sampling programme is carried out based on stratified sampling per Fishery Unit, which comprises area, gear and target species. Since the beginning of the sampling program, the number of fishery units has been modified due to the better knowledge of the fisheries as well as the creation of new gears (e.g. High Vertical Opening nets operated by trawls and pair trawls).

The working area is divided into four sectors with several harbours in every sector:

a) ICES Sub-areas I and II

b) ICES Sub-area XII

c) ICES Sub-areas VI and VII

d) ICES Divisions VIIIabd

e)ICES Divisions VIIIc (West and Central) and IXa (North).

The gears are sorted out into four groups: otter-trawls, pairs trawlers and High Vertical Opening (VHVO) bottom trawlers and pair trawlers.

The most important target species of the most important Spanish Fishery Unit are: hake, anglerfish, megrims, horse mackerel, mackerel, blue whiting, cod, shrimp and norway lobster.

Two raising methods are routinely applied to the whole time series of Spanish discards: Raising by landings (weight or number) or raising by effort (number of trips). Raising discards by landings is usually more suitable to the Spanish information due to the lack of information concerning some of the Spanish fleet operations, especially in relation to the fleet effort per hour per ship.

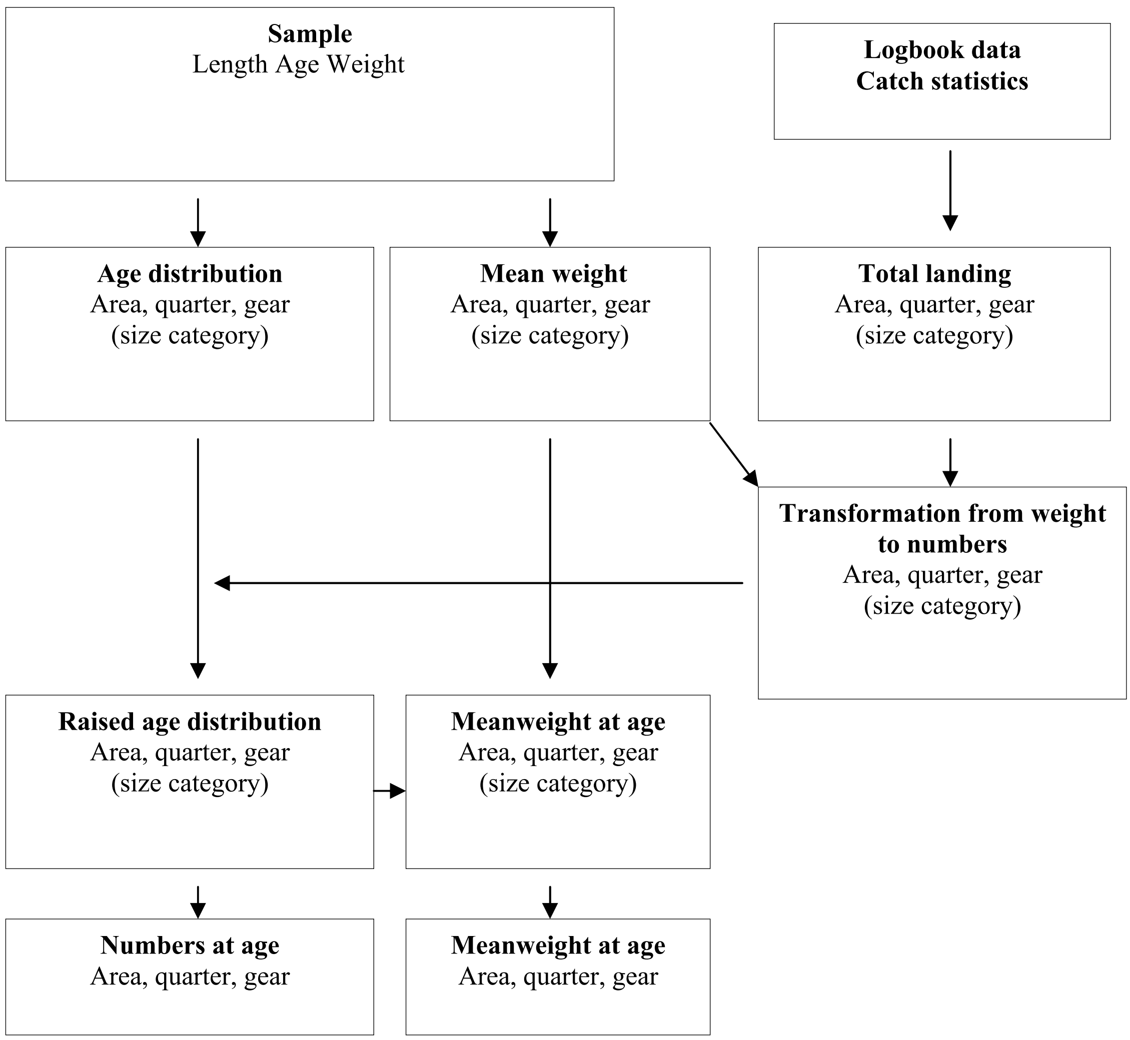
Mediterranean Area

Spain carried out a sampling bottom trawl discards on board commercial vessels in the western Mediterranean in 1995. During 2003 a pilot project was carried out to assess discard by fishery unit.

6.16 Sweden

Standard sampling and raising procedures of commercial catches

In Sweden the vast majority of stocks, for which commercial catch data are collected, are sampled by the ”random direct method”. Random samples are taken from landings (unsorted or by size category depending on species) within the different strata. All fish included in a sample are analysed for length, weight and age. This gives an age distribution within each sample. Swedish sampling of commercial catches are stratified by area (for most species subdivision), quarter and gear. For some species sampling is further stratified in size categories.

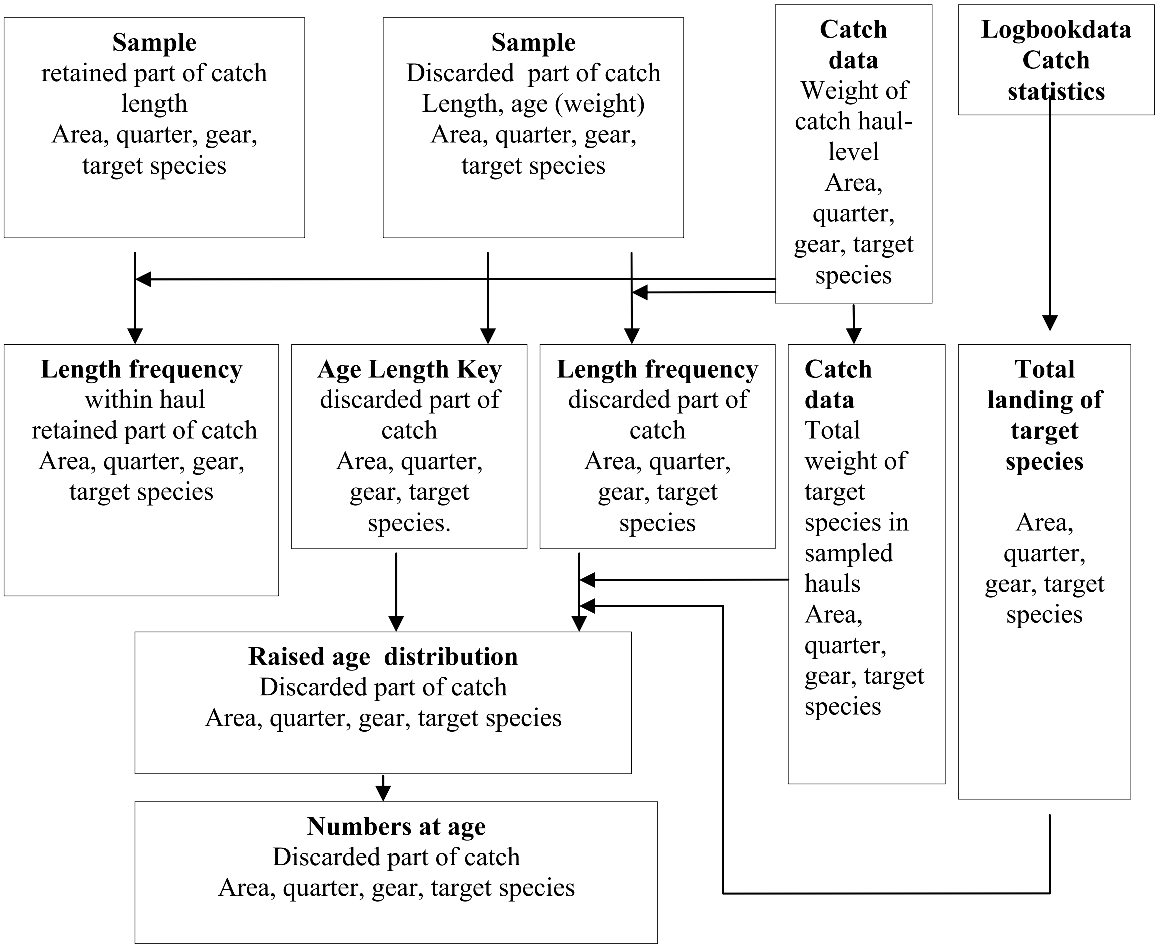


Standard sampling and raising procedures of discard sampling

Swedish discard sampling is carried out onboard commercial fishing vessels. Vessels to be monitored are selected in a ”quasi” random way among a large number of vessels. Swedish discard sampling in general follow manuals agreed on within the IBSSP project (EC study 98/024). Sampling is stratified on area (ICES subdivision), quarter, gear and target species. Sampled information includes a) vessel and gear characteristics b) place, date, time and duration of fishing operation c) total weight of discard and landing by all species caught d) separate length distributions of discard and landings by all species caught e) otoliths per cm group of undersized fish (length stratified age sampling) of selected species. All Swedish catch data sampled during discard sampling in the Kattegat and the Baltic Sea are included in the regional database BALTCOM (FishFrame).

Total commercial landings of target species by stratum / total landings of target species in samples by stratum

Figure 2 Swedish discard



6.17 Summary concerning ToR e

Landings

Two different raising procedure approaches are used when raising from sampling level to total landings:

Direct raising procedure:

Raising factors obtained by dividing national catch weight per market category, quarter and ICES Division by the market category weights of available age samples for corresponding areas and periods. Therefore, the total number by age is estimated.

In direct raising procedure:

Raising factors obtained by dividing national catch weight per market category, quarter and ICES Division by the market category weights of available length samples for corresponding areas and periods. The total number per length class can be estimated and to estimate total number by age a length / age key has to be applied.

Discards

As for the landings, two different raising procedure methods are used when estimating total discard in number per species. Either total discard is estimated by raising by effort or by catch. If the effort approach is used it is very important that the samples vessels are representative for the fleet or fleet segment. The advantage by using the effort approach is the possibility of being able to estimate "black or grey" landings. By using the catch approach this opportunity is not possible.

The PGCCDBS could not at the present stage recommend one approach before others.

7 EXECUTIVE SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The PGCCDBS acknowledge the need of establishing Regional Planning Groups dealing with coordination and planning of sampling and that regional groups need to be dynamic and flexible. The PG suggests that RPG should be independent from ICES but in order to ensure linkage to ICES that the RPGs could report to the PGCCDBS and thereby being linked to the ICES "umbrella".

The PGCCDBS therefore recommends the following tasks as minimum to be dealt with by the Regional Planning Groups at there first meeting:

- Regional coordination and co-operation in collecting biological data of landings of fish and shellfish.
- Report on the main deficiencies in data collection and recommend on how these can be improved.
- Establish bilateral agreements between countries on the biological sampling (length and age) of landings by foreign flag vessels.
- Explore the possibilities of (i) task sharing between countries and (ii) setting up joint programmes for the collection of growth, sexual maturity and fecundity data for all analytically assessed fish and shellfish stocks in their region.
- Compare existing manuals for biological sampling and report on inconsistency and advice on best practice.
- Explore the possibilities of (i) task sharing between countries and (ii) setting up joint programmes for the collection of growth, sexual maturity and fecundity data for all formally assessed fish and shellfish stocks in their region.
- Collate information on existing manuals for biological sampling, in view of putting together standard manuals that could be used by all countries in the region.
- Explore the possibilities of co-funding studies that are beyond the financial capacity of single countries.

The future of the PGCCDBS in relation to the RPGs was discussion and the general opinion of the PG was that the PGCCDBS is considered as an important link between southern - northern and eastern - western countries. Furthermore, the PG found that a forum where general topics and problems could be discussed and agreed is needed and that the PGCCDBS could facilitate this.

There was a general consensus on the usefulness of up starting the process of draw up a common data collection manual or data collection catalogue. The first draft of this or these manuals should be compiled by the RPGs and at a later stage reviewed by the PGCCDBS.

The PG agreed in trying on a regional basis to set up a real time system to ensure adequate spatial / temporal data collection. "Meta" data on the sampling carried, on a monthly basis is transmitted to all the members of the RPGs in order to take real time actions in order to sample any "sampling wholes". Furthermore, it was agreed to try to use the present version ISLDB software as tool to get overview of the spatial / temporal sampling on a month or quarterly basis.

I some areas the fishing fleet mainly consists of small boats but in a large amount. For this small scale fishery, especially within the Mediterranean, is very difficult to setup sampling schemes. The PG suggested that this problem as a first go should be solved by setting up a random sampling scheme, unstratified on location of the fishery, on gears and on sizes of vessels. Furthermore, it was suggested to get experience from other sampling schemes set up for small scales fisheries such as sampling recreational fisheries. In other parts of the world such sampling schemes exists.

A workshop devoted exclusively on sampling design should be organised in the beginning of 2005 with the ToR:

a) analyse the results of precision obtained by each country

b) advise on sampling strategies including stratification and sampling effort

Because the work to be done at this workshop must be a follow-up work with duration of 3 or 4 years, this workshop should be established as an ICES Study Group.

The PGCCDBS recommends its next meeting to be held in Ostende, Belgium in the beginning of March 2004 with the ToR:

a) review the reports from the Regional Planning Groups and address common issues and propose further actions to be taken;

b) propose sampling methodology for fleet/fishery based data collection;

c) review existing information and propose sampling strategies for recreational fisheries;

d) review national descriptions of small scale fleets by country and evaluate the strategies used by different countries to obtain basic information for management purposes;

f) review the report of the WKSCMFD;

g) review the possibilities of using shared ALKs;

h) review the progress of the common regional sampling manuals;

i) review the reports from the age-reading exchanges and workshop and identify on a regional basis the candidate stocks and species requiring improved ageing;

8 ACKNOWLEDGEMENTS

The Planning Group participants thank the IEO, Palma de Mallorca, Spain and especially Director Dr. Federico Alvarez for the invitation to meet in Palma and for providing excellent working facilities and service, together with beautiful weather, at least for the last two days.

9 REFERENCES

Commission Regulation (EC) No 1639/2001 of 25 July 2001 on establishing the minimum and extended Community programmes for the collection of data in the fisheries sector and laying down detailed rules for the application of the Council Regulation (EC) No 1543/2000.

Council Regulation (EC) Nº 2371/2002 of 20 December 2002 on the conservation and sustainable development of fisheries resources under the Common Fisheries Policy.

Council Regulation (EC) Nº 2347/93 of 12 October 1993 establishing a control system applicable to the common fisheries policy[7] as last amended by Council Reg. (EC) Nº 1954/2003 of 4 November 2003.

[7] O.J. L261; 20.10.93, p.1

EMAS: Evaluation of Market Sampling. EU Study project 98/075.

FIEFA: Providing a Framework to Improve the Assessment of the main Demersal and Pelagic Fisheries in Western Europe EU Study project 95/013.

IBSSP 1: International Baltic Sea Sampling Programme I. EU Study project 96/002.

IBSSP 2: International Baltic Sea Sampling Programme I. EU Study project 98/024.

ICES CM 1999/D:2: Manual for the International Bottom Trawl Surveys (Revision VI).

ICES CM 2001/ACFM:26: Report of the Planning Group on Commercial Catch, Discards and Biological Sampling.

ICES CM 2003/ACFM:16: Report of the Planning Group on Commercial Catch, Discards and Biological Sampling.

SAMFISH: Improving Sampling of Western and Southern European Atlantic Fisheries. EU Study project 97/059.

Table 1. Countries responsible for organising otolith exchanges in 2004, 2005 or 2006 and age determination workshops in 2004. Information on the latest otolith exchange and latest workshop is provided based in the information available to the PG. The species listed are the species that require age reading according Appendix XV of the Data Directive.

SPECIES		Latest otol. exch.	Latest Workshop	RESPONSIBLE COUNTRY 2004	2005	2006
Sandeel	*Ammodytidae*				Denmark	
Scabbardfishes	*Aphanopus* spp.	1999	2000			
Alfonsinos	*Beryx* spp.					
Atlanto-Scandian Herring	*Clupea harengus*		1999			
Herring	*Clupea harengus*	2001-03	2001-02		Workshop in 2005 in Finland	
Conger	*Conger conger*					
Roundnose Grenadier	*Coryphaenoides rupestris*				France	
Seabass	*Dicentrarchus labrax*					
Anchovy	*Engraulis encrasicolus*	2001	2002		Spain	
Cod	*Gadus morhua*	2000-01	2001			Ireland
Witch	*Glyptocephalus cynoglossus*					
Bluemouth rockfish	*Helicolenus dactylopterus*					
Four-spot Megrim	*Lepidorhombus boscii*					
Megrim	*Lepidorhombus whiffiagonis*	1997	1997	Spain		
Black-bellied Angler	*Lophius budegassa*	2001	2002	Workshop in 2004 in Portugal		
Anglerfish	*Lophius piscatorious*					
Haddock	*Melanogrammus aeglefinus*					
Whiting	*Merlangius merlangus*	1999	2000	Scotland	Workshop in 2005 in England	
Hake	*Merluccius merluccius*	2003	1999	Workshop in 2004 in Spain		Workshop in Spain
Blue whiting	*Micromesistius poutassou*			Denmark	Workshop in 2005 in Denmark	
Lemon sole	*Microstomus kitt*					
Blue ling	*Molva dypterygia*					
Forkbeard	*Phycis phycis*					
Plaice	*Pleuronectes platessa*	2003	2003			
Saithe	*Pollachius virens*				France	
Turbot	*Psetta maxima*			Netherlands		
Salmon	*Salmo salar*	2002-03	2002-03			
Sea trout	*Salmo trutta*					
Sardine	*Sardina pilchardus*			Portugal	Workshop in 2005 in Cassablanca	
Spanish mackerel	*Scomber japonicus*					
Mackerel	*Scomber scombrus*	2001	1995			
Brill	*Scophthalmus rhombus*			Netherlands		
Redfishes	*Sebastes* spp.		1997	Spain		
Sole	*Solea solea*	2001	2002		England	
Seabreams	*Sparidae*					
Sprat	*Sprattus sprattus*	2001	1992	Workshop in 2004 in Norway		
Blue jack mackerel	*Trachurus picturatus*					
Horse mackerel	*Trachurus trachurus*		1999		Netherlands	
Pouting	*Trisopterus luscus*					
Norway pout	*Trisopterus esmarki*					

Workshop on Discard Sampling Methodology and Raising Procedures

Danish Institute for Fisheries Research,

Charlottenlund,

Denmark.

2 – 4September, 2003

Final Report, 6/10/03

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1 INTRODUCTION

1.1 Background and terms of reference

In the report of their 2003 meeting, the ICES Planning Group on Commercial Catch, Discards and Biological Sampling (PGCCDBS) noted that:

> "Many countries are about to start or have recently started discard-sampling programmes in order to fulfil the data requirements in the Data Directive, and some are encountering problems. In view of this, and the EU Commission's action plan on discards (COM (2002) 656), it is very important to review existing programmes and data series and evaluate procedures, in order to ensure that discard programmes are designed in a way to provide robust estimates which can be used in stock assessments."

> "Some institutes felt that the quality of their discard sampling programmes is good. However, only few had completed an evaluation of the quality of their sampling. The PG considered that there is a need to standardise and disseminate methods to enable institutes to complete such an evaluation."

As a result of the concerns, PGCCDBS recommended that a workshop on Discard sampling methodology and raising procedures be conducted. This workshop took place at DIFRES, Charlottenlund, Denmark on 2-4 September, 2003 with the following terms of reference:

a) Identify data requirements and appropriate discards sampling strategies and methods (e.g. stratification, mandatory and optional variables, selection of vessels, gears, etc.)) to collect fisheries data which fulfils requirements related to stock assessment.

b) Review the sampling strategy and methods in established discard sampling programmes and develop guidelines in order to minimise bias and maximise precision.

c) Identify raising procedures which minimise the bias and maximise the precision of estimates taking into account the sampling procedure and the use of the data.

1.2 Participants

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1.3 Scope

Observers on board fishing vessels can potentially collect a wide range of different types of information. In the current context however, as noted in Term of Reference A, the main concern is with the collection of discard data for use in stock assessment. This tends to imply the collection of relatively detailed information for a relatively restricted number of species, i.e. those fish or shellfish species for which stock assessments may be required. It is noted that there is also increasing interest in the use of discard data in the evaluation of the wider, ecosystem effects of fishing. This requires information about all components of the catch, and may thus require a different sampling approach. The workshop also gave some consideration to this aspect of discard data collection, although it was treated as a lower priority than the stock assessment context.

1.4 Sources of information

Many of the issues covered in this report have previously been discussed by the ICES Study Group on Discard and Bycatch Information (SGDBI), which met annually over 2000 to 2002. Reports are available at:

http://www.ices.dk/reports/acfm/2000/sgdbi/sgdbi00.pdf

http://www.ices.dk/reports/acfm/2001/sgdbi/sgdbi01.pdf

http://www.ices.dk/reports/acfm/2002/sgdbi/sgdbi02.pdf

The reports include

- inventory of ~35 projects on discard sampling and modelling in the ICES area (SGDBI, 2000, Section 2)
- methods for raising discard samples to the haul, trip and fleet level (SGDBI, 2000, Section 3)
- methods for sampling fishing trips or vessels (SGDBI, 2000, Section 3)
- compilation of discarding estimates in the ICES area (SGDBI, 2001, 2002)
- discussion of discarding in relation to stock recovery plans, stratification for discard sampling, problems associated with sampling national vessels fishing from ports in other countries (SGDBI, 2002)

In addition to these reports, other sources of information available to the group included working documents and presentations made at the workshop meeting, and the reports of EC-funded projects on discard sampling. Some of these sources of information have been compiled for circulation with this report. Another recent reference on the subject, which was not available for consideration by the Workshop is 'Guidelines for developing an at-sea fishery observer programme' by Davies & Reynolds (2003).

1.5 Structure of report

Section 2 of this report gives an introduction to the context for discard sampling as it summarises the causes and consequences of discarding, and discusses the use of discard data in stock assessment. Section 3 covers the statistical aspects of discard sampling and thus addresses terms of reference b and c. Section 4 covers the remaining, more practical aspects of sampling and thus addresses term of reference a. Many of the discard sampling schemes which currently exist in Europe have been described in the literature mentioned in Section 1.4, but there are also now other schemes in existence which have not previously been documented in this way, so Section 5 includes descriptions for some such schemes. Recommendations arising from the workshop are summarised in Section 6.

2 DISCARDING AND STOCK ASSESSMENT

2.1 Discarding

The following summary of discarding and its causes and consequences is adapted from FAO (1997) and Valdemarsen (2002).

Discarding is a global issue. The magnitude for the quantities of fish discarded was provided for the first time in an assessment published by FAO in 1994. Annual discards from the world's fisheries were estimated at that time to range from 17.9 million to 39.5 million tonnes. A subsequent re-evaluation of these estimates, together with adjustments allowing for subsequent reductions in discarding, indicates that current levels are lower. The most recent FAO estimate of 20 million tonnes, if correct, is however about 25 percent of the reported annual yield from marine fisheries.

Discarding and by-catches occur because most of fishing gears and fishing practices are not selective enough for the species and sizes being targeted and because target species inhabit also areas which are occupied by a wide range of other species.

The discarding of targeted species and bycatches has long been recognized as a problem. Usually discarding constitutes a reduction of future harvesting opportunities and it might have negative consequences for the environment and ecosystem.

2.1.1 Definitions of “discarding”

There are several practices in discarding:

a) Discarding of catch. Organisms, fish or other animals, which have been retained by a fishing gear, have been brought on board a fishing vessel or landed and have subsequently and voluntarily been returned to the sea or disposed of.

b) “Slipping” of fish. This almost always occurs with purse seines and hence with pelagic fish, usually mackerel and herring. On some occasions, a catch is made but prior to bringing the fish onto a ship it is discovered that the fish are too small or of poor quality. The whole or part of the catch is then released, dead or moribund, into the sea.

c) Escaping fish. As in slipping but also including organisms which escape from fishing gears (usually nets) when the gears are at the surface of the sea immediately prior to being hauled onto a fishing vessel. For example, when a demersal otter trawl is brought to the surface of the sea, the tension in the netting of the gear is reduced and many fish may escape at that time.

The following definition might be useful when addressing discarding practices.

“Discard” is the proportion of the catch, which has been taken onboard the catching vessel and which subsequently is thrown back to sea dying or dead. In addition, fish that during the capture process has been taken to the surface and handled in such a way that they are likely to die after release, including ‘slipping’, is also considered as discards.

2.1.2 Reasons for discarding

There are number of reasons for discarding. They are mainly legislative and/or economic or just belong to fishing practices. In many instances the individual reasons operate simultaneously. In a number of cases legislation make discarding compulsory affecting both juvenile and adult specimens. For example European Community legislation implicitly or explicitly requires discarding of fish, molluscs and crustaceans for specimens which are smaller than defined minimum landing sizes, catches in excess of defined percentage compositions of catches taken with of nets of a given mesh size and catches in excess of quotas.

National legislation may also imply or insist on discarding. In some countries national quotas of fish are allocated at national level into sectoral quotas or ITQs. In practice, when a vessel or sector of the fleet or has taken its quota, and if no further quota becomes available, catches in excess of a sectoral quota or ITQ may not be landed but should be discarded, even if a national quota is not exhausted.

Reasons for discarding may be listed as follows:

- **Fish of the wrong size**
  - Fish economically too small (no markets)
  - Under-sized fish (landing legally prohibited)
- **Fish of wrong species**
  - Species quota reached or vessel not licensed to land that species
  - Problem in mixed species fishery regulated by quotas (for example cod-haddock-whiting fishery in the North Sea)
  - Low-value species (e.g. in coastal mixed-species gillnet fishery)
- **Fish are damaged or spoiled**
  - Damages caused by gear or fishing operation
  - Fish are spoiled too fast because of too high temperature conditions
  - Damages caused by predation in gear (e.g. seal in a salmon trap-net)
  - Fish spoiled by waste substances and by other marine pollution
  - Fish are spoiled because of too long soaking time (e.g. in gillnet fishery)
- **High grading**
  - Less valuable fish are discarded to make space for more valuable catch
  - To preserve individual quotas for later use
  - Large fish are retained in preference to smaller size groups even though the latter may be greater than the minimum landing size.
- **Lack of space onboard**
  - Every fishing vessel has restricted storage space. In "mixed fisheries" where several species of fish are caught simultaneously by each operation of the fishing gear, the master of a vessel may prefer to keep the more valuable species in preference to the less valuable.
- **Species quota reached**
  - Capture of non target species prohibited by quota-regulations
- **Year-class variation**
  - A strong incoming year-class often attracts additional effort and causes additional discarding
  - Due to inadequate gear selectivity large numbers of small fish are captured
- **Season**

- A fish specimen may or must be discarded if caught in a wrong season (e.g. a closed season)

2.1.3 Consequences of discarding

Discarded specimens are usually dead or moribund. Thus catching and then discarding practices have consequences, for example, in stock assessments and fishery management:

Firstly, the majority of specimens caught and then discarded are small and small specimens are sexually immature. That means reduction of future spawning stock biomass, which is at the moment one of the key parameters in fishery management.

Catching small fish reduces the growth potential of the stock and thus reduces the potential yield from a fishery with obvious economic consequences.

Discarding rates are often not very well estimated or they are totally unknown. In such cases discards may represent a major source of uncertainty about the real fishing mortality rates exerted on stock/stocks.

2.2 Use of discard data in stock assessment

The main objective of including discard data into stock assessment is to improve the estimates of removals from the population due to fishery. When discards form a substantial part of the catch for a given species, including accurate discard data is generally considered to improve the estimates of fishing mortality and recruitment. However, this is of prime importance when the discard patterns are variable over time due to e.g. yearclass effects, economic incentives or changes in the restrictiveness of TACs. When discard patterns do not vary over time, the inclusion of discards data would simply be a scaling parameter that does not affect the perception of the dynamics of the stock.

When discard data would be included into the data available for stock assessment, two distinct applications can be distinguished: (1) the estimation of the historic time series and biological reference points and (2) the short- and medium-term forecasts. When historic time series are to be re-estimated with newly available discards data, it is important to assess the extent of the discards data in time. A landings time series of e.g. 40 years and a discards time-series of e.g. 8 years could basically give rise to two different scenarios:

- estimate discards for the years prior to the discards collection program by use of modelling. The modelling of historic discard patterns should ideally take into account the effects of changes in mesh size, minimum landings size, economic incentives and TAC restrictions, but in the absence of such analysis a simpler approach such assuming a fixed discard rate for all past years may be appropriate. Additional modelling work is needed on these issues, preferably in conjunction with those datasets where relatively long series of discards data are available.
- only carry out the assessment for the years where discards data is available. This scenario would make it unlikely that a meaningful stock recruitment relationship or biological reference points can be estimated.

In cases where discard rates at age are found to vary substantially from year to year, an assessment without discards is likely to give a rather poor representation of actual trends in recruitment to the stock. In such cases, using a simple approach, such as assuming fixed discard rates at age for the earlier, years for which no discard data are available, will not change the perception of recruitment during these earlier years, but it will allow discard data to be used for more recent years. If the discard data are of sufficient quality, this should improve the perception of recruitment for the recent period.

The importance of including discard data for a short term forecast does not necessarily depend on a long time series of discard data, particularly for stocks with relatively few age-classes present in the population. As long as an historic assessment of the total catch can be carried out over a certain number of years, the forecast can be based on that assessment. This is likely to give more realistic estimates of recruitment and (juvenile) fishing mortality.

The collation of discard and landings data to give total catch data would benefit from the levels of precision between the two sources being to a certain extent comparable. The addition of discard data with a very high variance to landings data which is relatively precise, could potentially make it difficult to trace year-class or length-class effects through the population.

The main species which suffer high discard rates (in temperate waters) are: haddock, whiting, plaice, *Nephrops*, and hake. Other species may include mackerel and cod (depending on the growth rate). For some stocks of these species, discard data have already been used historically.

Many stock assessment which are currently being carried out within e.g. ICES, are based on single stocks. Within that context the use of discards data would focus on delivering estimates of total number of discards by year. However, there appears to be a clear tendency towards more fishery-based assessments. This is mainly evident from the development of mixed fisheries models that try to model the short term effects of different management options on the developments of different fleets or fisheries and their implied effects on stocks (STECF 2002; Vinther *et a*l, 2003). Within a mixed fisheries framework, the use of discard data would be most useful when the data are available by stratum (e.g. gear/area) and when it includes discards on both target and non-target species.

The survival rate of discards has been investigated by several authors (e.g. Jean, 1963; van Beek *et al*, 1998) and was generally found to be low. However, for species or stocks where the survival rate can be demonstrated to be relatively large, this should be incorporated into the estimation of the total catch.

The requirements for discards data for different types of assessment models can be summarized as follows:

- Age based assessment models: discards numbers at age and discards weight at age (e.g. plaice, haddock).
- Length based assessment models: discards numbers at length and discards weight at length (e.g. Nephrops).
- Biomass based assessment models: discards biomass (e.g. tuna).

Estimates of discards by fleet might also be used in estimating CPUE data for use in any of these methods.

In conclusion, the group notes that it is desirable that substantial analyses to be carried out before (short) data-series can be used in stock assessment. This work should focus on modelling of historic discard patterns and on estimating recent discard patterns by fishery (stratum). The latter is of prime importance for mixed fishery models which are become increasingly important for the biological advice to the different management authorities. Once this step has been taken, the group considers that progress will have been made towards a more realistic appraisal of developments in the North East Atlantic fisheries.

3 SAMPLING AND ANALYSIS GUIDELINES

A sub-group met to consider terms of reference:

b) Review the sampling strategy and methods in established discard sampling programmes and develop guidelines to minimise bias and maximise precision.

c) Identify raising procedures that minimise the bias and maximise the precision of estimates taking into account the sampling procedure and the use of the data.

The sub-group noted that most established discard sampling programmes are based on some form of stratified sampling. The bias and precision of the resulting discard estimates depends on things such as the

- number of strata
- sampling effort per stratum
- method of selecting samples (e.g. random, quasi-random, convenience)
- variability in the data (within and between strata)
- estimator used (including the choice of raising procedure)

The performance of a few sampling programmes have been evaluated in various reports (some of which are summarised in Section 3.1). However, these programmes are quite diverse, apply to different types of fisheries, and have reported their results in different ways. Although these evaluations can guide discussion on appropriate sampling strategies and methodologies, they are insufficient on their own to provide general guidelines.

The sub-group considered that the results from a wider range of discard programmes are necessary to provide generic advice. In particular, the discard data collected under the Data Collection Regulation could be used to provide variance estimates and other summary statistics to:

- assess current levels of precision
- compare alternative raising procedures
- identify logistic and methodological problems associated with current sampling strategies

In addition, the data would allow an exploration of alternative sampling strategies (e.g. different choice of strata, sampling allocations) that would demonstrate the levels of precision that might be achievable for different levels of sampling (and at different costs).

Section 3.1 summarises the experience from several established discard programmes. Section 3.2 describes the summary information that could usefully be estimated from the discard data obtained under the Data Collection Regulation. Section 3.3 describes ways of providing some quality control on the choice of samples (e.g. are trips sampled at random or 'close to random'). Section 3.4 gives a prototype Discard Sampling Review Form for collating the summary information described in Sections 3.2 and 3.3. The Review Form could initially be used as a tool to assess current sampling guidelines. However, a simplified Review Form might later be used as a standard reporting tool for ICES or the EU. Section 3.5 discusses the problem of unsampled strata.

3.1 Experience of established discard programmes

3.1.1 Scottish discard sampling programme

The Scottish Discard Sampling Programme is based on random stratified sampling by year, quarter, area and gear. However, the programme is over-stratified. For example, on the West of Scotland, there are ~ 20 trips per year to cover 180 strata (9 sampling areas, 5 gears and 4 quarters). This leads to problems in estimating total discards because unsampled strata need to be accounted for in some way. It also makes it difficult to estimate the precision of the programme because there is virtually no replication (i.e. more than one trip per stratum). Stratoudakis et al (1999) developed a method for collapsing the strata to estimate total discards and the precision of this estimate. For a subset of the data, they found the coefficient of variation of estimates of total species discards to be ~ 50% for the West of Scotland and ~ 25% for the North Sea (where ~ 60 trips are sampled each year). The whole time series is currently being analysed to re-estimate discards from 1978 onwards and to suggest a simplified stratification for future sampling.

3.1.2 Spanish discard sampling programmes (ICES area)

Spain has sampled discards on commercial vessels in 1987, 1988, 1993, 1994, 1997, 1999-present. Total discards have been estimated using the methods described by Trenkel (SGDBI, 2000) and Rochet et al. (2002). However, to date, levels of variability have only been assessed at the haul level. Numbers of fish discarded vary considerably from haul to haul. For example, numbers of hake discarded in the Spanish Baka Otter Trawl Mixed Fishery in ICES Divisions VIIIc and IXa had a between-haul CV of ~ 200%. Similarly, numbers of blue whiting discarded by Spanish Pair Trawl in the same area had a CV of ~ 210%. Changes in the sampling stratification had no effect on the CVs.

3.1.3 English discard sampling experiences

CEFAS Lowestoft have been sampling discards since 1994 using national and EU funds. Initially, 2 observers sampled a small set of co-operative NE coast roundfish and Nephrops trawlers. Next, observed trips were directed towards 4 gear-related strata to balance sampling better across the fleet. However, it was difficult to observe trips in every gear and quarter stratum with only 2 observers. As a result, coverage of the fleet was little better than before and variances could not be estimated. An EC project developed a sampling scheme with probability proportional to size (pps). The intention was to minimise bias by randomised sampling with large, active vessels thought to discard most given a larger probability of selection. CVs on estimates of the total numbers of fish of each species discarded or retained by the fleet varied between 25 and 50% (Cotter *et al*. 2002) The random sampling and lack of strata in this scheme were considered good because a wider range of vessels was sampled and the scheme was easy to implement. However, historic data on fishing effort used to assign sampling probabilities to vessels were not reliable. As a result, the pps scheme was less statistically efficient than simple random sampling. Subsequently, random selection of trips without gear or area strata was used for the NE coast trawl fisheries. Since 2001, the EC Data Collection Regulation allowed extension of CEFAS sampling to fisheries around the English and Welsh coasts. Sampling is in line with the stratification scheme set out in the regulation.

3.1.4 Irish discard sampling programme

Optimum sampling levels in the Irish discard sampling programme were obtained by Borges et al. (submitted) considering cost and precision objectives simultaneously. Multistage analysis established the precision achieved in the past (1993 to 2002), and a cost function estimated the cost of the programme based on the time spent by observers in different tasks. Gear, fishing ground, targeted species and ICES Division were the main factors affecting discarding. Discarding also varied between haul, trip and vessel. The optimum sampling levels indicated that the current sampling scheme should be redesigned to sample a greater number of vessels. The analysis by fleet components, as described by the gear used, fishing ground and target species, shows high CV's (24 to 69%) in the total number of fish discarded per hour and suggests a marked increase in sampling levels. Reductions in the present budget will only imply marginal decreases in precision, although changes in cost variables can have an impact on sampling levels. On the other hand, halving the CV will imply a considerable increase in sampling and associated cost.

The results above showed that the precision levels specified in the Data Collection Regulation would not be achieved by the Irish discard sampling programme, since variability is expected to be higher for less aggregated data (e.g. species numbers at age). This highlighted the need to restructure the sampling programme and increase sampling effort. The nature of the fishing activity in Ireland and the results of Borges et al. (submitted) have changed the sampling focus of the Irish discard programme in 2003 to a fleet based approach. Twelve demersal fleets were identified in the Irish fishery for discard sampling regarding the DCR specifications, the state of the stocks and stock importance (national share of the quota). Due to other considerations, such as human resource constraints and sampling precision achieved in the past, three fleets were eliminated from the 2003 sampling effort allocation. This decision will improve the discard estimations of the remaining fleets, although increases the number of un-sampled fleets (strata) with all its data analysis implications (see Section 3.5).

3.2 Summary statistics from Data Collection Regulation discard data

Although the performance of discard sampling programmes described above can guide discussion on appropriate sampling strategies and methodologies, the data from a wider range of discard programmes are necessary to provide general guidelines. In particular, summary information about stratification, sampling levels and variability from the discard data collected under the Data Collection Regulation could be used to:

- assess current levels of precision
- compare alternative raising procedures
- identify logistical and methodological problems associated with current sampling strategies
- explore alternative sampling strategies

This Section describes the summary information that should be collated across discard programmes. In particular, summary information should be collated for two alternative raising variables: number of trips and total landings (across species). These raising variables have been selected because they have been widely used in the past and because they should be available in all discard programmes. Their performance can therefore be compared over a range of programmes. However, the sub-group noted that other raising variables might perform better and would welcome the submission of corresponding summary information.

The summary information is described for programmes based on stratified random sampling (e.g., Thompson SK, 1992, Sampling, John Wiley & Sons). Note that:

- Summary information should be provided for each stratum. A top level of stratification is specified by the Data Collection Regulation, but in practice a greater level of stratification might be used. Results should be reported at the most stratified level.
- Sampling levels should relate to the *primary sampling unit*. In random sampling, the 'fishing activity' within a stratum is divided into a number of primary sampling units, each of which has an equal probability of being observed. Usually, the primary sampling unit is the fishing trip but other possibilities include the fishing vessel or

the deployment of a gill net. The definition of the primary sampling unit is necessary to avoid confusion with *secondary* sampling units such as hauls within-trips (which are not sampled at random). For simplicity, we shall talk about trips and hauls, rather than primary and secondary sampling units.

- Even though sampling is rarely truly random, the summary information should still be supplied. However, interpreting the information becomes harder as sampling becomes less random. Section 3.3 considers reasons for non-random sampling, its possible effect, and quality control checks on the selection of trips.

- Sometimes, trips have an unequal, but known, probability of selection. For example, sampling might be 'probability proportional to size'. The appropriate formulae for the summary information can be found in Thompson (1992).

Information on sampling levels

For each stratum s, we require

- the number of primary sampling units (trips) sampled

- the total number of primary sampling units (trips)

Variance information for raising by number of trips

The following information should be supplied for

- total biomass discarded across species
- total biomass discarded of each commercial species
- numbers at age discarded of each commercial species (for some age range).

For stratum s, suppose we sample n_s trips and let N_s be the total number of trips. Let d_{st} be the observed discarded quantity on trip t, $t = 1 \ldots n_s$. For example, d_{st} might be the total biomass of haddock discarded on the trip. Note that the quantities d_{st} have been raised to trip level and thus have averaged out, to a certain extent, the haul-to-haul variation in discarding within-trips.

Let

$$\bar{d}_s = \frac{1}{n_s} \sum_{t=1}^{n_s} d_{st}$$

be the sample mean discards in the stratum. Further, let

$$\sigma_s^2 = \frac{1}{n_s - 1} \sum_{t=1}^{n_s} (d_{st} - \bar{d}_s)^2$$

be the sample variance. Raising by the number of trips (assumed known), discards in stratum s is estimated to be

$$\hat{D}_s = N_s \bar{d}_s$$

with variance

$$\mathrm{Var}(\hat{D}_s) = \left(1 - \frac{n_s}{N_s}\right) N_s^2 \frac{\sigma_s^2}{n_s}$$

The estimate of discards across strata is then:

$$\hat{D} = \sum_s \hat{D}_s$$

with variance

$$\text{Var}(\hat{D}) = \sum_s \text{Var}(\hat{D}_s)$$

The appropriate summary statistics to record for each stratum would then be n_s, N_s, $\bar{d}_s$, σ_s^2.

Variance information for raising by total landings (across species)

The following information should be supplied for

- total biomass discarded across species
- total biomass discarded of each commercial species
- numbers at age discarded of each commercial species (for some age range).

Let l_{st} be the total landings (across species) on trip t, let $\bar{l}_s$ be the sample mean total landings and let L_s be the stratum total landings. The sample ratio is then

$$r_s = \frac{\bar{d}_s}{\bar{l}_s}$$

Discards in stratum s are estimated to be

$$\hat{D}_s = L_s r_s$$

and discards across strata are estimated to be

$$\hat{D} = \sum_s \hat{D}_s$$

To estimate variance, we need the quantity

$$\tau_s^2 = \frac{1}{n_s - 1} \sum_{t=1}^{n_s} (d_{st} - r_s l_{st})^2$$

Then

$$\text{Var}(\hat{D}_s) = \left(1 - \frac{n_s}{N_s}\right) N_s^2 \frac{\tau_s^2}{n_s}$$

although sometimes an alternative estimator

$$\text{Var}(\hat{D}_s) = \left(1 - \frac{n_s}{N_s}\right) \frac{L_s^2}{\bar{l}_s^2} \frac{\tau_s^2}{n_s}$$

is used (Thompson, 1992). The variance of $\hat{D}$ is then

$$\mathrm{Var}(\hat{D}) = \sum_s \mathrm{Var}(\hat{D}_s)$$

as before. The appropriate summary statistics to record for each stratum are now n_s, N_s, $\bar{l}_s$, L_s, r_s and τ_s^2.

Comments

The discard data could also be used to estimate species landings (at age). These estimates could be compared to those based on official reported landings and market sampling data. Such a comparison might help assess the selection of trips in the discard programme (see Section 3.3).

The formulae for estimating discards using total landings can be generalised to any raising variable.

The sub-group also made the following general observations about raising procedures:

- Raising by number of trips should give an approximately unbiased estimate of total discards

- Simulation studies by Stratoudakis et al (1999) suggest that raising by total landings will give approximately unbiased estimates of total discards provided that there are at least five samples per stratum. However, the results might not apply to fisheries markedly different to those simulated. It is also unclear what will happen when there are fewer samples per stratum.

- Raising by total landings will give biased estimates of total discards if the fleet landings are biased (e.g. due to misreporting). However, at least landings-at-age and discards-at-age will be biased in the same way.

3.3 Quality control of trip sampling procedures

Ideally, a sampling programme will give all primary sampling units (trips) a known probability of being observed. Stratified random sampling (usually) gives all sampling units within a stratum the same probability of being observed. However, other schemes such as sampling proportional to size (pps) are possible. Randomisation allows means and variances to be estimated with well-known statistical properties. In particular, stratified random and pps sampling schemes can give unbiased estimates of total discards.

However, true random sampling is rare in discard programmes. Many countries attempt random sampling but cannot observe all trips in every stratum due to lack of co-operation by the fishing industry, the small size or poor safety of vessels, or for other practical reasons. Other countries do not attempt random sampling, possibly because they see it as difficult to implement or because they deliberately target a subset of vessels for logistical reasons. Lack of randomisation produces a sample with unknown bias and statistical properties. There is therefore a need to know how closely the actual sample of trips approximates a random sample from the stratum; i.e. is the sample 'close to random'.

In the following paragraphs, we recommend

1. a simple, standard way of obtaining a nearly-random sample of fishing trips within a stratum so far as practical constraints on sampling will permit

2. simple ways of assessing whether the actual sample of trips is substantially different from a typical random sample

Sampling proposal

All the vessels in a stratum to be sampled are listed just prior to the sampling period (quarter, year, 3-year period, etc.). It is important that the list is up-to-date since many fleets change rapidly. Vessels are drawn (selected) at random and listed in the order of drawing. The drawing is 'with-replacement'. That is, a vessel can be drawn more than once, in which case more than one trip may be observed during the sampling period. Observers then contact the owners of each selected vessel in the order of listing and try to arrange to sail on the next fishing trip. If necessary, the list may be extended with more vessels drawn using the same method. A note is kept of all vessels unavailable for sampling and the reasons for this. This method gives a random sample of all fishing trips available for observation and provides an estimate of the fractions of the fleet that are unavailable for the different reasons. The fraction unavailable should be reported on the Discard Sampling Review Form (Section 3.4) and monitored by the appropriate authorities.

Some countries may not be able to implement this proposal because they do not maintain up-to-date lists of vessels in a fleet. Priority should be given to rectifying this situation. Poorly defined stratum membership compromises the performance of discard estimators. Strata should be designed so that their definitions are expected to be stable over the proposed sampling period.

Discard sampling assessment proposal

The sample of trips observed during a sampling period may be compared with (1) the sample of trips drawn but unavailable for observation, and (2) with the population of vessels in the stratum. The comparisons should be easily achievable and use readily available data. For example, comparisons could be made using histograms or descriptive statistics of fishing hours, days at sea per trip, and/or vessel lengths. The results could usefully appear on the Discards Sampling Review Form (Section 3.4). Notable differences should be carefully considered to assess whether bias might have been caused either by the sampling method, or by the nature of the unavailable fraction of the population. Testing for statistically significant differences between the sample trips, the unavailable trips, and the population is not recommended.

3.4 Discard Sampling Review Form

This section presents a prototype form for collating:

- general information about each discard programme
- summary information on stratification, sampling levels and variability (Section 3.2)
- quality control information about the choice of trips and the proportion of trips unavailable for sampling (Section 3.3)

The form builds on that developed by SGDBI. In its current form, it would be suitable as a tool to assess current sampling guidelines. Subsequently, it could be developed into a standard reporting tool for ICES or the EU.

NB The form has been constructed quickly and it should be refined and tested before being used.

Discard Sampling Review Form

General information on the sampling program

Geographic coverage (EC 2002/1639 areas)	
Participating countries/institutes	
Fleets and fisheries covered	EC 2002/1639 gear categories
Objectives	pilot, regular
Funding	Data Collection Regulation, other
Coordinator(s)	
Year	2002
Method of selecting vessels	random, quasi random, co-operative vessels only
Types of data collected	
Documentation of data (reports, publications)	
Products/dissemination	which data sent to e.g. WG
Lowest (effective) stratum level	e.g. gear (3), vessel class (2), quarter (4) Total strata sampled : 11
Potential auxiliary raising variables	Effort (trip duration, duration of hauls, soaking time, length of gear (set nets), number hooks), total landings, landings by species. Only useful if the variable is also available for the whole fleet!

Deployed sampling effort

Primary sampling unit: e.g. trip

Stratum	Number of units sampled	Total number of sampling units	Number of failures to get onboard for sampling[1)]
Stratum 1			
Stratum 2			

1) due to e.g. lack of co-operation or safety concerns

Total discard biomass[2)] estimates and achieved precision per stratum

	Raising by trip		Raising by landings[3)]			
Stratum	Average discards in stratum $\bar{d}$	Discards sample variance σ^2	Estimated ratio *r*	Variance of ratio τ^2	Average landings in sample $\bar{l}$	Total landings in stratum *L*
Stratum 1						
Stratum …						

2) total discards biomass can refer to fish + benthos or to all fish discards or to all commercial fish from the sampled trips.

3) total landings or landings for set of species used for raising

Discard biomass estimates and achieved precision per stratum for species A

	Raising by trip		Raising by landings[3)]			
Stratum	Average discards in stratum $\bar{d}$	Discards sample variance σ^2	Estimated ratio *r*	Variance of ratio τ^2	Average landings[3)] in sample $\bar{l}$	Total landings in stratum *L*
Stratum 1						
Stratum …						

Discard biomass estimates and achieved precision per stratum for species B…

Same for all species of interest

Discard numbers at age estimates and achieved precision per stratum for species A

Estimates should be provided for most important age

Age :

	Raising by trip		Raising by landings[3)]			
Stratum	Average discards in stratum $\bar{d}$	Discards sample variance σ^2	Estimated ratio *r*	Variance of ratio τ_2	Average landings[3)] in sample $\bar{l}$	Total landings in stratum *L*
Stratum 1						
Stratum …						

Discard numbers at age estimates and achieved precision per stratum for species B…

Same for all species of interest

Summary discards estimates and achieved precision per year for the given area (all strata combined)

	Raising by trip		Raising by total landings[3)]	
Quantity	Total discards	CV on total discards	Total discards	CV on total discards
Total biomass				
Biomass species A				
Biomass species B…				
Numbers age x species A				
Numbers age x species B…				

Total landings in sampled strata, national and international by species in a given year[4)]

Species	Total landings in sampled strata	National landings	International landings
Species A			
Species B…			

4) The landings covered by the sampling programme are compared to the national and international landings to assess the 'relevance' of the sampling programme

Summary statistics regarding the quality control of the data (see Section 3.3)

Sample populations and strata populations can be investigated using the following:

- Average duration of hauls or comparison of histograms
- Fishing location (maps, average location, proportion of trips per subarea, …)
- Landings composition
- Comparing raised landings from discards trips to total landings reported in national databases
- Date of trips (e.g. proportion of trips per month or quarter)

3.5 Unsampled strata

In the data regulation 1639/2001 the stratification scheme with four different vessel length groups and 10 different fishing techniques gives 40 strata, and most countries have several areas and fisheries defined according to target species potential giving a lot of strata to collect. Given the small number of observers and the number of trips that they can cover there is a high risk of empty cells in the sampling scheme.

There can be several reasons why strata are not sampled. There might be a mismatch between the number of strata and the resources available. In this case it is vital to either increase resources or revise the stratification (i.e. reduce the number of strata). Sometimes, reducing strata will mean combining 'similar' strata. Alternatively, pilot studies and expert knowledge might identify fisheries with little or no discards that can be excluded from the sampling scheme.

Empty strata might also arise when skippers, or groups of skippers, refuse access to observers, when groups of vessels cannot be sampled for safety reasons, or when there are problems with sampling very long trips (i.e. Dutch freezer trawlers).

If the sampling scheme includes empty cells, decisions must be made on how to include these strata in the total discard estimate. One way is to 'borrow' estimates from similar strata or use a mean of all other strata. Another way would be to record the data as missing and add nothing to the total.

It is recommended that

- decisions on how to deal with missing strata are left to assessment working groups,

- discard estimates are reported to assessment groups on a stratum basis with supporting data on sampling levels etc.

4 PRACTICAL ASPECTS OF SAMPLING

Section 3 is primarily concerned with the statistical aspects of discard sampling, and as such included some consideration of issues such as stratification of sampling and selection of vessels. There are also more practical, logistical issues concerned with discard sampling, and these are considered below.

4.1 Selection of strata for sampling

There are two broad reasons for stratifying sampling; for statistical and for practical reasons. Statistically, using strata which represent, e.g. groups of vessels which are similar with regard to their discard practices should result in estimates of discards which are of higher precision. From a practical perspective, it is necessary to allocate sampling effort in some way, and stratification represents a useful way of doing this.

How strata are defined depends on the objective of the sampling scheme, e.g. whether the requirement is to obtain estimates of the total discards, or discards for specific species or fisheries. It is here assumed that the primary use of the data will be for stock-assessment purposes, in which case what would be required would be annual estimates of the total discards by species, usually expressed as numbers at age. Further, reflecting both practical considerations and likely future developments towards a more fleet- or fishery-based approach to stock assessment, it is also assumed that discards will be collected to obtain estimates at a fleet or fishery level, which can then be aggregated to stock level. This requires that all fisheries with discards of the relevant stock are sampled.

Decisions about stratification will also require consideration of the amount of observer effort which is available. In general it is better to have relatively few strata so that more than one sample can be obtained from each stratum, than to have large numbers of strata, many of which are only sampled once, or not at all. Analysis of the long-running Scottish discard sampling scheme (Stratoudakis *et al,* 1999) has indicated that this scheme is over-stratified in this manner – see Section 3.1.1. It should be noted that any stratification should also be reflected in the quantities used to raise the data to total estimates, e.g. effort or total landings.

Defining strata will typically require specific local knowledge about the fisheries in the area of interest. Co-operation with local fisher's organisations can provide a very useful source of such local knowledge. With respect to stratification by gear, the nature of the fleet will often provide a natural stratification. For instance, if half of the vessels in a particular fishery are trawlers, and the other half are gill-netters or artisanal vessels, then it would be sensible to treat these two vessel groups as separate strata. However, not all fisheries are so easy to classify in this way. In particular, vessels fishing in more northern fisheries are often trawlers which may fish with a wide range of different mesh sizes and net configurations even in the same fishery. To give one example, sampling of otter trawlers off the North East coast of England found more than 100 different net and twine configurations in 275 observed trips (Cotter, in prep). In cases such as this, further subdivision may be both difficult and inadvisable.

Any stratification by season which may be required will also depend on the nature of the fishery. If there are large changes in discarding on a relatively short time scale it may be appropriate to use a short time step (e.g. month) to reflect this. Again, this decision would require expert local knowledge on the fishery. In cases where there is little or no prior knowledge of discarding practices, results from short-term, exploratory discard sampling may be useful in determining which fisheries are most important for discarding.

There is a discussion of this issue in section 6.4 of ICES (2002; SGDBI, report ICES CM 2002/ACFM:09).

4.2 Selection of vessels

Section 3.4.1 of ICES (2000, SGDBI report, CM 2000/ACFM:11) gives a list of the possible approaches to selection of vessels for sampling, together with their advantages and disadvantages. As outlined above, we here assume that some strata have been predefined, so we are thus concerned with selecting vessels from within these strata for sampling. Section 3.3 of this report proposes an approach to selecting vessels for sampling. In practice it will normally only be possible to sample a subset of the vessels in a given stratum, due e.g. to lack of space on the vessel, or unwillingness to accept an observer. Some sampling schemes use a small subset of the vessels, so that a small number of vessels are sampled regularly (the "co-operative sampling" of ICES, 2000). However, this approach has potential problems with bias if the sampled vessels are not representative of the overall fishery. It would be possible to sample a wider range of vessels if observers were given the legal right to board vessels. The alternative approach would be to work in close co-operation with the fishing industry in order to develop trust so that more vessels becoming willing to accept an observer and the list of vessels to be sampled becomes less restricted.

4.3 Information collected at sea

There is potentially a very long list of different piece of information which could be collected by an observer on a commercial fishing trip. However, for practical reasons it is necessary to identify which are the most important. The definition of importance will be determined by the purpose of the sampling scheme, hence here we are concerned with estimation of discards.

Many parameters are of interest concerning discard data and it is not possible to give a definitive list of variables, which should be mandatory for all discard sampling strategies. At the same time, there are parameters, which as a minimum have to be recorded so that the data are sufficient to serve as input data for assessment. For this reason the table below gives a list of variables grouped into mandatory (M) and optional (O). The definition of mandatory variables is that they are either part of the stratification (S) or that they are input data for the stock assessment (A). The assessment method may vary and this means that the list of mandatory variables will change accordingly.

The list is subdivided into trip-, haul- and gear related information in order to indicate the hierarchical grouping of the data.

The table is based on an update of the list given in the final report from the EC Project: 95/094 "On-board sampling of fish landed and discarded by commercial vessels".

TRIP

Variable	Explanatory notes	Status (**M**andatory or **O**ptional)	Justification (**S**tratification. or **A**ssessment)
Trip code	Unique trip id (by country and year).	M	S
Stratum code	Identifies which stratum the trip belongs to	M	S
Vessel code	Unique vessel id (by country).	M	S
Type of vessel	E.g. beamer, trawler, long liner gill-netter.	M	S
Engine power	Horse power or Kwats.	M	S
Vessel length	Overall length of the fishing vessel.	M	S
Capacity of fish basket or box	If necessary in order to be able to estimate total weight of catch.	O	(A)
Port, date & time of departure		M	S
Port, date & time of arrival		M	S
Port of discharge	If catch not unloaded at port of arrival.	O	(S)
Target species and sizes	Intended catch and sizes.	O	S
Other notes	General trip objectives and restrictions on fishing (e.g. filled catch quotas, poor market values and other factors affecting outcome of trip).	O	
Usual number of hauls per day		O	
Usual haul duration		O	
Fishing grounds	The name of the ground actually fished (Exact position is recorded for each haul/set).	O	S

HAUL/SET

Date		M	S
Haul number	Unique haul id (by trip).	M	S
Gear code	Gear id. Key parameters for gear description.	M	S
Shooting time		M	S
Shooting depth		M	S
Shooting position		M	S
Hauling time		M	S
Hauling depth		M	S
Hauling position		M	S
Fishing duration	The time between the gear has start and stopped fishing.	M	A
Gear damage	Indication of any deviation from normal.	M	A
Crew shift (if not always the same)	Recording of change in discard pattern.	O	
Sea state, wind speed and direction		O	
Quantities of catch, discard, and retained fish on all sample levels relevant for estimation of total catch by species.	All weight information by species for each set of sub-samples necessary for raising from sub-sample level to total catch.	M	A
Total quantities of benthos ,weed, rubbish etc		O	A
Length information	Length distribution of all relevant species with indication of measuring units.	M	A
Mean weight	Information on mean weight by length group. At least for assessment relevant species.	O	A
Age information	Age determination of otoliths or scales etc. for all assessment relevant species.	M	A
Factors affecting stowage of fish	E.g. quota restrictions, fish-hold full, low value etc.	O	
Other notes		O	

GEAR			
Gear code	Gear id. Key parameter to the haul/set description.	M	S
Gear characteristics	Type of gear (demersal trawl, mid water trawl, gill net, trammel net etc.) mesh sizes in codend/netting, indication of selection panel.	M	S
Additional gear characteristics	E.g. tickler chains, mean and s.d. of measured mesh sizes, codend rig, as appropriate for each gear type.	O	

Many of the parameters given in the above table may be important in some sampling schemes but not others, and hence are described as optional. It is also useful to distinguish between those parameters which are essential for their use, e.g. in defining strata or estimating total quantities, and other parameters which may be useful in interpreting or analysing data but are less important for the primary purpose of estimating totals discarded.

For stock assessment purposes what is required is relatively detailed information (e.g. length and age information) for those species subject to routine assessments, and this requirement is reflected in the above table. For studies of the broader ecosystem effects of fishing, information would also be required on the other components of the catch/discards, both of non-commercial fish species and other fauna. This is also reflected in the above table to a certain extent although the collection of information on benthos etc. is suggested as an optional, rather than mandatory parameter. As a general point it is desirable to obtain as detailed information as possible for a subset of the hauls during a trip, than to obtain incomplete information for all hauls. If some hauls are not sampled, it will of course also be necessary to record this in order that the data from the sampled hauls can be raised to the trip total.

4.4 Self-sampling

'Self-sampling' refers to discard sampling programmes in which the fishers take samples of their own catches. Such programmes have been used in France, England, and elsewhere. Potential problems with this method concern whether fishers may take a representative sample of the catch. For this reason it is desirable to cross-check data obtained using this method with observer data. There may also be legal problems associated with retaining discards on board. Nevertheless, self-sampling provides the only method of sampling certain vessels, e.g. very small boats, unsafe vessels. It may also be useful for small-scale fisheries which are not sufficiently important to justify sending an observer to sea, e.g. potters, small scale net fisheries, etc.

5 ADDITIONAL INFORMATION ON SAMPLING SCHEMES

Many of the existing discard sampling schemes in Europe have been previously described in the Reports listed in Section 1.4, notable in SGDBI 2000. This is not true of all existing discard schemes however, so some additional schemes are described in this Section.

5.1 Recent discard sampling programs carried out in the Italian seas

Small pelagic fishery. Within the framework of the EU project 97/065 “Discards from the Adriatic small pelagic fishery” the occurrence of discarding at sea of sardines caught by the Italian fleet in the Adriatic Sea was investigated, using data and samples collected by an observer on board of the fishing vessels. Data were analysed by regression tree models and estimated discards were added to the landings. Discards were calculated for the period 1987-1999, as their values were thought negligible before 1987. Stock assessment on the time series 1975-1999, with and without discard correction, was carried out by means of the population dynamics method VPA.

Rapido trawl fishery. Within the EU Study contract n. 99/051 “Study on the mixed-species catches of the *rapido* trawl fishery along the Italian coasts” (2000-02) data on fishing areas, landings, fishing effort, fishing yields and composition of the retained and discarded catch, as well as the size composition of the target *(S. vulgaris*) and the most relevant commercial species were collected in northern Adriatic, eastern Ligurian Sea and central Tyrrhenian Sea. Data collection plan included sampling of landings and fishing effort and observations on board of commercial vessels at 20-day intervals. Catch of each haul was analysed according to the commercial categories adopted by the fishermen of each area: target species, “kept” by-catch and discarded by-catch; this last fraction was further subdivided in “commercial” and “non commercial” species. Occurrence and composition of debris (dead shells, stones, etc.) was also registered. Number and total weight were recorded for each species as well as the individual size of *S. vulgaris* and of the most relevant commercial species. Abundance and biomass were standardised as number of individuals/km^2 and kg/km^2. Ecological Use Efficiency, Stock Use Efficiency indices and discard (kg) produced for one kg of retained biomass were calculated as different approaches to evaluate the ecological impact produced by rapido trawling.

Small-scale fisheries. Data on discards of small-scale fisheries were collected in the framework of a 2-year project funded by the Italian Government (1999-2000) and carried out in northern Adriatic and eastern Ligurian Sea. Weekly sampling was performed at the main mooring sites to record amounts and composition of landings, technical features of gears, fishing time, grounds and effort. At the same time, periodic observations aboard of commercial vessels were carried out to investigate composition of retained and discarded catch, as well as demography and biological parameters of target species. The catch was subdivided in target species, kept by-catch, discard of commercial species (discard C) and non commercial species (discard NC). Catch data were standardised as number of individuals and biomass caught in 1 hour and by 5000 m of gear. The importance of discard on catches was assessed using the Ecological Use Efficiency (EUE) and the Stock Use Efficiency (SUE) indexes.

Bottom trawling. Many projects specifically addressed to discard of bottom trawling were carried out in the last decade, in collaboration with other countries institutes; most were funded by EU.

All the projects collected data by direct observations of researchers during habitual fishing trips. Data collection included sampling on board commercial trawlers, examination of the discard samples in the laboratory, and data on the trawl fleets and landings in the study ports.

Trawl discards can include non-commercial species, but also marketed species, depending on size.

The results showed that discards were fairly relevant, with high variability, values ranging, on average, from 25% to 35% of the total biomass caught. In general, about half or more of the discard is made by no-marketable species. Gear, depth, season and fishing grounds were the main factors affecting discarding, but variations could depend on market demand and commercialisation as well.

The results of some of these projects were presented to the FAO-GFCM (General Fisheries Commission for the Mediterranean), Sub-Committee of Stock Assessment. Based on these results GFCM recommended the inclusion of discards in the assessments submitted to the SCSA.

During 2003 two national pilot projects are being carried out along the Italian seas according to the EC regulations 1543/00 and 1639/01 to assess discard of the target species by management unit. Expected results are:

- total estimated weight discard by fishery management and year
- discard length distribution by fishery management and year
- discarding size by target species

6 RECOMMENDATIONS

The Workshop recommends that

a) the Discard Sampling Review Form should be tested and refined

b) the Discard Sampling Review Form should be completed for as many discard sampling programmes as possible

c) the information in the Discard Sampling Review Forms should be collated and used to:

- assess current levels of precision of discard estimates
- compare alternative raising procedures, particularly number of trips and total landings
- identify logistic and methodological problems associated with current sampling strategies
- explore the effect of alternative stratifications, sampling levels, etc on the precision of discard estimates and the corresponding cost of obtaining them
- produce guidelines for sampling and raising that might be generally applicable across a wide range of programmes.

7 WORKING DOCUMENTS AND PRESENTATIONS

The following material was available to the Workshop in the form of Working Documents or Presentations

L. Borges; Optimum sampling levels in discard sampling programmes.

A. Carbonnell; Spanish Mediterranean sampling discard programs trawl fleets.

N Cingolani, G Kirkwood, G Arneri, A Santojanni, A Belardinelli, A Giannetti, G Colella, S Donato & C Barry; Discards from the Adriatic small pelagic fishery (EU Project 97/065)

J Cotter; Analysis and modelling of the trawl fisheries off the NE coast of England

B Couperus & M Pastoors; Dutch discards sampling; pelagic freezer trawlers

G Fabi & F Grati; Monitoring of discarding and retention by common sole gillnet fishery in the Adriatic sea.

G Fabi & F Grati; Monitoring of discarding and retention by Rapido trawl fishery in the Adriatic sea.

R. Fryer; The Scottish discard sampling scheme

P. Martin; Estimation of trawl discards in the western Mediterranean. European hake (*Merluccius merluccius*) as case study.

N Pérez & J Bellido; Summary of discard sampling, Spanish protocol (ICES area, IEO) to meet requirements from EU sampling fishery program.

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