Advisory Committee on Fisheries Management **ICES CM 2000/ACFM:11**

REPORT OF THE

Study Group on Discard and By-Catch Information

ICES, Headquarters

20–22 March 2000

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International Council for the Exploration of the Sea

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Section **Page**

1 INTRODUCTION

1.1 Participants

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1.2 Terms of Reference

It was decided at the 87th Statutory Meeting in 1999 (C. Res. 1999/2ACFM05) to establish a Study Group on Discard and By-catch Information (SGDBI) under the chairmanship of J. Cotter (UK) to meet at ICES Headquarters from 20–22 March 2000 to:

a) prepare an inventory of all projects on collection of discard and by-catch information in the ICES area†, including documentation of the data sets, fleets and fisheries covered, and site where the data are held, including contact individual;

b) review pertinent information and provide guidance on protocols how to raise samples in the data sets to reflect discards and/or by-catches of the corresponding fleets or fisheries;

c) consider the report of SGDIB* and update information as necessary.

† The Convention for the International Council for the Exploration of the Sea (as amended) 1964 states that the Council is 'to be concerned with the Atlantic Ocean and its adjacent seas, and primarily with the north Atlantic (art. 2)'.

* SGDIB =Study Group on Estimation of the annual amount of discards and fish offal in the Baltic Sea, chaired by Jørgen Dalskov, 22–24 Feb. 2000. The report of this meeting was made available in time for the meeting of SGDBI on 20 March 2000.

1.3 Justification

ICES currently does not deal with information on discards and by-catches from fisheries in a systematic manner with regard to activities of Working Groups, Advisory Committees and SCICOMs. Although not all fleets and fisheries are covered by programmes which monitor discards and by-catches, data from many programmes that have been implemented are not currently available, at least not in ways which can be used by ICES Working Groups and Committees. ICES science and advisory efforts are hurt by this inadequacy of the data available to it on discards and by-catches, as both accuracy and credibility of results may be affected.

This is the first of three planned meetings. The second to be held about 12 months later will accumulate the results of applying the protocols to the inventoried data sets, combine the results into a useful product for reporting scientifically defensible estimates of discards and/or by-catches for the corresponding fleets and fisheries. These data would be provided to the knowledgeable Working Groups of ICES for review and comment on accuracy, completeness and comments from the Working Groups. Pertinent information would be reviewed and protocols proposed for ongoing monitoring of fleets and fisheries to enable ICES to have available accuracy information on the total catches of marine species by fisheries.

1.4 Working papers

Working papers received by the meeting were:

1) Trenkel, V., Peronnet, I., and Rochet, M-J. Estimation of fisheries discards with an example from the Celtic Sea. (IFREMER, Nantes)
2) Weber, W. Plaice and sole discards in the Plaice Box. (Institut f. Seefischerei, Hamburg)
3) Kulka, D. W. Estimation and incorporation of discarding in fisheries management. A Canadian perspective. (NW Atlantic Fisheries Centre, St Johns)
4) Cotter, J. Thoughts on raising discard data for observed fishing trips to estimates for the fleet. (CEFAS, Lowestoft)
5) Pope, J. and Cotter, J. Theoretical developments. (CEFAS, Lowestoft, copied from EC report 93/003, see 2.1.1.4)

The first four papers were drawn upon for preparing this report. The fifth could be useful for future discussions about the value of using discarding data in fish stock assessments. Copies of these papers are available from the chairman.

1.5 Abbreviations

The following abbreviations are used in this report:

AZTI	Fundacisn AZTI Instituto Tecnolsgico Pesquero y Alimentario (Spain)
BFAS	ICES Baltic Fisheries Assessment Working Group
CEFAS	Centre for Environment, Fisheries, and Aquaculture Science (England)
CLO-DvZ	Centrum voor Landbouwkundig Onderzoek - Department Zeevisserij (Belgium)
DARD	Department of Agriculture and Rural Development (Northern Ireland)
DIFRES	Danish Institute for Fisheries Research
EC	European Commission
EU	European Union
FRS	Fisheries Research Services (Scotland)
HAWG	ICES Herring Assessment Working Group
IEO	Instituto Español de Oceanografia (Spain)
IFREMER	Institute français de recherche pour l'exploitation de la mer
IMR (Norway)	Institute of Marine Research
IMR (Sweden)	Institute of Marine Research
ISH	Institut für Seefischerei, Hamburg
MHSA	ICES Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine, and and Anchovy
MIFRC	Marine Institute Fisheries Research Centre (Ireland)
NAFC	North Atlantic Fisheries College (Shetland)
NEPH	ICES Working Group on *Nephrops* Stocks
NSDS	ICES Working Group on the Assessment of Northern Shelf Demersal Stocks
NSSK	ICES Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak

NWWG	ICES North-Western Working Group
RIVO	Netherlands Institute for Fisheries Research (formerly Rijksinstituut voor Visserijondersoek (The Netherlands)
SEAFISH	Sea Fish Industry Authority (England)
SSDS	ICES Working Group on the Assessment of Southern Shelf Demersal Stocks
STECF	Scientific, Technical and Economic Committee for Fisheries (European Commission)
WGECO	ICES Working Group on Ecosystem Effects of Fishing Activities

2 INVENTORY OF PROJECTS ON COLLECTION OF DISCARD AND BY-CATCH INFORMATION IN THE ICES AREA

The Study Group prepared this inventory from information collected by members before and during the meeting. Current projects, and those finishing within the previous ten years (approximately) which were not direct precursors to current projects are presented with details. The Group excluded projects primarily related to the development of fishing gear because any associated assessments of discarding would be specific to the gear being developed. Information on projects existing outside the 11 countries and provinces represented at the meeting was obtained if readily available but is more likely to be incomplete. Information for Northern Ireland was taken from the report of the NE Atlantic and Western Channel WG of the STECF, held January 2000. Information for Ireland was submitted to the Study Group by MIFRC, Dublin. Other information for these countries was taken from EC reports of associated projects, as shown on the forms.

The listings below are classified into four types of project:

- Sampling of fish catches on commercial fishing vessels by observers or by the fishing crew (2.1);
- Simulated commercial fishing to estimate discarding using a research vessel (RV) or charter vessel equipped with commercial gear(2.2);
- Interviewing of people in the fishing industry concerning discarding; also literature review (2.3);
- Modelling of discarding (2.4).

2.1 Commercial catch sampling projects

Details of each catch sampling project are summarised in the forms below, beginning with internationally collaborative projects, then ordered by country, alphabetically. Remarks supplied by Study Group members are appended to indicate local progress with sampling or other features of the project. Methods of sampling vessels are sometimes described as 'opportunistic', 'co-operative', 'random' etc. The meanings attached to these words are given in Section 3.

For each project, the Study Group was asked whether available results might be suitable for raising to fleet level with a view to contributing data on discarding to a stock assessment for the fishery. A positive answer is indicated in the forms by stating 'stock assessment' as an actual or potential use of the data. Negative answers are also noted. However, the Group did not have time to evaluate the contribution the data might make in any particular case. This could be a task for a future working group. In principle, knowledge of discarding permits complete estimation of fishing mortality but this benefit could be negated if the estimates of discarded quantities have excessive sampling variance or bias.

Restrictions on data useage: Sampling of commercial fish catches in European seas is undertaken only with the permission of the owners and skippers of each vessel. For this reason, all information which might be linked with a particular vessel either directly or by deduction is likely to be strictly confidential. However, for most projects, discarding data aggregated by region, gear, season, etc. are available to ICES and possibly to other scientists. Special restrictions apply in some countries, as noted in the forms under 'Restrictions on data use or dissemination'.

The following geographic indexing of catch sampling projects may be helpful. The first two Section identification digits are omitted, i.e., 2.1.1.1 becomes 1.1:

Arctic:	12.3
Baltic:	1.1;
Skagerrak, Kattegat:	1.1; 1.2; 4.1; 13.1
Atlantic:	1.7; 3.1; 6.3; 7.1; 8.1; 11.1; 11.2; 11.3; 12.2; 12.4; 12.5
Biscay;	1.3; 1.4; 6.1; 7.1; 12.1; 12.2
Portuguese coast:	1.3; 1.4; 12.2
North Sea:	1.2; 1.4; 1.5; 1.6; 1.7; 2.1; 4.1; 7.1; 9.1; 11.2; 11.3
Channel:	6.2;
Irish Sea:	1.3; 1.4; 5.1; 8.1; 10.1
Celtic Sea:	1.4; 6.1; 6.2; 7.1; 8.1; 12.1; 12.2

2.1.1 INTERNATIONAL

2.1.1.1 International Baltic Sea Sampling Project II (IBSSP II)

EU study 98/024, funded until July 2001. This project is for the time being the last of three succeeding projects partly funded by EU.

Participating countries and Institutes	National labs in: Sweden (8–95 – 7–01), Finland (8–97 – 7–01), Estonia (8–97 – 7–01), Latvia (8–95 – 7–01), Russia (8–97 – 7–01), Poland (8–95 – 7–01), Germany (8–95 – 7–01), Denmark (8–95 – 7–01) and Lithuania as observer, who might submit old and new discard data later on.			
Geographic coverage:	Baltic: IIIa + sub-divisions 22, 24 – 32.			
Fleets and fisheries covered:	All major fleets and fisheries in the area except German gill net.			
Type of data collected including species:	Discarded fish: All relevant measurements for stock assessment are done for all assessed species and length distributions are made for all other species. Full range of gear parameters is obtained. The catches are normally worked up by station.	Retained fish: All relevant measurements for stock assessment are done for all assessed species and length distributions are made for all other species. Full range of gear parameters is obtained. The catches are normally worked up by station.		
Co-ordinator or contact individual:	Henrik Degel, DIFRES, Charlottenlund, Denmark.			
Site(s) where data are held:	CDs distributed to participants. After midsummer 2000 access is possible via internet on SQL-server.			
Documentation of data:	A number of interim and final reports (Study 94/58, Study 98/002) and minutes from co-ordination meetings.			
Restrictions on data use or dissemination:	For scientific purposes all participating countries can use all data on request in writing to the project co-ordinator. The co-ordinator makes inquiries to the countries involved and passes the answer to the applicant. All use of data in connection with ICES Assessment WG is allowed without further approving.			
Actual data users:	BFAS. Also for special investigations (condition factors).			
Potential uses for data:	Stock assessment (biological information and tuning information), gear selection, distribution pattern, growth studies, fleet definitions, fishing pattern studies.			
Objectives:	• Provide biological information as input for stock assessments in the area. • Provide basis for calculation of discards rates. • Improvement of relation between biologist and fishermen. • Consistency in sampling procedures between countries surrounding the Baltic Sea.			
Method	On-board observers when possible. If vessels are too small the discard is brought back and worked up by scientists employed by national labs.			
Method of selecting vessels: e.g opportunistic co-operative random/statistical	Two strategies dependent on country: • Vessels are randomly selected from a large number in order to reflect the size distribution of the vessels, trip length, fishing pattern etc. for each stratum. • A few selected vessels are sampled regularly. It is assumed that the selected vessels are representative of a large number of vessels.			
Sampling stratification (if any):	Year, country, fleet, Sub-division, quarter.			
Sampling effort (planned): 17/08–99 – 31/07–01	Country	Days at sea	Number of trips	Other effort ?
	Sweden	600		
	Finland	120		
	Estonia	12		
	Latvia	350		
	Russia	320		
	Poland	35		
	Germany	150		
	Denmark	250		

Remarks:
Historically the sampling of biological information from the commercial fleets has been conducted in various ways in the countries around the Baltic Sea. This has led to data, which were of fluctuating quality and often incommensurable when applied as input for fish stock assessment. The primary goal of the project is to improve the assessment of commercially important stocks in the Baltic Sea and Kattegat. In addition, a common database and sampling manual are being developed. Age-length keys are compared among countries. An important spin-off from the project is better communications with the Fishermen's organisations.

For sea sampling, two different strategies are applied among countries. Germany and Latvia use a strategy where few recurrent vessels are selected. These vessels are assumed to be representative for a larger group of vessels concerning catches and fishing pattern. The rest of the countries (Sweden, Poland, Estonia, Russia, Finland and Denmark) more or less randomly select the vessels for sampling of a given fishery from a large number of vessels, depending on agreement of the skipper. Efforts are made to cover vessels of different sizes and various duration of fishing trips. It is the objective to include as many different vessels as possible in the sampling scheme. National sampling efforts are allocated according to quantities landed. This assures that the biological data are directly applicable to the national landing statistics.

Sampling of commercial vessels is normally done on board by observers but is carried out in harbour during landing if this is not disadvantageous (e.g., fisheries where no discards are obtained), if vessels are to small to carry an extra person, or if for some other reason sampling on board is impossible to organise. When possible and when the observers are confident with the skipper and crew, the part of the catch which is normally discarded is landed separately from the normal landed part of the catch and worked up and recorded. The same information is collected as if the observer has been on board.

For each observed haul or gill net set the following catch data are collected:

- Total weight of discard and landing by species as ungutted fish.
- Separate length distributions of discard and landings by all species caught.
- Otoliths and individual mean weight per cm-length group of selected species.

In addition all relevant vessel, gear and geographical information is recorded. The following Table shows the number of hauls and sets sampled per year and country:

Country	Year					
	1995	**1996**	**1997**	**1998**	**1999 (first half only)**	**Total**
DEN	117	545	713	368	182	**1925**
DEU	17	110	154	183	68	**532**
EST	0	0	0	52	30	**82**
FIN	0	0	0	474	212	**686**
LAT	44	171	241	252	142	**850**
POL	13	129	112	206	119	**579**
RUS	0	0	359	386	116	**861**
SWE	90	344	191	401	188	**1214**
Total	**281**	**1299**	**1770**	**2322**	**1057**	**6729**

The sampling intensity will stay approximately unchanged up till project end 31/7 – 2001. The number of trips sampled covers approximately 0.5% of the total number of commercial trips made in the period.

It is intended that the database will in future not only provide discard information but also the basis for central calculation of age aggregated catch in numbers per tonne landed for all countries fishing in the Baltic Sea. This will assure that the input to the assessment model used by the Baltic Fish Assessment Working Group will be calculated in a consistent and well-documented way. From mid year 2000 the common database will be reorganized into a web-based version allowing participating countries to access all data through Internet. In this connection a more complete check of data will be established.

2.1.1.2 Monitoring discarding and retention on fishing vessels towing demersal gears in the North Sea and Skagerrak

EC study 98/097 funded until March 2001. Some sampling under this project continues that under 2.1.1.4 below.

Participating countries and Institutes	Norway, IMR Belgium, CLO-DvZ Sweden, IMR England, CEFAS Denmark, DIFRES Holland, RIVO Germany, ISH Scotland, FRS and France, IFREMER are liaising partners			
Geographic coverage:	The North Sea and Skagerrak, IV and IIIa			
Fleets and fisheries covered:	Towed demersal gears (otter trawls, beam trawls, pair trawls, seiners)			
Type of data collected including species:	Discarded fish: Length and age distributions of cod, saithe, haddock, whiting, sole and plaice. Sex of plaice. Some benthos quantified.	Retained fish: Length distributions. Sex of plaice. Other biological data are usually obtained from market sampling.		
Co-ordinator or contact individual:	Prof S Buckland, Mathematical Institute, University of St Andrews			
Site(s) where data are held:	Nationally plus international database at CEFAS, Lowestoft			
Documentation of data:	See 2.2.4. Papers in preparation			
Restrictions on data use or dissemination:	Data from Dutch and Danish fleets currently restricted to national use.			
Actual data users:	National governments, scientists			
Potential uses for data:	Data submitted to NSSK w.g. but not yet used for stock assessments. Also likely to be useful for technical measures, fishery management, environmental effects.			
Objectives:	• To monitor numbers-at-age of main commercial species discarded and retained by North Sea towed demersal gear fisheries; • To recommend a stock assessment method best suited to use of on-board catch sampling data (see 2.4.2); • When possible, to estimate non-commercial species discarded.			
Method	On-board observers.			
Method of selecting vessels:	Random sampling is intended but in some countries sampling is limited to co-operative vessels or may be opportunistic.			
Sampling stratification (if any):	By country and quarter.			
Sampling effort (planned) per year:	Country	Days at sea	Number of trips	Other effort ?
	Norway	200	8	
	Sweden	200		
	Denmark	250		
	Germany	200		
	Holland	200		
	Belgium	200		
	England	200		

Remarks:

General
The intention of this project is to monitor discarding and retention for the North Sea and Skagerrak as a whole fishing area. By summing all national results, a larger sample size and more statistical precision is obtained than can be obtained by countries sampling and estimating individually. Several countries experienced difficulties in gaining access to fishing vessels for sampling but experience in countries where sampling has been conducted for several years suggests that access problems will gradually diminish. This opens the way for randomised sampling of the fleet and reduced risks of statistical bias. A significant part of the project involves research on stock assessment methods to find those best suited to use of on-board catch sampling data.

Belgium
Before this EU-project Belgium was not participating in a similar discard programme. So setting up a sampling scheme and convincing the industry to co-operate was our first goal. Recruiting sampling officers proved difficult. Vessel owners and/or fishermen were approached individually but not all vessels welcomed observers on board. So CLO-DvZ started with an overlap of opportunistic and co-operative sampling and plans to move to simple random sampling. Although Southern and Central North (IVb,c) are the main fishing grounds, a major part of the Belgian fleet shifts during the year from one fishing ground to another causing a supplementary problem for the organisation of an on board sampling in the North Sea and Skagerrak. Nowadays the onboard sampling programme is running and discards and catch data, on a haul by haul basis, are collected on Belgian vessels towing demersal gear and stored in a database. The information on the Belgium fishing fleet (logbook information) provided to CLO-DvZ by official authorities on conditions of confidentiality, is rather detailed, and contains information which allows using different kinds of raising methods. Once there are enough discards data available CLO-DvZ intends to evaluated different raising methods and will proceed with the most accurate.

Denmark
The project is on schedule concerning the number of trips carried out and all data obtained are stored in the national database. The circumstance that the project is carried out in close cooperation with the Danish Fishermen's Organization implies that a quite demanding quality check has to be carried out before the data are released for further use. This check is in progress and is expected to be finished mid summer 2000 in due time so that data can be presented at the North Sea Assessment Working Group.

England
England has sampled its North Sea fish catches since 1994 but sampling was at a low level at the beginning of the current project until early in 2000 due mainly to recruiting problems. Future sampling effort should reach 200 days at sea. In the last 2 quarters of 1999, 11 trips (202 hauls) were sampled. The sample population was identified as any English or Welsh registered vessel that could possibly operate in the North Sea or Skagerrak using a towed demersal otter or beam trawl. This fleet consisted of a relatively stable list of vessels compared to the fleet 'landing to the east coast'. Vessels selected randomly with equal probability and with replacement are approached in the order of drawing for permission to sample the next trip taking place in the North Sea. Co-operation with the fishing industry is good and so far no vessels have refused to take an observer to sea. England also has a data co-ordination role in the project. Other project partners supply their data and fleet information to CEFAS for summation to a European fleet estimate of discards on a quarterly basis. Information will be supplied to the North Sea and Skagerrak Demersal Working Group.

Holland
Starting problems arose due to lack of co-operation by fishery unions. Problem was solved by a mutual contract (RIVO – Fishery union), after the Danish example. This contract states that no data will be disseminated until there is permission from the fishery unions. A steering committee was installed which will convene every half year. Practical problems are solved ad-hoc. Sampling achieved in 1999: three vessels - one in 3rd quarter, 2 in last quarter; all beam trawlers. In 2000 to date (first quarter): three vessels - 2 beam trawlers, 1 pair trawler. No problems are expected for sampling 2 other vessels for this quarter. Also an English-Dutch joint trip on an English registered vessel landing to Holland. Remaining 15 vessels need to be approved by union, but no problems foreseen.

Norway
In Norway saithe is the main target species for the vessels operating towed gears in the North Sea. The sampling of discard data from the Norwegian fleet started in August 1999. We experienced problems in getting observers on-board. For 1999 the problem was due to low vessel quotas, which resulted in low trawling effort in the North Sea. This year the problem has been to find vessels, which have cabins/beds enough for an observer. We have also had technical problems on some vessels, and cancellation caused by bad weather conditions. The total quota of saithe for the first half of 2000 was caught by the 17 of February, and the fishery will stay closed until 13 August. We have not experienced any major lack of co-operation with either the fishery union or the participating fishermen. For the first quarter we had observers on three trips. Two of the trips were cancelled due to technical/weather problems. In total, we contacted 50 vessels before the trawling fisheries in the North Sea were closed.

Sweden
Two to four sampling officers are engaged in the study. On the whole, contact with the industry is good. Vessels fishing with bottom otter trawls, *Nephrops* trawls, shrimp otter trawls and Danish seiners have been sampled. Usually, both retained and discarded fish species are measured by haul. Notes on invertebrates (to major taxonomical groups) are made. The amount of discarded *Nephrops* is also measured (size limit 13 cm).

2.1.1.3 Monitoring of discarding and retention by trawl fisheries in Western Waters and the Irish Sea in relation to stock assessment and technical measures

EC Project 98/095 funded June 1999 – June 2001. Some sampling under this project continues that under 2.1.4 below.

Participating countries and Institutes	United Kingdom (SEAFISH, CEFAS, University of Plymouth, Queens University Belfast). Spain (IEO, AZTI) Ireland (MIFRC (liaison only))	
Geographic coverage:	Irish Sea (VII), Biscay (VIIIabd and c) and Portuguese coast (IXa)	
Fleets and fisheries covered:	SEAFISH & Univ. of Plymouth: Otter and Beam Trawling: including foreign owned 'Flagged vessels' in Division. VIIf,g,j,h Queens University Belfast: All trawl gears; Nephrops; whitefish otter and pelagic trawls also share sampling of 'Flagged vessels' in Division. VIIa. AZTI: Bottom trawlers ('Baka') in Division. VIIIa, b, d & Sub-area VII (Div. VII j,h,k), Pair trawl with Very High Vertical Opening Nets in Division. VIIIa, b, d & VIIIc (eastern part) IEO: Trawl in Sub-area VII and Division. VIII c and IXa and Pair trawls in Division. VIIIc and IXa.	
Type of data collected including species:	Discarded fish: Age and length of assessed species. SEAFISH: hake, megrim, monk, sole, cod, haddock, whiting. QUEEN´S UNIV.: Nephrops AZTI: hake, megrim, monk, blue whiting and horse mackerel. IEO: hake, megrim, blue whiting and horse mackerel	Retained fish: Length of assessed species SEAFISH: hake, megrim, monk, sole, cod, haddock, whiting. QUEEN´S UNIV.: Nephrops AZTI: hake, megrim, monk, blue whiting and horse mackerel. IEO: hake, megrim, blue whiting and horse mackerel
Co-ordinator or contact individual:	William Lart, Sea Fish Industry Authority, St Andrews Dock Hull, England	
Site (s) where data are held:	At the participant institutes	
Documentation of data: (Report, manuals, reports of preceding or associated projects, scientific papers)	This project arises out of EC projects BIO-ECO/93/003 and 95/094 which achieved sampling in some of the métiers studied but in most cases for periods of less than 2 years.It is also relevant to NOVARRAST (FAIR-CT96–2001). At the moment there is no report available.	
Restriction on data use or dissemination:	ICES w.g. only	
Actual data users: e.g., ICES working groups	SSDS, Fishing Industry	
Potential uses for data:	Stock assessment Effects of trawling on benthos Relevant as a biological basis for technical measures. Fisheries management	
Objectives:	• To review the data requirements for discard studies of towed gear fisheries. • To obtain quantitative information on the pattern of discarding and technical interactions for stock assessment purposes in the major towed gear fisheries in the western approaches over a period of one year. • To understand the factors affecting discarding and retention of catch in these fisheries.	

	• To evaluate the impact of technical measures designed to reduce discarding in these fisheries. • To assess the feasibility of using discard studies to obtain samples of non commercial species and benthos in order to assess the effects of fishing on ecosystems.			
Method e.g., on-board observers; sampling by fishers	On-board observers (SEAFISH, AZTI, IEO) Samples taken by fishermen (SEAFISH)			
Method of selecting vessels: e.g., opportunistic co-operative random/statistical	IEO: vessel stratified sampling AZTI: vessel stratified sampling SEAFISH: random sampling with replacement. Probability of selection of a vessel for sampling is proportional to a measure of the size of the vessels (vessel dimensions or recorded landings). QUB: simple random sampling with replacement.			
Sampling stratification (if any)	IEO: by gear/sea area and port AZTI: by gear and sea area SEAFISH: No stratification is specified. QUB: No stratification is specified.			
Sampling effort (planned) over 5 quarters:	Country	Days at sea	Number of trips	Other effort?
	Spain	600	200	
	Spain	342 (minimum)	49 (minimum)	
	United Kingdom	160 (minimum)	40 (minimum) (8–12 trips/quarter)	

Remarks:

General
National Liaison Industry Groups were established and the first coordination meeting was carried out during July 1999. Sampling discards on board commercial vessels started in the last quarter of 1999 and first quarter of 2000. In order to understand the impact of discards on the sustainability of the stocks, data on total catch composition and discarding practices will be obtained for all metiers contributing significantly to the fisheries. Also, the current project will review the data requirements for discard studies in order to design a statistically sound sampling strategy to provide quantitative information to ICES on the pattern of discarding in the fisheries studied during a one year period.

Spain, AZTI
AZTI started sampling during the first quarter of 2000 and will continue until the first quarter of 2001. In the following Table fleets, sea areas and targeted species under the objective of the current project are presented:

Fleet	Sea Areas	Target species
'Baka' trawl	VIIIabd	Hake, anglerfish and megrim.
	VII	Hake, anglerfish and megrim.
Pair Trawl with Very High Vertical Opening Nets	VIIIabd	Hake, anglerfish and megrim.
	VIIIc	Hake, horse mackerel and blue whiting

From January till mid March 2000, the effort deployed to carry out the sampling has been translated into:

Fleet	Sea Areas	Number of Days at sea
'Baka' trawl	VIIIabd	23
	VII	
Pair Trawl with Very High Vertical Opening Nets	VIIIabd	20
	VIIIc	3

England
The Seafish Industry Authority are sampling commercial catches using on-board observers. They are also developing fisher self sampling techniques. In addition samples of benthos captured by trawlers are being collected and sent to the University of Plymouth for analysis. All data will be collected and analysed to allow use by ICES working groups. Sampling effort is targeted on otter and beam trawlers fishing for hake, megrim, sole, cod, haddock and whiting in ICES Areas VIIf,g,h, and j.

Spain, IEO
The IEO project covers the activities of the Spanish trawl fleets in ICES Sub-area VII and trawlers and pair trawlers in Divisions VIIIc and in the Northern Spanish part of IXa. Its aim is to provide knowledge about discards of commercial species, necessary for stock assessment. In this sense, estimates will be made considering the total catch corresponding to the main retained species available to gears in the sampled area, and the proportion of catch returned to the sea.
In the following Table fleets under the objective of the current project are presented.

Fleet	Sea Areas	Target species
'Baka' trawl	VII	Hake, anglerfish and megrim.
'Baka' trawl	VIIIc, Ixa	Mixed fishery with Blue whiting, hake, anglerfish megrim., mackerel and horse mackerel
Pair Trawl	VIIIc, Ixa	Blue whiting

Sampling is stratified random by gear and harbour. Discard estimations by species as megrim in Sub-area VII are being prepared to be presented in SSDSWG this year.

2.1.1.4 On-board sampling of discarding and retention by commercial vessels

EC study 95/094 funded 1996 – 1998.

Participating countries and Institutes	England, CEFAS, Univ. E. Anglia France, IFREMER Spain, IEO Northern Ireland, Queen's University Scotland, FRS (liaising partner), St Andrew's Univ. (statistical modelling) Ireland, MIFRC (liaising partner) Denmark, DIFRES (liaising)			
Geographic coverage:	North Sea (IV), Celtic Sea, Biscay (VIIb,c,g,h, VIIIa), Biscay (VIIIc + Northern Spanish part of IXa), Irish Sea (VIIa, VIa)			
Fleets and fisheries covered:	Towed Demersal gears			
Type of data collected including species: (both retained and discarded) Mesh, fishing positions etc. Cod, haddock, whiting, saithe, sole, plaice	Discarded fish: Length distributions ages sex (plaice, dogfish only) (some benthos data)	Retained fish: Length distributions sex (plaice only)		
Co-ordinator or contact individual:	J Cotter, CEFAS Lowestoft			
Site(s) where data are held:	National institutes			
Documentation of data:	• On-board sampling of fish landed and discarded by commercial vessels EC Report 95/094 (1999); papers in preparation. • Report of a previous project: Assessment of discarding rates for commercial species of fish. EC Report 93/003 (1995)			
Restrictions on data use or dissemination:	Data from Danish fleets currently restricted to national use.			
Actual data users:	SSDS, NEPH National governments, scientists.			
Potential uses for data:	Data submitted to NSSK. but not yet used for stock assessments. Also may be useful for technical measures, fishery management, environmental effects.			
Objectives:	• To implement and test the on-board catch sampling scheme recommended in the final report of BIOECO 93/003; • To develop models of discarding and landing by commercial vessels (see 2.4.3); • To recommend desirable effort for an ongoing programme for monitoring discards and landings.			
Method	On-board observers; sampling by fishing crew in France and Northern Ireland.			
Method of selecting vessels:	random sampling was intended but not achieved in all countries. Others used vessels known to be co-operative.			
Sampling stratification (if any):	by country + quarterly; in some countries by gear or metier			
Sampling effort (achieved during project):	Country	Days at sea	Number of trips	Other effort?
	France		49	

	Spain		100	
	N. Ireland		35	
	England		78	
	Ireland		51 (1997 only)	

Remarks:

General
EC project 93/003 recommended a statistically based method for selecting vessels for on-board catch sampling. This involved selection of vessels with probability proportional to expected fishing power. The intention of EC 95/094 was to try out this method in different countries. Good sampling rates were achieved but randomised sampling caused problems because knowledge about fleets was inadequate, because of vessel mobility among fleets, and because of restrictions on access to vessels. Probability sampling was successfully implemented in England but, disappointingly, did not improve survey efficiency because fore-knowledge of the fleet proved unreliable. England now uses a simple random sampling scheme with replacement (see 2.1.1.2).

France
In 1997 the French Celtic Sea was sampled for estimating discards; the fleet was separated into three main "métiers":

- - benthic trawlers fishing monk, megrim, and skates
- - demersal trawlers fishing cod, whiting and hake
- - *nephrops* trawlers fishing nephrops

The sampling was stratified by métier and quarter and is at two levels sampling (trips and hauls).
The length of all species in the discards were measured and each individual was weighted. Samples for age reading were taken for all commercial species. The landings for the corresponding trips were sampled in the harbours. No information by haul was collected. The data were raised based on the sampling design (see summary of working paper).
In 1998 the same method was used for sampling the artisanal *Nephrops* trawlers in the Bay of Biscay. The sampling was done using on board observers.

2.1.1.5 Research on Crangon Fisheries' Unerring Effect (RESCUE)

EC study 94/044 funded March 1995 – May 1997

Participating countries and Institutes	Denmark: DIFRES Charlottenlund, DIFTA Hirtshals Germany: ISH Netherlands: RIVO, IJmuiden Belgium: CLO-DvZ, Ostend UK: SAST, Grimsby France: IFREMER, Boulogne			
Geographic coverage:	North Sea coastal waters			
Fleets and fisheries covered:	North Sea *Crangon* fleets			
Type of data collected including species:	Discarded fish: Shrimps – *Crangon crangon* Bib and poor cod - *Trisopterus spp*. (not differentiated) Cod - *Gadus morhua* Whiting – *Merlangius merlangus* Gurnards – *Trigla spp*. (not differentiated) Turbot – *Psetta maxima* Brill – *Scophthalmus rhombus* Flounder – *Platichthys flesus* Plaice – *Pleuronectes platessa* Dab – *Limanda limanda* Sole - *Solea solea* Solenette – *Buglossidium luteum*	Retained fish: Shrimps - *Crangon crangon* Bib and poor cod – *Trisopterus spp*. (not differentiated) Cod - *Gadus morhua* Whiting - *Merlangius merlangus* Gurnards - *Trigla spp*. (not differentiated) Turbot - *Psetta maxima* Brill - *Scophthalmus rhombus* Flounder - *Platichthys flesus* Plaice - *Pleuronectes platessa* Dab - *Limanda limanda* Sole - *Solea solea* Solenette - *Buglossidium luteum*		
Co-ordinator or contact individual:	ir. B. van Marlen, RIVO, IJmuiden Netherlands.			
Site(s) where data are held:	At each of the above mentioned institutes			
Documentation of data:	Final Report of RESCUE to the EU, RIVO Report C054/97, DG-XIV, *05 February 1998, revised version*			
Restrictions on data use or dissemination:	Acceptance by EU formally necessary, probably no restriction.			
Actual data users:	ICES Crangon Working Group ICES Fishing Technology and Fish Behaviour Working Group			
Potential uses for data:	• Demersal species stock assessments for the North Sea; • advice for improved selectivity of Crangon gear through technical measures (veil nets and/or sorting grids)			
Objectives:	The objective of RESCUE was to obtain more accurate information on the extent of the by-catch problem in the *Crangon* fisheries in the major fleets in the European Community waters. • to make a technical inventory of vessels, onboard sorting equipment, gears and effort used in the for brown shrimp (*Crangon crangon* L.) fisheries. • to estimate the discard levels of juvenile fish and undersized brown shrimp in the fleets of the participating countries from samples taken onboard commercial vessels.			
Method	Onboard observers on commercial charters			
Method of selecting vessels:	Vessels chartered			
Sampling stratification (if any):	None			
Sampling effort (achieved during project):	Country	Days at sea	Number of trips	Other effort No of hauls
	Denmark		13	87
	Germany		34	151
	Netherlands		6	18
	Belgium		19	96
	UK		30	163
	France		0	0

Remarks:

The project is closed, and has a follow up in ECODISC (2.4.1)and DISCRAN (2.1.1.6)

2.1.1.6 Reduction of discards in Crangon trawls (DISCRAN)

July 1999 to 2001

Participating countries and Institutes	UK (Newcastle university/Dove marine Lab.) Germany – ISH Holland – RIVO (Ijmuiden) Belgium – CLO-DvZ (Oostende)			
Geographic coverage:	North Sea			
Fleets and fisheries covered:	North Sea *Crangon* fisheries as studied in projects RESCUE (2.1.1.5) and ECODISC (2.4.1).			
Type of data collected including species:	Discarded fish: Age, length of plaice, dab, sole, cod, whiting, C. crangon	Retained fish: Age, length of Plaice, dab, sole, cod, whiting, C. crangon		
Co-ordinator or contact individual:	Andy Revill, DML			
Site(s) where data are held:	Dove Marine Laboratory (UK) and currently still being collected.			
Documentation of data:	No reports written so far Associated reports from RESCUE and ECODISC project.			
Restrictions on data use or dissemination:	Unknown			
Actual data users: e.g., ICES working groups	ICES Crangon working group Gear workshop			
Potential uses for data: e.g., stock assessment,	Can be used for quantifying amounts of discards by different gears and allow new selective gears to be developed.			
Objectives:	To collect discard data and develop selective shrimp gears.			
Method e.g., on-board observers; sampling by fishers; etc.	On board observers			
Method of selecting vessels:	Oppotunistic and cooperative			
Sampling stratification (if any):				
Sampling effort (planned for whole project)	Country	Days at sea	Number of trips	Other effort ?
~ 100 - 200 hauls	UK	~ 30	~ 30	
	Belgium	~ 30	~ 30	
	Netherlands	~ 30	~ 30	
	Germany	~ 30	~ 30	

2.1.1.7 Estimating discarded mackerel and herring from the Scottish and Norwegian purse seine fleets in the North Sea

EC study 96/082; sampling took place under this or related projects from 1997–1999, 1999–2000, and 2000–2002.

Participating countries and Institutes	FRS, Aberdeen, Scotland UK, IMR, Bergen, NAFC, Shetland (NAFC)			
Geographic coverage	North Sea (IVa) and West of Scotland (VIa)			
Fleets and fisheries covered:	Scottish and Norwegian vessels fishing for Herring and Mackerel			
Type of data collected including species:	Discarded fish: Length data for all species Age/sex/maturity data for herring/mackerel	Retained fish: Distribution of effort and catches Length data for all species Age/sex/maturity data for herring/mackerel		
Co-ordinator or contact individual:	Sandy Robb, FRS Reidar Toresen, IMR			
Site(s) where data are held:	FRS IMR, Norway			
Documentation of data:	Final EC report June 1999 (Study Nr. 96/082)			
Restrictions on data use or dissemination:	Data used only in aggregated form – not identifiable to vessel level.			
Actual data users:	HAWG, MHSA for information on slipping (i.e., discarding without taking the net on board) and discarding.			
Potential uses for data:	Information used to aid understanding of operation of Scottish pelagic fleet and to improve fishing mortality estimates. However, data are not thought to be useful in stock assessments.			
Objectives:	• Estimation of extent and nature of discarding from the herring & mackerel fisheries. • Provide these data for input into standard ICES stock assessments. • Improve accuracy of data on the location of commercial vessel fishing activities. • Obtain spatially accurate biological data for the fisheries on herring and mackerel			
Method	On-board observers			
Method of selecting vessels:	Opportunistic			
Sampling stratification (if any):	Determined by seasonality of fisheries: c. 50% of Scottish sampling trips directed at Mackerel fishery in quarter 4–1, with remainder directed at Herring fishery, predominantly in quarter 3.			
	Country	Days at sea	Number of trips	Other Effort
1997 to 1999	FRS	73	8	
	NAFC	38	10	
1999 to 2000	FRS	75	8	
2000 to 2002	FRS	100/year	10/year	
	IMR	120/year	12/year	
	NAFC	120/year	12/year	

Remarks:

Scotland
Sampling of Scottish pelagic fisheries has been on a more limited basis than in the two preceding surveys. The schemes should be regarded more as observer schemes than discard sampling trips as the typically large, single-species catches associated with pelagic fisheries means that little in the way of on-board sorting goes on; it is more that in some cases the whole catch is slipped rather than being brought aboard. The information from these cruises has proved valuable in obtaining information on the operation of the Scottish pelagic fleet.

Norway
The project started in 1996, and was planned to last for three years. There was an agreement with the fisheries union on running this project. Each year the union sends a list of vessels which agree to take observers on-board. Then the project leaders contact vessels from the list to decide where and when to put observers on-board. The sampling effort depends on the number of observers available. Discarding is estimated and the catch recorded. There were no attempts to raise the discards to fleet level, since an observer-effect on the discarding was expected. The project is extended for two more years.

2.1.2 BELGIUM

2.1.2.1 Exploration of the fishing opportunities for Norway lobster in the Fladen area (Northern North Sea).

July 1999 – December 2000.

Participating countries and Institutes	Belgium, Local Producer Organisation (PO), fishing industry, CLO-DvZ.			
Geographic coverage:	IVa Fladen area northern North Sea			
Fleets and fisheries covered:	Vessels: Exploratory fishing trips with 2 vessels. Target species: *Nephrops*. Fishing gear: Twin trawls.			
Type of data collected including species:	• Full details on towing conditions and on origin of samples • Full details on catch, landings and discard composition for most hauls (quantities taken and size compositions). All commercial species in landings and discards. Fish measured in 10 cm size classes. *Nephrops* measured in 5 mm carapace length size classes			
Co-ordinator or contact individual:	Project co-ordinator: Rederscentrale (Belgian PO). Scientific co-ordinator: Dr Frank Redant, CLO–DzV, Oostende.			
Site(s) where data are held:	CLO-DzV.			
Documentation of data:	Report in preparation			
Restrictions on data use or dissemination:	The distribution of the data is restricted at present, since part of the data were collected on conditions of confidentiality. Clearance to disseminate the data needs to be obtained from the sponsoring agencies, and from the ship owners.			
Actual data users:				
Potential uses for data:	NEPH but data not thought suitable for stock assessment purposes.			
Objectives:	• To collect information on the distribution of *Nephrops* and by-catch fish on the Fladen Grounds, in view of the establishment of a sustainable and economically viable Belgian *Nephrops* directed fishery in the area. • To collect discard data as part of the investigations.			
Method	Data recording and sampling at sea by fishermen; analysis of the samples by personnel of the Sea Fisheries Department			
Method of selecting vessels:	Exploratory fishing trips with 2 vessels willing to co-operate.			
Sampling stratification (if any):	Geographical stratification			
Sampling effort (planned):	Country	Days at sea	Number of trips	Other effort?
	No. of discard samples analysed: 107 in 1999. No discard sampling planned for 2000.			

Remarks:

Exploratory fishing trips covering the Fladen area were organised. The two participating vessels, the only vessels of the *Nephrops* fleet operating in the Fladen area, collected 107 discard samples. The discards results obtained by analysing a subsample of different hauls were first raised to haul level, and subsequently raised to trip level using the total number of hauls. The collection of discard data was a secondary objective. The sampling approach using fishing crews could be useful in future discards projects.

2.1.3 CANADA

2.1.3.1 Canadian Fishery Observer Program (5 regions).

1980 – present.

Participating countries and Institutes	Canada - Fisheries and Oceans • Northwest Atlantic Fisheries Ctr. • Bedford Institute of Oceanography • Mawrice Lamontage Institute • Moncton Fisheries Ctr. • Nanamo Biological Sta.			
Geographic coverage:	Canada - Atlantic and Pacific			
Fleets and fisheries covered:	Most fleets fishing in Canadian waters, fin fish and invertebrates inshore and offshore.			
Type of data collected including species:	Discarded fish: Set by set records of all fin fish and invertebrates	Retained fish: same		
Co-ordinator or contact individual:	David Kulka, Science Branch Fisheries and Oceans, Northwest Atlantic Fisheries Ctr, St. John NF Can. Other Program coordinators.			
Site(s) where data are held:	Science Branch on each of 5 regions St. Johns NF, Darthmouth NS Quebec City Que, Moncton NB, Nanaimu BC			
Documentation of data: (Reports, manuals, reports)	See references: Kulka 1995, 1996, 1997, 1998a, b, 1999; Parsons *et al.*. 1998			
Restrictions on data use or dissemination:	Available to scientists for the purpose of stock assessment			
Actual data users: e.g., ICES working groups	• Stock assessments, • Scientists within CSAS (Can. Stock Assessment Secretariat) and NAFO (Northwest Atlantic Fisheries Organisation) • Uses vary among fisheries.			
Potential uses for data:	Could be used more widely for stock assessments, assessment of technical measures, fishery management, socio-economic research and for assessing environmental effects of fishing.			
Objectives:				
Method	On board observers and port samplers			
Method of selecting vessels:	Primarily opportunistic, coverage generally high (up to 100%), may be deployed for surveillance purposes.			
Sampling stratification (if any):	By fleet and fishery (by statistical area), directed fishery, vessel class gear, time period.			
Sampling effort (planned):	Country	Days at sea	Number of trips	Other effort ?
In 2000	Canada	~ 40 000		
	Atlantic			
	+			
	Pacific			

Remarks:

Canada has collected information on discards and by-catch since 1980 through fairly extensive coverage of the fishing fleets by at sea observers. Observer programs exist for both the Atlantic and Pacific Oceans. Canadian observers are afforded the legal right to work on board fishing vessels, observe fishing operations and collect data through the Canadian Fisheries Act. They perform a dual function, collecting detailed data from all aspects of the fishing operation and they also monitor compliance to regulations including discard monitoring where such activities are not permitted. Catch information including discards plus associated biological samples are obtained on a set by set basis.

Fleet coverage in the early years of the program was confined mainly to large vessel Canadian (varying coverage up to 100% for some fisheries) and non-Canadian offshore fleets (coverage at 100%). In recent years, coverage has expanded to smaller vessels and cost recovery has been extended to all fleets. The resulting data have been analysed and discard rates in various fisheries have been reported in research documents since about the mid-1980's. Particularly in recent years, estimates of discarding in the form of weights and age dis-aggregated numbers has been incorporated into the assessment process for a number of stocks. More detailed studies on lost yield and spatial patterns in discarding have also been conducted. The information is also used to assist in management decisions such as closures due to excessive catches of small fish. Observer data has become an integral part of the input for the management of many Canadian stocks.

2.1.4 DENMARK

2.1.4.1 Danish gillnet fisheries in the North Sea

2000–2001

Participating countries and Institutes	Denmark, DIFRES			
Geographic coverage:	North Sea and Skagerrak, IV, IIIa			
Fleets and fisheries covered:	Gillnetters targeting various species.			
Type of data collected including species:	Discarded fish: All relevant measurements for stock assessment are done for all assessed species and length distributions are made for all other species. Full range of gear parameters are obtained. The catches are normally worked up by station.	Retained fish: All relevant measurements for stock assessment are done for all assessed species and length distributions are made for all other species. Full range of gear parameters are obtained. The catches are normally worked up by station.		
Co-ordinator or contact individual:	Jørgen Dalskov DIFRES, Charlottenlund			
Site(s) where data are held:	DIFRES			
Documentation of data: (Reports, manuals, reports of preceding or associated projects,scientific papers)	None yet			
Restrictions on data use or dissemination:	For scientific purposes all countries can use aggregated data on request in writing to the project co-ordinator.			
Actual data users: e.g., ICES working groups	NSSK.			
Potential uses for data:	Stock assessment.			
Objectives:	• Provide biological information as input for stock assessments in the area. • Provide basis for calculation of discards rates.			
Method e.g., on-board observers; sampling by fishers; etc.	Observers on board commercial vessels.			
Method of selecting vessels: e.g opportunistic co-operative random/statistical	Vessels are randomly selected among a large number in order to reflect the size distribution of the vessels, trip length, fishing pattern etc. for each stratum.			
Sampling stratification (if any):	Sub-division, quarter.			
Sampling effort (planned):	Country	Days at sea	Number of trips	Other effort ?
Denmark		100		

2.1.5 ENGLAND

2.1.5.1 Bycatch of cod by vessels (<10m) trawling for flatfish in the Irish Sea

Feb 2000 - April 2000

Participating countries and Institutes	CEFAS UK Other Irish Sea fishing nations are completing similar projects but for different fleets. Details of their work are not known.			
Geographic coverage:	Eastern Irish Sea			
Fleets and fisheries covered:	Under 10 m vessels. Otter trawling and beam trawls.			
Type of data collected including species: gear, position, length data, age data (cod only)	Discarded fish: All species cod is priority species	Retained fish: All species: cod is priority species.		
Co-ordinator or contact individual:	Kevin Stokes, CEFAS, Lowestoft			
Site(s) where data are held:	CEFAS, when collected			
Documentation of data:				
Restrictions on data use or dissemination:				
Actual data users:	UK Government			
Potential users for data:	NSDS			
Objectives:	To assess catches of the above fleet with especial interest in cod in relation to a cod ban in the Irish Sea			
Method	On board samplers			
Method of selecting vessels:	Nominated by Industry with agreement of enforcement agencies			
Sampling stratification (if any):				
Sampling effort (planned): Otter Trawl Beam Trawl	Country	Days at sea 20 5	Number of trips 20 1	Other effort?

Remarks:

CEFAS are supplying staff to sample 20 sea-days aboard the small inshore under 10m otter trawl fleet targeting flatfish and 5 days aboard beam trawlers, both fleets operating in the eastern Irish Sea. This was requested by the industry and the UK government (MAFF) following the introduction of a ban on fishing if cod is either targeted or caught as a by-catch. If these fleets do not catch cod in quantity then a derogation will be supplied to allow them to continue fishing in future years. All species are measured for length and quantified in volume but only cod will be otolithed and aged.

2.1.6 FRANCE

2.1.6.1 Assessment of discards for commercial species: theory and application to the multi-species fisheries in the Bay of Biscay and the Celtic Sea

1991

Participating countries and Institutes	France, IFREMER, Lorient	
Geographic coverage:	The Celtic Sea and The Bay of Biscay, VIIg-h; VIII a-b	
Fleets and fisheries covered:	• Benthic, demersal and *Nephrops* semi-industrial off-shore trawlers in the Celtic Sea; • Artisanal *Nephrops* in-shore trawlers in the Bay of Biscay	
Type of data collected including species:	Discarded fish: Length compositions and age composition for the commercial species	Retained fish: Not sampled at same time
Co-ordinator or contact	Isabelle Peronnet, IFREMER, Lorient	

individual:				
Site(s) where data are held:	IFREMER Lorient			
Documentation of data:	EC final report DGXIV/b/1:4930 from the 22/04/1991			
Restrictions on data use or dissemination:	No restriction			
Actual data users:	SSDS, NEPH			
Potential uses for data:				
Objectives:	• To implement on- board catch sampling for the French fleets in the Celtic Sea and the Bay of Biscay. • To provide catch at age by fleet for megrim, whiting, cod, hake and monkfish for the Southern Shelf Working Group.			
Method	• Sampling by fishers in the Celtic Sea; • Observers on board for the Bay of Biscay.			
Method of selecting vessels:	Random:statistical			
Sampling stratification (if any):	It is a two level sampling scheme. The first level sampling unit is the trip, the second level unit is the haul. The stratification is based on the "metier" and the quarter.			
Sampling effort (executed):	Country	Days at sea	Number of trips	Other effort?
1991	Celtic Sea	260	20	
	Bay of Biscay	18	18	

2.1.6.2 Les rejets dans la pêche artisanale française de Manche occidentale

(Discards in the french artisanal fleets operating in the Western English Channel).
EU contract CE/DG XIV-C-1 n° 1992/06 & 1992/021

April 1992- April 1993

Participating countries and Institutes	France, IFREMER			
Geographic coverage:	Celtic Sea and Channel, VIIe, VIIf, VIIg, VIIh			
Fleets and fisheries covered:	1. semi-industrial offshore trawlers 2. artisanal coastal trawlers 3. coastal fixed nets			
Type of data collected including species:	Discarded fish: length frequencies of all species		Retained fish: 1. port sampling 2. & 3. length frequencies of all species	
Co-ordinator or contact individual:	Yvon Morizur, IFREMER, Département Ressources halieutiques, BP 70, F- 29280 Plouzané			
Site(s) where data are held:	Co-ordinator			
Documentation of data:	Morizur, Y, Pouvreau, S., Guénolé, A. (1996). Les rejets dans la pêche artisanale française de Manche occidentale, Edition IFREMER, 127 pp.			
Restrictions on data use or dissemination:	unknown			
Actual data users:				
Potential uses for data:	For managing coastal fisheries not covered by international stock assessments			
Objectives:	Collect information about coastal fisheries which do not fall under international management.			
Method	1. on board observers and sampling by fishers; 2. & 3. on board observers			
Method of selecting vessels:	random sampling of trips			
Sampling stratification (if any):	stratification by fleet, harbour (for 3.) and quarter			
Sampling effort (executed in 12 months):	Country	Days at sea	Number of trips	Other effort?
semi-industrial offshore trawlers	France	35 (observer) 47 (fishers)	10	
artisanal coastal trawlers	F	26	17	
coastal fixed nets	F	43	31	

Remarks:

A fleet stratified sampling design was used for this study carried out between April 1992 and April 1993. The study aimed at estimating discards and landings for the principal "métiers". The studied métiers were inshore trawling, offshore trawling, and netting (fixed nets with small or large mesh sizes). All species were taken into account. Multivariate analysis was used to identify the most important factors for discarding and to post-stratify the data. Discard rates and length compositions were obtained by species in each strata. The results were not raised to the fleets but it seems possible to carry out the calculations for the trawlers. Information about fishing effort, total number of trips made during the period and the landing per species are available for alternative raising methods.

2.1.6.3 Estimates of discards for the deep- sea fisheries for industrial and semi industrial French fleet; In "Ecologie et biologie des poissons profonds exploités par leapêche industrielle et semi- industrielle dans l'Atlantique Nord Est"

1996

Participating countries and Institutes	France IFREMER Lorient and University of Bretagne Occidentale (UBO) de Brest France			
Geographic coverage:	NE Atlantic, V and VI			
Fleets and fisheries covered:	Industrial and semi-industrial French fleet catching deep water species			
Type of data collected including species:	Discarded fish: length and age compositions for the deep sea species: *Coryphaenoides rupestris, Alepocephalus bairdii, Deania calcea, Lepidion eques, Alepocephalus rostratus, Caelorinchus occa.*		Retained fish: Length and age composition by species Weight by species	
Co-ordinator or contact individual:	Valérie Alain, Universite de Bretagne Occidentale, Brest			
Site(s) where data are held:	UBO Brest, France			
Documentation of data: (Reports, manuals, reports of preceding or associated projects,scientific papers)	Alain, V. (1999)			
Restrictions on data use or dissemination:	Data published in a thesis.			
Actual data users:				
Potential uses for data:	Stock assessment			
Objectives:	To assess the impact of the fisheries on deep-sea resources			
Method	Observers on board			
Method of selecting vessels:	Co-operative			
Sampling stratification (if any):				
Sampling effort (planned):	Country	Days at sea	Number of trips	Other effort?
1996	France	120	8	

Remarks:

The study was part of a larger study about the ecology and biology of the deep species. The number and the weight of the fish retained and discarded were sampled in 1996 during 4 trips of two boats. In this study it was assumed that the discards and landings were proportional. This proportion was found to vary with depth and area. The proportion was used to raise the results to the total fleet. In this case it is difficult to raise by the fishing effort because the real effort directed on deep sea species is unknown. An analysis of the specific compositions and the quantities of discards by species was done for each area and depth strata.

2.1.7 GERMANY

2.1.7.1 Sampling of 8 German commercial fisheries

EC Study 1997/0004
April 1998 to September 2000.

Participating countries and Institutes	Germany, ISH			
Geographic coverage:	• North Sea, IV: Cod, Saithe, Plaice, Sole, Herring, Mackerel, Horse Mackerel • West Scotland, VI: Herring, Mackerel, Horse Mackerel; • Shelf edge, Vll+VIII: Mackerel, Horse Mackerel; • Atlantic, XII: Redfish • Atlantic, XIV: Redfish, Greenland Halibut			
Fleets and fisheries covered:	North Sea Roundfish Fishery; North Sea Flatfish Fishery; Big Pelagic Trawler Fishery			
Type of data collected including species: weight,length, age	Discarded fish: All, if possible, age: target species.	Retained fish:All, if possible, Age: target species		
Co-ordinator or contact individual:	Peter Cornus			
Site(s) where data are held:	ISH			
Documentation of data:	See references: Weber & Lamp,1983;Lamp & Weber, 1984; Weber, 1995; Also: Report of EU-Study 94/19; Intermediate Report for Study 1997/0004			
Restrictions on data use or dissemination:				
Actual data users:	NWWG, HAWG, WGECO, MHSA NAFO Scientific Council, OSPAR: North Sea Task Force			
Potential uses for data:	NSSK, stock assessment, technical measures, fishery management, socio-economic, environmental effects			
Objectives:	• To enhance sampling data on commercial fisheries. • To collect data on discards of target species. • To collect data on discards of non-target species. • To study the ecological impact of fisheries			
Method	On-board observers			
Method of selecting vessels: e.g opportunistic co-operative random/statistical	Opportunistic and co-operative. Random sampling not possible.			
Sampling stratification (if any):	stratification according to fishery, quarter and area			
Sampling effort (planned per year):	Country	Days at sea	Number of trips	Other effort?
North Sea Demersal Fishery:		ca. 120	17	
Redfish/Greenld.HalibutFishery		ca. 180	6	
Big Pelagic Fishery		ca. 150	7	

Remarks:

Onboard-sampling in Germany has developed in several steps: Collection of retained and discarded catch data

- on cod in the cod fishery (1982–84)
- on target species and important by-catches in the cod and beam trawl fishery (1993–94)
- on all species caught in demersal and pelagic fisheries (since 1995)

Though there are no legal regulations for biological sampling at the market or at sea, the co-operation with fishermen in general is very good. However, because of vessels changing the fishery, landing abroad or being a flag vessel, to which the contacts could not be made, random sampling until now was not possible.

2.1.8 IRELAND

2.1.8.1 SAMFISH, FIEFA and EC study contracts 97–0059 + 99–099 Projects

SAMFISH – 2000 to 2002;
FIEFA – 1989 to 1999;
EC 97/0059 – 1998 to 2000;
EC 94/013 – 1996 to 1998.

Participating countries and Institutes	Ireland (only) Other partners sample discards under other projects			
Geographic coverage:	Sub-area VI and VII			
Fleets and fisheries covered:	Beamer, Otter Trawl, Nephrups Trawl Whitefish + flatfish fisheries			
Type of data collected including species:	Discarded fish: length/weight/age commercial species Discard rates length all fish	Retained fish: Length/weight/age		
Co-ordinator or contact individual:	Dr Paul Connolly Dr John Joyce			
Site(s) where data are held:	Marine Fisheries Services Division Abbotstown. Dublin 15			
Documentation of data: (Reports, manuals, reports of preceding or associated projects, scientific papers)	Protocols Manual ICES Symposium on Ecosystem Effects of Fishing Also Section in Report of EC 95/094 (June 1999). See 2.1.1.4			
Restrictions on data use or dissemination:	No restrictions Acknowledge EC + marine Institute			
Actual data users: e.g., ICES working groups	ICES: NSWG, SSWG Other EU projects			
Potential uses for data: e.g., stock assessment,	Stock Assessment Technical Measures Socio Economic			
Objectives:	To Assess discarding practices in Irish Fleet			
Method e.g., on-board observers; sampling by fishers; etc.	On board observers			
Method of selecting vessels: e.g opportunistic co-operative random/statistical	Cooperative/opportunistic			
Sampling stratification (if any):	None			
Sampling effort (planned):	Country	Days at sea	Number of trips	Other effort ?
1997, VI + VIIa	Ireland		19	
1997, VIIb,c,g,j	Ireland		32	

2.1.9 NETHERLANDS

2.1.9.1 Discard-onderzoek

Project 7089: 1968 – 1990.

Participating countries and Institutes	Netherlands (RIVO)			
Geographic coverage:	North Sea and Dutch estuaries			
Fleets and fisheries covered:	Beam trawl, Otter trawl, pair trawl, shrimp trawl, pelagic trawl, gill nets			
Type of data collected including species:	Discarded fish: • length composition of all discarded fish species per haul (not all hauls) • numbers of other species discarded • volume of discarded fraction measured in baskets	Retained fish: • length composition of a selection of landed species (hauls combined)		
Co-ordinator or contact individual:	Frans van Beek, RIVO, Ijmuiden			
Site(s) where data are held:	RIVO Ijmuiden			
Documentation of data: (Reports, manuals, reports of preceding or associated projects,scientific papers)	See references: Veen, J.F. de, and W.F. Rodenburg, 1971. Veen, J.F. de, P.H.M. Huwae and M.S.S. Lavaleye, 1975Vlasveld, P., 1977. Leeuwen, P.I. van, 1984Faasse, M.A., 1987. Beek, F.A. van, P.I. van Leeuwen and A.D. Rijnsdorp 1989. Beek, F.A. van, 1990. Beek, F.A. van, P.I. van Leeuwen and A.D. Rijnsdorp. 1990. Rijnsdorp, A.D. and F.A. van Beek, 1991. Beek, F.A. van. 1995Beek. F.A. van, 1998. Beek, F.A. van, 1998.			
Restrictions on data use or dissemination:	Data may only be published in aggregated form requiring permission of fisheries unions.			
Actual data users: e.g., ICES working groups	WGECO (inventory of discarding in the North Sea) WGNSSK (mesh assessments, plaice box) STECF (mesh assessments) ACFM/ACME (advice)			
Potential uses for data:	Data not suitable for assessment, no annual age composition			
Objectives:	Assessment of discarding in Dutch fisheries.			
Method	On-board observers			
Method of selecting vessels:	Opportunistic Co-operative			
Sampling stratification (if any):	The intention was to sample all major fishing areas regularly in the North Sea at a low frequency.			
Sampling effort (planned):	Country	Days at sea	Number of trips	Other effort?
project stopped in 1990				

2.1.10 NORTHERN IRELAND

2.1.10.1 Northern Ireland Nephrops trawlers

Early 80s to present.

Participating countries and Institutes	Northern Ireland, DARD Belfast			
Geographic coverage:	Irish Sea, VIIa			
Fleets and fisheries covered:	Northern Ireland *Nephrops* trawlers			
Type of data collected including species:	Discarded fish: Whiting: length; weight; age *Nephrops*: length, sex, maturity Other fish: length Other inverts: aggregate weight		Retained fish:	
Co-ordinator or contact individual:	R Briggs, DARD Belfast			
Site(s) where data are held:	DARD Belfast			
Documentation of data: (Reports, manuals, reports of preceding or associated projects, scientific papers)	See references: Briggs, R. P. 1985, 1992. Armstrong *et al.*. 1998. Also see R.Briggs 'Discard sampling in Northern Ireland' in EC report BIOECO 93/003 'Assessment of discarding rates for commercial species of fish'.			
Restrictions on data use or dissemination:				
Actual data users:	ICES NSDWG, NAWG			
Potential users for data:				
Objectives:	Estimation of quarterly numbers of *Nephrops* discarded by length class and sex, and numbers of whiting discarded by age class.			
Method	On board observers and samples provided by skippers			
Method of selecting vessels:				
Sampling stratification (if any):				
Sampling effort (planned):	Country	Days at sea	Number of trips	Other effort?
	Northern Ireland		4–6 per month	

2.1.10.2 Northern Ireland twin-trawl and pelagic trawlers

April 1997 to Sept 1998.

Participating countries and Institutes	Northern Ireland, DARD Belfast			
Geographic coverage:	Irish Sea, VIIa			
Fleets and fisheries covered:	Northern Ireland twin-rig and pelagic trawlers			
Type of data collected including species:	Discarded fish: length frequency of all species	Retained fish: length frequency and ages		
Co-ordinator or contact individual:	M. Armstrong, DARD Belfast			
Site(s) where data are held:	DARD Belfast			
Documentation of data: (Reports, manuals, reports of preceding or associated projects, scientific papers)	Armstrong, M. *et al.* 'Estimation of quantities of fish discarded and retained in the Irish Sea by Northern Ireland twin-trawl and pelagic trawl vessels' in Report of EC project 95/094 'On board sampling of fish landed and discarded by commercial vessels.' See 2.1.1.4			
Restrictions on data use or dissemination:				
Actual data users:	ICES NSDWG, NAWG			
Potential users for data:				
Objectives:	Estimation of quantities of white fish and *Nephrops* discarded by length and age.			
Method	On board observers			
Method of selecting vessels:	Random			
Sampling stratification (if any):				
Sampling effort (planned):	Country	Days at sea	Number of trips	Other effort ?
1997–1998	Northern Ireland		22 pelagic 13 twin-rig	

Remarks:

The number of trips sampled appeared inadequate for robust estimation of numbers discarded or landed at age in the target fleets. Catch-rates varied widely between trips for reasons not related to the size or power of the vessels. (Taken from EC report 95/094, June 1999, p159.)

2.1.11 SCOTLAND

Scottish discard sampling schemes can be Divided into two broad categories; routine sampling programmes and smaller scale, more exploratory sampling. The former are represented by the demersal and *Nephrops* sampling schemes, with smaller scale sampling of pelagic and deepwater fisheries.

2.1.11.1 Scottish deep water demersal sampling

EC project CT 95–0655 (1996 – 1998); EC study 97/0084 (May 1998 – April 2000)

Participating countries and Institutes	FRS Marine Laboratory, Aberdeen, Scotland UK			
Geographic coverage:	Rockall Trough (ICES Area VI)			
Fleets and fisheries covered:	Scottish and French trawlers fishing for deepwater species on the slopes of the Rockall Trough			
Type of data collected including species:	Discarded fish: Length data for all species		Retained fish: Length data for all deep water teleost species	
Co-ordinator or contact individual:	Tom Blasdale & Andrew Newton, FRS Marine Laboratory, Aberdeen			
Site(s) where data are held:	FRS Marine Laboratory, Aberdeen			
Documentation of data: (Reports, manuals, reports of preceding or associated projects, scientific papers)	• Methodology as per Jermyn, (1985). • Report of CT 95–0655 "Developing deep water fisheries: data for their assessment and for the understanding of their impact on a fragile environment" • Report of 97/0084 "Environment and Biology of deep-water species *Aphanopus carbo* in the NE Atlantic: basis for its management.". • Blasdale & Newton, (1998).			
Restrictions on data use or dissemination:				
Actual data users:	ICES Study Group on the Biology and Assessment of Deep-Sea Fisheries Resources			
Potential users for data:	Species sampled not yet routinely assessed & specific gear selectivity not studied. Information could be used to aid understanding of ecological impact of fisheries. However, coverage generally poor.			
Objectives:	Improved understanding of impact of trawling on deepwater fish communities.			
Method	On-board observers			
Method of selecting vessels:	Opportunistic within strata			
Sampling stratification (if any):	Fleet (Scottish/French) & quarter			
Sampling effort (planned):	Country	Days at sea	Number of trips	Other effort?
	Scotland		c. 4/year	

2.1.11.2 Scottish demersal discard sampling scheme

1975 to present (North Sea); 1976 to present (Division VIa).

Participating countries and Institutes	FRS Marine Laboratory, Aberdeen, Scotland	
Geographic coverage:	North Sea (IV) and West of Scotland (VIa)	
Fleets and fisheries covered:	Scottish trawlers, pair trawlers, seiners and Nephrops trawlers	
Type of data collected including species:	Discarded fish: Length data: All species Age data: Cod, haddock, whiting, saithe	Retained fish: Length data for all species
Co-ordinator or contact individual:	Ken Coull, FRS Marine Laboratory, Aberdeen	
Site(s) where data are held	FRS Marine Laboratory	

Documentation of data:	• Methodology as per Jermyn, (1985). • Data in Reports of ICES WG on the Assessment of Demersal Stocks in the North Sea & Skagerrak (WGNSSK), and • WG on the Assessment of Northern Shelf Demersal Stocks (WGNSDS). • Data also used in various other studies, notably a PhD study by Y. Stratoudakis – see Remarks.			
Restrictions on data use or dissemination:				
Actual data users:	Data used routinely by NSSK & NSDS Data have also been used e.g., in • assessment of effects of gear selectivity changes on fishery yields and on availability of discards to seabirds; • assessment of impact of discarding on non-target species; • study of factors affecting fishers discarding practices etc. – See Remarks.			
Potential uses for data:				
Objectives:	• Estimation of quantities and age compositions of discards of cod, haddock whiting and saithe by Scottish vessels; • estimation of quantities and size compositions of discards of other species by Scottish vessels.			
Method	On-board observers			
Method of selecting vessels:	Opportunistic within strata			
Sampling stratification (if any):	Sampling area/quarter/gear			
Sampling effort (planned):	Country	Days at sea	Number of trips	Other effort?
	Scotland		c. 80/year	

Remarks:

The Scottish demersal discard sampling scheme commenced in 1975 in response to an ICES resolution (ICES C. Res. 1975/4:22) which stressed the importance of the collection of discard data as an aid to improving the assessment of fish stocks. Sampling of the North Sea fisheries started in 1975, and in 1976, the scheme was extended to cover ICES area VIa (West of Scotland).

The estimates of Scottish discards of North Sea haddock and whiting are routinely used in the assessment of these stocks (e.g., Anon., 1994). In both cases, the Scottish landings account for a large proportion of the total international landings so the Scottish discard estimates can be taken as being representative of overall discarding practices. No other time series' of discards are available for these stocks. For North Sea cod, the Scottish landings account for a smaller proportion of the total landings, so the Scottish discard data have not been routinely used. In Division VIa, the haddock and whiting discard data are routinely used in assessments.

The original discard sampling scheme is described in Jermyn and Hall (1978), and data from the first five years are summarised in Jermyn and Robb (1981). The processing of Scottish demersal landings and discard data is described in Armstrong and Hall (1987). Current discard sampling procedures are given in Jermyn (1985). Reeves (1990) fitted linear models to a subset of the data for North Sea haddock. Data on discards of non-commercial species collected as part of the sampling scheme have recently been summarised by Jensen, Emslie and Coull (1994). Scottish discard and selectivity data are used by Furness (1992) to predict the effects of changes in selectivity and fishing effort on the availability of discards to seabirds.

Data from the Scottish demersal sampling scheme were analysed as part of a PhD. Study (Stratoudakis, 1997). This study considered a number of different aspects of discarding including factors affecting discarding practice by fishers (Stratoudakis *et al..*, 1998); and approaches to estimating total discards (Stratoudakis *et al..*, 1999). Other results from the study have included work on a non-target species (Stratoudakis et al, 1997) and comments on studies of the dependence of seabirds on discards (Stratoudakis 1999).

2.1.11.3 Scottish Nephrops discard sampling scheme

1989 to present.

Participating countries and Institutes	FRS Marine Laboratory, Aberdeen, Scotland			
Geographic coverage:	Nephrops functional units: • Firth of Forth (ICES Division IV); • Moray Firth (IV); • North Minch (VIa); South Minch (VIa); Clyde (VIa). • Fladen (IV) from April 2000 onwards.			
Fleets and fisheries covered:	Scottish vessels fishing for *Nephrops norvegicus* in the above areas.			
Type of data collected including species:	Discarded fish: *Nephrops norvegicus* only	Retained fish: *Nephrops norvegicus* only		
Co-ordinator or contact individual:	Adrian Weetman, FRS Marine Laboratory.			
Site(s) where data are held	FRS Marine Laboratory			
Documentation of data:	• Methodology as per Jermyn, (1985). • Data in Reports of Nephrops Working Group, e.g., ICES CM 1999/ACFM:13 More detailed in-house protocol for data collection available from above address.			
Restrictions on data use or dissemination:				
Actual data users:	Data used routinely by NEPH. In addition, used for *ad hoc* evaluations for UK policy customers.			
Potential uses for data:	Data are collected on length compositions by area allowing use in • assessment of effects of change in gear regulation given information on selectivity of current gears. • evaluation of state of stocks.			
Objectives:	Estimation of quantities, sex ratio and size compositions of *Nephrops* from sampled functional units.			
Method	On-board observers and limited amount of shore based discards.			
Method of selecting vessels:	Opportunistic within strata			
Sampling stratification (if any):	Quarterly by functional unit. In addition, monthly samples in the South Minch since July 1995, and monthly samples in the Firth of Forth from September 1995 to February 1997.			
Sampling effort (planned):	Country	Days at sea	Number of trips	Other effort?
	Scotland	40 (inshore areas)+ 28(Fladen)	c. 24/year	

Remarks:

The Scottish sampling scheme for *Nephrops* discards started in approximately 1989 and is comparable in scope and methodology to the Scottish demersal discard sampling programme. However, the scheme considers only discards of *Nephrops* because initial studies indicated that sampling both the fish and the *Nephrops* discards during a given trip was not practical. In addition, the area and gear coverage is more limited given the more specialised nature of the *Nephrops* fishery. The sampling aims to obtain quarterly samples from each of five of the *Nephrops* functional units, although in some years coverage of some areas has been monthly, and coverage will soon be expanded to include the fishery on the Fladen Ground.

2.1.12 SPAIN

2.1.12.1 Discard of the Spanish trawler fleet in Sub-area VII

1987 to 1988

Participating countries and Institutes	Spain, IEO			
Geographic coverage:	Shelf edge, VII			
Fleets and fisheries covered:	Spanish Trawl in Sub-area VII			
Type of data collected including species:	Discarded fish: Length of Megrim		Retained fish: Length of Megrim	
Co-ordinator or contact individual:	Nélida Pérez, IEO, Vigo			
Site(s) where data are held:	SSDSWG			
Documentation of data: (Reports, manuals, reports of preceding or associated projects, scientific papers)	Pérez N. and Ph. Moguedet Estimates of the horse-mackerel (Trachurus trachurus) discards from the Spanish trawler fleets in the ICES Division VII. Working Paper in Pelagic Stocks in Divisions VIIIc and IXa and Horse Mackerel. Hake WG. Moguedet Ph. and N. Pérez. 1989.Estimates of discards from the Spanish trawler fleets in the Sub-area VII. Working paper in the Working Group on Fisheries Units			
Restrictions on data use or dissemination:				
Actual data users:	SSDSWG			
Potential uses for data:	Stock assessment			
Objectives:	Length composition of megrim in Sub-area VII for Stock Assessment			
Method	On board sampling			
Method of selecting vessels:	Co-operative			
Sampling stratification (if any):	by Quarter			
Sampling effort (planned):	Country	Days at sea	Number of trips	Other effort ?
IEO	Spain	408	24	

Remarks:

This project was the first estimation of Spanish discard trawlers with observers on board in Sub-area VII. The objective was to estimate the discard of the main commercial species in Sub-area VII (hake, anglerfish, megrim and ne). Length composition of discard of megrim was used in stock assessment. This information is available in SSDSWG and in working papers.

2.1.12.2 Discards of the Spanish fleet in ICES Divisions.

EC Project Pem/93/005.
1994 to 1996.

Participating countries and Institutes	Spain, AZTI, IEO			
Geographic coverage:	AZTI: VIIIc IEO: VI, VII, VIII & IXa.			
Fleets and fisheries covered:	AZTI: Purse seine in Division VIIIc IEO: Trawl in Sub-areas VI, VII, VIII and IXa Pair Trawl in Divisions VIIIc and IXa Gillnet in Division VIIIc Long line in Sub-areas VI, VII and VIII			
Type of data collected including species:	Discarded fish: Length distribution of Blue whiting, Hake, Horse mackerel, Megrims, Monks, Mackerel, Nephrops Total discard estimation	Retained fish: Length distribution of Blue whiting, Hake, Horse mackerel, Megrims, Monks, Mackerel, Nephrops		
Co-ordinator or contact individual:	Nélida Pérez, IEO, Vigo			
Site(s) where data are held:	ICES, Fisheries Department, IEO SSDSWG			
Documentation of data: (Reports, manuals, reports of preceding or associated projects, scientific papers)	See references: 1996. Pérez N., V. Trujillo, P. Pereda.ICES 1996.Pérez, N., Pereda, P., Uriarte, A., Trujillo, V., Olaso, I & S. Lens. 1996.Olaso I., F. Velasco, P. Pereda and N. Pérez. 1997.Trujillo V., N. Pérez and P. Pereda			
Restrictions on data use or dissemination:	SSDSWG			
Actual data users:	Megrim in Sub-area VII. SSDSWG			
Potential uses for data:	Stock Assessment			
Objectives:	• Discard rates for different species and gears. • Length composition of discards of commercial species in Sub-areas VII VIII and Division IXa for Stock Assessment			
Method	On-board observers			
Method of selecting vessels:	Vessel stratified sampling			
Sampling stratification (if any):	Area, Gear and Harbour			
Sampling effort (planned):	Country	Days at sea	Number of trips	Other effort?
AZTI	Spain	157	157	
IEO	Spain	986	217	

Remarks:

This EC project was developed by AZTI and IEO between 1994 and 1996. During 1994, observers carried out the sampling program on board of commercial vessels. The project covered fishing activities of some of the most important Spanish fleet.

Discard estimation of the most important commercial species necessary in stock assessment (as megrim in Sub-area VII) wa provided. Also the discard rate for all species catches for different gears sampled. Estimation of the total discard (commercial and non commercial species, including species of pinnipeds, cetaceans and sea birds) was made.

2.1.12.3 On-board Observers Programme of Distant Waters Fisheries (Project nº 502):Commercial Cod Fishery

1983, on-going.

Participating countries and Institutes	Spain, IEO			
Geographic coverage:	IIb and IIa (Svalbard)			
Fleets and fisheries covered:	Spanish Cod Fleet (Pair trawlers)			
Type of data collected including species:	Discarded fish: Length data of Cod (*Gadus morhua*): Others: - Biological data (Length/Weight, maturity stage and stomach content) Otoliths		Retained fish: Length data of Cod (*Gadus morhua*): Others: - Biological data (Length/Weight, maturity stage and stomach content) Otoliths	
Co-ordinator or contact individual:	Sergio Iglesias IEO Spain			
Site(s) where data are held:	Distant Waters Fisheries Department. IEO			
Documentation of data:	Documents presented to the Arctic Working Group – 1983			
Restrictions on data use or dissemination:	ICES WG			
Actual data users:				
Potential uses for data:	Arctic Fisheries Working Group (AFWG)			
Objectives:	• To carry out samples of the major commercial species • To monitor and evaluate the fishery • To estimate total catch of cod			
Method	On-board observers			
Method of selecting vessels:	Co-operative			
Sampling stratification (if any):				
Sampling effort (planned):	Country	Days at sea	Number of trips	Other effort?
2000 (planned)	Spain	180	1	
1999	Spain	117	1	
1998	Spain	97	1	
1997	Spain	175	2	
1996	Spain	192	2	

Remarks:

This project targets the Spanish Pair trawler fleet fishing in Divisions IIb and IIa (Svalbard). The main objective of this project is to evaluate the cod fishery in which targeted species are gadoid species (e.g., haddock) and species such as saithe and plaice, also important in the catches.

2.1.12.4 On-board Observers Programme of Distant Waters Fisheries (Project nº 502):

Oceanic Redfish Fishery (XII and XIVb ICES).
1995 to present.

Participating countries and Institutes	Spain, IEO			
Geographic coverage:	XII and XIVb (Reykjanes)			
Fleets and fisheries covered:	Spanish Freezer Fleet (Pelagic)			
Type of data collected including species:	Discarded fish: Length data of Oceanic Redfish (*Sebastes mentella)* Others: - Biological data (Length/Weight, maturity stage and stomach content) Otoliths		Retained fish: Length data of Oceanic Redfish (*Sebastes mentella)* Others: - Biological data (Length/Weight, maturity stage and stomach content) Otoliths	
Co-ordinator or contact individual:	Sergio Iglesias IEO Spain			
Site(s) where data are held:	Distant Waters Fisheries Department. IEO			
Documentation of data:	Documents presented to the the North Western Atlantic Fisheries Working Group. 1996			
Restrictions on data use or dissemination:	Available to ICES WG			
Actual data users:				
Potential uses for data:	North Western Atlantic Fisheries Working Group (NWWG). North East Atlantic Fisheries Commission (NEAFC).			
Objectives:	• To sample the major commercial species • To monitor and evaluate the fishery • To estimate total catch of oceanic redfish *Sebastes mentella*			
Method	On-board observers			
Method of selecting vessels:	Co-operative			
Sampling stratification (if any):				
Sampling effort (planned):	Country	Days at sea	Number of trips	Other effort?
2000 (planned)	Spain	300	2	
1999		108	2	
1998	Spain	132	3	
1997	Spain	160	3	
1996	Spain	611	6	
1995	Spain	316	3	

Remarks:

This project targets the Spanish freezer fleet (pelagic) in ICES sub-area XII and Division XIVb (Reykjanes) The main objective of this project is to monitor and evaluate the fishery targeting oceanic redfish, Others species caught are sharks, granadiers, and wolffish.

2.1.12.5 On-board Observers Programme of Distant Waters Fisheries (Project nº 502):

Deep Species Fishery in the XII and XIV - ICES Division (Hatton Bank).
1996, on-going.

Participating countries and Institutes	Spain, IEO			
Geographic coverage:	XII (Hatton Bank)			
Fleets and fisheries covered:	Spanish Freezer Fleet (trawlers)			
Type of data collected including species:	Discarded fish: Length data of oceanic deep-species	Retained fish: Length data of oceanic deep-species		
Co-ordinator or contact individual:	Sergio Iglesias, IEO Spain			
Site(s) where data are held:	Distant Waters Fisheries Department. IEO			
Documentation of data:	Study Group on the Biology and Assessment of Deep- Sea Fisheries Resources (SGDEEP). 1996			
Restrictions on data use or dissemination:	Available to ICES WG			
Actual data users:				
Potential uses for data:	Study Group on the Biology and Assessment of Deep- Sea Fisheries Resources (SGDEEP)			
Objectives:	• To carry out samples of the major commercial species • To follow-up and evolution of the Fishery • Total catch of deep-species * smoothhead (*Alepocephalus bairdii*), roundnouse grenadier (*Coryphaenoides rupestris* blue ling (*Molva dipterygia*): * Portuguese dogfish (*Centroscymnus coelolepis*)			
Method	On-board observers			
Method of selecting vessels:	Co-operative			
Sampling stratification (if any):				
Sampling effort (planned):	Country	Days at sea	Number of trips	Other effort ?
1999	Spain	177	2	
1998	Spain	433	8	
1997	Spain	194	6	
1996	Spain	173	5	

2.1.13 SWEDEN

2.1.13.1 Discarding in the Swedish inshore purse seine sprat fishery

1970 and 1997–1998. Continuation will be discussed in the autumn of 2000.

Participating countries and Institutes	IMR, Lysekil, Sweden			
Geographic coverage:	Coastal areas in the Swedish part of Skagerrak and Kattegat.			
Fleets and fisheries covered:	Purse Seine fishering fleet for Sprat, Herring			
Type of data collected including species:	Discarded fish: In principal all pelagic fish species		Retained fish: Sprat herring	
Co-ordinator or contact individual:	Fredrik Arrhenius			
Site(s) where data are held:	IMR, Lysekil			
Documentation of data:	See references: Arrhenius et al (1998a & b);			
Restrictions on data use or dissemination:	None			
Actual data users:	National Board of Fisheries			
Potential users for data:	Data probably not suitable for stock assessment			
Objectives:	To estimate discarding in the inshore purse seine fishery.			
Method	On-board observations and sampling by fishers			
Method of selecting vessels:	Random			
Sampling stratification (if any):	Geographical			
Sampling effort (planned):	Country	Days at sea	Number of trips	Other effort?
	Sweden			

Remarks:

Possible sources of variation included haul, trip, temporal, and spatial but as the by-catch of the fleet was not calculated, the relative importance of the different sources of variations was not considered. It was concluded that this study is important because of the lack of other data on this potentially important fishing with respect to discarding. However, the study was never intended to give valid estimates of the number of discarded fish by the fleet, and should be neglected from a possible future study of raising to fleet level for this reason. Nevertheless, the report gives on-board estimates of the spatial distribution of by-catching sites as well as an indication of the ratio of discarding relative to retention in one particular year.

2.2 Simulated commercial fishing projects

2.2.1 FRANCE

2.2.1.1 Echantillonnage biologique des rejets de poissons et autres organismes dans le Golf de Gascogne (RESSGASC)

(Biological sampling of discards of fish and other species in the Bay of Biscay) data:
1985 (?) – today.

Participating countries and Institutes	France, IFREMER			
Geographic coverage:	Bay of Biscay 44°30N and 1°20W to 47°50N and 4°30W			
Fleets and fisheries covered:	trawlers operating 'vendéen' gear			
Type of data collected including species:	Discarded fish:		Retained fish: port sampling	
Co-ordinator or contact individual:	Philippe Moguedet, IFREMER, DRV- RH, La Rochelle			
Site(s) where data are held:	co-ordinator			
Documentation of data: (Reports, manuals, reports of preceding or associated projects,scientific papers)	Guichet, R., Moguedet, P., Mesnil, B., Battaglia, A. (1998). Echantillonnage biologique des rejets de poissons et autres organismes dans lde Golfe de Gascogne, Rapport final, Contract Bio ECO 94 – 054 CEE DG XIV, 121 pp.			
Restrictions on data use or dissemination:	Unknown			
Actual data users:	SSDS for hake discards estimates by length			
Potential uses for data:	Stock assessment of other species than hake			
Objectives:	Estimation of discards for hake, *Nephrops* and sole and construction of age-length keys for sole			
Method	Scientific vessel, estimation based of length-frequency data from port sampling.			
Sampling stratification (if any):	Stratification by quarter.			
Sampling effort (planned):	Country	Days at sea	Number of HAULS	Other effort ?
	1995, France		136	
	1996		120	
	1997		160	

Remarks:

In 1991 a study was carried out in the same area using the same methodology but concentrating on the commercial species. In contrast to the study described above, a ratio estimator was used for obtaining estimates of total discards for the commercial species. The data were raised to each métier using the number total of hauls made by each métier. Age and length compositions and the weight discarded were estimated for commercial species only (megrim, monkfish, skates, cod, whiting, nephrops and hake). The landings were sampled by the national sampling program but no sampling of the trips covered in the study was carried out.

2.2.2 SWEDEN

2.2.2.1 Estimates of bycatches in the eel fishery on the Swedish west coast

1998–9.

Participating countries and Institutes	Sweden, IMR, Lysekil, Institute of Coastal Research, Oregrund.			
Geographic coverage:	Coastal Waters in the Swedish part of Skagerrak and Kattegat.			
Fleets and fisheries covered:	Small-scale fishery in Swedish Coastal Waters, the eel fishing fleet.			
Type of data collected including species:	Discarded fish: Number, age, length of cod, plaice, flounder; in principal all fish species	Retained fish: Eel		
Co-ordinator or contact individual:	Henrik Svedang, IMR			
Site(s) where data are held:	IMR, Lysekil, Sweden			
Documentation of data:	Svedang, H. 1999. Undersokning av alryssjefiskets bifangstproblem i Vasterhavet. (Investigation of discards problems in eel fishing on the Swedish west coast). Fiskeriverket Rapport 5, 5–31. With English Summary. (National Board of Fisheries).			
Restrictions on data use or dissemination:				
Data users	National Board of Fisheries			
Potential uses for data:	Due to the high discarding-rate the information could be useful for cod stock assessment groups, as well as for technical measures and fishery management.			
Objectives:	To estimate the annual amount of discarding in the eel fishery and to estimate the mortality of discarded fish.			
Method	• Field estimates of fishing efforts in selected areas in 1998; • Fishing mortality was estimated by experimental fishing; • Experimental fishing with RV to estimate CPUE in one area.			
Sampling stratification (if any):	Field estimates of fishing efforts were achieved by temporal and geographical stratification.			
Sampling effort (planned):	Country	Days at sea	Number of trips	Other effort?
				3 week field study in 1998

Remarks:

Possible biases: Estimates of fishing effort were only obtained for one year. Moreover, and with respect to this particular fishery, probably more important, fishing effort was only studied in some parts of the total potential fishing area. Thus the actual fishing effort might have been either over- or under-estimated. CPUE was not studied by on-board observations. Hence, spatial and temporal variation in by-catching was not covered in the study. Fishing mortality is likely to be rather dependent on the fishing and examination procedures, which can be supposed to vary between fishermen.

Conclusion: The study was not designed to give annual, validated data on the numbers of discarded fish, but rather whether *F* in eel fishing could be a factor worth considering. However, as the quantity of cod discarded was estimated to be relatively high (1–6 million 1 year-old cod), this is a fishery that should be given further attention at least in relation to Skagerrak and Kattegat.

2.3 Interviewing and review projects

2.3.1 INTERNATIONAL

2.3.1.1 Economic aspects of discarding

Reporting: April 2000.

Participating countries and Institutes	UK – Nautilus Consultants, Holland - LEI-DLO, France – Cofrepeche			
Geographic coverage:	• UK Case study (IVa & IVb - North Sea) • Dutch Case study (IVb & IVc - North Sea) • French Case Study (VIII -Bay of Biscay)			
Fleets and fisheries covered:	• Dutch North Sea Beam Trawl Flatfish, • French Nephrops Trawl, • British Whitefish Trawl			
Type of data collected including species:	Discarded fish:		Retained fish:	
Co-ordinator or contact individual:	Rod Cappell (UK), Erik Buisman (LEI)			
Site(s) where data are held:	With Project participants			
Documentation of data:	Draft report due April 1st 2000, supplied to MAFF Economics (Resource Use) Division, London			
Restrictions on data use or dissemination:	MAFF report may be confidential			
Actual data users:				
Potential uses for data:	Could be relevant for technical measures and socio-economic aspects			
Objectives:	• To establish the economic incentives to discard and the economic impact of discarding behaviour. • To estimate impacts of changes in fisheries regulations and compare to Norwegian discard ban system.			
Method	Telephone questionnaire survey of 70 skippers in Britain.			
Sampling stratification (if any):				
Sampling effort (planned):	Country	Days at sea	Number of trips	Other effort?
Questionnaires				70

Remarks:

2.3.1.2 Study on the problem of discards in fisheries

Completed: April 1999.

Participating countries and Institutes	Megapesca Lda., Portugal, contracted by Science and Technology Options Assessment of the European Parliament
Geographic coverage:	European Community waters
Fleets and fisheries covered:	All EU and Norwegian fisheries
Co-ordinator or contact individual:	Megapesca Lda.
Site(s) where data are held:	
Documentation of data:	Reported April 1999
Restrictions on data use or dissemination:	Report publicly available.
Actual data users:	European Parliament
Potential uses for data:	Relevant for development of policy to reduce discarding.
Objectives:	Multi-disciplinary study • to define the extent and nature of the problem of discards in fisheries, • to identify and analyse the key issues involved, and • to present the most significant policy options available for adoption by the European Parliament.
Method	Review of published and grey literature, interviews.

Remarks:

A comprehensive study of European discarding, research, and policy options. A comparison is made with Norwegian experience whose discarding regulations contrast with those of the EU.

2.3.2 NORWAY

2.3.2.1 Estimating the actual Norwegian landings of North Atlantic cod

March 2000 to September 2000.

Participating countries and Institutes	Norway, IMR			
Geographic coverage:	Norway			
Fleets and fisheries covered:	Norwegian vessels targeting North Atlantic cod			
Co-ordinator or contact individual:	Odd Nakken (IMR Norway)			
Site(s) where data are held:	IMR Norway			
Documentation of data:	Not available at the time.			
Restrictions on data use or dissemination:	The information has to be anonymous.			
Actual data users: e.g., ICES working groups				
Potential uses for data: e.g., stock assessment,	Arctic fisheries wg. for information on the quality of the data on landings.			
Objectives:	• To estimate the total discard from the fisheries. • To estimate illegal landings			
Method	Anonymous interviews of fishermen, people in the fishing industry and the distributive trades.			
Method of selecting interviewees.	Random			
Sampling effort (planned):	Country	Days at sea	Number of trips	Other effort ?
March-September 2000				

Remark:

The project is just starting.

2.4 Modelling studies

A small number of modelling studies was known to the Group. These were intended to improve the efficiency with which discarding data were collected and utilised and so were thought relevant to mention in this report. They are listed below.

2.4.1 Economic consequences of discarding in the Crangon Fisheries (the Ecodisc project)

To July 1999

Participating countries and Institutes	• UK (Dove marine Laboratory of University of Newcastle: University of Lincolnshire and humberside: (EMARE: CEFAS: ARBEE computer consultants), • Belgium (CLO-DzV) • Germany (Bundesforschungsanstalt fur Fisherei) • Denmark (DIFMAR).
Geographic coverage:	North Sea
Fleets and fisheries covered:	Inshore shrimp fisheries (*Crangon*) of the project nations.
Co-ordinator or contact individual:	Andy Revill
Site(s) where data are held:	University of Newcastle (Dove Marine Laboratory)
Documentation of data:	Final report: Economic consequences (etc. as title). EU (DG XIV A:3) financially assisted project no. 97/SE/025. Associated project – RESCUE
Restrictions on data use or dissemination:	
Actual data users:	ICES *Crangon* working group
Potential uses for data:	Relevant for stock assessments for round and flat fish, technical measures, fishery management (e.g., closed areas) and socio-economic studies.
Objectives:	To determine the biological and economic impacts of the discarding of juvenile round and flat fish in the *Crangon* fisheries in the North Sea sector of the EU waters.
Method	Modelling of data collected by onboard samplers from the "RESCUE" project.

2.4.2 Recommendation of a method for utilising on-board catch sampling data in stock assessments

April 1999 – March 2001
Contact: Prof. Steve Buckland, St Andrew's University, Scotland.

This is a theoretical part of the catch-sampling project for the North Sea and Skagerrak; see 2.1.1.2 above. State-space models are being considered for the purpose of stock assessment utilising sampling data collected at sea on commercial vessels. Previously, St Andrews (M. McCracken *et al.*) have undertaken modelling of discarding and retention on North Sea vessels fishing for gadoids. This was reported in EC project report 95/094, see 2.1.1.4 above. The chapter was entitled 'Comparisons of estimators of total discarded and total retained with and without modelling prior to estimation.' A paper is in preparation.

2.4.3 Modelling of retained and discarded catches by European trawlers

1998 to present.
Contact: Dr Michelle Allan, Biometrics Division, Department of Agriculture and Rural Development, Newforge Lane, Belfast BT9 5PX, Northern Ireland

This is a continuation of theoretical work begun under EC project 95/094 'On-board sampling of fish landed and discarded by commercial vessels'. See 2.1.1.4 above. Two sampling methods, equal probability and probability proportional to x (ppx), were investigated in order to recommend an optimum sampling strategy for carrying out discards surveys for data collected by Northern Ireland, England and Spain for various gear types. The equal probability estimators examined were the simple random, ratio and regression estimators against the ppx estimator. For the data sets used in this study the ppx scheme offered insufficient advantage over the simpler equal probability method to justify the greater complexity in implementing ppx. The optimum sample based estimator, for each gear type within each country where optimum is defined to be the one which offers the greatest precision, can then be used to estimate discarding on a wider scale.

Reference: Allen *et al.* (in press).

2.4.4 Estimation of fisheries discards with an example from the Celtic Sea

current.
Contact: Dr V Trenkel, Laboratoire Maerha, IFREMER, BP 21105, 44311 Nantes

This project is explores various ways of estimating discards in numbers and weights using the data collected in the Celtic Sea during EC project 95/094 'On-board sampling of fish landed and discarded by commercial vessels'. See 2.1.1.4 above. Estimation of variance components for a stratified and multi-stage sampling design was carried out and optimisation of the allocation of sampling effort for the fleets studied. It was found that by far the greatest variance component was due to between trip variability compared to between haul or within haul variability. Estimates of discarded numbers by age group for commercially important species had large confidence intervals, stressing the need for a more intensive sampling programme in order to obtain precise estimates by species and age group.

Other modelling aims to predict discards in years of no sampling. Use of data that are either available from port sampling or require less effort for collection than the usual sampling program is being explored.

3 RAISING DISCARD DATA TO ESTIMATES FOR THE FLEET

3.1 Introduction

Four ways of estimating discarding by a commercial fishery are known:

1) Sending trained observers on fishing trips. They count and measure discarded and, usually, retained fish for all catches or, sometimes, for a selection of catches taken on each trip. This is the commonest method used in ICES waters; see Section 2.
2) Asking fishers to collect, preserve and hold samples from their own catches. These are then processed by scientific staff when the vessel returns to port.
3) Simulating commercial fishing. A research vessel, or, better, a commercial fishing vessel is chartered and deployed with gear similar to that used commercially. The level of discarding can be estimated from the length distributions found in the catches by comparison with the length distributions in landed commercial catches. It is necessary to assume that fishing technique successfully simulates that of commercial vessels and that fishing was geographically and temporally representative of how the fleet fishes.
4) Modelling. Casey (1996) described a method for estimating discarding using data for total landings by the fleet, knowledge of the size selectivity of commercial fishing gear, and knowledge of the length distributions of the fish population. The latter may come from a research vessel survey using a small mesh trawl. This method may be helpful when no direct measures of discarding can be obtained. Although many assumptions are inherent in the method, no raising problems arise because modelling is applied to the total landings data.

Methods 1, 2 and 3 all require raising factors to convert sample results for individual catches, trips or vessels to estimates of discarding by the fleet over a given sampling period, e.g., a quarter of a year. One common way to form the fleet estimate is to raise the quantity of fish in a sample of a catch to an estimate of the quantity in that catch, then similarly from the individual catch to the trip, from the trip to the vessel, and finally from the vessel to the fleet. Quantities might be weights or numbers of fish.

3.2 Estimating quantities in a single catch

The following text is edited from EC project report BIOECO 93/003. It explains sources of variance when estimating quantities discarded and retained from a single catch when, as is often the case, counting or measuring of every fish caught is not possible.

Two fishing boats, even if similar outwardly, seldom process their catches in exactly the same way. Fish pounds are of various shapes and sizes; fish may be picked out by hand or with a conveyor belt; the whole catch may or may not be containerised initially; discards may be selected by eye or by measurement; they may be tossed overboard immediately or accumulated and shovelled over in one or more large lots; and the fish for landing may or may not be gutted and sorted. Discarded fish can be mixed with varying quantities of marine weed, rubbish etc. ('trash') depending on grounds and gear type, making sampling difficult. Sampling can also be constrained by the space and shelter available for working, the weather, and by time. It is important that observers conduct their work without unduly holding up the normal processing of fish for landing and marketing. A further time constraint arises because, for safety, the observer should not usually remain on deck alone when the crew have finished their work. For these reasons, samples often represent only a small proportion of the catch, leading to sampling variance.

Additional sampling variance arises because a catch of fish tends to be clumpy and poorly mixed due to sorting in the net and settling in the pound because of motion of the ship (Tamsett et al. 1999). Mixing and shuffling of samples is usually impractical on small fishing vessels. The best, least biased, sample is usually made up from subsamples taken from different positions in the catch. However, each different vessel is likely to require a fresh assessment by the observer of how best to sample the discarded and retained fractions of the catch and how to estimate the quantities of each. Two methods in use are:

i) Sampling retained and discarded fish separately for length composition. This may be obligatory because of immediate discarding overboard from a conveyor belt or by the crew. The observer must then concentrate on collecting as many discards as possible and deal with the retained fish subsequently. A separate raising factor is needed for each fraction. These are found from the quantity retained and an estimate of the total quantity caught.

ii) Sampling the whole catch before it is sorted by the crew then sorting the sample into discarded and retained portions. This gives a direct estimate of proportion discarded and so permits the quantity discarded to be estimated from the quantity retained. The same raising factor is applied to both fractions of the sample of the catch.

There are advantages and disadvantages to both methods which affect accuracy. Estimation of catch volume in method (i) can be extremely difficult since a catch seldom spreads to a uniform depth in a pound. Members of the crew can be asked to assist with a visual estimate, but their experience of estimating quantity may relate to the marketable fish rather than to the unsorted catch. On the other hand, the results from method (ii) could depend upon who sorts the sample of catch. Ideally, the crew will sort it separately from the rest of the catch, but this can be an imposition when they are very busy. If the observer sorts, the discarding rates may differ from those of the crew.

3.3 Raising catches to trips

Having estimated results for individual catches, estimates of fish discarded and retained for the whole fishing trip are needed. Catch results are simply added if all were sampled but, if not, raising is often by the ratio of the number of catches sampled to the number of catches taken on the trip.

3.4 Raising trip estimates to fleet estimates

The best method of raising trip estimates to fleet estimates is likely to depend on

a) how the trips were selected as a sample from all trips made by the fleet; and

b) what information is available for the fleet over the sampling period.

Accurate estimation depends, of course, on sampling bias, and on how much reliable information about the fleet for the given sampling period can be brought into the sampling and estimation process. However, modelling assumptions may be implicit in this process. Sampling and estimation methods, mostly known to have been used in observer programmes summarised in this report, are classified and commented upon below. The classifications allow for the fact that some observer programmes sampled trips while others sampled fishing vessels.

3.4.1 Classification of methods in use for sampling fishing trips or vessels

a) *Opportunistic sampling:* Trips are sampled opportunistically, e.g., by joining the first available vessel on a visit to a port. This method is easily implemented but prone to bias if, due to operating habits, certain vessels with specific discarding practices are more likely to be sampled than others.

b) *Co-operative sampling:* The same vessels are visited repeatedly for sampling trips because other vessels in the fleet are thought to be unco-operative. This method may be the only option when a sampling programme is starting in a fishery most of whose personnel are resistant to observation. It may be advantageous for assessing trends of discarding over time because use of the same vessels diminishes variance (but it may also cause bias with respect to the fleet).

c) *Simple random sampling without replacement (SRS):* A definition of the fleet and a list of all vessels in it is available. A sample of vessels is chosen randomly and one trip is observed on each, generally the next available. The probability of drawing each vessel is $1/N$, or as close as can be arranged in practice, where N is the number in the fleet. Listing the fleet may be a problem for this and other statistically based methods; see 3.4.2 below.

d) *Simple random sampling with replacement (SRS+):* As method c) but more than one trip will be observed for each vessel if it is drawn more than once. The order of drawing the vessels determines the order of sampling the trips so far as practically possible. Special estimation formulae must be used to allow for sampling with replacement.

e) *Probability sampling (PS):* Each vessel in the fleet is assigned a probability of sampling so that the sum over all vessels is 1. The probabilities may relate to estimated fishing power, gear, trip length or some other weighting system intended to give an efficient sampling scheme. Vessels are usually picked randomly *with* replacement so that the assigned probabilities do not change as each vessel is chosen. This means that more than one trip may be observed for each vessel. Probability sampling is a competitor for stratified sampling. It avoids the needs to define strata and to sample more than one trip in each. Estimation formulae and modelling of results are more complicated when vessels are not all assigned the same probability of sampling.

f) *Stratified sampling (StS):* Methods a) to e) above can be applied within sampling strata. For example, fishing vessels may be classified by gear or metier, and fishing trips may be classified by fishing locality or port. Most surveys are stratified in time by season or year. Stratification may be applied to improve the accuracy of the estimate of the total quantity discarded by a fleet. To be successful in this way, variation between strata should be contrived to be high and variation within strata low. Commonly however, stratification is simply used to spread sampling effort evenly over different sectors of a fleet or region because estimates by stratum are required. Stratifying factors can be crossed but large numbers of strata call for correspondingly large numbers of sampling staff and may also result in inefficiency, if allocation of at least some sampling effort to all strata diverts effort from the most variable and/or quantatively important. Definition of strata may be difficult when vessels change gear or metier, sometimes during a single trip.

3.4.2 Fleet information

The types of information about the vessels in a fishing fleet for a given period tend to vary from fishery to fishery and country to country. Typical circumstances are:

a) The number of vessels is known but gears vary because of seasonal or opportunistic changes.

b) The gears are known but the number of vessels varies because of movements to and from other fisheries, de-commissionings, new builds, breakdowns, etc..

c) The number of vessels and the gears in use are both known.

d) Information about length, power, etc. is available for each vessel.

e) The number of trips made by each vessel in each sampling period is known.

f) A good measure of fishing effort on every trip is available.

g) The locations of fishing and the retained catches are known with confidence.

Defining a fleet for the purposes of sampling can be difficult, particularly in circumstance a) or b). For example, should one include national vessels which land overseas, foreign vessels which land nationally, itinerant vessels, etc. Some fleets change rapidly over time in numbers of vessels, gears used, port, etc. Also, certain information about vessels and fleets, e.g., trips, effort, is only known at the end of the sampling period and so cannot be applied to improve sampling efficiency, only in estimation or modelling once results have been obtained. Depending on the fishery and how it is regulated, some information is inherently unreliable. For example, quantities landed and fishing locations may not be reported accurately in a fishery regulated by regional quota.

3.4.3 Methods of raising trip results to estimate discarding by the fleet

a) *Raising by landings*: Discards can be raised in relation to landings by the observed vessels (or trips) and landings by the whole fleet. This is the ratio estimator discussed by Stratoudakis *et al.* (1999). Landings for an observed trip can usually be found accurately. However, doubt about the accuracy of the total landings for the fleet leads to similar doubt about estimated total discards. Independent estimates of landings and discards by the fleet may be preferred. The method assumes that all vessels have an equal chance of being sampled. This and other ratio estimators give biased estimates with small sample sizes (Thompson 1992, Stratoudakis *et al.* 1999, and Section 6).

b) *Raising by number of vessels*: Raising the discard results from a sample of trips to an estimate for the fleet for the period is simply achieved using the numbers of boats in the sample and in the fleet. This is often sufficient for opportunistic, co-operative, SR, and vessel stratified sampling but no information about the types of vessels in the fleet or their activities is being used. The method assumes that all vessels have an equal chance of being sampled. If not, sampling probabilities have to be used in calculations.

c) *Raising by number of trips*: This uses the numbers of trips for the sample and the fleet. The number of trips by all vessels in the fleet must be available for the sampling period. Estimation can be more accurate because information about the number of trips made by each vessel is being used. This and more elaborate raising methods are probably not worthwhile for opportunistic or collaborative sampling because of the possibilities of bias inherent in the samples. Also, a danger of under-weighting the most active vessels arises when a SR sample chosen by vessel is

raised by trip since each vessel has only one chance of being sampled regardless of the number of trips it made. The method assumes that all trips have an equal probability of being sampled.

d) *Raising by trips/vessel and number of vessels*: This is proposed for SRS+. First an estimate of discarding by each sampled vessel individually for the whole sampling period is made according to the number of trips sampled and the number made by that vessel over the period. Then the results for the sampled vessels are raised to the fleet by numbers of vessels.

e) *Raising by effort measures other than trips*: Days at sea or hours of fishing are expected to relate closely to quantities discarded and may therefore be preferred for deriving raising factors. Usually, however, specific days or hours at sea cannot be selected in advance for independent observation and, for example, it is likely that catches during two hours on the same trip will be more alike than two hours each from different, independently chosen trips. If vessels or trips are the units selected for sampling but fishing effort is used to raise the results, biases may arise in the results.

f) *Raising by probability of sampling*: The PS method requires that results for each vessel be weighted in inverse proportion to the assigned probability of sampling (Thompson 1992). This may be very efficient if the probability of sampling was proportional to quantities discarded but that ideal is difficult to arrange in practice. The procedure suggested is that results be raised by trip for each vessel to a total for the sampling period, then that these estimates be inserted into the PS sampling formulae to obtain the fleet estimates. The amount of information about the fleet utilised by this method depends on how much is incorporated into the probabilities of sampling assigned to each vessel. Unfortunately, this information may be poorly known at the start of a sampling period leading to worse-than-expected estimation.

g) *Raising by strata*: Any of the raising methods a) to f) can be applied within sampling strata.

h) *Modelling*: Results from design-based sampling, i.e., sampling methods a) to f), can be raised to the fleet using a model. It is necessary to know predictors of discarding both for the vessels (or trips or hauls) sampled as well as values for the predictors for the whole fleet. A ratio estimator is considered to be an example of this because it assumes proportionality between discarding and the covariate, e.g., landings. Use of more elaborate models for raising is not known at present.

4 RAISING AND SAMPLING METHODS CURRENTLY IN USE FOR DISCARDS

This chapter discusses and comments on raising and sampling methods being used in a selection of discard projects from the list in chapter 2. It illustrates some of the many problems which have been encountered and the diverse solutions found for them. The Study Group did not critically discuss the different approaches described.

4.1 International Baltic Sea Sampling Project (Section 2.1.1.1)

The first attempt to estimate the total discard in the Baltic Sea was made during the SGDIB meeting in Riga in February 2000. Due to time constraints only 1998 was considered although discard data were available from mid 1995 to mid 1999.

Considering the sampling unit in discard sampling is the fishing trip, the natural choice from a statistical point of view would be to raise the sampling result to the total using trips. Unfortunately, this was not possible because no effort statistics were available for most countries. Only landing statistics were generally accessible and therefore the study group saw no other possibility to obtain the estimate than using the national landing statistics post-stratified on fleet for raising the discard sampling data.

Fleets were defined for each country which were believed to be homogeneous concerning discard pattern and which covered all fisheries where discarding was known to occur. The fleet definitions were based on gear, mesh size and target species. No formal analysis defining the fleets was made due to data and time constraints. Sampling data and landing statistics were stratified on country, ICES Sub-division, quarter, and fleet. For each stratum a specific raising factor was defined as:

$$\frac{\text{Total landing (sum of all species)}}{\text{Retained part of catch (sum of all species) in samples}}$$

The raising factors were applied on each species discarded. The total discarded (in tonnes) was then obtained by summing up the discarded amount for all species. For a detailed description of the raising procedure used, please consult the Study Group Report.

For Danish data, effort statistics were available and in order to get an impression of the possible bias that would arise from using landing statistics instead of effort statistics (number of trips), the Danish data set was in addition raised using trips by stratum (same stratification as used in previous analysis) as raising factor. The results were rather close to each other (5557 tons using trips and 5842 tons using landing as raising factor).

Conclusively it can be said that in order to obtain more precise estimates of discarding it is recommended that:

- Fleets should be defined based on adequate analyses and not just based on subjective criteria.
- The raising factor should be number of trips and therefore effort statistics should be collected and recorded in each country and reported to the Assessment WG.

4.2 Monitoring discarding and retention on fishing vessels towing demersal gears in the North Sea and Skagerrak. (Section 2.1.1.2)

This note refers only to the English component of this project. Sub-samples from both retained and discarded fish in each catch are measured and raised to the catch level using the ratio of volume caught/volume sampled. Sampled data can be raised to quarter by calculating a discard rate per hour for each trip and multiplying this by the reported fishing effort by that vessel during the whole quarter. This will give an estimate of the total number discarded (retained or caught) by the vessel which can then be added to all sampled vessels' estimates for the quarter. These can then be used to give an average per hour for the sampled vessels which can be raised using the officially declared fishing effort (hours) for the whole population/fleet of vessels, to give a total number discarded.

Sampling strata are not currently used except for season. Experience with stratification by gear showed that minimal sampling quota were extremely difficult to achieve in every stratum with low numbers of observers, poor weather, unreliable scheduling of fishing trips, etc. As a result, total discarding sometimes could not be estimated statistically and sampling efficiency was generally low. However, post sampling stratification has been carried out at the request of the North Sea demersal working group to give numbers retained and discarded by different gear types and quarter. This was

achieved in most cases although where sampling effort was low for some gear types, estimates had to be given at half yearly or yearly intervals only.

4.3 Monitoring of discarding and retention by trawl fisheries in western waters and the Irish Sea in relation to stock assessment and technical measures (Section 2.1.1.3)

AZTI (Spain) uses stratified random sampling by quarter, gear and sea area. At the present no raising method has been chosen, however an exploratory analysis of the variances of the estimates will be carried out on raising by weight/numbers of the total fleet landings and by the effort (number of hours) deployed by the fleet.

In general, discard and retained data collected by species, on a haul basis, will be raised to the total catch during the complete trip and from there, by using the total fleet landings of the same combination of gear and sea area, a total estimation of the discards and retained fish will be obtained. It is expected to compare the results of this method of raising to those resulting from raising by trip/vessel and number of vessels and also raising by trips of that fleet.

4.4 On-board sampling of discarding and retention by commercial vessels (Sections 2.1.1.4 and 2.4.4)

4.4.1 France

(Short summary of working paper « Estimation of fisheries discards with an example from the Celtic Sea » by Verena Trenkel, Isabelle Peronnet and Marie-Jöelle Rochet, Ifremer, France.)

Sampling was carried out in 1997 and followed a stratified sampling design by métier and quarter. For each stratum, random sampling in three stages was carried out: fishing trip, hauls within fishing trip and measurement of a certain fraction of the discards per haul. The actual sampling was carried out by the fishers, with the exception of the *nephrops* trawlers, for which an observer went onboard for some trips. All species were counted and length was measured.

The raising procedure followed the sampling design assuming that simple random sampling occurred at each level. Samples were first raised to the haul and then to the trip level. Final estimates by métier were obtained using the total number of trips carried out by the members of each métier. The variance due to each sampling level was calculated. Estimation was carried out both for numbers discarded and for weights. It was found that coefficients of variation were rather high for some species and varied dramatically between species. The largest variance component was due to the difference between sampling trips. Variance components for within-sample as well as between-haul variations were negligible compared to the between trip variation.

4.4.2 Spain (IEO)

Compared three different ways of raising discard data to fleet level. Data were obtained for WRPH (weight retained per hour), WDPH (weight discarded per hour), NRPH (number retained per hour) data and NDPH (number discarded per hour) by gear and harbour. Firstly, they were raised to the total effort of each fleet and gear. Secondly, the total catch (landings and discards) of the Spanish fleet was obtained from the estimated retained and discard weight and number of all sampled trips, raised to the total weight and number of landings of the fleet per harbour and gear.

The kilograms per hour method raised to fleet effort to estimate retained catch show similar results in some species. Nevertheless for some of the species there are big differences for retained estimate compared to the values obtained from markets regarding weight as well as number. These differences could be due to bad location of fleet effort per gear or harbour. Fishing hours do not make a good estimate of the effort per species of more pelagic or migrating behaviours. Other causes could be found in misreporting landings in some species, specially in small fish. Nevertheless the fact that the biggest differences appear in species such as Mackerel, which is a species of little economic value and no big problems of minimum legal size, puts this hypothesis under question.

Discard results show small differences in the estimate due to the use of different methods for some species (Four spot megrim, Hake and Blue whiting). Nevertheless species as Megrim, Black Anglerfish, Mackerel, Horse Mackerel and Nephrops show broad differences.

4.5 Plaice and sole discards in the Plaice Box (Section 2.1.7.1)

An example of the application of the ”ratio estimate” as raising method is given in a Working Document by W.Weber: Plaice and sole discards in the Plaice Box. Using German on-board sampling data from the years 1993–1998 two

approaches were made to estimate the amount of plaice and sole discards per year in the Plaice Box: The discard figures were raised from the employed effort and from the catches of the target species to the total, separately for the fishery on plaice (MO=100mm) and on sole (MO=80mm). Whereas both raising methods led to similar results in plaice discards per year, there were found considerable differences in sole. An explanation could be a pronounced patchiness of young soles, which would call for a higher sampling intensity.

4.6 Scottish discard sampling projects (Section 2.1.11)

Discard data for the principle commercial species obtained during the Scottish demersal and *Nephrops* sampling schemes are raised to stratum level using the ratio between the total species landings in that stratum and the species landings on the sampled trips. Full details of the procedure used are given in Armstrong and Hall (1987). For the non-commercial species sampled during the demersal sampling, estimates of total discards are obtained using total demersal landings within the stratum as the auxiliary information. Sampling of the pelagic and deepwater fisheries has been on a smaller scale, and no attempt has been made to raise these to fleet level.

Stratoudakis *et al.*. (1999) considered the estimation of total quantities of discards by the Scottish demersal fleet, and compared a number of different estimators with that currently in use. As the existing scheme includes a large number of strata, the sample size is invariably small, with seldom more than one sample per stratum and many strata left unsampled. In this situation Stratoudakis *et al.*. (1999) show that the stratum ratio estimator used at present shows considerable positive bias and high variance. They demonstrate that using total demersal landings or total gadoid landings in place of species landings produces more precise, and less biassed estimates for haddock and whiting. However, more satisfactory estimates are obtained for all species by partially collapsing the strata and using total gadoid landings as auxiliary information.

5 SUBMISSION OF DATA TO FISH STOCK ASSESSMENT WORKING GROUPS

Although a considerable number of discard studies are carried out already, only relatively few of the results from those studies are incorporated in the relevant stock assessments done in various working groups. The reasons for this are numerous, but one impediment is the lack of well-established formats for submission of discard data, which facilitate an easy integration into the assessment procedure.

The Study Group suggests that the data should be submitted in a form that fulfils the criteria for input data normally established for the landed part used by the fish stock assessment models i.e., with discards tabulated as numbers by age group. In addition, the mean weight at age etc. should be given.

In order to get discard data and landings data to be corresponding, it is important to be aware of the spatial, temporal and organisational structure of the landing statistics provided to a given working group. Ideally, the data for the discards should be sampled according to this structure. However, it should be pointed out that this may lead to an inefficient discard sampling scheme, especially if the number of sampling strata is too high for the number of observers available for sampling at sea. Alternatively, it may be possible to post-stratify accumulated discard data to correspond with the structure of the landings data. Users of such data need to be aware that sampling CVs may not be uniform across all strata.

As an example of a form that would facilitate the incorporation of discard data in a standard assessment, the SG has modified the form now used by several assessments working groups, but originally designed by the HAWG.

WG for the Assessment of

Discard Data

Country:	
Species:	
Year:	
Revised (date):	

	1st Quarter	2st Quarter	3st Quarter	4st Quarter	All quarters
DIVISION(S)	DISCARDS (tonnes)	DISCARDS (tonnes)	DISCARDS (tonnes)	DISCARDS (tonnes)	Total Discard (tonnes)
Total					

LENGTH DISTRIBUTIONS OF DISCARD BY AREA, FLEET AND QUARTER

WG for the Assessment of

Country:		Area:	
Species:		Fleet:	
Year:		Unit:	
		Revised (date):	

Length (half cm)	Length (cm)	Quarter1	Quarter 2	Quarter 3	Quarter 4	All year
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
.						
.						
.						
	TOTAL numbers					

	Tonnes					

DISCARD NUMBERS, LENGTH AND WEIGHT AT AGE

WG for the Assessment of

Country:		Division:	
Species:		Fleet:	
Year:		Revised (date):	

	Quarter 1			Quarter 2			Quarter 3			Quarter 4			All year		
Winter-Rings	Numbers at age (‘000)	Mean Length (cm)	Mean Weight (kg)	Numbers at age (‘000)	Mean Length (cm)	Mean Weight (kg)	Numbers at age (‘000)	Mean Length (cm)	Mean Weight (kg)	Numbers at age (‘000)	Mean Length (cm)	Mean Weight (kg)	Numbers at age (‘000)	Mean Length (cm)	Mean Weight (g)
0															
1															
2															
3															
4															
5															
6															
7															
8+															
Total/Mean -->															
Catch		(t)			(t)			(t)			(t)			(t)	
SoP		(t)			(t)			(t)			(t)			(t)	
SoP	100%	(%)		100%	(%)		100%	(%)		100%	(%)		100%	(%)	
No. aged		(n)			(n)		0	(n)			(n)			(n)	

6 DISCUSSION POINTS

Sampling methods should be considered when discussing the raising of discarding data to fleet level because a method of raising which is incompatible with the method of sampling could cause bias and perhaps imprecision. For example, if vessels are sampled randomly with equal probability from a fleet listing while results for each vessel are raised to the fleet level in relation to the numbers of trips each made over the sampling period, a sampling bias towards vessels making the fewest trips will arise. However, the terms of reference for this Study Group did not ask for an assessment of discard sampling methods *per se*.

In practice, a wide variety of sampling and raising methods are in use in ICES areas as the inventory in chapter 2 shows. The variety is caused by wide differences in fleet structure, fishing vessels, and gears, often changing with season or locality. Additionally, scientists regionally have tended to develop their own ideas about sampling and raising methods. Although most of these methods are easy targets for criticism on theoretical grounds, there are still no generally accepted "correct" methods which can be put forward to replace them in all cases. It is important to remember the major logistical difficulties facing most discard sampling projects (see Sections 3.2 and 3.4.2), and the generally low levels of sampling effort which have been applied in most European projects.

The Scottish demersal fishery discard sampling scheme (project 2.1.11.2) is notable in Europe for its longevity, for regularly providing data which are used in stock assessments, and for having been the subject of a published statistical analysis. This is given in Stratoudakis *et al.*. (1999), with a brief summary in Section 4.6 of this report. In the absence of formal statistical analysis of other discard sampling schemes and approaches, it is difficult to make any specific conclusions about “the best method” to use to raise data from other schemes to fleet level. However by drawing on the information assembled in this Report, and on the findings of Stratoudakis *et al.*. (1999) it is possible to make a few generalisations.

In the case where vessels can be sampled at random from a defined population, classical sampling theory (e.g., Thompson, 1992) makes both raising of the data and variance estimation relatively straightforward. This remains true for slightly more complex schemes with limited stratification such as the example given by Trenkel *et al.*. (section 4.4.1). However most of the schemes summarised in Section 2 are characterised by relatively low numbers of trips distributed across a variety of strata, with the strata often reflecting operational as much as statistical considerations. A consequence of this is that the number of samples in each stratum is likely to be small.

While Trenkel *et al.*. (WP1) use a sample mean estimator which is known to be unbiassed (Thompson, 1992; Stratoudakis *et al.*, 1999) any of the discard sampling schemes summarised in Section 2 raise estimates to stratum level using some form of auxiliary information such as total species landings or some measure of fishing effort together with a ratio estimator. This is similar to the approach used in the Scottish demersal sampling scheme which uses a ratio estimator based on species landings within the strata. In theory, precision is improved because the auxiliary information is additional to the sample values in the estimation process. However, Thompson (1992) notes that in circumstances where the number of samples in each stratum is small, a ratio estimator is likely to lead to biassed estimates. In their analysis, Stratoudakis *et al.* (1999) concluded that this is the case for the Scottish scheme. In view of the broad similarity between the Scottish scheme and many of the others summarised here, at least in terms of the low number of samples per stratum, it seems likely that a ratio estimator may also result in biassed estimates if used in other schemes. A particular problem arises if different strata receive different sampling efforts, leading to different biases in each.

Stratoudakis *et al.* (1999) found that the ratio estimate based on landings of individual species resulted in estimates with considerable positive bias. Use of *total* gadoid landings or *total* demersal landings reduced this bias for estimates of haddock and whiting discards, so an approach based on a more aggregated estimate of stratum landings in this way may merit exploration for other schemes. In the case of the Scottish scheme, estimates made after partial collapse of the stratification proved to have more satisfactory statistical characteristics overall. This supports the general conclusion that sampling schemes with a relatively low number of strata, and reasonable numbers of samples from each stratum are desirable.

Like Scotland, Canada also has a long-running discard assessment project, having started in 1980. A major contrast with the European situation is that observers are afforded a legal right to work on board fishing vessels leading to almost 100% coverage of fishing trips for all but the smallest vessels. The scheme is made possible by being financed by the fishing industry. Obviously, statistical sampling and raising problems become much less of an issue in this circumstance. Observers are also responsible for monitoring compliance with fishery regulations, a situation which might be viewed as compromising the accuracy of their estimates of discarded and retained catches. This is not thought to be a serious problem because studies of fish length distributions in landings in port found these to be generally comparable with those obtained for the retained catch by the observer at sea. Observer data are being utilised routinely in Canada for stock assessments and have become an integral part of the input for the management of many stocks.

Observers permit the effectiveness of discard reduction measures to be assessed whilst in commercial use. For example, the Nordmore sorting grate developed originally for Norwegian shrimp fisheries was made mandatory in Canadian shrimp fisheries in 1995. Fishery observers were used to find the width of bar spacing which gave the largest reduction of by-catch adult redfish. The large archive of observer data now built up in Canada permits detailed temporal and spatial analysis of discarding patterns, allowing problem situations to be identified and cured if possible. (Information summarised from working paper 3; see references cited in 2.1.3.1).

Returning to the European situation where only a small fraction of all fishing trips is sampled, the Study Group felt that the issue of variance estimation was almost as important as the method of point estimation of discards for two reasons. Firstly, it provides an estimate of the precision of discard estimates which may in some situations be very poor. Secondly, it allows the main sources of variation to be identified. These might be usable to improve the sampling scheme if desired. An example is provided by the French finding (section 4.4, and not unknown elsewhere) that variance between trips was much higher than variance between-samples-within-a-catch or between-catches. This implies that sampling effort should be directed to sampling as many trips as possible. Two ways of achieving this without increasing the numbers of scientific staff for a sampling programme are (a) to use probability sampling or stratification to increase the number of short fishing trips observed at the expense of long fishing trips (as has been tried in England), and (b) to foster sampling by fishing crews in the absence of an observer, i.e., method 2, Section 3.1, as used in projects 2.1.1.4, 2.1.6.1, 2.1.6.2, 2.1.10.1, and 2.1.13.1and as suggested by Tamsett et al. (1999). The variance of discard estimates for international fisheries can also be reduced by collaboration between countries because the number of independently sampled trips is greater than can be achieved by countries individually. Problems of sampling fishing or landing in other countries can also be tackled. This approach is being used in the Baltic (2.1.1.1) and the North Sea and Skagerrak (2.1.1.2).

Variance estimation is closely linked to the methods of estimation and raising. For sample-based estimators, standard textbooks provide the appropriate variance formulae. The general assumption is that sampling has been random in some way. For non-random sampling schemes or estimators using auxiliary information, the variance of each estimator has to be developed. Model-based approaches may be helpful in this regard. These require that a model be accepted, e.g., discarding as a function of vessel length, fishing locality, and season. Then vessels and/or trips are selected for observation so as to be spread over the full range of each predictor. This can give better sampling efficiency than randomised sampling schemes and permits an estimate of variance, albeit model-dependent, in the absence of randomisation. Modelling of fishing vessel catches is mainly in an exploratory phase in Europe at present (Section 2.4) and the Group was not aware of any current studies using a model-based sampling approach.

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