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Report of the Study Group on Practical Implementation of Discard Sampling Plans (SGPIDS)

24 June – 28 June 2013

Lysekil, Sweden

ICES International Council for the Exploration of the Sea

CIEM Conseil International pour l'Exploration de la Mer

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Contents

Executive summary

SGPIDS 3 met 24 June – 28 June 2013 in Lysekil, Sweden attended by 19 participants from 12 different nations, and chaired by Alastair Pout (UK Scotland) and Marie Storr-Paulsen (Denmark). The study group focused on practical aspects of implementing sampling plans with participants providing case studies, worked examples, and progress reports that covered three main themes: sampling frames based on vessel lists; random vessel selection procedures; on-board sampling and estimation. The chair of WKBYC (Bram Couperus) attended and continued the liaison with this group.

Setting up sampling frames based on vessels lists was explored through six different national case studies. The EU fleet register can provide the basis for a national vessel list but the SG stressed the need for additional information from logbooks, sales notes and other sources to further inform the stratification. Stratification criteria considered included: vessel size; the use of passive or active gears; and geographical location of fishing or observer locations. These gross distinctions within national fleets enabled national programmes to define a small number of sampling strata into which national vessel lists could be divided. Various metrics and their respective merits were briefly considered for optimizing effort allocation between strata. However the SG continued to emphasize the difficulty of reconciling the small sample size of most national programmes with requirements from a variety of different end users for samples to be collected for particular domains. The extent to which these issues can be resolved through post stratification and domain estimation remain to be explored.

Quality indicators (QI) based on the numbers of vessels in the national fleets, and the number of trips they conduct, in relation to the planned and realized number of trips sampled were generated in a number of case studies. The SG felt a useful distinction should be made between the number of planned samples by stratum (input QIs), which would be appropriate to the assessment of a sampling plan, and the number of achieved samples in relation to the fleet totals (output QIs) which would be more relevant to stock assessment groups.

The implementation of random vessel selection procedures were reviewed for six national observer programmes with four programmes being able to calculate non-response rates (and industry refusals) from 2011-2 data. Direct comparison between non-response rates of different programmes is not yet possible due to differences between national programmes in the time window over which individual vessel selection attempts operate, and the relative effort expended trying to secure a trip on a fishing vessel. The SG recommends that a vessel's "next trip" be used as the criteria to define the selection attempt and that the effort to secure a trip is the same for all attempted contacts. Currently there is no proper way of dealing with vessels in the list for which there is no appropriate trip available at the time of the selection event

The SG recommends that national programmes should summarize their vessel contact attempts using (at least) the 6 contact categories (Not available, No contact details, Observer decline, No answer, Industry decline, Successful sample) to ensure standardization and comparability. In the absence of comparable non-response and refusal rate, these would be appropriate to include in the QI table. The QI table should not be considered out of context of the scheme to which it relates.

The SG emphasized the considerable advantages of operating a random selection system both in improving the statistical robustness of the data, and in fostering dialogue and securing cooperation with industry.

Various case studies presented comparisons between realized sample data and the wider population of vessels being sampled (e.g. of the spatial-temporal distribution, gear types, landing categories, and catch composition). Particularly where non-response rates and refusal rates are high it is suggested that national programmes use such comparisons to examine potential bias in the sample data.

The calculation of on-board sample weights was explored for seven national case studies. Sample weights for numbers at length could be calculated in all cases though for numbers-at-age this was possible for only one case using existing collection protocols. Aggregated ALK are used at various levels and the use of sample weights for age samples would represent a considerable departure in estimation methodology, if not sampling protocol, for most national programmes. Linking an age sample to the haul or set is required if sample weights for age are to be calculated. Weight estimates were obtained in a variety of ways, through on-board measures of individual fish or groups of fish, or derived from length weight relationships. Uncertainties in discard estimates were greatest where catches were large and diverse, and protocols that involve quantifying, rather than estimating the total discard can be recommended to improve estimates. The practical difficulties of achieving probability based selection of a discard sample on-board were recognized.

The data exchange format of RDB-FishFrame would require a number of additional new fields and modification to the estimation procedure to enable at-sea sample weights to be calculated correctly.

The SG welcomed the identification of particular "hotspot" fisheries and fishing areas for the bycatch of protected and endangered species (PETS) presented by the chair of WKBYC. The SG endorsed the view that their monitoring was entirely appropriate to at-sea sampling programmes and recommends that observer's recording forms and national databases include the appropriate fields and species codes to facilitate the monitoring of PETS bycatch.

1 Introduction, Terms of Reference and Adoption of the Agenda

1.1 Introduction

SGPIDS was originally proposed by PGCCDBS (ICES 2010a) in response to a request from the Regional Coordination Meeting for the North Sea and Eastern Arctic (RCM NSandEA; 2010). The aim was to foster the exchange of experience and expertise between experts on all aspects of discard sampling. With the revision of the DCR and the recommendations of various ICES expert groups, the remit of the third and final meeting of the study group has focused on implementation of design based sampling, building on progress from SGPIDS 2 in 2012 and the advice of the WKPICS sampling methodology working groups.

1.2 Supporting Information

Priority	
Scientific justification	The coordination and planning of discards sampling is part of the tasks of PGCCDBS and more regionally of the Regional Coordination Meetings (RCMs). However, these groups lack expertise, scope and time to deal with the practical aspects of discard sampling. This meeting can build upon the outcome of WKDRP, WKEID, WKACCU, WKPRECISE, WKMERGE and WKPICS with regard to the tools and methodology used to analyse discard data and its sampling bias.
Resource requirements	Particpants should bring descriptions of samping protocols to the meeting. Resources, i.e. case studies, working documents and/or published work, are required to study on board sampling techniques to define appropiate quality indicators (ToR c). Reports of results of sampling designs (and discard estimates) (ToR d).
Participants	The Group is normally attended by some 10–20 members and guests.
Secretariat facilities	Meeting facilities, including sharepoint and secretarial support.
Financial	No financial implications.
Linkages to advisory committees	ACOM
Linkages to other committees or groups	WKPICS, RCMs, WGBYC, PGCCDBS.
Linkages to other organizations	EC (DCF reform 2012-2013).

1.3 Terms of Reference

a) Review and refine the use of sampling frames and vessel selection procedures for at-sea sampling programmes;

b) Evaluate, and where necessary develop, the quality indicators for discard sampling programmes, as defined at SGPIDS 2 2012, and WKPICS 2 2012.

c) Assess on-board data collection protocols in respect of estimation procedures appropriate to design based at-sea sampling schemes (as set out in WKPICS 2) and RDB data formats.

d) Review the reporting of discard estimates and quality indicators of national sampling designs for end-users and as metadata to regional databases;

e) Continue to collaborate with ICES WGBYC on integrating the reporting of protected, endangered and/or threatened species.

1.4 Adoption of the Agenda

The terms of reference were addressed using three work themes, each of which was the focus for the work of a subgroup, and through plenary presentations and discussion. In accordance to the "practical implementation" aspect of this study group case studies and worked examples were used to explore the issues in each of these work themes. The report structure follows these work themes with reference to the terms of reference covered by each. Due to time constraints, the wide-ranging nature of ToRs (a) to (c), and the number of participants, terms of reference (d) was only briefly addressed during one of the plenary sessions (see Annex 2 for agenda). ToR (e) was addressed by the chair of WKBYC. The adopted agenda of the Study Group on Practical Implementation of Discard Sampling plans is presented in Annex 2 of this report.

2 From Populations to Sampling Frames (ToR A and ToR B)

2.1 Design based sampling envisaged under DC MAP

The whole premise of survey sampling is to select, with known probability, individuals from a population. Samples collected in this way can then be used to make inferences about the total population. For the at-sea fisheries sampling schemes envisaged under the DCMAP the populations concerned are the vessels conducting commercial fishing and the fishing trips they make over a given period of time. Having a clear understanding of the size and activities of these populations is a prerequisite to devising a sampling design, being able to set up sampling strata, being able to specify a sampling frame and being able to produce unbiased estimates about the population.

Several ICES expert-groups WKPRECISE (ICES 2009), WKMERGE (ICES2010b), WKPICS 1 (ICES 2011a) have recommended that in order to achieve statistically robust estimates of commercial catches at-sea sampling programmes should endevour to move towards the adoption of stable sampling strata using sampling frames based on vessel lists. It is important to emphasis however, that the provision of catch estimates that are specific to ICES areas, periods, and métier, are not precluded by this process. Rather estimates for "domains of interest" such as these can be provided through domain estimation (see WKPICS 2, ICES 2012b).

2.2 Challenges with the present at-sea sampling schemes under DCF

Under the Data Collection Framework (DCF) (CR No. 199/2008, CD 2010/93/EU) national on-board observer programmes were designed to estimate the catch of commercial marine fisheries, in particular those individuals discarded at-sea. These estimates are included in many fish stock assessments so that the contribution of discards to the fishing mortality of a large number of species is taken into account in management measures. Commission Decision 2010/93/EU (of 18 December 2009) set specific directions for the stratification of national discard sampling programmes. The overarching goal was that "*Sampling must be performed in order to evaluate the quarterly length distribution of species in the catches, and the quarterly volume of discards. Data shall be collected by métier referred to as level 6 (…) and for the stocks listed (...)*". The métier definition at level 6 included: Activity, gear class, gear group, gear type, target assemblage and mesh size, as well as a number of prescribed vessel length classes. The stock list included the main stocks exploited in European waters as well as some stocks of sensitive species caught as bycatch (e.g. deep-water species). The DCF further stated that "*in order to optimize the sampling programmes, the métiers (...) may be merged*" as long as the merging is supported by "*statistical evidence*". The métiers required to be sampled were defined by the DCF based on a ranking system involving the total landings, total value of individual métiers, and, if available, the proportion of discards registered in the métier. The DCF further stated that "*the sampling unit shall be the fishing trip"* and that *"sampling intensity shall be proportionate to the relative effort and/or the variability of catches of the métier"* and that *"the number of fishing trips to be sampled shall ensure good coverage of the métier"* setting a target level or precision – for the discard estimates, it was *"the level making it possible to estimate a parameter either with a precision of plus or minus 40 % for a 95 % confidence level or a coefficient of variation (CV) of 20 % used as an approximation*".

These DCF requirements for at-sea sampling generally imposed a fairly large number of strata within each country with available estimates indicating that to reach the precision target a large number of samples should be collected within each stratum. Most countries are not able to afford the amount of sampling implied by the extremely detailed stratification scheme imposed by the DCF. Furthermore, experience built at national institutes and exchanged on several ICES fora during the DCF implementation (e.g. ICES 2011 a,b) revealed that the métier approach to stratification posed a number of practical difficulties that were incompatible with statistically sound sampling (ICES 2010, ICES 2011a, 2012a and ICES 2011b, 2012b reports). Among the latter feature a) the impossibility of accurately determining the total number of métiers prior to the fishing season (e.g. new target species or fishing areas may come up), b) difficulties in the allocation of sampling effort to DCF strata since the total number of trips and vessels in each métier is not known prior to the sampling season, c) difficulties in the classification of vessels and trips that perform several fishing operations with different gears and so belong to several métiers, d) uncertainties in the determination of total effort per métier caused by differences in the source of data (logbooks, auction sales), e) the mistaken perception that sampling strata had to match domain definitions and f) the ubiquitous adoption of target driven quota sampling that ignored the principles of probability based sampling. Under such circumstances, it was found impossible to carry out rigorous sampling design using a probability-based approach that warrants unbiased discard estimates.

2.3 Sampling frame case studies

This sections sets out to explore the construction of new sampling frames for discard sampling programmes that are based on national vessel registers, and potentially additional information such as sale slips or fishing activity. Of concern were the following topics:

- How to identify the "populations" and "study populations" for which we need to produce estimates , using lists of vessels and trips obtained from a national vessel register, or census logbook and sales slip information.
- Test different types of stratification of national vessel lists into sampling frames and compare them with DCF based sampling frames.
- Test the allocation of sampling effort both between strata (to achieve domain coverage, cost-effective sampling, for logistical reasons and to maximize precision) and within the stratum (to achieve a sampling plan that will provide representative sampling opportunities over time).
- Evaluate the recording of quality indicators for this stage of the sampling design
- First trial at a template for a regional sampling programme.

The case studies demonstrate the approaches and results of sampling frame design, effort allocation between strata, and the ability to generate quality indicators. Case studies are presented for Denmark, Portugal, Germany, Sweden, Norway and France. In the case of Norway the approach taken is to describe the sampling scheme carried out; Norway is not under DCF and has historical experience in discard sampling and discard estimation under a discard ban. In the case of France the approach taken is to look at the feasibility of constructing sampling frames of vessels based on the existing métier based stratification of trips, rather than starting from a register of vessels and attempting to find new strata. Each case study features a) details on current sampling under DCF, b) details on the approach taken to split the vessel register into new stra-

ta, c) details on putative effort allocation between/within strata and d) an analysis of quality indicators. In the end a joint discussion is made along with recommendations that follow from experience gained.

2.3.1 Case-study 1: Denmark

2.3.1.1 Current sampling under DCF

Since 2011 the observer trips have been selected from separate lists defined by merged métiers and area. Each vessel can be in several lists, and a sampling effort is allocated to each list. For the observers to pick a vessel from a list, a "lucky wheel" has been set up, where the observer presses a button and gets a vessel randomly selected to contact. The probability of picking a vessel within a list is weighed by the number of trips the vessel conducted in the combination of merged métier and area the previous year. Gillnetters are not sampled by on-board observers, but by self-sampling. Within Denmark the observers are located in two different places, Charlottenlund and Hirtshals, and the sampling effort is divided between these two locations.

To follow the recommendations from ICES expert groups like SGPIDS and WKPICS for a statistically sound sampling scheme, Denmark would like to set up vessel lists, where a vessel would only belong to one list, and using a more simple stratification. In the case study below the possibility that vessels can be split into a group of vessels using active gears and a group of vessels using passive gears is explored. The gillnetters are in general smaller vessels where it is difficult to have room for observers, and making them a separate list will make it possible to continue the self-sampling program for these vessels. For the part of the fleet using active gears the on-board observer program would continue.

2.3.1.2 Approach taken to split the vessel register into new strata

The following data are available for the Danish at sea sampling design:

a) FLEET_REGISTER - Denmark has a national vessel register including information like vessel id, vessel length, gross tonnage, overall length, home harbour and each vessel is registered with a vessel type. The information from the vessel register is considered to be stable and predictable. The list is updated continuously and DTU Aqua has an online access to the database.

b) LOGBOOKS - The logbook register provide information about fishery conducted in the past. The dataset includes, among other variables, catch (weight) per fishing trip and fishing date, vessel, gear, and species. These data are compiled and stored by the national fisheries directorate and DTU Aqua has an online access to the database.

c) SALES - Dataset that includes, among other variables, landings (weight and value) per landing date, port, vessel, first buyer and species. The national fisheries directorate is collecting the data and and DTU Aqua has an online access to the database.

Data from the observer program that has been conducted for several years can be used to get information on which parts of the fleet have higher discard than other and thus might need a higher sampling effort.

In the Danish vessel register, each vessel is registered as a vessel type. In this case study we tried to use these vessel types to specify the Active and Passive gear

groups. The figure below (Figure 2.3.1) shows the number of vessels by type. It shows that there are a large number of vessels registered as gillnetters, which can be grouped directly into the Passive gear group. Some of the remaing are polyvalent vessels, which can not immediately be placed into one of the Active/Passive gear groups. An example is the Danish seine/Gillnetter. Additionally, some vessel types can be clearly defined as groups that are not a part of the sampling scheme, like barges or mussel dredgers.

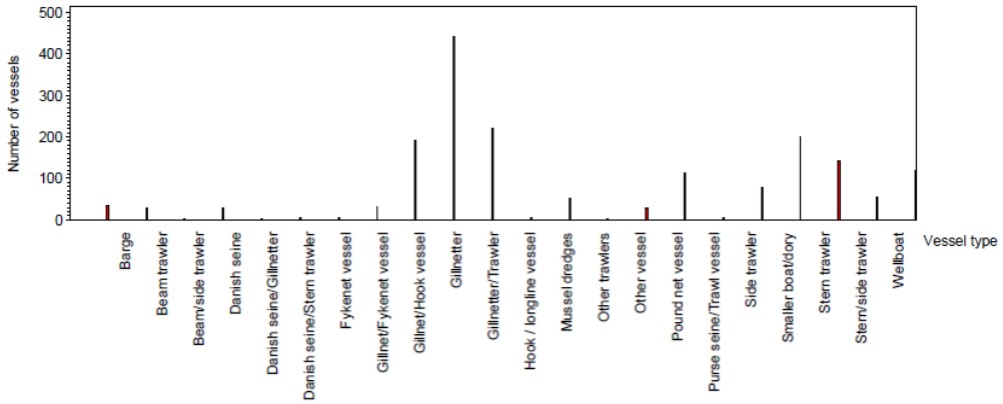


Figure 2.3.1: Number of active vessels (2012) from the Danish vessel register by vessel type.

To support the decision on which gear group a vessel type belongs to, and investigate to what extent this information can be trusted, the gear information from the logbooks was compared to the vessel type. The figure below shows the distribution of trips by active/passive gears. The gear information only exists for vessels that are obliged to fill in logbooks, so there is also an "unknown" gear group in the figure below. The figure shows that some vessel types are clearly using passive or active gears, other groups are more polyvalent, and therefore these vessels have to be included in the vessel group were they have been spending the main part of the effort.

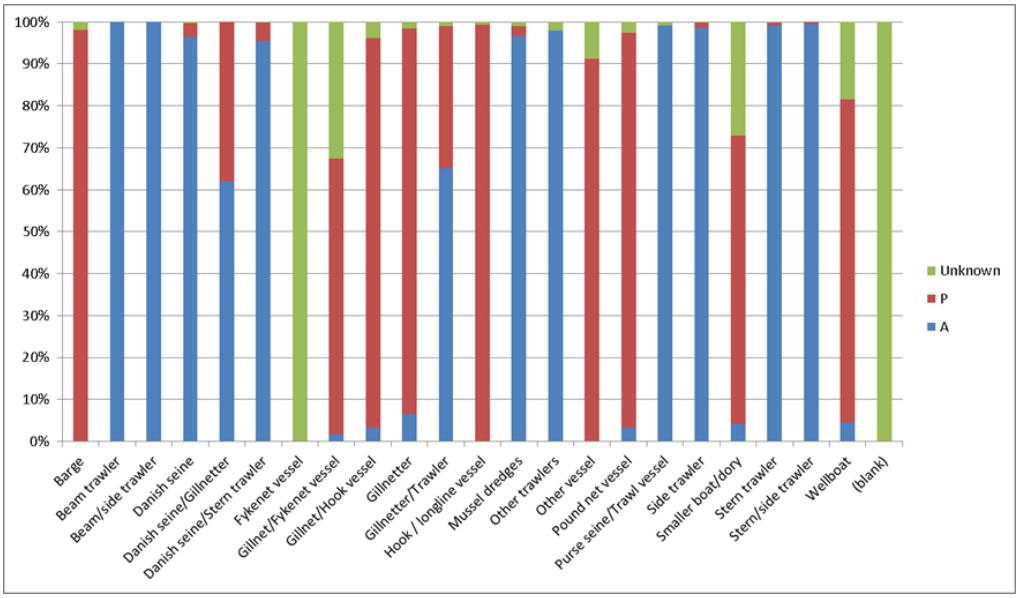


Figure 2.3.2: The distribution of trips active(A)/passive(P) gears used (2012) by vessel types from the Danish vessel register. Unknown is the trips without logbooks.

Using the information from the figure above, the grouping into active and passive types can be verified in Table 2.3.1, some vessels are very small vessels which are not a part of the sampling program, and can be excluded from the sampling frames of at-sea observer programmes.

Table 2.3.1 shows the vessel types, the number of vessels registered as each type, the minimum, maximum and mean vessel lengths found in the type, and the grouping in Active/Passive from the vessel type name, and using the gear information.

Vessel type	Number of vessels	Min Loa (m)	Max Loa (m)	Mean Loa (m)	Active/Passive (vessel type)	Active/Passive gear (gear information)
Barge	34	4	6	4.7	Very small vessels	-
Beam trawler	29	15	42	19.8	A	A
Beam/side trawler	1	16	16	16.0	A	A
Danish seine	27	12	26	17.4	A	A
Danish seine/Gillnetter	3	11	14	12.3	A	A
Danish seine/Stern trawler	7	11	30	21.9	A	A
Fykenet vessel	6	4	7	5.0	Very small vessels	-
Gillnet/Fykenet vessel	31	4	12	6.4	P/Very small vessels	P
Gillnet/Hook vessel	191	4	16	8.1	P	P
Gillnetter	444	3	27	7.9	P	P
Gillnetter/Trawler	221	4	23	9.5	?	A
Hook / longline vessel	4	6	9	7.8	Very small vessels	-
Mussel dredges	52	8	40	13.0	Dredge	-
Other trawlers	1	24	24	24.0	A	A
Other vessel	27	4	7	4.7	Very small vessels	-
Pound net vessel	113	4	12	6.9	Very small vessels	-
Purse-seine/Trawl vessel	4	57	76	65.0	A	A
Side trawler	77	8	40	16.0	A	A
Smaller boat/dory	200	3	9	4.9	Very small vessels	-
Stern trawler	143	6	89	23.0	A	A
Stern/side trawler	55	10	68	21.3	A	A
Wellboat	119	4	9	5.4	Very small vessels	-

Inside the group of vessels using active gears, there is a group of pelagic vessels that are not a part of the fishery that is sampled for discards because they perform a fishery considered having very little discards, but with occasional slipping, which is difficult to monitor. To investigate if the pelagic vessels appear as a separate vessel type, the Figure 2.3.3 was produced for the Active vessel type group, which shows the amount of trips conducted using pelagic/demersal gears. The conclusion is that there is not a single vessel type group consisting of vessels using pelagic gears.

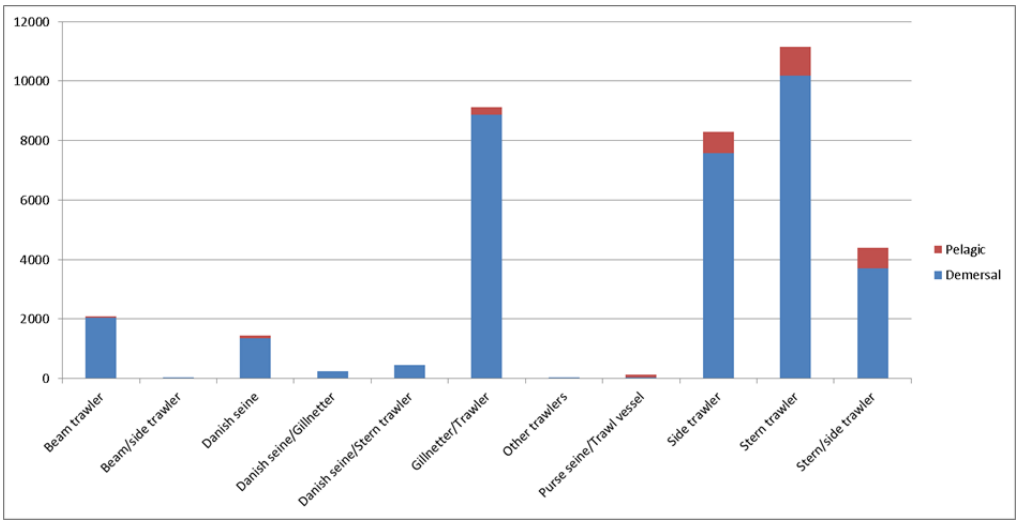


Figure 2.3.3: Number of trips in the group classified as Active gear types by type and divided into trips with pelagic and demersal gears 2012.

The group classified at gillnet vessels are generally small vessels for which it is difficult take observers on board. The number of vessels by vessel length group is illustrated in Figure 2.3.4.

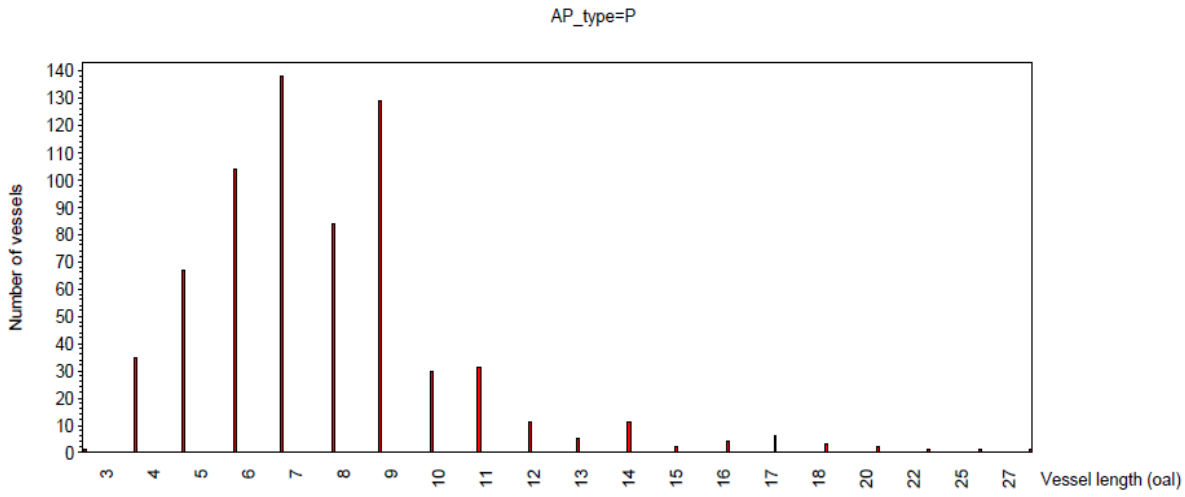


Figure 2.3.4: Number of vessels by vessel length in the group classified as Passive gear types.

The group of vessels using "Passive" gears has many small vessels that do not have VMS, which was only required on vessels larger than 12 meters in 2012, so it is not possible to get an overview of the spatial distribution of this group by VMS, but an attempt is made in Figure 2.3.5 for the vessels with lengths above 12 meters.

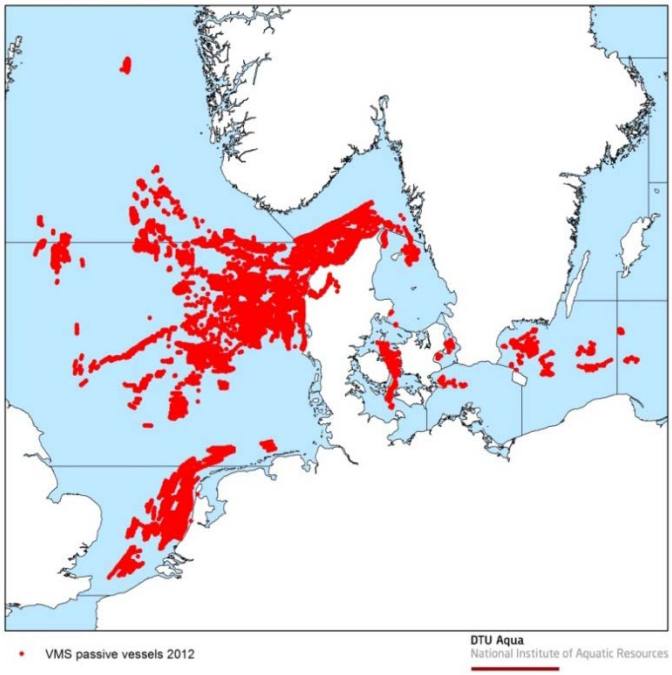


Figure 2.3.5: VMS distribution of the vessels grouped as Passive 2012.

Figure 2.3.6 shows the VMS distribution of the vessels grouped as "Active" for 2012. This group of vessels has a much larger spatial range. Therefore it could be investigated if a group of vessels can be defined that go far away to fish, which are not covered in the observer program were trip length currently is not considered in the weighting system.

Figure 2.3.6: VMS distribution of the vessels grouped as Active 2012.

The group Purse-seine/Trawl (Figure 2.3.7) might be excluded from the sampling frame, but further investigations have to be made about the species composition within the catch for this vessel group.

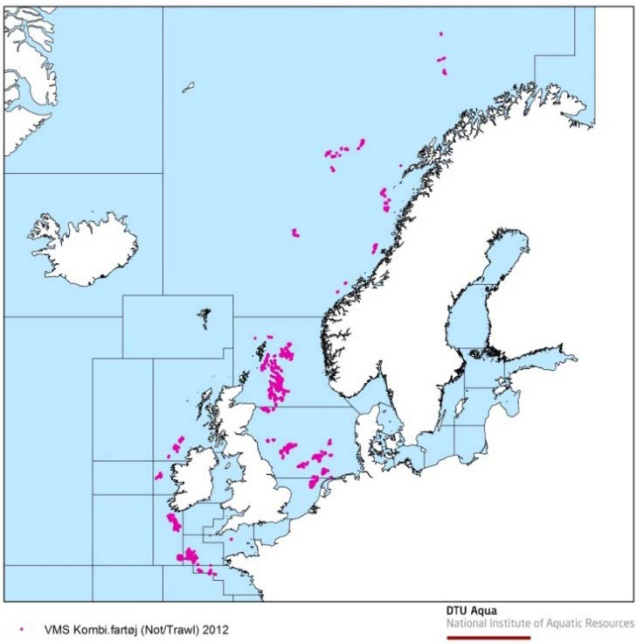


Figure 2.3.7 VMS from the Purse-seine/Trawl vessel type (2012)

2.3.1.3 Effort allocation between/within strata

In the Danish observer program effort allocation between strata is based on the numbers of trips conducted for the same strata the year before. The thought behind this approach was that in the first couple of years with the random draw list, effort between strata should be allocated in an equal way without any prior weighting depending on the discard rates. When discard data has been analysed effort could be increased /decreased between strata depending on the variance in the estimate. However currently effort is only allocated depending on numbers of trips conducted the year before.

In Denmark the observers are located in two different places: one covering the sampling in the Skagerrak and the North Sea and one covering Kattegat, inner waters and the Baltic Sea. The sampling effort need to be distributed between these two groups.

One possible solution is that a central person is contacting the vessels and distributes the observer trips among the observers, depending on where the vessel departs from. The problem with this solution is that some observers prefer to make the contact themselves.

Another solution is to split the vessel lists spatially. To do this an analysis has to be made to investigate if groups of vessels can be identified that most of the time go to the same area to conduct the fishery. There will be another group of vessels that are more mobile and conduct their fishery in different areas. The patterns in this group also have to be analysed. It is also a possibility that the vessels can be divided spatially based on their home harbour in the vessel register.

2.3.1.4 Analysis of quality indicators

Denmark has started to look into some of the quality indicators suggested by ICES 2012b, ICES 2013 and ICES 2012a. Some of the main analysis conducted in an annual basis is numbers of unique vessels, the total numbers in the fleet, refusal and success rate. Some further quality indicators were analysed to be presented for SGPIDS, these analysis is shown in section 3.6.1 and 3.6.2.

The table below summarizes some quality indicators for the Active/Passive gear type groups.

	ACTIVE	PASSIVE
Number of vessels	568	666
Number of trips 2012	41221	31732
Percentage contribution to total landings 2012	89.1	2.7

The number of observer trips conducted in 2012 was 229.

It is obvious that the sample size will be small in relation to what is needed to be covered: temporal coverage requires there to be samples throughout the year, the spatial coverage includes the North Sea, Skagerrak, Kattegat, Western Baltic and Eastern Baltic, there are different fisheries to be covered and the discard estimates are often requested by métier.

2.3.2 Case-study 2: Portugal

On-board sampling of Portuguese vessels operating in ICES Division IXa

2.3.2.1 Current sampling under DCF

The Portuguese discard sampling program on vessels operating in the Portuguese waters of ICES Division XIa is currently based on a set vessel groups that roughly correspond to the main métiers practiced in Portuguese waters (as defined in the National Programme and DCF regulations). Vessels selection is quasi-random from within a set of cooperative vessels. Every year, the following métiers and sampling effort objectives are set: OTB_CRU (n=12 trips), OTB_DEF (n=27 trips), LLS_DWS (n=12 trips), GNS_DEF (n=12 trips), GTR_DEF (n=12 trips), TBB_CRU (n=12 trips) and PS_SPF (n=24 trips). Sampling effort has been defined based on a trip based Neyman allocation which is considered valid for the entire DCF period. Within each métier, sampling effort distribution in space and time is proportional to effort or landings but severely constrained by logistic difficulties such as difficulties in the transportation of observers to certain ports. So far, estimates at fleet level have only been provided for métiers OTB_CRU and OTB_DEF which vessel lists and fishing behavior have proven fairly consistent through time and where sampling dates back to 2004. In other métiers, sampling and estimation have proven more difficult and have not yet been reported. This is particularly the case of the métiers GNS_DEF and GTR_DEF (sampling dating back to 2009), where a) a large number of smaller vessels that cannot take observers onboard is involved, b) vessels may be licensed for multiple gears other than GNS and GTR (e.g. FPO, LLS), and c) a multiplicity of species can be targeted per fishing trip, make it particularly difficult to provide robust estimates.

2.3.2.2 Approach taken to split the vessel register into new strata

The following data are available for sampling design in Portuguese fisheries:

a) FLEET_REGISTER - comprehensive list of Portuguese vessels alongside with their physical characteristics (length overall, etc). This list is quarterly updated and publicly available at http://ec.europa.eu/fisheries/fleet/index.cfm. It includes both active and inactive vessels and vessels that are licensed to operate in national waters, and/or, in non-national waters (e.g. NAFO, NEAFC, CECAF) throughout the year.

b) LICENCES - List Portuguese vessels licensed to operate in Portuguese waters. This list includes area, gear type (DCF level 4) and mesh size (DCF level 6) of fishing licenses owned by individual vessels. This list is provided by the Directorate-General for Natural Resources, Safety and Maritime Services (DGRM) and sent to the fisheries institute (IPMA) on an annual basis.

c) LOGBOOKS - Dataset that includes, among other variables, catch (weight) per fishing trip and fishing date, vessel, gear, and species. These data are compiled by the national fisheries directorate (DGRM) and sent to the fisheries institute (IPMA) on an annual basis.

d) SALES - Dataset that includes, among other variables, landings (weight and value) per landing date, port, vessel, and species. These data are collected daily at auction houses, compiled at (DGRM) and sent to IPMA on an annual basis.

Broad management and regulations have historically been set in terms of 3 main types of vessels (trawlers, purse-seiners, polyvalent) and linked to vessel size categories (e.g. maximum length of gillnets depends on vessel size; the operation of smaller local vessels is restricted to the vacinity of their home port etc.). Such regulations are intrinsically related to licensing procedures that take place annually (in general at the beginning of the year) but that remain relatively unchanged throughout the year. They thus provide a possible framework for annual definition of sampling frames and sampling strata. At this SGPIDS, a first trial of the use of the fleet register and license information was conducted using 2011 data.

2.3.2.3 Determining primary vessel lists

The original FLEET_REGISTER for 2011 presented 8550 vessels. From these, in 2011 only 2929 were presented with licenses that allowed them to fish in ICES Division IXa. These vessels constitute the Portuguese fleet licensed to operate in Portuguese waters. The data were split into three primary non-overlapping lists of vessels: Bottom Otter Trawl (OTB), Purse-Seine (PS) and Other gears (OTHER) (Table 3.3.2). OTB and PS lists were defined based on the licensing of OTB and PS fishing gears, respectively. List OTHER included only vessels that do not carry a license for OTB or PS. In the OTB subset only 1 vessel was licensed for a fishing gear other than OTB. In PS however, 78.5% of vessels were licensed for PS and another gear. In list OTHER 95.4% of vessels carry more than one fishing license. A more complete characterization of the 3 primary sublists in terms of landings, is displayed in Table 2.3.3 and 2.3.4.

Table 2.3.2: Number of vessels in the 3 main vessel lists of the Portuguese fleet operating in Division IXa. Table is based on FLEET_REGISTER and LICENSE data (2011)

	OTB		PS		Other
Length class	Only OTB	with other gears (but not PS)	Only PS	with other (but not OTB)	one or several gears (no OTB or PS)
[0-10]	4	1	1	57	2226
[10-12]	0	0	2	31	137
[12-18}	8	0	4	38	198
[18-24]	8	0	23	30	60
[24-40}	63	0	14	5	19
[40, +]	0	0	0	0	0
Total	84		205		2640

Table 2.3.3. Number of vessels, landings (ton), number of trips and number of days-at-sea of the three Portuguese primary lists. Table is based on several data sources (2011). "sa" = based on sales data; "lb" - based on logbook data

	OTB				PS				OTHER			
Length class	n_vessels	Landings (sa)	No. trips (lb)	No. days at sea (lb)	n_vessels	Landings (sa)	No. trips (lb)	No. days at sea (lb)	n_vessels	Landings (sa)	No. trips (lb)	No. days at sea (lb)
[0-10[	5	185	142	256	58	1836	0	0	2226	8005	376	391
[10-12[	0	0	0	0	33	4453	2229	3352	137	2140	10395	11282
[12-18[	8	481	811	1716	42	10394	3887	6278	198	7837	20474	27768
[18-24[	8	554	790	2131	53	49915	5610	7328	60	5272	5128	11268
[24-40[	63	12553	6760	12785	19	20495	1983	2238	19	949	144	543
[40, +[	0	0	0	0	0	0	0	0	0	0	0	0

Table 2.3.4. Summary statistics for trip duration in each of the three Portuguese primary lists. Table is based on logbook data (2011)

	OTB				PS				OTHER			
Length class	min	median	average	max	min	median	average	max	min	median	average	max
[0-10[	1	3	2.7	6					1	1	1.1	5
[10-12[					1	2	1.6	5	1	1	1.1	11
[12-18[	1	3	2.6	7	1	2	1.7	8	1	1	1.4	17
[18-24[	1	3	2.9	6	1	1	1.6	20	1	2	2.9	23
[24-40[	1	2	2.8	35	1	1	1.1	26	2	8	7.1	14
[40, +[	---	---	---	---	---	---	---	---	---	---	---	---

2.3.2.4 Improving the Primary vessel lists

The primary lists previously obtained are still far from the métiers defined in the DCF. Namely, the OTB list includes vessels of both the OTB_CRU_>=55_0_0 and the

OTB_DEF_>=65_0_0 metiérs which are subject to distinct regulations (e.g. bycatch allowed per fishing trip) and have substantially different target species and discard rates. On the other hand, the PS list still may include multi-gear vessels that do not target small pelagic fisheries thus providing categorization that departs from the currently used PS_SPF_>=16_0_0 métier. List OTHER is also lumping together vessels with quite different target and discard patterns such as gillnets/trammelnets (GNS/GTR) targeting demersal fish and deep-water set longlines targeting black scabbardfish. In an attempt to better approximate current knowledge of fleet activity while retaining the possibility of a proper probability-based sampling design we tested a further refinement of previous Primary vessel lists using license information that incorporates mesh size.

2.3.2.5 Improving the Primary vessel lists (Bottom Otter Trawl, OTB)

Over the last decade, increased evidence has been built on the importance of bycatch regulation for discard practices. In Portugal, OTB vessels can carry up to three OTB licenses - 55-59 mm, 65-69 mm , and >=70 mm, even if some combinations are more frequent than others. In Portugal, mesh size influences discards by increasing (or reducing) the size of fish caught but also by means of fish and crustacean bycatch % allowances. Mesh size categorization hence constitutes a natural refinement of Primary lists when discard sampling programmes are being considered. Consequently, we divided the primary OTB list into 3 mesh size categories. Vessels that carry 55-59 mm license, vessels that carry 65-69 mm license and vessels that only carry license >=70 mm. Analyses of these subsets of the primary list of OTB vessels is detailed on table 2.3.5 and 2.3.6. Further analysis demonstrated that 100% of vessels with 55-59 mm license effectively landed crustaceans as their most valuable catch (i.e. crustaceans comprised >70% of the value of annual sales of individual vessels) and will hence be incorporated in estimates of an OTB_CRU_>=55_0_0 métier. Sales records also indicated that 96% of vessels licensed with 65-69 mm mesh size and 100% of vessels licensed only with >=70 mm mesh size landed fish as their most valuable catch, thus having carried out mostly OTB_DEF_>=65_0_0 métier in 2011. These results evidence the relative stability of sampling frame but also good perspectives on post-stratification of results obtained from license derived sampling frames into DCF métiers.

Table 2.3.5. Number of vessels, landings(ton), number of trips and number of days-at-sea in the three OTB sublists derived from the primary OTB list. Table is based on several data sources (2011). "sa" = based on sales data; "lb" - based on logbook data

	OTB 55-59 mm				OTB 65-69 mm				OTB >=70 mm only			
	n_vessels	Landings (sa)	No. trips (lb)	No. days at sea (lb)	n_vessels	Landings (sa)	No. trips (lb)	No. days at sea (lb)	n_vessels	Landings (sa)	No. trips (lb)	No. days at sea (lb)
[0-10[					4	151	86	198	1	34	56	58
[10-1[												
[12-1[					8	481	811	1716				
[18-2[	4	322	460	1095	4	232	330	1036				
[24-4[	22	1209	1815	4844	31	10837	4458	6121	10	507	487	1820
[40, +												

Table 2.3.6. Summary statistics for trip duration in the three OTB sublists derived from the primary OTB list. Table is based on logbook data (2011)

	OTB 55-59 mm				OTB 65-69 mm				OTB >=70 mm only			
Length class	min	median	average	max	min	median	average	max	min	median	average	max
[0-10[					1	3	2.8	6	1	1	1.3	3
[10-12[												
[12-18[					1	3	2.6	7				
[18-24[	1	3	2.6	5	1	3	3.2	6				
[24-40[	1	3	5	35	1	1	1.6	5	1	4	4.7	33
[40, +[												

2.3.2.6 Improving the Primary vessel lists (Purse-seine, PS)

The purse-seine fishery targeting small pelagics, namely, sardine, chub mackerel and horse mackerel, is a fishery of major economic importance in ICES Division IXa. As such it has remained an important component of the Portuguese onboard sampling programme. Present data indicates that discarding in this fishery is reduced but slipping requires monitoring. Contrary to OTB vessels, PS vessels that target small pelagics cannot be easily discriminated from other vessels carrying PS licenses because most vessels carry the same mesh size (>=16 mm) license and bear licenses to other gears (Table 2.3.2). Consequently, a different discrimination methodology must be used if one needs to individualize a sampling frame of PS vessels that predominantly target small pelagics. At SGPIDS the use of landings data from the previous year (2010) was tested in obtaining such a refinement. Briefly, we determined the percentage of small pelagics (PIL, HOM, MAS) in annual landings (in weight) of PS vessels and used a threshold of >70% of small pelagics as indicative of PS vessels targeting small pelagic fish. Vessels with <70% landings were put into a separate PS_OTHER category. The results are displayed in Table 2.3.8 and 2.3.9.

Table 2.3.8. Numbers of vessels, landings(ton), number of trips and number of days-at-sea in the two PS sublists derived from the primary PS list. The table is based on several data sources (2011). "sa" = based on sales data; "lb" - based on logbook data.

	PS_SPF				PS_OTHER			
	n_vessels	Landings (sa)	No. trips (lb)	No. days at sea (lb)	n_vessels	Landings (sa)	No. trips (lb)	No. days at sea (lb)
[0-10[	31	1675	0	0	27	161	0	0
[10-12[	27	4272	1864	2881	6	181	365	471
[12-18[	34	9901	3434	5555	8	493	453	723
[18-24[	52	49915	5598	7199	1	0	12	129
[24-40[	18	20495	1983	2238	1	0	0	0
[40, +[								

Table 2.3.9. Summary statistics for trip duration in the two PS sublists derived from the primary PS list. Table is based on logbook data (2011)

	PS_SPF				PS_OTHER			
Length class	min	median	average	max	min	median	average	max
[0-10[	0	0	0	0	0	0	0	0
[10-12[	1	2	1.7	5	1	1	1.3	4
[12-18[	1	2	1.7	5	1	2	2	8
[18-24[	1	1	1.3	5	5	11	12.6	20
[24-40[	1	1	1.1	26	0	0	0	0
[40, +[								

2.3.2.7 Improving the Primary vessel lists (Other, OTHER)

Due to time constraints, improvements to OTHER list were not pursued at SGPIDS but preliminary analysis indicate that combinations of gear x mesh size (similar to the OTB example) and target species analysis (similar to the PS example) may provide further discrimination namely in what concerns the subset of vessels that operate deep-water set longlines that target black scabbardfish in ICES Division IXa.

2.3.2.8 Sampling effort allocation between/within strata

At SGPIDS Portugal tested different types of Neyman allocation of hypothetical n = 100 trips. Data used in analysis is from 2011 and simulates results from a possible Neyman allocation for the year 2012. Vessels with <12 m length were excluded from the analysis as their small size makes them more prone to a self-sampling programme than to onboard observations. Results show that the range of sampling effort allocated to each Primary sampling frame is relatively narrow when number of vessels, no of trips or number of days at sea are considered (Table 2.3.10). This pattern changes when landings are included, which causes sampling effort to be allocated from OTHER (with lower landings) to the PS (with higher landings) due to the larger relative landings of the small pelagic fishery compared to the more OTHER segment. It must be emphasized however that the PS_SPF fishery registers little discards.

Considering that it does not appear to exist a major difference in the median and average trip length across the fleets, this exercise was repeated using the results of trip allocation for the sublists considered in the case of OTB and PS (2.3.10). Results show the allocation that could be obtained from simple proportional sample allocation based on number of trips obtained from logbook records. Two aspects are noticeable: a) under such a sampling effort 2 trips per quarter will not be obtainable in some strata (which raises the issue of the need to increase sample size to provide coverage to multiple fisheries) and b) incomplete coverage of smaller sized vessels may still bias the allocation with respect to the realized number of trips, leading to an oversampling of larger vessels.

Table 2.3.10. Example of effort allocation (n=100 trips) across the three primary lists derived fro the Portuguese fleets for vessels over 12m. Small differences between totals are due to rounding approximations

	OTB				PS				OTHER			
Length class	n_vessels	Landings (sa)	No. trips (lb)	No. days at sea (lb)	n_vessels	Landings (sa)	No. trips (lb)	No. days at sea (lb)	n_vessels	Landings (sa)	No. trips (lb)	No. days at sea (lb)
[12-18[	2	0	2	2	9	10	9	9	42	7	45	39
[18-24[	2	1	2	3	11	46	12	10	13	5	11	16
[24-40[	13	12	15	18	4	19	4	3	4	1	0	1
[40, +[	0	0	0	0	0	0	0	0	0	0	0	0
Total trips	17	13	18	23	24	75	25	22	59	13	57	55

Table 2.3.11. Effort allocation to the sublists of vessels of 12m or over determined for the Portuguese OTB and PS fleets using trips. Small differences between totals are due to rounding approximations

	OTB			PS		
Length class	OTB 55-59 mm	OTB 65-69 mm	OTB >=70 mm only	PS_SPF	PS_OTHER	OTHER
[12-18[	0	2	0	8	1	45
[18-24[	1	1	0	12	0	11
[24-40[	4	10	1	4	0	0
[40, +[	0	0	0	0	0	0
Total trips	5	13	1	24	1	57

2.3.2.9 Quality indicators

Quality indicators for vessel lists derived to date are mostly related to the output obtained from sampling programmes (e.g. number of trips observed relative to number of trips registered in the fishery) and only indirectly to the quality of the list adopted. Output indicators do not necessarily relate to the quality of sampling design: e.g. sampling coverage or coverage of total landings of a specific species can only be judged a posteriori and are strongly dependent on variables that cannot be controlled a priori by observer teams like, e.g. weather conditions, fish prices, reductions in fishing effort, etc. To evaluate this situation, Portugal compared both a priori and a posteriori quality indicators for the OTB 55-59 vessels (Table 2.3.12). These results were derived for the sampling frames considered in the previous sections. They show that a priori quality in terms of trips covered as expected from the sampling design and sampling effort allocation was actually a little worse than the one realized at the end of the year. This difference was due to less trips made by the fleet and to one extra trip observed onboard.

Table 2.3.12. A priori quality indicator and a posteriori quality indicator of the Portuguese onboard sampling data for OTB 55-59 mm sampling frame.

	A priori indicator (planned)			A posteriori indicator (achieved)		
Length class	No. trips planned	No. trips (lb) in 2010	% coverage	No. trips sampled (2011)	No. trips (lb) in 2011	% coverage
[18-24[	0	455	0	0	460	0
[24-40[	12	2075	0.58	13	1815	0.72

2.3.2.10 Final considerations from the Portuguese case study

The following conclusions can be drawn from the Portuguese case-study:

1) The EU fleet register provides a useful and publicly available reference that can be used as basis in fleet segmentation. It does not however, provide sufficiently detaile with regards to licenses possessed by individual vessels so, for the time being, the register will have to be merged with national data to obtain, for example, more complete gear and mesh size information.
2) EU fleet register information can be used in combination with more specific national data (national license lists and records of vessels landings) to objectively derive vessel lists for use in probability-based sampling design schemes.
3) Effort allocation may vary significantly according to criteria used, standardization at regional level may be required but will have to consider overall minimum sample sizes per strata. Effort allocation based simply on landings may lead to oversampling of fleets with largest landings when these do not present significant or very variable discards or species composition.
4) Quality indicators can be derived that differentiate between what can be controlled a priori by sampling design and what actually happens in the fishery. These indicators more efficiently distinguish between what is to be expected from probability based sampling design and a priori information available on the fishery and what actually occurs in the fishery throughout the sampling year and cannot be controlled a priori by managers of the onboard sampling programmes.

2.3.3 Case-study 3: Germany

2.3.3.1 Current sampling under DCF

Data collection on discard of German fishing vessels has been conducted in the North Sea, Skagerrak, the North Atlantic and the Baltic Sea according to the DCF framework. Since 2012, several métiers have been merged. Additionally, areas were combined resulting in a stratification scheme with respect to area, gear, month and vessel size. The main sampling unit within the German sampling scheme is the vessel, and thus, randomized vessel lists have been created to assign at-sea sampling effort to strata, resulting primarily in the segmentation of the German fleet into active gears, such as beam trawlers, demersal trawlers and/or demersal seiners and pelagic trawlers, and passive gears, separated for the Baltic Sea and the North Sea/Eastern Arctic/ North Atlantic, respectively.

2.3.3.2 Identification and characterization of the study population: approach taken to split the vessel register into new strata.

To identify the study population, data from the fleet register of the European Commission (http://ec.europa.eu/fisheries/fleet/index.cfm?method=Download.Menu&country=DEU) have been used. The fleet register provides information on length, main gear, second gear and gross tonnage for each vessel registered making it possible to assign each vessel to a list according to strata. In 2012, the German active fleet consisted of 194 vessels, mostly small gillnetters (< 10m in length; Table. 2.3.13). In total, the majority of main gear was covered by GNS (70%) and TBB (20%). The distribution of main gear by length class is given in Table 2.3.13, Figure 2.3.8 summarizes the overall length distribution of the fleet.

Table 2.3.13. German active fleet in 2012 stratified by main gear and length class

Length class	GNS	TBB	OTB	PTB	FPO	DRB	LLS
< 10m	116	1			6		3
10m - 12m	12	1	1				
12m - 18m	4	25	6	1			
18m - 24m		9	1				
24m +		3	4			1	
Total	132	39	12	1	6	1	3

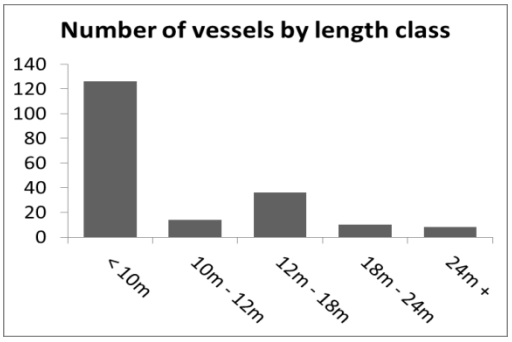


Figure 2.3.8.: German fleet segmentation by length class.

However, the analysis of second gear reveals that many vessels have multiple gears and thus, may use different gears during the next trip than they are supposed to according to the list they were assigned. The variety of the German active fleet in 2012 according to second gear is shown in Table 2.3.14., 80% of second gear was covered by FPO, LLS and OTB.

Table 2.3.14.: German active fleet in 2012 stratified by second gear and length class."NO" = no secondary gear.

Length class	FPO	LLS	OTB	NO	GNS	GTR	OTM	PTB	PTM	TBB
< 10m	59	50	2	6	6	1		1		1
10m - 12m	2	7		4	1					
12m - 18m		1	27	1	2	1		3	1	
18m - 24m			9							1

24m +			2	1			4	1		
Total	61	58	40	12	9	2	4	5	1	2

2.3.3.3 Sampling effort allocation between/within strata (2012)

In total, 26 different strata/métiers have been identified for the German sampling programme (corresponding to the vessel lists), 8 for the Baltic Sea and 18 for the North Sea/Eastern Arctic/ North Atlantic region. For each of those, sampling effort has been allocated by merging information from the recent vessel list and logbook data from the previous year that provide information about the trips realized in 2011 as a reference (assuming a similar temporal and spatial pattern of fishing trips in 2012).

For at-sea sampling and onshore observations, 54 trips and 60 trips were planned, respectively. A detailed list of the planned at-sea sampling by fishing activity and region is provided in Tables 2.3.15a and 2.3.15b and for the onshore sampling in the Baltic Sea in Table 2.3.15c.

Table. 2.3.15a: Allocation of at-sea sampling effort to métiers – Baltic Sea

Fishery - Baltic Sea	Planned No. of trips at sea
Trawls targeting cod and flatfish	14
GNS targeting cod and flatfish	6
Pelagic fisheries targeting sprat and herring	2
Total	22

Table. 2.3.15b: Allocation of at-sea sampling effort to métiers – other regions

Fishery - North Sea, North Altantic, Eastern Arctic	Planned No. of trips at sea
Trawlers targeting cod, saithe	2
Trawlers targeting herring	1
Beam trawl targeting brown shrimp	8
Trawlers targeting mackerel, herring	2
Trawlers targeting gadoids	6
Trawlers targeting sandeel	1
Beam trawl targeting flat fish	4
OTB targeting plaice	2
OTB targeting Greenland halibut	1
OTM targeting blue whiting, mackerel, horse mackerel	3
OTB targeting Greenland halibut	2
Total	32

Table 2.3.15c. Allocation of onshore sampling effort to métiers – Baltic Sea

Fishery – Baltic Sea	Planned No. of trips on shore
Trawls targeting cod and flatfish	26
GNS inshore targeting herring	16
GNS targeting cod and flatfish	2
GNS inshore targeting freshwater fish	2
Pelagic fisheries targeting sprat and herring	12
Trawls targeting whiting and flatfish	2
Total	60

In 2012, a total amount of 44643 fishery trips was realized in the Baltic Sea (~29000), the North Sea/Eastern Arctic (~15600) and the North Atlantic 36; (see Table 2.3.16.), reflected by 194 samples that were taken at sea and on shore, respectively. A comparison of planned and realized samples is provided Figure 2.3.9.. On average, 0.4% of all trips have been accompanied by sampling, ranging between no coverage for some fisheries (e.g. GNS inshore targeting freshwater fish in the Baltic Sea) and 50% of trips sampled (e.g. trawlers targeting in the North Sea). However, please note the different numbers of realized trips.

Table 2.3.16: Summary of realized trips by region and métier of the German fisheries in 2012.

Region	Fishery (métier)	Realized No. of trips during the sampling year
Baltic Sea	Trawls targeting cod and flatfish	2899
Baltic Sea	GNS inshore targeting herring	4710
Baltic Sea	GNS targeting cod and flatfish	13075
Baltic Sea	GNS inshore targeting freshwater fish	6442
Baltic Sea	Pelagic fisheries targeting sprat and herring	1012
Baltic Sea	Trawls targeting whiting and flatfish	887
North Sea and Eastern Arctic	Trawlers targeting cod, saithe	17
North Sea and Eastern Arctic	Trawlers targeting herring	2
North Sea and Eastern Arctic	Trawlers targeting herring	0
North Sea and Eastern Arctic	SSC targeting haddock	36
North Sea and Eastern Arctic	Gillnets targeting flat fish	12
North Sea and Eastern Arctic	OTB targeting Norway lobster	15
North Sea and Eastern Arctic	Gillnets targeting flat fish	3
North Sea and Eastern Arctic	Beam trawl targeting brown shrimp	14789
North Sea and Eastern Arctic	Trawlers targeting mackerel, herring	27
North Sea and Eastern Arctic	Trawlers targeting gadoids	300
North Sea and Eastern Arctic	Trawlers targeting sandeel	0
North Sea and Eastern Arctic	Beam trawl targeting flat fish	188
North Sea and Eastern Arctic	OTB targeting plaice	106
North Sea and Eastern Arctic	OTB targeting Norway lobster	87
North Atlantic	OTB targeting Greenland halibut	2
North Atlantic	OTM targeting blue whiting, mackerel, horse mackerel	9
North Atlantic	GNS targeting anglerfish	8
North Atlantic	FPO targeting deep-sea red crab	4
North Atlantic	OTB targeting Greenland halibut	11
North Atlantic	OTM targeting redfish	2
Total		44643

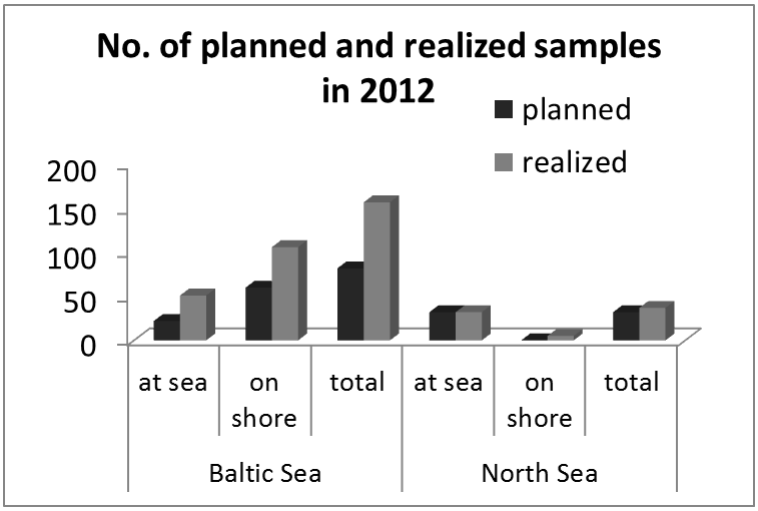


Figure 2.3.9.: Sampling of the German fishery in 2012 (category North Sea includes Eastern Arctic/ North Atlantic samples).

2.3.3.4 Analysis of quality indicators

The German fishery in the North Sea/ Eastern Arctic/ North Atlantic uses active gear only. For the Baltic Sea, Table 2.3.17. provides quality indicators for the fleet segmentation into active gear/ passive gear.

Table 2.3.17.: Quality indicators for the German fisheries in the Baltic Sea.

AT-SEA-SAMPLING		
Baltic Sea 2012		
	Germany	
Strata from the sampling frame	Fleet 1 - Active gear	Fleet 2 - Passive Gear
	e.g. active gear (Trawler)	e.g. passive gear
Importance: Contribution to national landing	82%	18%
Quality indicator		
Total number of vessels in the fleet	60	50
Number of trips sampled onboard of vessels	23	24
Total number of trips conducted by the fleet	8500	37300

2.3.4 Case-study 4 : Sweden

2.3.4.1 On-board sampling of Swedish vessels

The main objectives (beside fulfilling the requirements of 2010/93/EU) of the Swedish on-board sampling scheme is to provide estimates of discards for a selection of stocks to relevant expert working groups (ICES and STECF) as well as gaining overall knowledge of discarding in Swedish fisheries. The main challenges are to collect data that is representative for the sampled fisheries as well as using the available sampling effort the best way. The sampling programme is focused on demersal trawlers in the Baltic Sea, Kattegat and Skagerrak. Pelagic fisheries are not sampled at sea. If discarding occurs during pelagic trips it is usually through slipping and it is very difficult for

observers to estimate amount of slipped fish. It is also a potential risk for an observer effect since it is an active choice (which can be affected of the presence of an observer) of the skipper to slip fish. Passive gears are only sampled if there is an international assessment of the target species and if the catches by the gear is "considerable". The main reason for this is that discard rates in passive fisheries are relatively low. In reality this means that Sweden is sampling gillnetters / longliners targeting cod in eastern and western Baltic as well as potters targeting Nephrops in area IIIa (Skagerrak and Kattegat). These groups of vessels are however relatively easy to distinguish from the rest of the fleet and will not be discussed further within this case study.

2.3.4.2 The demersal trawl fisheries

In Skagerrak demersal trawl fisheries are diverse. The fisheries includes Pandalus fisheries with a 35 mm mesh, Pandalus fisheries with a sorting grid, Nephrops fisheries with a sorting grid and a fishery targeting Nephrops and/or fish with a minimum of 90 mm mesh (from 2012 is it mandatory with selection panels). All these fisheries have very different exploitation patterns and discard rates. In Kattegat most of the fisheries are directed towards Nephrops (with or without sorting grid). The Baltic Sea is a more simple system where all the trawlers targets cod. Access to different fisheries is regulated with national licenses. Some vessels are specialized in one fishery while others take part in several. The activity level also differs between vessels. Some fish extensively throughout the year while others only do a few trips.

2.3.4.3 Sampling 2009-2012

The Swedish sea-sampling programme was initiated in 1995. Vessels to be sampled were selected in a more or less ad-hoc way until 2009. The different fisheries were considered strata allowing us to produce estimates from the different fisheries. In 2009 Sweden decided that a more systematic approach for selection of trips to sample was needed in order to meet questions on the representatively of the data. The main problems that we had (and still have) are that end-users in most cases want estimates by stock and fisheries, vessels participate in several fisheries, fisheries with the most effort do not necessarily produce most discards and that our available sampling effort is low.

The assumption was made that a vessel has a similar fishing pattern from one year to another. Based on logbook information from the preceding year lists were made with expected trips for each of the fisheries. Trip was considered PSU and a vessel could appear in several lists. Trips to be sampled were then selected from the lists in a random way and non-responses recorded. Sampling effort was allocated to the different fisheries in a way that each fishery first got a minimum level (12 trips). Fisheries where discard data are used in the assessment and where Sweden have a considerable part of the catches (e.g Eastern Baltic cod) got the remaining available sampling effort.

Advantage with this approach was

- All fisheries of interest were sampled
- Sampling effort could be directed to fisheries of high relevance
- Non-response rates could be achieved for individual fisheries

Disadvantages with the approach

- Trips are not considered suitable as PSUs.

- A lot of contact attempts resulted in that the vessel was occupied in another fishery – how to deal with this in a non-response context.
- Observers became frustrated when they had to decline trips when the vessels were involved in another fishery.

2.3.4.4 Sampling 2013

Based on the experiences from 2009-2012 as well as outcomes from WKPICS Sweden decided to try a new design for 2013.

The following information was available for sampling design in Swedish fisheries:

1) FLEET_REGISTER - comprehensive list of Swedish vessels (active and inactive) alongside with their physical characteristics (LoA) and main fishing gears.

2) LOGBOOKS - Dataset that includes, among other variables, catch (weight) per fishing haul and fishing date, vessel, gear, and species. The information on gear is more comprehensive in the Swedish logbook than in the EU logbook. Sweden have different codes for, for example the different types of trawls and selective devices. These data are compiled by the Swedish Agency of Marine and Water Management. Data available for vessels with an obligation to carry logbooks.

3) MONTHLY FISHING JOURNALS - Dataset that includes, among other variables, catch (weight) per month, number of fishing days, vessel, gear, and species. These data are compiled by the Swedish Agency of Marine and Water Management. Data available for vessels that do not have an obligation to carry logbooks.

4) DATA from previous years of sea-sampling program

2.3.4.5 Data source to establish list of PSUs

The fleet register contained (2013) 1386 vessels. Out of these were 217 registered to fish with OTB either as first or second gear. In the logbook from 2012 were 182 vessels involved in trawl fisheries for demersal species. The reason for the difference is primarily that many vessels targeting pelagic species are registered for OTB since bottom trawls sometimes is used catching herring and vendace in the Baltic Sea. The fleet register further only holds information on gear type (e.g. OTB) while the logbooks hold information on characteristics (e.g. selection devices, number of trawls and mesh-sizes) of the gear type as well. For 2013 Sweden decided to use the 2012 logbook to establish list of PSUs. The main reason for this is that the assumption that the 2012 vessels will remain in the fishery 2013 probably will cause less problems than using the fleet register and including vessels that we know do not participate in the fisheries of interest.

The sizes of the vessels are between 9-39 meters with a mean of 17 meters. Vessels of all sizes are involved in all fisheries. The larger vessels are more involved in the Baltic Sea cod fishery and in the Pandalus fishery while the smaller ones are more active in the trawl fisheries with grids.

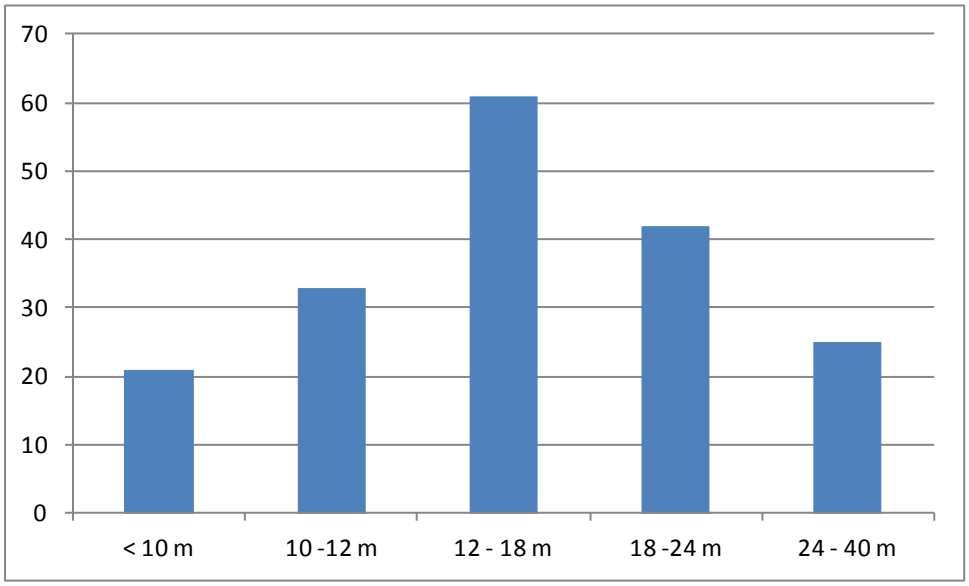


Figure 2.3.10 showing number of vessels by LoA class in the demersal trawl fisheries

2.3.4.5.1 Establishment of lists of PSUs

The objective of the sampling scheme is to produce estimates of discards from the different demersal trawl fisheries in Skagerrak, Kattegat and Baltic Sea.

The fisheries are

- Trawl fisheries targeting cod in eastern and western Baltic
- Trawl fisheries with >=90 mm meshsize in Skagerrak (IIIaN)
- Trawl fisheries with >=90 mm meshsize in Kattegat (IIIaS)
- Trawl fisheries with sorting grid targeting Nephrops in Skagerrak
- Trawl fisheries with sorting grid targeting Nephrops in Kattegat
- Trawl fisheries targeting Pandalus (35 mm meshsize) (IIIa)
- Trawl fisheries with sorting grid targeting Pandalus (IIIa)

The main challenge from a design point of view is that two thirds of the vessels participate in more than one fishery (Table 2.3.18). Management actions during the last few years have further increased the usage of sorting gears which reduce the amount of discards in general and discards of round fish in particular. This has resulted in sorting grids being used in a large proportion (70% in area IIIa) of the conducted trips (Table 2.3.19). From a design perspective this means that a straightforward design with all trawlers in one list and a random selection of vessels will result in lot of grid trips with relatively low discards being sampled. Non responses for grid trips were also lower in 2009-2011 than for non-grid trips indicating that even more grid trips will be sampled. This may not be the most effective use of the available observer effort. For 2013 Sweden thereby decided to split the overall vessel list into different strata. The intention is to allow us to allocate sampling effort to increase the chance to sample fisheries where estimates of discards are used in the assessment and/or where discard rates are high.

Table 2.3.18 showing how many different fisheries Swedish trawlers take part in.

Fishery	Area	Target species	No. of trips 2012	Trip length (days)	Average trip length (days)
OTB_DEF	Baltic Sea	Cod	2011	1-8	3
OTB_MCD_>=90	IIIaN	Fish and Nephrops	972	1-5	2
OTB_MCD_>=90	IIIaS	Fish and Nephrops	1039	1-3	1
OTB_CRU_70-89_2-35	IIIaN	Nephrops	4427	1-3	1
OTB_CRU_70-89_2-35	IIIaS	Nephrops	1754	1-3	1
OTB_CRU_35-69	IIIa	Pandalus and Fish	1035	1-7	3
OTB_CRU_35-69_2_22	IIIa	Pandalus	1624	1-3	2

Table 2.3.19 showing amount of performed fishing trips by fishery during 2012

No of fisheries	No of Vessels	%
1	63	35
2	52	29
3	35	19
4	26	14
5	4	2
6	2	1

For 2013 Sweden thereby decided to split the vessel list into three lists

- One list with vessels active in the Baltic Sea

Discard data on cod from the observer program is used in the assessment by the Baltic Sea AWG. The design of the sampling scheme thereby needs to assure that the relevant data are collected. Trawlers that are active in the Baltic Sea thereby constitute a list of its own. A relatively large part (35 out of 47) of these trawlers is further only active in the Baltic Sea.

- One with vessels in IIIaN predominately fishing with meshsize >=90 mm

The fishery with a 90 mm meshsize in IIIaN target Nephrops and a variety of different fish. The rate, amount and composition of discards are variable but in general relatively high. Species discarded are further often of relevance for different assessments. During previous years it has been most difficult to get observer trips from this fishery (high non-response rate). To make sure that we got trips from this fishery the 10 vessels with most trips in this fishery was put in a list of its own.

- One list with the remaining vessels

2.3.4.6 Sampling effort allocation

The available sampling effort for demersal trawlers for 2013 is 104 trips. Sampling effort was allocated to different lists based on the proportion of trips in 2012 (table 2.3.20). The minimum number of trips in a list is 8 (2 samples per stratum) since sampling is carried out by quarter. Some of the sampling effort was reallocated from the "other trawler" list to the Baltic list. The reason for this is that trips in general are longer in the Baltic and that we want to increase the chances to have data from both eastern and western Baltic.

Table 2.3.20 showing sampling effort allocation in the Swedish sea-sampling 2013

Samplingframe	No. of vessels	No. of trips 2012	% trips 2012	Trips in 2013 if proportional	Trips in 2013
Demersal trawlers in Baltic Sea	47	2011	16	16	24
Demersal trawlers >=90 mm IIIaN	10	864	7	7	8
Other demersal trawlers	125	9987	78	81	72
Total	182	12862	100	104	104

2.3.4.7 Conclusions

- The fleet register can be used as a basis for fleet segmentation. However, additional information such as logbooks or national fishing licenses can be used to fine tune the segmentation allowing for identification of study populations that are more in line with the objective of the sampling programme.
- The real challenge when designing on-board sampling programmes is the variability of fisheries in combination with low sampling effort. Knowledge from previous sampling years may be used in the design to optimize use of available the sampling effort.

2.3.5 Case-study 5: Norway - Sampling under a discard ban

2.3.5.1 Current sampling

Due to the economic importance of the marine fisheries, the vessel quota system, and the discard ban, Norway spends significant effort on surveillance of the fishery by the Coast Guard and the Directorate of Fisheries, with authorized landing sites and a trip ticket system for all commercial vessels, and VMS and mandatory electronic logbooks for all vessels with length greater or equal to 15 meters.

Biological sampling of commercial catches at sea in Norway is conducted by a few inspectors from the Directorate of Fisheries on board selected vessels and trips, by the Coast Guard, and through the Reference Fleet managed by the Institute of Marine Research (IMR). Port sampling is done by boat in northern Norway and by car or stationary staff in other areas.

The use of a comprehensive observer programs for catch sampling is not considered economically viable and practical for Norway because of the intricate coastline, large number of landings sites, the length of trips, and difficulties to recruit and maintain sufficient staff over time to operate a large observer program.

A high seas Reference Fleet was established as an alternative to an Observer Program in 2000 with 6 vessels, and was extended in autumn 2005 with a similar coastal Reference Fleet established along the entire Norwegian Coast. By 2013 the fleet comprises 20 coastal vessels (mainly gillnetters, 9–15 m long) and 19 high seas vessels representing demersal and pelagic trawlers, purse-seiners, longliners and gillnetters. A public announcement every fourth year opens up for the replacement of the fleet and motivates fishers involvement. The vessels are selected through a tender process where selection is based on gear type, fishing activity and geography. The objective is to have a Reference Fleet that is representative of the Norwegian fishing fleet.

The sampling "design" represents multistage sampling of fish where the primary sampling units (PSUs) are the individual vessels, and individual trips are the secondary sampling units (SSUs). Sampling of lower level units involves subsampling of the

catches of individual fishing operations, and random sampling of fish. Crew members onboard the RF vessels are trained to conduct self-sampling following IMR's protocols and are required to record detailed catch logbooks electronically.

2.3.5.2 Approach taken

A no-discard policy in Norwegian fisheries changes the focus of management and fishery indicators from landings to catches and from production to total fishing mortality.

Norwegian fisheries' management measures are designed to ensure that unwanted fish are not caught, and combines complementary measures in support of a no-discard policy. The main elements of Norway's discard policy include; (i) a requirement to change fishing grounds, temporal and permanent closure of fishing grounds (since 1984); (ii) a ban on discarding of commercial important species (since 1988, the list of species has been extended since 2009); (iii) special regulatory measures for certain fisheries; (iv) development of selective gear technology (since 1992-1997); (v) mesh size and minimum catch size of fish.

With a no-discard policy it is difficult for observers to get data on discards unless having a close to 100% observer coverage. The plan is therefore to either let the fishers in a reference fleet report (self-sampling) about discards by day or haul and raise this to total fleet effort, or use complete haul/set data (all species and sizes recorded) collected by the Coast guard, the Directorate of Fisheries or self-sampling fishers, and compare this information with landings data from the same vessels/fishing areas.

2.3.5.3 Primary vessel list

Below is a summary of the status of the Norwegian Directorate of Fisheries Register of

Norwegian Fishing Vessels (vessel register) as of 31 December 2012 (Anon. 2013). This register contains all fishing vessels used commercially.

The Figure 2.3.11 below shows the development in numbers of the active Norwegian fishing fleet since 1990. This is further broken down by area (county) in the following table 2.3.21.

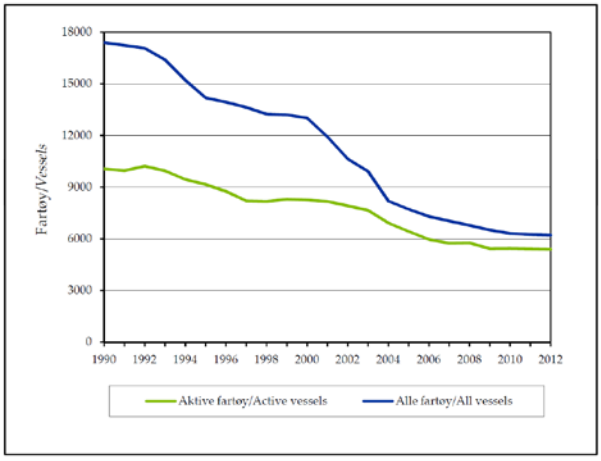


Figure 2.3.11 Development in numbers of the active Norwegian fishing fleet

Table 2.3.21

Geographical distribution (county)	LOA 0-<10 m	LOA 10-<15 m	LOA 15-<21 m	LOA 21-<28 m	LOA ->28m	TOTAL
Finnmark	465	322	23	9	15	834
Troms	426	290	19	17	23	775
Nordland	635	657	78	47	31	1448
Nord-Trøndelag	95	61	1	3	2	162
Sør-Trøndelag	145	106	3	2	5	261
Møre og Romsdal	274	211	8	14	76	583
Sogn og Fjordane	118	79	5	10	25	237
Hordaland	213	106	6	9	49	383
Rogaland	143	87	4	12	17	263
Vest-Agder-Østfold	267	161	8	12	6	454
Total	2781	2080	155	135	249	5400

2.3.5.4 Vessel registers by gear/fisheries and areas

By combining the information from both the vessel register and information from the Register of landings (catch register) one may get a picture of the share of the fishing fleet that actually is used for commercial purposes each year and hence a more correct population of vessels to sample from.

Based on recent years sales notes (trip-tickets) statistics (example from 2011 below) the effort can be further grouped in gear categories and/or target species categories. Note that the number of gillnet vessels in 2011 (6 858) exceeds the registered total number of active fishing vessels in 2012 (5 400) (see Table 2.3.22 below). Most of this discrepancy is caused by some vessels counted twice since they may have been sold and re-registered with a new registration number. This can be avoided if call sign, which stays the same irrespective of owner, is used instead of vessel registration number.

Table 2.3.22 Numbers of vessels by gear group.

Gear	Nos. different vessels	Nos. trip-tickets	Landed catch (1000 t)
Gillnet	6858	453216	157
Handline	4909	112540	40
Traps, fyke nets	3714	57332	8
Longline	2802	130082	143
Purse seine	1018	17836	1162
Shrimp trawl	680	101141	25
Danish seine	656	51012	89
Demersal trawl	386	32515	451
Pelagic trawl	142	1894	179

Below are given some examples of different approaches for sampling discards data and estimating discards when discards in reality is forbidden. The characteristics of these fisheries demand different sampling and estimation procedures. Pilot studies on this are currently conducted in Norway, and it is the plan to extend this to other fisheries and other/all areas to be able to give an estimate of total discards and unreported bycatch in Norwegian fisheries in future.

2.3.5.5 Pelagic fisheries

Norwegian herring and mackerel catches are mainly caught with purse-seiners. Most of the catches are for human consumption and the price paid for a catch depend on the size and quality of the fish. There is little quantitative information on the bycatch of non-targeted species in the pelagic fisheries. Although the bycatch is thought to be a small fraction of the total catch, the impact on the ecosystem could still be important because the pelagic catches are very large. The catches of pelagic species are typically pumped into holding tanks and delivered to the landings facilities without any sorting at sea. It has therefore been proposed to study how unreported bycatch/discards can be estimated by sampling catches delivered at landings facilities. A source of undocumented mortality at sea is caused by the slipping of fish of unwanted species, size or quality, or because the catch is too large (e.g. exceeds vessel capacity or the allocated quota). Norwegian law prohibits slipping of dead or dying fish, but such practices may, nevertheless, occur. Registration and estimation of slipping will, however, require other methods than described here.

Norges Sildesalgslag (NSS) is a nationwide sales organization for pelagic species owned by the fishers and is Europe's largest market provider for the sale of pelagic fish through electronic auctions. The most important species targeted by the pelagic fishery are herring, mackerel, blue whiting and capelin caught in the Barents Sea. NSS also handles foreign vessels that choose to land their catches in Norway. A close collaboration between IMR and NSS is essential to developing cost-effective schemes for sampling catches at landing facilities. NSS can provide a complete list of businesses where catches sold by NSS are landed and can provide real-time information about the pelagic fishery including; estimated catch size of the target species, where they will land the catch, and estimated time of arrival. Such information will be used to allocate the sampling effort among landings facilities efficiently over time. The sampling of landings will involve a multistage survey. The sampling frame will be based on a list of landing sites, with primary sampling units (PSU) being landing sites/days. Vessels that land catches from a fishing trip at a landing site/day (PSU) will form secondary sampling units. The survey design employed will include stratification of PSUs based on location, information on the expected proportion of total catches landed at the sites, season, etc. Each PSU may be stratified based on vessel type and target species.

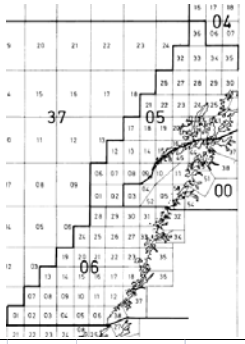
2.3.5.6 Demersal fisheries:

The data for estimating bycatch-rates for the demersal fisheries will be obtained from different sources at sea including the offshore and coastal reference fleets, the Coast Guard, and from surveillance. The two self-sampling reference fleets report discards in two different ways, indirectly and directly. The high seas reference fleet do it indirectly by every day reporting everything caught in a haul or set, i.e. total catch of all species, without separating what is retained and what is discarded. This is also how the Coast Guard and the Directorate of Fisheries are sampling and reporting from an onboard inspection at sea. The coastal reference fleet, however, reports daily and directly the number of fish discarded.

For the high seas fisheries, estimates of bycatch are obtained by comparing at-sea collected data with landings data, including the sales receipts available from the Directorate of Fisheries. The difference will be assumed to be unreported bycatch, most of which is discarded at sea. The analysis will include the comparison of reference fleet data with data from similar vessels in the entire fleet, by statistical area, month (or quarter if the data analysis indicates that this is more appropriate statistically) and by

main gear categories. Vessel size will also be taken into account in the analysis, using the size groups < 14.99 meters, 15-27.99 meters, and > 28 meters (or 300 GRT). In addition, data from the Coast Guard and surveillance will be used for quality control purposes and estimation verification (for example, existing paired experiments) of self-sampled data from the reference fleet.

Table 2.3.23 shows an example of discards estimation for small coastal vessels (gillnetters < 15 m) by using data from the coastal reference fleet. The PSU is a trip assuming that a sales note (trip ticket) represents the entire catch landed that day.



Time: 1st quarter 2012
Fleet: Gillnetters < 15 m in areas 0, 5 and 6
Discarded species: Cod

Area	# Reference fleet gillnetters < 15 m fishing in these areas	Reference fleet gillnetters < 15 m - Discarded cod in numbers	Trips or salesnotes	Discarded cod per trip	Total trips or salesnotes for gillnet vessels < 15 m in 2012 Q1	Sampling coverage	Total numbers of discarded cod by this fleet in 2012 Q1	Average cod length (cm)	Estimated individual weight (kg)	Discarded cod in tons by this fleet in 2012 Q1
0	3	295	93	3.17	7147	1 %	22671	90.8	8.2	187
5	6	235	170	1.38	6639	3 %	9177	90.1	8.0	74
6	2	185	67	2.76	3604	2 %	9951	78.8	5.4	54

The Norwegian procedure for estimating unreported bycatch or discards from the high seas demersal fleet (larger than 28 m) producing and freezing the fish at sea are illustrated below. Discards of entire species groups that are of no commercial interest are easily detected by comparing sampling at sea of entire haul/set catch compositions with what is being landed and sold according to the official sales notes. More difficult and challenging is it to observe and quantify "highgrading", i.e. discarding of undersized commercial species, since this kind of discarding may happen during the production and freezing of the fish at sea.

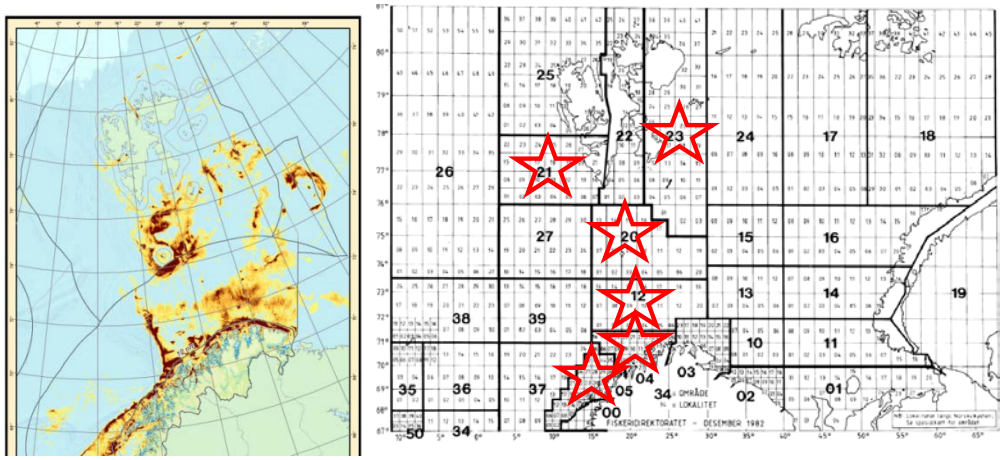


Figure 2.3.12

In order to avoid thawing the landed fish for length measurement, trawlers and long-liners are asked to deliver their on-board production reports which report the fish in size groups, read weight-groups. The production report size categories are then used and considered good proxies for the length distribution of landed fish. The difference in size distribution of landed fish and fish measured at sea is then indicative of highgrading and discards due to size. In a pilot study VMS data are used to define the population of vessels fishing in the relevant areas (i.e. areas 04, 05, 12, 20, 21 and 23) marked with red star symbols in the text Figure above. These vessels are requested to deliver their production reports.

2.3.5.7 Shrimp (Pandalus borealis) fisheries:

It has been recognized that the bycatch of other species is a common problem in shrimp fisheries (e.g. Cook, 2003; Garcia, 2007; Gillett, 2008). In both Norway and Russia, the practice of discarding fish is forbidden. In shrimp fisheries, however, small amounts of undersized fish are allowed to be caught as bycatch and discarded. In 1983, the Joint Soviet-Norwegian Fisheries Commission imposed a regulation that implied that fishing grounds would be closed if the number of taken as bycatch undersized cod and haddock exceeded certain limits per kilogramme of shrimp, and Norway therefore established a programme for the extensive monitoring of sensitive fishing areas. Since then, redfish and Greenland halibut have been added to the list.

The general outline of the estimation procedure is as follows: Bycatch or discard rates observed in research surveys and surveillance surveys are used as estimates of bycatch rates in the commercial fishery by taking account of the difference in selection properties of the gears used. Commercial shrimp catch by quarter and locality (the small rectangles in the Norwegian catch reporting system – see Figure 2.3.12 above) are combined with the surveys observations in the same quarter and locality. The observation "cells" are thus defined as the localities with commercial catch within a quarter. For cells with missing survey observations the discard rates are estimated by using all the observations within the whole Main Area. The annual bycatch estimates were then scaled according to the amount of catch not covered by survey data. Finally, the discard was raised to the total international shrimp fishery in the Barents Sea (Ajiad et al. 2007). A model-based estimation has been proposed in which spatio-temporal models are constructed for the variation in both the yield of shrimp and the amount of bycatch in space and time (Aldrin et al. 2012). Such a model can also be used to improve future sampling by deciding in which areas and seasons new samples are needed, or where sampling can be reduced.

2.3.5.8 Summary

The sampling design under a discard ban may be set up differently dependent on the fishery. The total catch may be separated into a retained part and a discarded part by sampling at sea with the discarded part finally raised to an appropriate total effort measure for the fleet/population in question. If this is not done reliably when having observers on board, an alternative would be to establish contracts with a number of representative fishers/fishing vessels (e.g. the Norwegian Coastal Reference fleet) that in a trustful way report and measure their discards daily. Another alternative procedure being used and tested in Norway is to let contracted fishers (e.g. the Norwegian High seas Reference fleet) or observers onboard, or the Coast Guard or inspectors from the Directorate of Fisheries report everything caught in a haul/set, e.g. per day, and compare such data from an area/fleet/period with the landed fish from the same area/fleet/period. The difference may then be recorded as discards. And finally and illustrated by the shrimp example above, if we know that everything of a species

and/or size-group is being discarded, then we may put an estimated selection curve on a scientific research survey gear to make that resemble a commercial gear, and from this estimate what is most likely discarded in the commercial fishery fishing on the same grounds. The use of such research survey data may also be extended to other periods if we can assume that the fish species/-size-groups are not migrating in or out of the area during the time difference.

2.3.6 Case-study 6: France

The objective was to examine whether the current strata of the métier-based sampling scheme of the French onboard observer programme are made up of homogeneous groups of vessels. The material consisted of the lists of vessels for 41 strata or substrata that were considered in the 2012 sampling plan. Not all strata could be included in the analysis because these lists are not generated for all métiers. The vessel lists included 2149 vessels which appear in 2979 occurrences. The number of occurrences of individual vessels in different métiers is reported in Table 2.3.24. Each vessel was listed in up to 6 métiers with 1498 vessels (70% of vessels) being listed in a single métier and 519 vessels being listed in two métiers. The distributions of vessel length, main and secondary gears, and area of registration were plotted per métier.

Results suggest that the current strata are very heterogeneous in vessel length, main/secondary gear used, and even area (Figures 2.3.13-2.3.16). Since this sampling frame had been designed to optimize precision of discard weights for the most important species, this suggests that it might be difficult to generate efficient strata based on vessel characteristics present on the EU Fleet Register only.

Table 2.3.24. Distribution of the number of occurrences of a given vessel in various métiers.

No of occurrences in different métiers	1	2	3	4	5	6
No vessels	1498	519	99	21	10	2

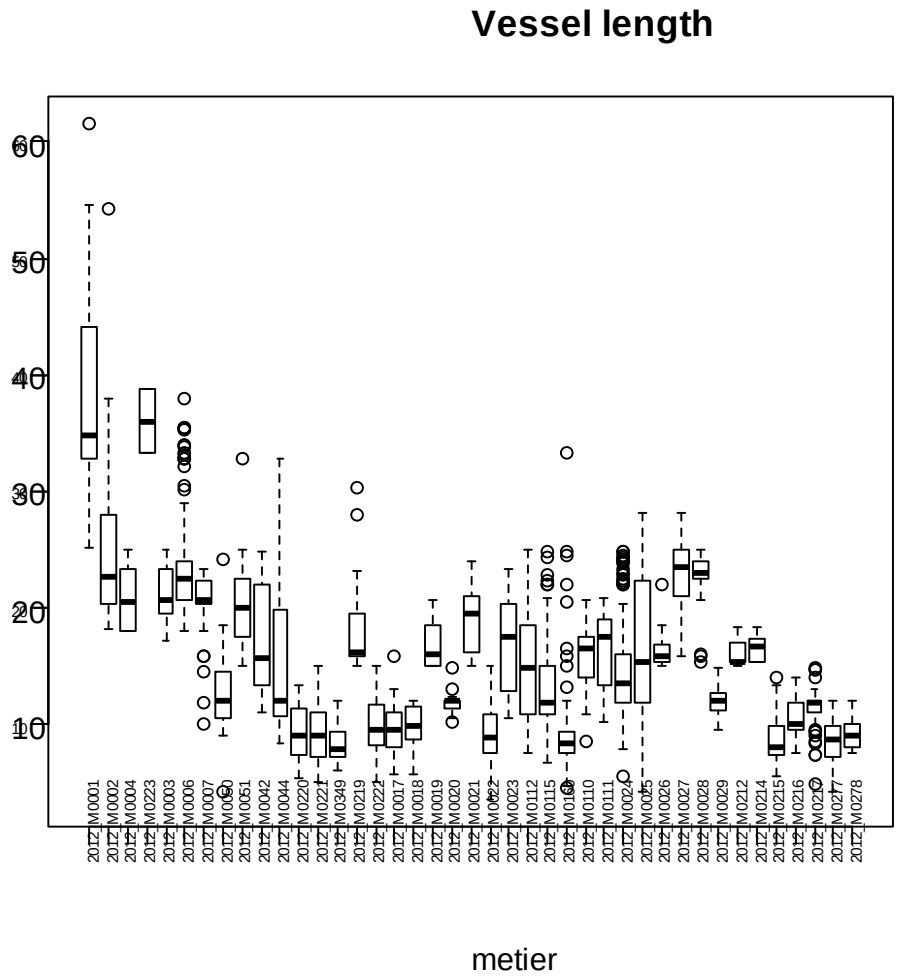


Figure 2.3.13 . Distribution of vessel length (m) for the vessels operating in each of 41 strata in the 2012 French sampling plan.

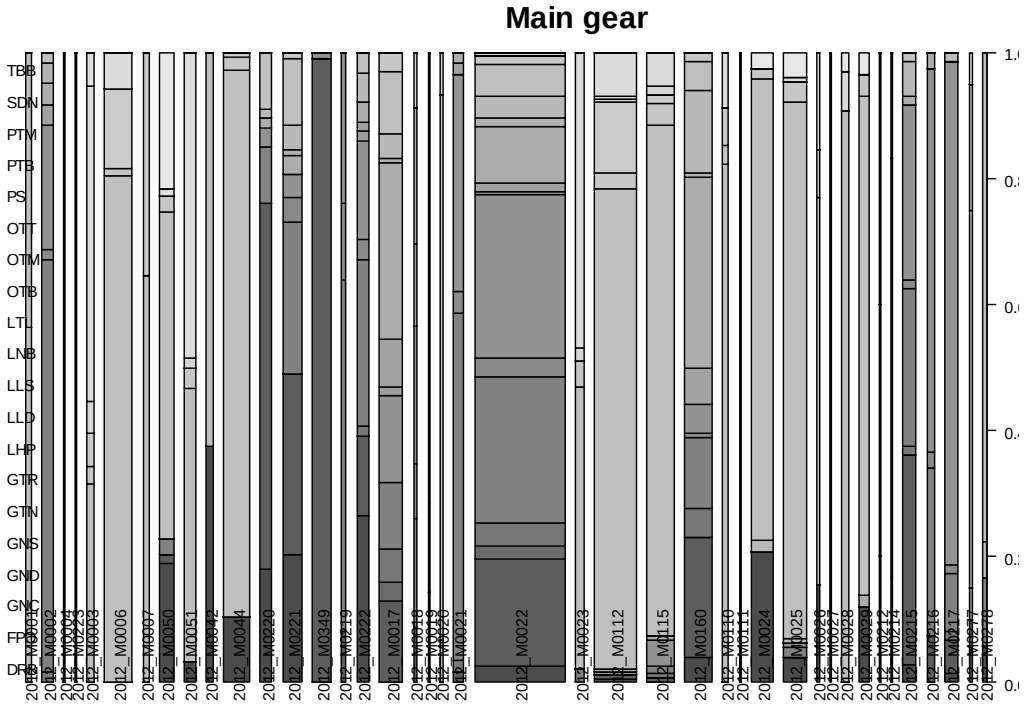


Figure 2.3.14. Distribution of main gear for the vessels operating in each of 41 strata in the 2012 French sampling plan. Grey levels run from light for passive gears to dark for active gears.

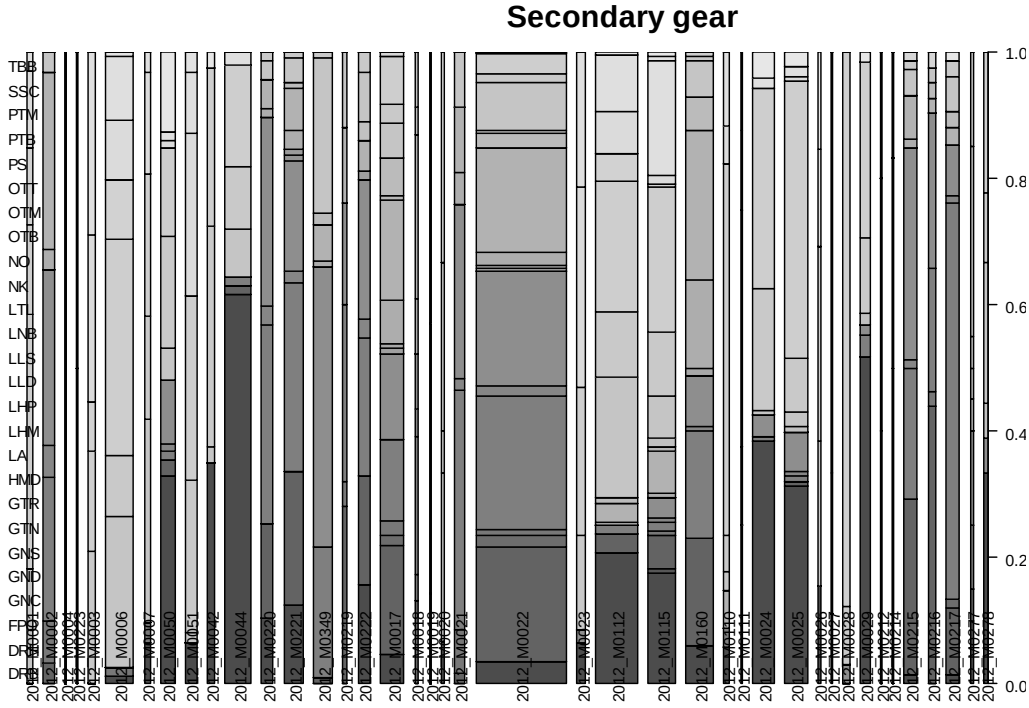


Figure 2.3.15. Distribution of secondary gear for the vessels operating in each of 41 strata in the 2012 French sampling plan. Grey levels run from light for passive gears to dark for active gears.

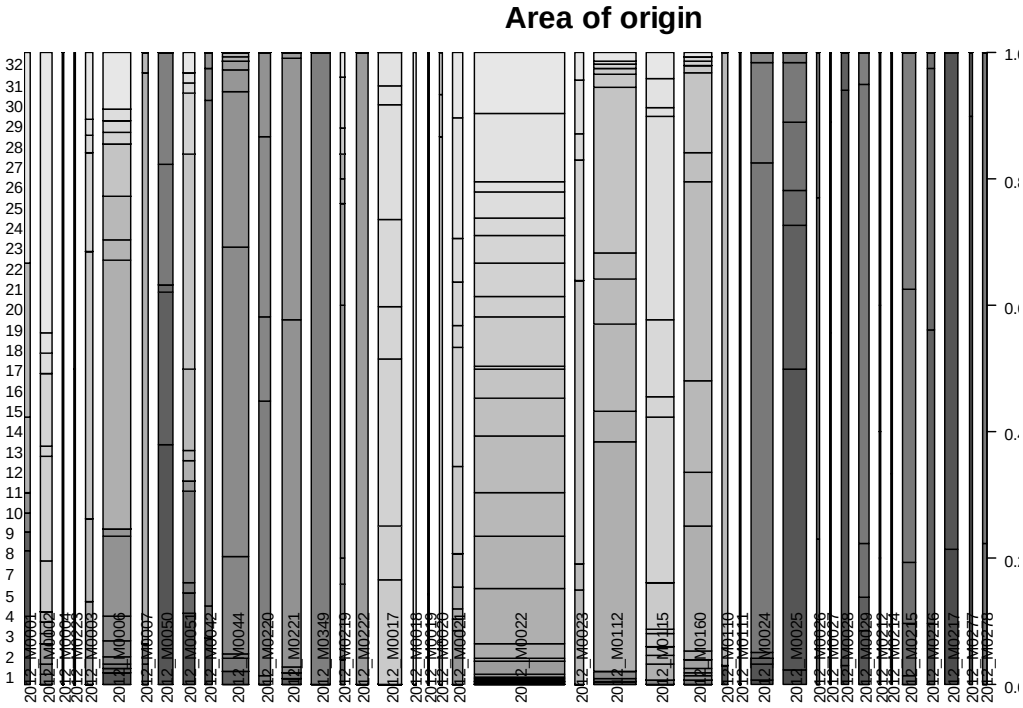


Figure 2.3.16. Distribution of area of operation for the vessels operating in each of 41 strata in the 2012 French sampling plan. Grey levels run from light for Northern areas to dark for Southern areas (Mediterranean excluded).

2.4 A template for regional sampling programme: the Skagerrak example

In 2013 Sweden, Norway and Denmark started a small-scale regional project to move towards a common sampling frame in the Skagerrak area. As Skagerrak will be the first larger area within the EU with a discard ban in place, it was thought that a better understanding on the different sampling programs both in harbours and at sea, was needed to make a estimate on the total catch within an area. The first step in this project was to agree on a set of variables to be analysed. Three different datasets were outlined in the study group.

- An Exchange format for an at-sea sampling frame
- An Exchange format for VMS data coupled with logbook information
- An Exchange format for the harbour sampling frame.

The first meeting was spent with agreeing on the variables used in the 3 different dataset to obtain a common understanding on the needed variables.

If a common sampling frame is to be set up for the harbour and at sea sampling programs, an overview of where the landings from Skagerrak take place most be in place, and where the nations have landings in other countries.

The landing harbour and the sales harbour is not always the same. Some landings are transported by truck from the landing harbour to an auction in another harbour. Therefore, in order to sample most cost-effective both information are needed.

To investigate if landings from several countries are in the same harbour, a common harbour reference as well as coordinates is needed for the harbours. UN has a standard code format called LOCODE, and EU has collected harbour codes from the na-

tions in a common excel file, which has been modified into the attached csv file. The file has many harbours in Europe, but is not complete, and especially the Norwegian harbours are missing.

The Buying Company is also included in the exchange format, as the main part of the landings ends up at the same buyer, and to make a cost-effective sampling scheme analysis should be conducted to investigate if the landings can be sampled from there.

The goal is to have a common dataset hosting all three nations' datasets on the agreed variables. Thereafter analyses will be conducted on where the main landings are conducted by species, compare the VMS plots to analyse different spatial behavior within the same fleet segment but between countries and to look into species compositions within the different fleet segments.

2.5 Discussion

2.5.1 Sampling frames construction and stratification

The case-studies in this section demonstrate some of the opportunities and some of the challenges that member-states will find when, under DC-MAP, they seek to implement probability-based sampling schemes.

The case studies demonstrate that the first requirement for setting up sampling frames, being able to access lists of vessels, is well met. The EU fleet register provides lists of vessels, by nationality, and includes details such as length and tonnage and, to a degree, details on the fishing license/mesh size/area of operation. However in themselves such lists do not always provide all the desired information on a vessel's activities that are required if informed decisions are to be made about stratification. At the national level, logbooks, vessel licences, sales information and various other sources of information are available to supplement, or in the case of logbooks and sales notes, to provide more reliable information on the fishing operations of a nation's active vessels.

The process of stratifying national lists into sampling frames throws up a number of issues.

First the analysis of the national lists demonstrates that in many instances large numbers of small vessels can be removed from the total population because of the difficulties in the on-board sampling of vessels under <12m. For these smaller vessels, there are often concerns in placing observers on-board because of a lack of space and for safety reasons. Alternative ways to sample these fleet components might include CCTV or self-sampling programmes. In a number of the case studies the removal of these small vessels results in the study populations left consisting of relatively few larger vessels (e.g. PT ~ 370 vessels, DE ~ 110 vessels, SW ~ 182 vessels).

The second aspect of the case studies was that it was in most instances feasible to stratify a national vessel list into a few large strata, based on gross characteristics of the vessels or their predominant type of fishing. For example the Danish case study explored a stratification based on vessels operating active and passive gears, the Portuguese case study a stratification of the national fleet based on trawlers, purse-seiners and "other", the Norwegian reference fleet is stratified into high seas and coastal components, and the German scheme splits fleet components into pelagic, trawlers and gillnetters. There are also instances of stratification by areas: Sweden, Germany and Denmark all make a distinction between vessels operating in distinct fishing areas such as the Baltic, Kattegat, Skagerrak, and North Sea.

The case studies also demonstrate that there is a general desire to refine primary vessel lists as much as possible so that strata consist of those vessels conducting particular fisheries. This is the situation in the Portuguese case study where a trial was made to isolate the vessels fishing for small pelagics with purse-seines from those that carry a purse-seine license but fish for something else or use other gears the majority of time. In the Danish case there is the issue of allocating trips to at-sea observer teams operating from different locations. In both cases, a need was felt to further divide vessel lists into more spatial or fisheries explicit groupings. From the case-studies, is was shown that by considering supplementary information, such as logbook information or landings records from previous years, it was possible to obtain subsets of vessels that are more likely to meet particular objective criteria. Fisheries are dynamic by nature and there will be no guarantee that vessels will behave similarly to historical records in the upcoming year. However, as the Portuguese case study suggests, if a robust threshold criteria is used on this historical data, and the fishery is reasonably predictable over time, then it is likely that mutually exclusive vessel lists (by fisheries or area) can be obtained.

The conclusions of the French case study suggest that to arrive at non overlapping vessel lists by a process of pooling vessels based on the métier of the trips they undertake is problematic not least because 30% of the 2149 vessels in the French fleet are active in more than one métier. On the other hand the characteristics of the vessels available from the fleet registers, on their own, did not provide sufficient information to enable vessels to be assigned to distinct métier defined groupings.

A recurring theme in the case studies concerned the problem of reconciling the requirement to provide data for quite tightly defined fisheries (often based on area, species group, and gear definitions) with the sampling frame approach. Important fisheries cannot always be easily separated out as being conducted by clearly defined groups of vessels. This problem can be compounded by the knowledge (as in the Swedish case) that distinct fisheries have quite different discard rates and often different non-response rates. Another manifestation of this problem are the polyvalent vessels, those operating a number of different types of gears and thus potentially active in a number of different fisheries. While these vessels were often the smaller ones in the fleet, this need not mean that their contribution to the discards is necessarily small. Given that national institutes have limited resources for on-board sampling (Germany ~ 54 trips Sweden ~ 104 trips Portugal ~ 111 trips) and are obliged to make best use of those resources, there is a very real desire to ensure that sampling effort is used to best effect.

The practical approach to this problem that emerges from the case studies is the practice of allocating trips in a more tightly defined way than the sampling frame is stratified. This gives rise to what is best described as a dynamic selection process, where the selection of a vessel from the list is conditional on the vessel's activities. For example the German, Danish and the Swedish scheme all use, in effect, a conditional acceptance criteria from a fleet list based on the activity of the vessel when it is contacted; for example whether it is operating in a particular area or using a particular gear type. One consequence of this approach is that the selection process generates an often substantial number of "unavailable" vessels that do not meet these conditions. How this "unavailable" category is dealt with in the selection process is considered at length in section 4. This approach has parallels with, for example, a social survey of smokers where households are selected but a resident in the household can only provide data if they fulfil a particular criteria i.e. they are a smoker (GATS 2010). The

implications of such an approach are in the calculation of sample weights at the estimation stage.

It is worth considering the role of domain estimation and post stratification in the design of a sampling scheme. A widely held misconception is that in order to estimate for a particular fishery, for example defined by métier, sampling needs to be targeted at that fishery. This is not the case. If probability based sampling of vessels can be achieved then the realized samples will yield data for the activity of those vessels that is both unbiased and up to date regarding the areas they fish, the gears they use and the species composition. Domain estimation can be used to generate estimates for particular fisheries by grouping all relevant data after they are collected. Post stratification can be used to correct for known imbalances in sample data, for example by comparison with census data available from logbooks (WKPICS 2 ICES 2012b). Both these stages in the estimation process appear to be rarely, if ever, used in the generation of catch estimates used for stock assessments.

2.5.2 Sampling effort allocation

Statistical theory indicates that sampling effort should be allocated in the most optimal way to attain desired precision level in the final estimates; small strata that contribute little to final estimates should be sampled less then large strata particularly if the large strata contribute more to the total and have high internal variability. Due to time constraints, issues around sampling effort were not extensively discussed during SGPIDS. However, the Portuguese case study does show that sampling effort allocation can provide very different results when different variables (vessels, landings, discards) are considered. This example points out that when only landings are considered a disproportionate amount of effort may end up being allocated to pelagic fisheries that discard relatively little (but that may have much slipping). As such a more reasonable approach may involve allocation based on the number of vessels or the number of trips. Such an alternative will be more feasible if the size of trips does not vary much within each stratum. Another alterative discussed was the use estimates of discard obtained in previous years to estimate the variability and contribution of the strata to the total discards of the national fleets. However, one should notice that discard patterns are subject to regulation and public/consumer perceptions that change throughout the year and that, with current budgets, there will always be relatively large segments of the fleet (e.g. <12m) where information may be absent or have little quality.

A consideration in the allocation of effort between strata is that in order to generate estimates of variance, precision and confidence intervals around estimates, then sufficient replicates samples are needed. It can be shown (ICES 2011a) that if nonparametric bootstrapping is used to generate confidence intervals then something upwards of ten replicate samples are the minimum needed to generate confidence intervals that reflect the true 95% distribution of a sample mean. Given that available sampling effort for national institutes from the case studies ranges 50 to 100 trips per annum this would suggest (taking a Figure of 12 sampled trips per strata) that the maximum number of strata for a national sampling scheme would be something like 4 to 8 strata. Over stratification leads to the reliance on imputation techniques to generate estimates and prevents credible precision estimates being calculated.

2.5.3 Quality indicators

WKPICS 2 (ICES 2012b) developed the suggestions from SGPIDS 2 2012 (ICES 2012a) for a quality assurance report for regional assessment data from at-sea sampling. This

template is reproduced in Figure 4.8. The quality indicators relevant to the design of the sampling frames and the allocation of effort are:

- The proportion of the national landings contributed by the vessels in the strata
- The size of the population being sampled, (number of vessels and number of trips)
- The number of realized samples, (number of unique vessels sampled and number of trips sampled)

These Figures were generated for the Portuguese and German case studies. A number of general conclusion were apparent from these indices.

First that the total population i.e. the size of the national fleet, needs to be specified, in particular the number of active vessels and the number of trips they made should be recorded. This should be broken down into the number of vessels by sampling strata *and* the number of active vessels that are not included in any sampling strata. The recording of active vessels is important; for example vessels under 12m vessels may be deliberately excluded from the sampling frames but should still be recorded in the population total. Conversely, sampling frames derives from vessel registers may include a number of vessels no longer active, which would be inappropriate to include in the population total. Population totals are likely to be known with greater certainty from logbook and sales note data than the EU vessel register. Set against this should be the envisaged number of trips planned *and* the realized number of trips sampled, the number of unique vessels sampled. This is, in effect, a simple numeric summary of the national sampling plan and the extent to which the sampling plan was achieved. In its totality the achieved sampling plan also expresses the coverage expected for a particular stock.

Second a useful distinction is to be made between the "input" and the "output" quality indicators. The input quality indicator would be the envisaged sampling plan, consisting of the number of planned trips to be sampled per strata. The output quality indicator would be the number of sampled trips, by (sampling) stratum, and/or domain actually achieved. The input sampling plan is of relevance in the evaluation of national proposals, the output realized sampling is of relevance to, for example, the assessment working groups that make use of the gathered data and derived estimates.

A possible quality indicator and a useful tool in the design of a sampling scheme, that was briefly discussed, was the design effect. The design effect is the ratio of variance of an estimate achieved by a particular sampling design, over that achieved from a simple random sample (see for example Moser and Kalton 1979, Lohr 2010). The estimate cannot of course be a direct estimate of discards but could be a suitable auxiliary variable. Alternative ways of stratifying the population could quite easily be explored using a simple simulation that replicated the envisaged design run on the census of trips by vessel available from a previous year's logbook data.

3 Vessel selection, non-response rates and refusal rates (ToR A and ToR B)

Probability based selection (random sampling or systematic random sampling) is fundamental to a design based estimate. Without it none of the assumptions of the estimates hold, you cannot calculate a measure of variance and you have no way of assessing bias. For an at-sea sampling programme the selection of the vessel is therefore critical to the whole process. This theme deals with the placing of an at-sea observer on a fishing vessel (though the principles apply equally to obtaining a sample from a vessel in a self-sampling scheme or from a reference fleet). It will build on the work of SGPIDS 2 (ICES 2012a section 4.2) in the calculation of a standard non-response and refusal rate and the WKPICS 2 quality indicators (ICES 2012b table 4.1).

This theme will consider:

3.1. Ways of identifying which vessels are available to be selected.

3.2. Practical ways of randomizing the selection of the available sampling units (vessel/trips)

3.3. Recording the selection process, using contact logs, selection forms etc

3.4. Communication

3.5. Calculating non-response and refusal rates to allow between nation comparisons

3.6. Linking samples to populations and ways of identifying bias.

3.7. Quality indicator table and potential end-users

3.1 Ways of identifying which vessels are available to be selected

Not all vessels within a draw list will be available for an observer trip. To make sure that numbers used for quality insurance between countries are comparable it is important that all countries use the same procedure for identifying these vessels.

Once you have a randomized vessel draw list for a fleet segment, you can start your contact attempts with the first vessel. You can call the skipper or vessel owner and ask if you can sail the next trip and categorize the answer according to section 3.3. Alternatively it may be possible in some instances to categorize a vessel as "Not available" without having contacted the vessel at all. This decision needs to be based on legitimate sources of information and is only applicable during the time window when the trip is to be undertaken. These sources of information can include

- VMS (Vessel Monitoring System, if the national institute has real-time online access to it),
- AIS (Automatic Identification System, see marinetraffic.com),
- Reliable information from other skippers you have talked to before (vessels from the same port usually know what the other vessels are doing),
- Reliable information from fishing associations, or
- other expert information.

Although there may be prior information on a vessel being "Not available", you may want to call the skipper to verify the information and introduce yourself to ensure

cooperation in the future or maintain contact. If there is no prior information on the availability status of a selected vessel, you should call the skipper or vessel owner directly and assign the answer to one of the categories given in section 3.3.

3.2 Randomizing the selection of the available sampling units (vessel/trips)

Different countries use different tools to create randomized vessel lists (e.g. using Excel, R; see also ICES 2012b). In addition, the use of randomized lists differed remarkably between countries.

Observers in UK-Scotland have a short time window to get onboard a vessel and the vessel list is reshuffled each time an observer gets a trip. Each single contact attempt (1 phone call) is considered as one attempt and the outcome transferred to the contact summary table. Many vessels can be categorized as "not available" using live-access to VMS information without phoning a skipper at all.

UK-England uses one randomized list for several observers simultaneously and the list is only reshuffled once each quarter. In case of no answer at the first contact attempt, usually three phone calls are used to check whether the skipper takes an observer. Trip opportunities are kept open for a maximum of one quarter.

Denmark uses the "lucky wheel", where vessels are weighted according to the number of trips. For each contact attempt the lucky wheel generates a new vessel at the top of the list. Observers call up to five times at different days in case of no answers in previous contact attempts. Trip opportunities are also kept open for a maximum of one quarter.

Baltic-Germany has a randomized list from which mainly one trip organizer assigns sampling trips to the observers. The aim is to get an observer trip, a self-sample or at least a personal statement from each vessel by contacting vessels one after the other on the list. Vessels unavailable at the time of contact enter a waiting loop where they can be "kept warm" until the end of the 1 year, but commonly until the next trip opportunity. The randomized list would be reshuffled once the end of the list is reached but effectively one randomized list is kept throughout the year.

The differences between countries in the practical ways of using randomized vessel lists rest on the

- different time windows used to ultimately board a vessel (the next trip (UK-Scotland), within a quarter (UK-England, Denmark), a year (Baltic-Germany)),
- use of a waiting list vs. instantaneous assignment to a contact categorization after one phone call (UK-Scotland only)
- different time-scales of re-shuffling the lists (e.g. reshuffle at the end of the list (UK-England, Baltic-Germany), reshuffle after each vessel selection (Denmark) or after each successful attempt (UK-Scotland)),
- centered responsibility of one trip organizer vs. several observers contacting vessels at different locations.

Figure 3.1 to Figure 3.4 show examples of draw lists used to sample Scottish trawlers, German gillnetters, English-Irish Sea Trawlers, and Danish beam trawlers. These examples demonstrate the diversity of approaches to generate and employ a randomized vessel list.

Despite the variety of approaches, a few basic considerations emerged:

- The randomized list has to be reshuffled either each sampling event or once you have reached the end of your randomized list.
- Vessels on the randomized list should be contacted from top to bottom one after the other.
- A waiting loop should be avoided; if a waiting loop is considered necessary, the number of contacts attempts should be standardized (e.g. to 3 or 5) before a vessel is assigned to contact category. In fact, the group was not sure whether a waiting loop is acceptable at all. Input from professionals involved in established telephone polls could be useful and these people may be contacted by members of the group prior to WKPICS 3 or the future WKCATCH. The main issue with a waiting loop seems to be the importance of maintaining equal probability by ensuring that each vessel on the list is approached with equal probability.

If the quarter is a stratum in the national sampling scheme, the vessel list should be re-shuffled at the start of each quarter whether or not the end of the randomized lists has been reached.

Demersal Observer Vessel Selection Form

Demersal Trawer vessel list as of Jan 2013

This form has a unique selection order for the trip specified.

Work down the selection order using the response sheet to record either why a vessel was not contacted, or the outcome if contacted.

Observer …. Craig Davis	**Year**	**2013**	**Vessel Selected _Starlight Rays**
Trip Number…Craig #1	**Quarter**	**1**	**Trip Dates _26/2/13 - 5/3/13**
	Area	**IV**	

Vessel	Selection Order	Not Contacted	Contacted
FIDELITAS_LK45_A11569	1	9	
MARIGOLD_INS241_C16553	2	5	
ENTERPRISE II_BF1_C16778	3	5	
OCEAN BOUNTY_PD182_C16198	4	7	
ADVANCE_WY77_A11729	5	7	
SUNRISE_FR359_A11608	6	7	
CASTLEWOOD_FR216_A11809	7	7	
SEAGULL_BF74_B14307	8	5	
MAIMAI_FR432_A11754	9	7	
RYANWOOD_FR307_A24617	10	8	
JUBILEE SPIRIT_GY25_C16090	11	7	
ACCORD_BCK262_A11558	12	7	
ELEGANCE_PD33_B10890	13	7	
CRYSTAL RIVER_FR178_A10524	14	3	
ARTEMIS_WY809_A11530	15	7	
SARDONYX II_BF206_B13709	16	SELECTED !	
MINERVA_FR147_C16852	17		
OPPORTUNE_WK171_A13900	18		
SHARYN LOUISE_LK250_A10558	19		

Figure 3.1. Draw list used by UK-Scotland for demersal trawlers in Quarter 1, 2013 in the North Sea.

trip_target_species	COD			
area	SD2224			
gear_class	passive			
Contact number	**Random number**	**Vessel code**	**Vessel_name**	**vessel_length_class**
1	0,992213368	FRExx	a	10-<12
2	0,985169229	GOEHxx	bb	12-<15
3	0,923959101	PRExx	---	<08
4	0,764412762	THIxx	---	<08
5	0,742742164	THIxxx	---	08-<10
6	0,72755069	POLxx	---	08-<10
7	0,701635514	BRExx	c	10-<12
8	0,623444894	FRExx	d	10-<12
9	0,604601672	WATxx	ee	10-<12
10	0,598301108	...	...	...
...	...	...	...	...

Figure 3.2. Annual draw list used by Baltic-Germany for passive gear (basically gillnetters) targeting cod in ICES Subdivisions 22-24 in the Baltic Sea. The vessel list was randomized using random number generated in Excel.

					2012 Qtr3						
VesselOrder	RSSNo	CurrentPLN	CurrentName	VesselLength	MainPort	NoTrips	AvgTripLength	HistoricObs	LastObserved	LastTrip	Observer
1	A11129	MT126	BONNIE LASS III	16.45	Whitehaven	1	2	3	23/07/2008	WN1908NT	DG00
2	A13282	WA5	PATSY ANNE	11.58	Whitehaven	17	1.4	10	02/06/2013	WN313NT	SD01
3	A12509	WA73	RADIANT STAR	12.8	Whitehaven	19	1.8				
4	B12267	FD399	BAY VENTURE	9.9	Whitehaven	22	1	2	16/01/2013	WN213NT	SD01
5	A19658	BW27	NATALIE ROSE	9.49	Whitehaven	21	1				
6	A12343	FD170	ALBION	12.17	Fleetwood	6	1	19	09/08/2012	FD412OT	SD01
7	B11316	MT123	SAM LEWETTE II	12.2	Maryport	13	1.8	1	04/05/2010	MT110NT	SD01
8	C16654	CL12	NEW VENTURE	8.8	Whitehaven	2	1				
9	B14677	PH586	GWALARN	9.95	Whitehaven	12	1				
10	B12111	WA224	RACHEL CLAIRE	9.65	Whitehaven	16	1	1	15/03/2012	WN212NT	SD01
11	A23545	WA2	SYRINEN	11.6	Whitehaven	11	1.6	15	04/07/2012	WN412NT	SD01
12	A24798	WA38	BARBARA ANNE	11.92	Whitehaven	16	1.9	11	10/10/2012	NS312NT	SD01
13	A15230	BW147	WAKIL II	9.88	Whitehaven	2	1				
14	A17005	MT99	GOLDEN FLEECE	13.9	Maryport	16	2.7	2	08/04/2004	FH104SD	RF00
15	C19901	WO5	NEW VENTURE	9.88	Whitehaven	22	1				
16	A10890	WA8	HEADWAY	18.22	Whitehaven	3	4.7				
17	B12750	WA72	TEDDERA	9.45	Whitehaven	25	1				
18	A20613	WA85	CRYSTAL STAR	9.05	Whitehaven	10	1.9	2	05/09/2012	WN612NT	SD01
19	A13108	MT55	ALAUNA	14.98	Maryport	12	2.8				
20	A22154	E50	REIVER	10	Whitehaven	18	1				
21	A24699	MT188	SINCERITY II	13.39	Maryport	11	1.5				
22	A12116	MT66	OUR JAMES	13.57	Maryport	1	1				
23	C18548	MT23	CHELARIS	14.98	Maryport	28	1.8	2	28/07/2008	MT208XT	DG00
24	A10538	WA37	SCOTIA	11.25	Whitehaven	21	1.9	4	12/10/2010	WN110OT	SD01
25	C18074	M147	HARMONI	14.96	Douglas	1	1				
26	A13557	WA35	KINLOCH	12.8	Whitehaven	20	1.8	3	13/10/2009	WN909NT	SD01
27	A12373	WA223	MY LADS	9.8	Whitehaven	31	1				

Figure 3.3. Draw list used by UK-England for Irish Sea Trawlers (historic information is given for each vessel on their activity and the most recent observer activity to help with planning)

Klik for valg af fartøj

LOG-NUMMER:
Område 4_2. Kvartal
3

Log-nummeret er det nummer hvorunder kommentarer til turen noteres.

Husk at gemme regnearket inden du lukker det ned.

VÆLG ET FARTØJ I OMRÅDE IV (TBB 2. KVARTAL):

Resultat	Område	Fiskeri	Kvt.	Nummer	Længde	Ture i 2010	fangst kg	Basishavn
	4	TBB_CRU_16-31_0_0	2	HVXX	19,99	31	38468	Havneby
	4	TBB_CRU_16-31_0_0	2	HVXX	23,95	28	47310	Havneby
	4	TBB_CRU_16-31_0_0	2	HVXX	19,3	28	46971	Havneby
	4	TBB_CRU_16-31_0_0	2	HVXX	18	28	31613	Havneby
	4	TBB_CRU_16-31_0_0	2	EXX	17,04	23	34699	Esbjerg
	4	TBB_CRU_16-31_0_0	2	EXX	15,97	23	36869	Esbjerg
	4	TBB_CRU_16-31_0_0	2	LXX	18,05	23	23235	Thyborøn
	4	TBB_CRU_16-31_0_0	2	HVXX	15,9	20	24851	Havneby
	4	TBB_CRU_16-31_0_0	2	RIXX	16,01	20	20307	Hvide sande
	4	TBB_CRU_16-31_0_0	2	EXXX	17,22	18	26571	Esbjerg
	4	TBB_CRU_16-31_0_0	2	RIXXX	18,5	17	21444	Hvide sande
	4	TBB_CRU_16-31_0_0	2	LXXX	22,2	16	28413	Thyborøn
	4	TBB_CRU_16-31_0_0	2	EXXX	17,19	15	21796	Esbjerg
	4	TBB_CRU_16-31_0_0	2	EXXX	18	15	23599	Esbjerg
	4	TBB_CRU_16-31_0_0	2	LXXX	19	12	10270	Thyborøn
	4	TBB_CRU_16-31_0_0	2	RIXXX	16,26	12	7919	Hvide sande
	4	TBB_CRU_16-31_0_0	2	LXXX	20,7	8	12504	Oddesund nord
Dette fartøj er udtrukket	4	TBB_CRU_16-31_0_0	2	LXXX	17,19	8	11749	Thorsminde
	4	TBB_CRU_16-31_0_0	2	LXXX	18	7	9464	Lemvig
	4	TBB_CRU_16-31_0_0	2	RIXXX	18,5	4	5981	Hvide sande

Figure 3.4. Draw list used by Denmark for beam trawlers targeting brown shrimp in the North Sea in quarter 2, using the "lucky wheel".

3.2.1 Vessel selection in a Reference fleet

A special case of randomizing the selection of vessels is required when discards sampling is done by means of the establishment and maintenance of a reference fleet.

In the Dutch self-sampling scheme which uses a reference fleet, a maximum of 25 vessels participate continuously in the sampling each year. This group of vessels functions as a reference fleet and as such, within this group, random selection of contacting vessels as described for many other national programmes does not apply.

However, random selection can be applied when recruiting the vessels for the reference fleet. Over time vessels of the reference fleet may be sold, enter a fleet segment outside the interest of the reference fleet or exit the reference fleet for other reasons. Then the vessel has to be replaced and this should also be done following a random draw list. In addition, to allow for variation in the vessels of the reference fleet, a maximum number of years that a vessel can be part of the programme could be agreed. After that period, the vessels exit the programme and new vessels are recruited, again using the random draw list method. For practical reasons, it would be advisable to only replace a part of the group in a particular year (Figure 3.5), because the new vessels will have to receive training. Available resources at the national institute running the programme will constrain the maximum number of vessels that can be replaced every year. The implication of this is that initially, just after the start of the programme, vessels may be in the programme longer to allow for phasing in this method.

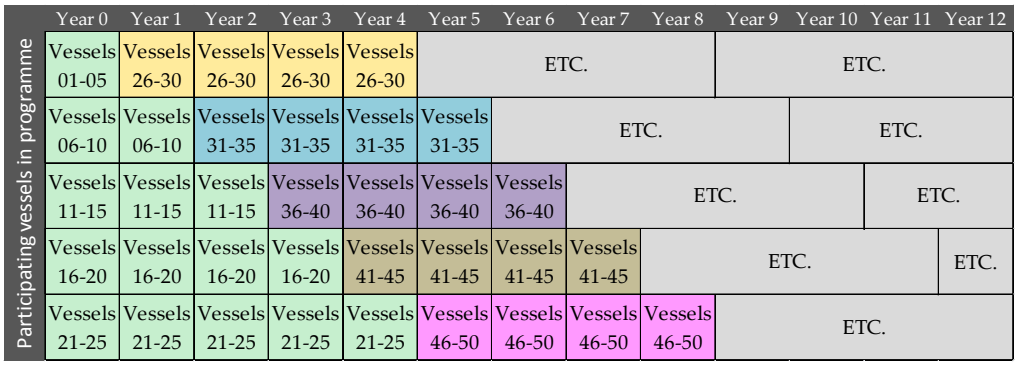


Figure 3.5. Schematic overview of an example of how phased replacement of vessels participating in the reference fleet to allow for variation in the composition of the reference fleet could be organized. Vessels 01-25 are the current participants (year 0). Year 1 indicates the implementation of this scheme. In year 1, 5 vessels are replaced, and another 5 in year 2 etc., until after 4 years the entire fleet has been replaced.

The Norwegian Reference fleet comprises 20 coastal vessels (mainly gillnetters, 9–15 m long) and 20 (at present 19) high seas vessels (32-80 m long) representing demersal and pelagic trawlers, purse-seiners, longliners and gillnetters. A tendering process similar to the description above has been developed such that not all of the vessels are changed at one time. A public advertisement (on the web and in newspapers) is used to give any vessel owner a chance to express his/her interest in joining the Reference fleet with all its obligations and opportunities. The chosen vessels that best fill all the requirements get a contract of 4 years. After 4 years half of the fleet will continue for another 2 years after a random draw by gear category for the high seas fleet and by statistical area (where the vessel's home port is located) for the coastal fleet. Those vessels that loose the draw will, however, get the opportunity to apply on equal basis as any newcomers for a new 4 years period. The current plan is thus to renew half of the fleet every second year, and to let each vessel get a 4 years contract.

3.3 Recording the Selection process

In order to calculate credible and comparable non-response and refusal rates each national at-sea sampling scheme must be based on:

1) a common contact protocol,

2) there must be a system for the recording and documenting the telephone calls or approaches made to industry (skippers, captains, vessel owner) when attempting to secure observer placement,

3) there must be a standardized way of categorizing the responses.

Contract Protocol

To ensure that a standardized contact protocol is in place it was advised that the request at point of contact should be for the *next trip.* The next trip can be defined as the next time/occurrence that the vessel in question would be departing port on a fishing voyage. This standardized request will negate the need for 'waiting list' or a second 'sub-list' for revisiting and therefore removes the possibility that these vessels will be selected with increased probability. It was recognized that the definition of *next trip* has to be for the trip that it is possible for the observer to be placed on. This is to allow for any necessary administration involved in placing an observer on a vessel.

The standard contact protocol would involve the following steps:

- Is the vessel available for sampling
- Can the vessel be contacted
- Is the vessel suitable as far as the observer / programme is concerned
- Is the contact attempt successful (i.e. were the phone calls answered)
- Was the vessel sampled

3.3.1 Recording the contact attempt

The selection process has to be recorded either by the observer of the trip organizer. This can be in the form of a vessel selection sheet (Figure 3.1), the electronic draw list (Figure 3.4) or a telephone log maintained by the trip organizer. An example of guidance for operating a selection for the English programme can be seen in Annex 4, and the list of categories for recording responses for the Scottish scheme are shown in Figure 3.6.

Categorizing the responses

The use of standardized responses allows each contact attempt to be recorded. It was felt that at-sea sampling programmes should, as a minimum, detail their selection categories within six grouping titles. Nations can of course decide to further divide these into appropriate subgroups but the 'minimum' as described (below) should be the accepted format for reporting

3.3.1.1 Not Available

Not available is defined as the vessel not being available for sampling access at the next fishing trip and within the programme sampling window. Sampling windows will vary between programmes as a result of some having full time or part time observers (spending their remaining working time on RV surveys, port sampling etc), and also on the number of observers available to individual programmes.

This category would be appropriate to vessels that were not possible to secure for reasons such as – already fishing at sea (and not returning in time to sail again for the sampling window), occupied on oil or guard duty related work, tied up for repair or maintenance work, has sunk or been sold, etc. It may also include vessels engaged in a non-target fishery or operating in an area not of interest, but this would depend on the specifics of the stratification used in the particular at-sea sampling scheme.

Vessels can be allocated to this category without actually having been contacted, by using tools such as VMS, AIS, market landings website, expert local knowledge, etc, see section 3.1.

The key identifier for 'not available' is the ability to be secured for the next trip. This response is one that the observer and or the vessel skipper/owner have no influence over.

3.3.1.2 No Contact Details

Obviously it will be impossible for an observer to arrange a voyage with a vessel if they do not have contact details for the skipper/captain. The subgroup felt that *every effort* must be made by the observer and the sampling/observer programme manager to secure contact details for all vessels of interest. It is advisable for at-sea sampling managers to attempt to secure all necessary contact details well in advance of the observer or sampling coordinator attempting to contact industry, in order to expedite the selection process. There are multiple sources of contact information, such as 'producer organization', fisheries inspectorate departments, harbour masters, industry

representative bodies, experienced observers, etc. Observers should record and detail the efforts and avenues they explored in their quest to secure contact details. This category should be used and regarded as a last resort only!

3.3.1.3 No Answer

Despite having correct contact details, it still may not be possible to establish contact with the skipper or vessel owner. Observer and or the programme managers should record details of these attempts. Whereas some national programmes operate on a single call attempt before moving on to the next vessel on the selection list, other national programmes may attempt more than once to establish contact. This is acceptable for these programmes but it is important to note that all vessels in a list should receive *equal* efforts of selection attempt; e.g if a programme's cap or call limit is set at 5 then no vessel on the random selection list should ever receive more than 5 attempts. It must be remembered that all attempts are to be made on the basis of placing an observer on the next trip.

3.3.1.4 Observer Declined

Even when a skipper may be willing to cooperate and take an observer to sea, the observer themselves may have concerns as to the safety of the vessel, or the lack of sleeping accommodation, etc .There are a multitude of legitimate reasons why an observer may not wish to sail on a particular vessel and it is important that managers respect these, especially when on the grounds of health and safety.

3.3.1.5 Industry Declined

There are many reasons why a vessel may decline to accept an observer. These reasons can take the form of a direct (or 'hard') "No", to an indirect (or 'soft') "No". An example of a 'hard' "No" would be because the skipper does not believe that scientists do a good job and are harmful to the industry. An example of a 'soft' "No" would be "not this time….maybe next month". However, as the observer trip to be conducted should be the next trip an industry answer as "next month" will still be a refusal for the next trip conducted. Regardless of the reason, any form of refusal, no matter how 'soft' it may be, must be regarded as an industry decline. Individual nations may of course decide to further sub divide and record industry decline to a higher degree.

With the situation of a direct or 'hard' "No", it was suggested that these cases should be revisited (re-called) on at least an annual basis, to ascertain whether attitudes have changed and therefore sampling opportunities may now be available. Until now, a 'hard' "No" were generally not revisited that often due to the, at times unpleasant, nature of the telephone conversations. Although difficult, these approaches must be made on an annual basis to reaffirm the position with regards to these vessels. No matter the interval of revisiting these 'hard' "No" cases, the vessels still have to be included in the draw list and to be registered if selected.

3.3.1.6 Sampled

This is the successful sampling of a vessel and should be recorded as such after the trip or voyage has been completed, rather than simply when the skipper or vessel owner has given approval.

As stated above, nations can of course decide to further divide categories into whatever subgroups they deem appropriate but it must be possible to aggregate any such categorization into the 6 standard response categories outlined above.

Not Contacted	
1.	**No longer / Not in Fleet** – decommissioned, sunk, sold, registered elsewhere.
2.	**Used this quarter**.
3.	**Vessel unsuitable** – boat in poor condition, too old or small, skipper/crew issues (explain how this is known).
4.	**Persistent definite refusals** – vessel won't take scientists, history of non cooperation.
5.	**Incorrect area** – ruled out by observer on basis of ICES area being fished (explain how this is known).
6.	**Non discard fishery** – ruled out by observer on basis of vessel operating in a non discard fishery (explain how this is known).
7.	**At sea** – fishing, oil job (explain how this is known).
8.	**Not fishing** – on slip, tied up for repairs, days at sea, quota, weather (explain how this is known).
9.	**Excessive travel required** (give explanation).
10.	**No contact information**.
Contacted	
1.	**No answer** – phoned but no answer.
2.	**At sea** – fishing, oil job.
3.	**Not fishing** – on slip, tied up for repairs, days at sea, quota, weather.
4.	**Incorrect area** – vessel not fishing in ICES area required.
5.	**Non discard fishery** – vessel using pots/creels crustaceans or dredging for scallops.
6.	**Direct "No"** – skipper or agent said no.
7.	**Indirect "No"** – skipper or agent gave other reason for declining e.g. no room, not this time but another time.
8.	**"Yes" but unsuitable logistics (for observer)** – excessive travel required, unsuitable departure date at the time vessel was contacted, genuinely no room o
9.	**"Yes" but trip did not take place** – broke down at harbour, vessel didn't sail due to weather.
10.	**"Yes" but trip not sampled** – left without observer.
11.	**"Yes" trip sampled**.

Figure 3.6. The contact and non-contact categories used to record responses in the Scottish scheme. Aggregations of these categories can be used to quantify all contacts into one of the 6 standard responses.

3.4 Communication

It is acknowledged that good communication is key to achieving and securing good relations with the industry and therefore increasing the potential of sampling opportunities. The recording of a refusal or non-response following contact with a skipper has the potential to be a negative experience for all concerned. Therefore the way that request is communicated, and how the purpose of the trip is explained to the skipper when he is contacted is very important. Poor communication can increase the likelihood of a negative conclusion and has the potential to reduce the overall willingness of fishers to collaborate with scientists.

After having briefly introduced him or herself, the questions asked by the scientist coordinating the trips (or observer) should be unambiguous to avoid confusion. It should be clear that the skipper is being asked whether it is possible to take an observer on board on his *next trip* planned. If the skipper indicates that is not possible for the next trip, but perhaps in a few trips time or next month for example, the trip coordinator needs to record this as an industry refusal. The skipper however probably does not relate to his response in that way and some careful consideration may be required as how to proceed with the conversation. Emphasizing that due to the random vessel selection design of the programme it is only the next trip that you are interested in and you cannot place his vessel on a waiting list. Emphasizing this point to the skipper may in the end persuade him to change his mind and take an observer on board on his next trip. If not, the observer should thank him for his willingness to collaborate later and inform him that by random draw his vessel may come up for selection at a later date, although you don't know when. In this way, the conversation can be ended more positively.

Observer programme managers may wish to consider arranging for their observers to undergo communication skills training and perhaps conflict management communication training. These skills may prove useful to observers not only when arranging trips but also whilst at-sea onboard vessels. Fishery observers are often the only representatives of fisheries science that skippers and crew may come face to face with. As such, observers act as a vital public relations tool for fishery institutes. During trips observers are often bombarded with a multitude of questions from the skippers and crew. To aid the observer, some institutes provide them with a booklet or brochure detailing all aspects of the institute's observer programme and also key details

concerning the fish stocks (e.g. stock levels, annual quota levels, population statistics, etc) of importance to the fleet in question.

Once a voyage is completed, institutes should provide the skipper / owners of vessels sampled with a brief report and summary of what sampling was undertaken on board and perhaps provide some basic charts or tables displaying the catch / discard / species composition.

An example of the conversation format that a typical call to a skipper by an observer, can be seen below:-

" Hello there ….Is that Mr ??????? … Hi … My name is ?????? and I'm from Marine Scotland Science. (You may know, we are sampling the commercial fleet of … - further explanation may be required at first contact…). *I was wondering if it would be possible to sail with you on your next trip to sample your discards ? "*

This is when the observer often will be asked questions by the skipper, relating to what the observer will be doing etc. It is important that the observer is fully briefed as to the programme's objectives so that he / she can answer all and any questions that may be posed at this stage.

3.5 Non-response and refusal rates to allow between nation comparisons

One of the key quality indicators of a probability based sampling schemes are the non-response rate and the refusal rates. These are measures of the proportion of the population from which samples are obtained, and the willingness, or ability, of the initial sample to provide the required information. Such terms are more commonly used in the context of social sampling e.g. Moser and Kalton (1971). SGPIDS 2 (ICES 2012a) proposed a means of calculating these quality indicators in the context of at-sea sampling based on the responses from a standardized contact procedure. Since then a number of countries have adopted this contact procedure and the study group in 2013 is in a position to review the suitability of this approach. Here we present Figures for Scotland, Germany, and Spain for 2012 and Denmark for 2011 and 2012.

3.5.1 Non-response Rate

As defined during SGPIDS 2 (ICES 2012a) the non-response rate is the proportion of all attempted contacts that ultimately fail to provide a sample, for whatever reason (ICES 2012b page 9). The non-response rate can be calculated from the number of non-responses divided by the total number of sequential selections or approaches.

The non-response rate is a measure of population that cannot be sampled, though it needs to be recognized that a high non-response rate does not in itself indicate biased sampling. Bias may only be an issue if the non-response is selective - a particular component of the fleet ends up being over represented or underrepresented and these components behave differently to the rest of the fleet. This would result in non-response bias in any population estimate. So while the higher the non-response rate then the greater potential there is for bias - it is not in itself indicative of bias. The reasons why an observer might not be able to sample a particular trip or vessel have been discussed in section 3.3. Many of these reasons are out of the control of the national sampling schemes. Identifying those which can be improved upon is a means of improving the sampling scheme.

3.5.2 Refusal Rates

As defined during SGPIDS 2 (ICES 2012a) the refusal rate in the fisheries context is the proportion of skippers who, having been successfully contacted ultimately failed

to allow the observer to go on-board to obtain the sample. This refusal rate is calculated as the number of industry refusals divided by the number of sequential selections or approaches *where contact was successfully made*. This refusal rate provides an indication of the industry reaction to the observer programme and is a useful measure of their cooperation.

The higher the refusal rate the more potential for bias but, as with the non-response rate, it is not in itself indicative of bias. A high refusal rate indicates a lack of cooperation by the industry for whatever reason. As discussed in section 3.3 there may be a number of reasons for this response some of which the country might be able to improve on. At WKPICS 1 Denmark presented an example of how they were able to use this refusal rate at industry meetings to improve industry cooperation. In this example their success rate went from 2% to 54% over the year.

It is important to note that, following recommendations from this SG, industry refusals will include those incidences when fisher were prepared to take the observer to sea but not on that occasion, as well as the point blank refusals. As suggested in section 4.3, it is advisable in a call log to distinguish between the two types of industry refusal (the 'hard' "No" and the 'soft' "No") even if they are combined in this instance. It would be useful in any dialogue with the industry to make that distinction. It needs to be recognized that the refusal rate can be contentious so care should be taken when publishing or using this refusal rate.

The observer refusal rate should also be considered. This rate relates to non-responses which might simply be due to health and safety criteria or policy set by the institute or programme managers. Again, a high observer refusal rate is not indicative of bias but does provide the opportunity for bias. A high rate is worth investigating - to identify if a particular component of the fleet activity is underrepresented.

3.5.3 Success Rates

SGPIDS 2 (ICES 2012a page 9) suggested using the term "success rate" as an alternative to the refusal rates (1- the refusal rate). This term provides a more moderate reference focusing on the more positive outcome.

3.5.4 Review of application and use of non-response and refusal rates

The categorized responses from sampling schemes of example fleets in Denmark, Germany, Scotland and Spain are shown in Figure 3.7. For these examples it was possible to calculate the non-response based on the SGPIDS 2012 recommendations, but not the refusal rate. The number of successful contacts was not always available and so a "raw industry refusal rate" is presented here. This was calculated as the total number of industry declines divided by the number of sequential. A "coverage rate" defined as 1-non-response rate is also presented.

	Denmark		Germany		Scotland	Spain
	Kattegat trawlers		Trawlers	Netters	Trawlers	Marin trawlers
ICES scale	2011	2012	2012	2012	2012	2012
Not available	80	10	18	32	470	3
No contact details	0	0	1	0	0	0
No answer	19	16	9	7	0	5
Observer declined	40	12	0	0	55	0
Industry declined	104	46	9	2	2	10
Sampled	40	44	44	36	14	10
Total Number of selections	***283***	***128***	***81***	***77***	***541***	***28***
"Raw Industry Refusal Rate"	0.37	0.36	0.11	0.03	0.00	0.36
"Coverage Rate"	0.14	0.34	0.54	0.47	0.03	0.36
Non- response rate	0.86	0.66	0.46	0.53	0.97	0.64

Figure 3.7. Examples of standard responses and calculated non-response and raw refusal rates

There are two aspects of this table, and the calculation of the quality indicators, that the study group was particularly concerned with. First, how to deal with vessels that were considered as unavailable; second the differences in the time window used by different schemes and how vessels were selected (multiple or single lists, observers of trip organizers) and the effect this had on how the total number of selections were calculated.

The unavailable issue is demonstrated by the high non-response rates in the Scottish scheme and the Danish scheme in 2011. In 2011 a large number of the Danish trawlers were not fishing in the area they were required to sample and a number of vessels were sold, both these factors contributing to a large number of "unavailable" vessels. In the Scottish scheme the observers have a very tight window of two weeks in which to arrange and undertake a trip. They have access to live VMS so they are able to determine very quickly which vessels are unavailable and as a consequence there are always a considerable number of vessels that the observer might not consider contacting because they are at- sea and would not be possible to sample within the time frame. For those that are available - if they are unable to get a response from one phone call then they move down the list. These practices contribute to the large number of "unavailable" vessels.

In contrast, for both the Danish scheme and the German scheme they will call a vessel more than once or until they get a response and allow a vessel to be 'kept warm'- or in a waiting loop. If a vessel was unavailable at the time of the first selection they were kept 'on the boil' to be picked up later – which would ultimately count as a positive response. This 'keeping warm' could last as long as the sampling period, for Denmark it was a quarter and Germany a year. A full year of response rates is not available from the English but for the system they presented they keep vessels warm for the sampling period of a quarter as well. The validity of this has been discussed in

section 3.1 where the SG recommends that when organising a trip the response is based around the availability of the vessel for the next trip.

The limited sampling period in the Scottish scheme means vessels cannot be kept 'warm' to be sampled later and as a consequence there would always be greater proportion of vessels which the they are unable to sample. This contributes to a consistently high non-response rate in their current scheme which through the large number of unavailable vessels they are very unlikely to be able to improve on. This is a product of the scheme the structure and its operation which is heavily influenced by the number of trips that need sampling and the limited number of staff available to go to sea. Because the Danish, German and English schemes have larger sampling windows to work with, they have greater flexibility and have greater opportunity of picking up the next trip.

Each observer in the Scottish scheme is provided with a full list of vessels so there is a chance that the same vessel could be counted as unavailable twice in the same period by different observers. In the Spanish and German examples each have one coordinator working through one list allocating trips to observers. The English have a similar system where a number of observers work down the same list one observer following on from another observer's selection. So in these schemes one response, whether positive or negative, affects the next selection. The Danish have a system where each observer makes a random selection each time. Each of these different systems will impact on the not-available response and therefore the total number of non-responses. So the response rates of the different schemes are not directly comparable and should not be judged on these rates alone.

The study group considered calculating a modified measures of non-response by excluding those non-available vessels from the non-response rate but there was concern that this removed vessels from the non-response calculation that where a legitimate part of the non-response rate.

3.5.5 The reporting of non-response and refusal rates

Due to the concern over non-response calculation and the issue of the unavailable vessels the study group felt that these rates, at present, do not allow objective comparison of the performance of different sampling schemes of different countries. For example, if taken out of context, the non-response rate from a scheme using a reference fleet would always be 0 (the coverage rate 100%) and likewise a scheme that had an ad-hoc selection process could generate a low non-response rate and a low refusal rate. In contrast schemes where were using a randomized vessel list would be expected to have a noticeably higher non-response rates and refusal rates. Therefore it was considered that these rates should not be compared without knowledge of how the sampling scheme was designed and worked, how the "not available" category was defined, and what analyses for bias had been carried out.

The recommendations from SGPIDS 2 (ICES 2012a) were considered by WKPICS 2 and these have been included as quality indicators in a template for a Quality Assurance Report (ICES 2012b table 4.1). This is reproduced in Figure 3.8. However if a standard approach for reporting on sampling design is to be adopted by ICES or the EU it is important that there is the scope within the report for the programme manager to explain the rates for their schemes.

The study group considers that the response categories are listed in the QA report with the numbers of occurrences for each response and, if a standard rate is required, then there is scope for describing the context under which the Figures were compiled.

The study group considered that, at present, the metrics that can be calculated from the logged responses are useful primarily for a programme manager to monitor and improve the effectiveness of the selection process within their scheme at the national level. As a quality indicator these data can be useful measures for:

1) The rate may be indicative of potential sample bias and can be used by the programme manager as a signal to investigate whether there is any bias.

2) These rates provide the programme manager with a measure of the performance of the scheme and a target to, if possible, improve on. For example these results have been used by Denmark in negotiations with the industry.

3) They provides auditors and expert groups with the indication that these schemes are being monitored and, with reference to attached comments by the programme manager, should provide assurance that the country is maintaining as good a rate as they can.

3.6 Linking samples to populations and ways of identifying bias.

Linking the sample to the population depends on first the ability to identify all the vessels in a fleet of interest, and second the ability to record which vessels from that wider population are sampled. If these stages are achieved then it is possible to make comparisons between the behaviour of sampled vessels and that of the wider fleet, the expectation being that the sampled vessels will be a representative of the wider fleet providing probability based sampling has been achieved. Differences in the samples and the population will be due to the sample size and the inherent variability of the population. However if the non response rate is high *and* the non-response vessels behave differently from the sampled vessels there is the potential for non-response bias. This should be revealed by gross disparities in the comparisons of the derived samples and the behaviour of the total fleet.

It should also be born in mind that the "observer effect" where a vessel allows an observer on-board but changes its behaviour during that trip will result in unrepresentative sample data. This type of bias will not be apparent from the non-response rate, only through a comparison of the characteristics of the derived sample and the wider pattern of fleet behaviour.

Here we illustrate some of the comparisons that are possible between sampled vessels and aspects of fleet activity:

- Spatial distribution, by gear type, from the Dutch self-sampling scheme.
- Spatial distribution and sorting groups of the Danish fishery
- Gear types in Dutch beam trawlers.
- Spatial distributions, sorting groups and species composition of Danish trawlers in the Kattegat

The general conclusion of these illustrative examples are that it is recommended that a number of different approaches are tried to check that the observer sampling trips conducted are actually representative of the fishery. This is particularly important if a substantial non-response or refusal rate is recorded within a fleet segment. Such comparisons are also useful for demonstrating a need for post-stratification re-weighting the sample data. Failure to compare sampled and population data could result in a bias in the final estimate.

3.6.1 Spatial distribution by gear type of the Dutch self-sampling scheme.

Self-sampling trips by the Dutch reference fleet in 2012 are shown in figure 3.8. These maps show the sampled trips (plotted as black dots) vs. the distribution of effort of the fleet (colouring of the statistical ICES squares), in order to judge whether the samples taken on self-sampling trips by the Dutch reference fleet are representative for the distribution of the total fleet. The maps show that the distribution of the sampled trips and the distribution of the fleet coincide very well. This suggests that self-sampling fishers do no alter their behaviour in terms of the choice of their fishery when they are tasked to take a sample for the scientific monitoring programme.

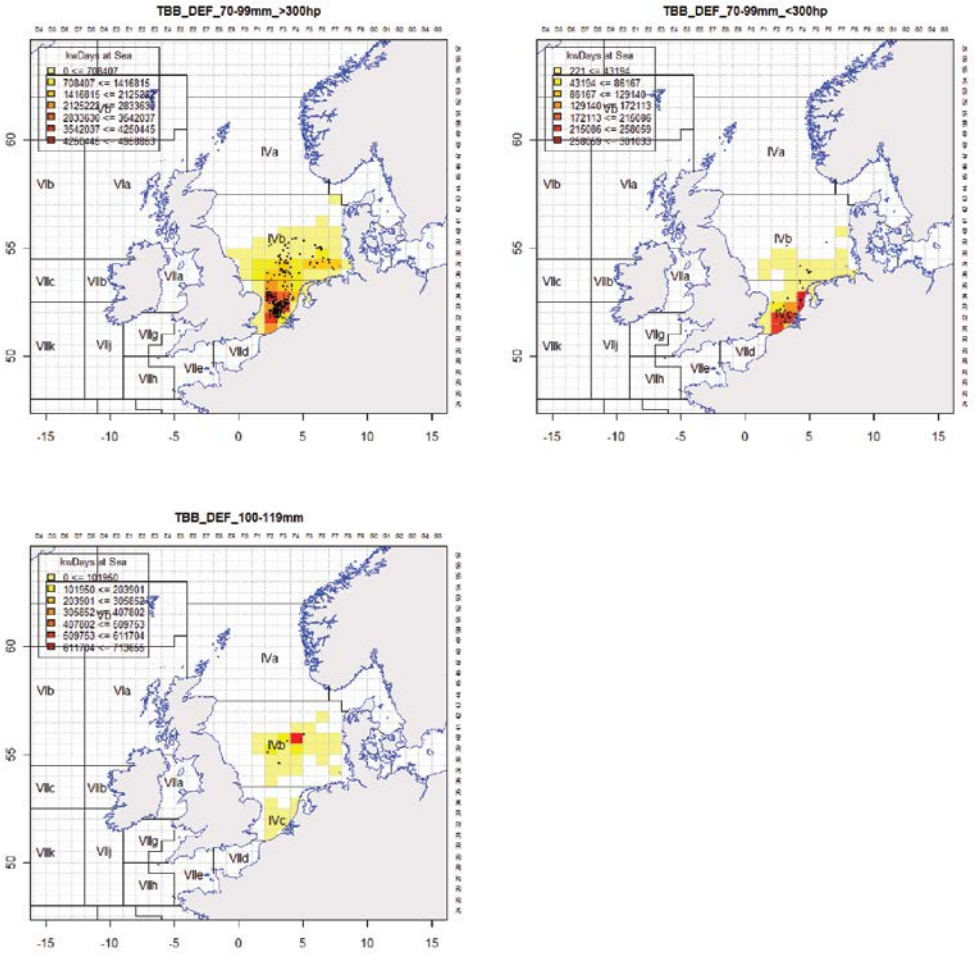


Figure 3.8. Representativeness of sampling by the Dutch reference fleet

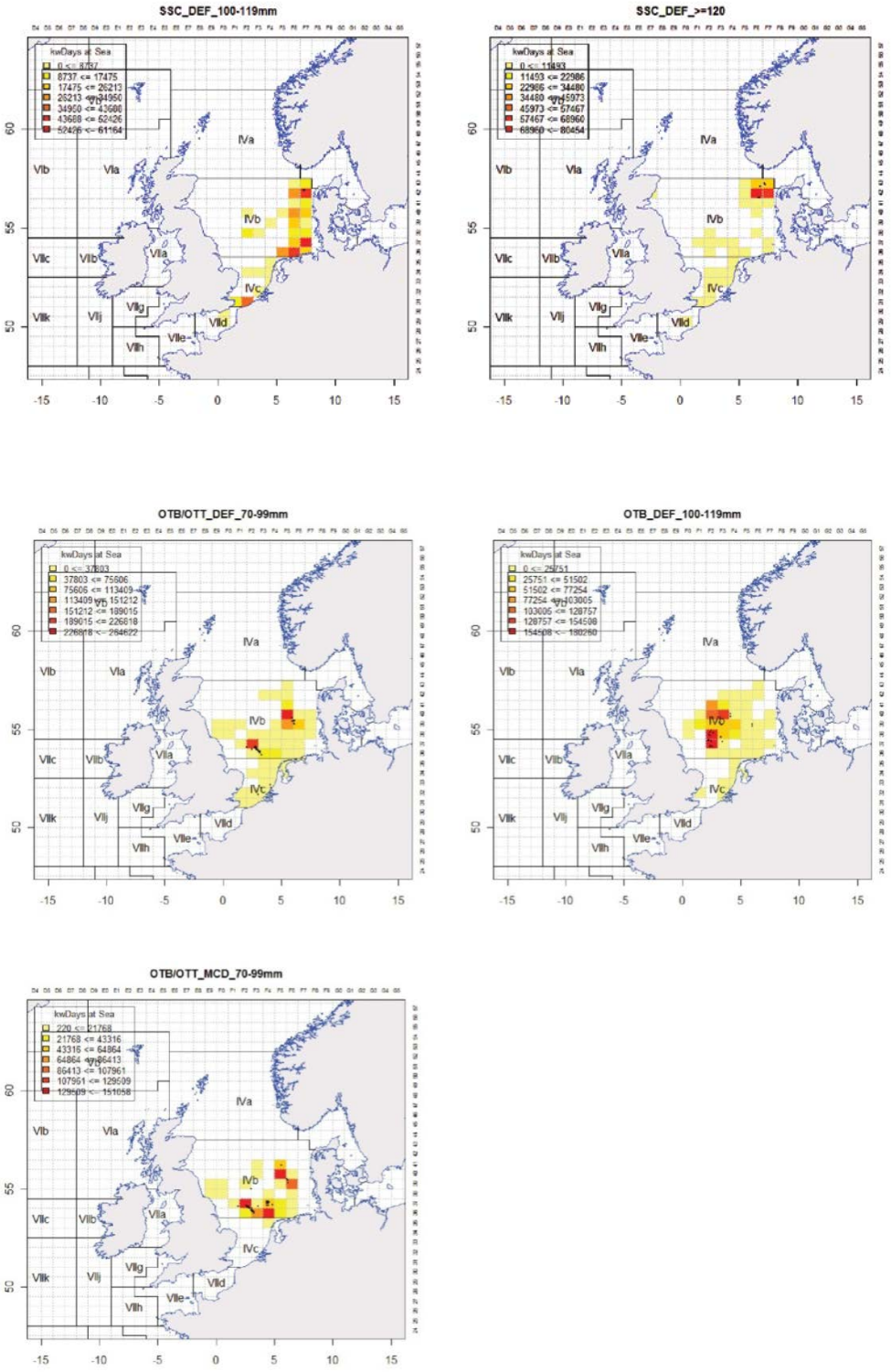


Figure 3.8 (continued). Representativeness of sampling by the Dutch reference fleet

3.6.2 Spatial distribution and sorting groups of Danish fishery

In the Danish observer program a similar approach were conducted were VMS data were compared to the sampling location (Figure 3.9). In the Danish example VMS data were used, thereby excluding the smallest vessels however but given more precise information on location. In comparison, the Dutch example used all landing data

were included from the sale slips given the opportunity to include vessels below 12 meter, however with less detailed area information.

To investigate if there is bias the landing pattern can be compared between the observed fleet and the total fleet within that area. A large difference in landing pattern between the observed and the total fleet could be an indication of highgrading. However, awareness of the sampling size in the observer fleet has to be taking into account. In Denmark comparison has been conducted in different fleets groups in relation to cod and the results are very much area dependent.

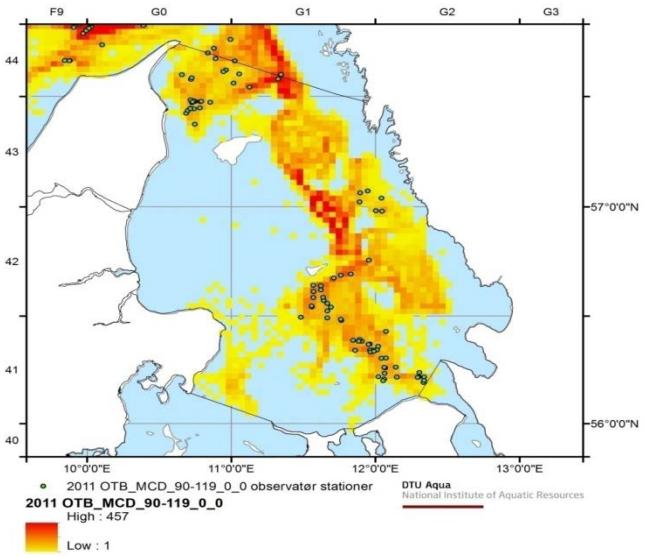


Figure 3.9. Example of Danish VMS information (yellow) compared with the sampling location from the observer program (green dots).

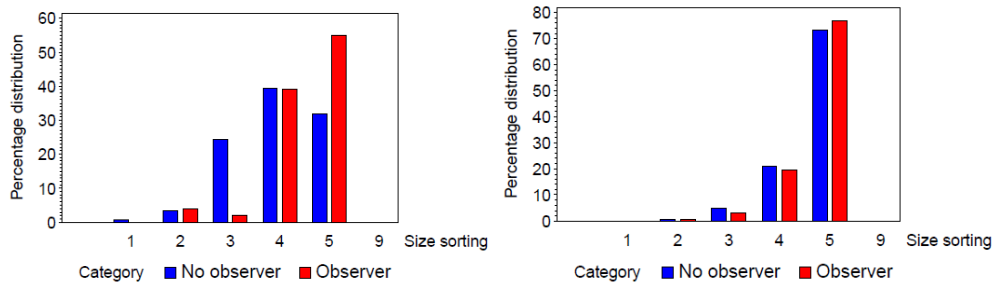


Figure 3.10 Comparison in relative landing sizes for cod between Danish observer and non-observer trip on an annual basis. The Figure to the left is from Kattegat and to the right from the Eastern Baltic. Size group 5 indicate the smallest size group and group 1 the largest.

3.6.3 Gears within the sampled vs. the un-sampled Dutch beam trawler fleet

A specific worry in relation to representativeness of the reference fleet, which has been raised on several occasions has been the fact that new gear types have been introduced in recent years, such as pulse gears and sum wings. Some vessels in the reference fleet are using these gears. However, the use of these gears in the fleet at large is not registered in logbooks and so, it is not possible to raise the obtained sampling data separately for this group of vessels. Alternatively, the data from conventional beam trawlers and those using new gears are taken together and raised to the total métier. A mismatch in the relative composition of the sampling fleet and the total fleet could cause a bias in the raised estimates. Figure 3.11 shows the compositions of

the two fleets and suggests that beam trawlers using sum wings are somewhat over-represented in the sampling fleet. If discard rates or composition is altered because of the usage of this gear, this would, if uncorrected, cause a bias in the raised estimates. No comparison of the discards rates of sum wing using vessels vs. others has been conducted.

A known mismatch between the proportions of, for example gear types, in the total population with that in the sample can be corrected for through the use of post stratification; the proportions in the total population being used to adjust the weight of the proportions in the sample.

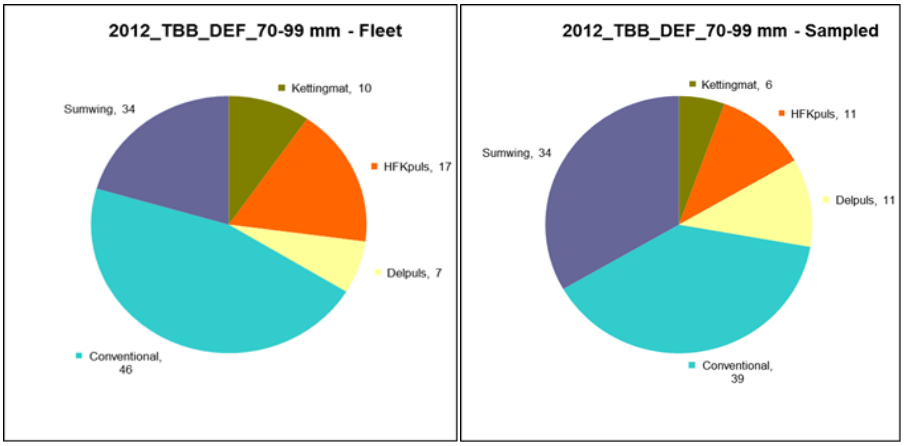


Figure 3.11. Composition of subtypes in relation to conventional gears in the Dutch beam trawl fleet (left). Composition of sampled beam trawl gear subtypes (i.e. sumwings, chain mats/'kettingmat'; HFK- and Delpuls manufactured electric trawl gears) in relation to conventional conFigureurations.

3.6.4 Spatial distribution sorting groups and species composition of Danish trawlers in the Kattegat

In the Danish sampling program analysis was conducted on the vessels refusing to bring observers compared to the rest of the fleet. The spatial distribution indicated that in a part of Kattegat (43G1) very few trips were conducted with observers and that a very large number of the fishers refused to bring observers when fishing in this area. A further comparison of the landing patterns for cod by sorting groups between the ICES square 43G1 and the rest of the area (Figure 3.13). showed that within an area 43G1, north, south and blank there were very little difference between the landing pattern in the sorting groups between vessels refusing to bring observers and the rest of the fleet. However there were indications of difference between areas.

Comparison was also made in the species composition between the vessels that refused to bring observers and the rest of the fleet. This indicated (Figure 3.14) that there was a difference in the landing composition between the two groups. However, this comparison was also made on an area basis were area 43G1, the north, the south and the rest of the area were compared (Figure 3.15). This analysis showed that although the species composition was similar in the main part of the catch composing, there were also differences. In the Northern part a small amount of dab were caught and in the southern part a large part of the catch composed of greater weever (Trachinus draco). Therefore it could not be concluded that the difference in the species landings composition between vessels refusing to bring observers and the rest of the fleet was duo to changed behaviour rather than an area effect.

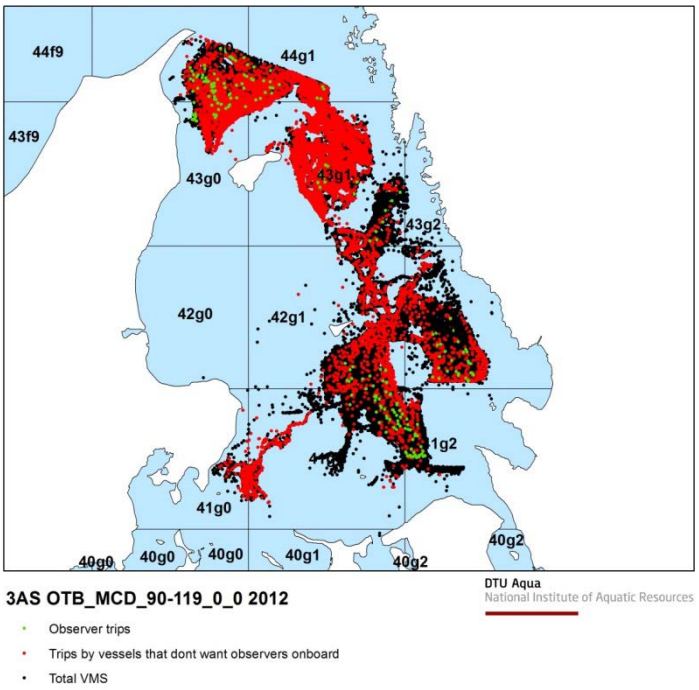


Figure 3.12. VMS data from the Danish trawlers in Kattegat in 2012. Black dots indicates the total fleets in the area and the red dots are the vessels who has refused to bring observers on board. Green dots are conducted hauls within an observer trip.

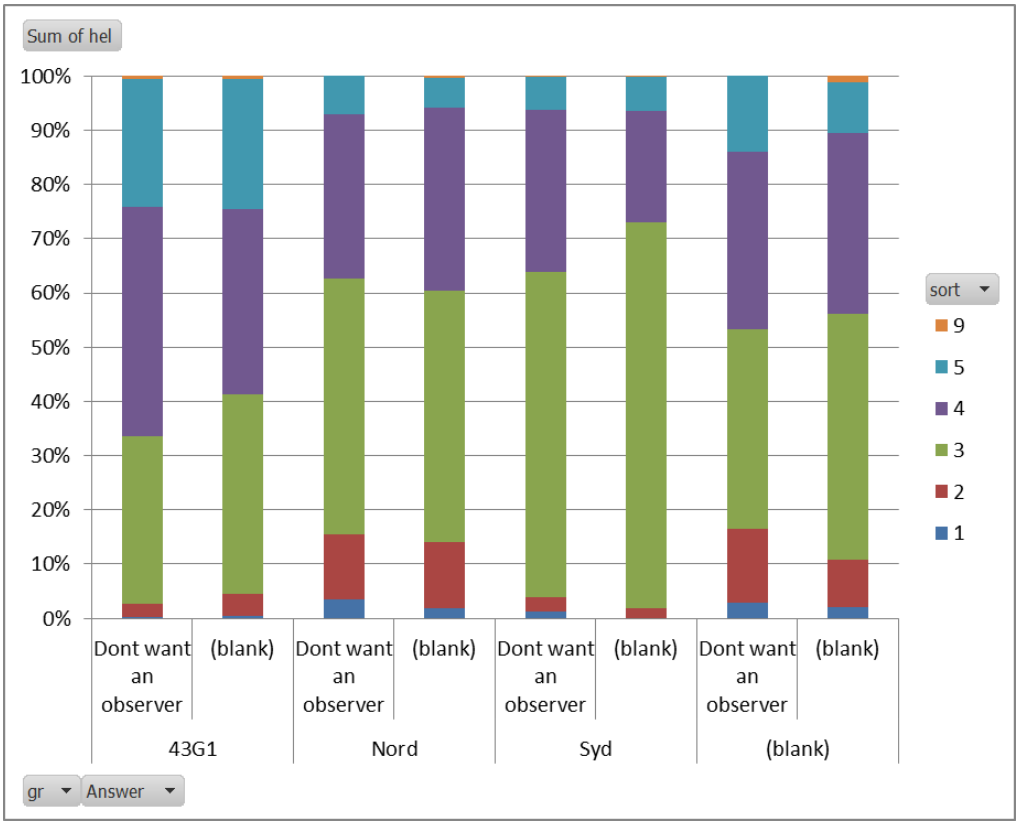


Figure 3.13. Comparison of landed sorting groups between the vessels refusing to bring observers and the rest of the fleet from the same area 43G1, north, south and blank.

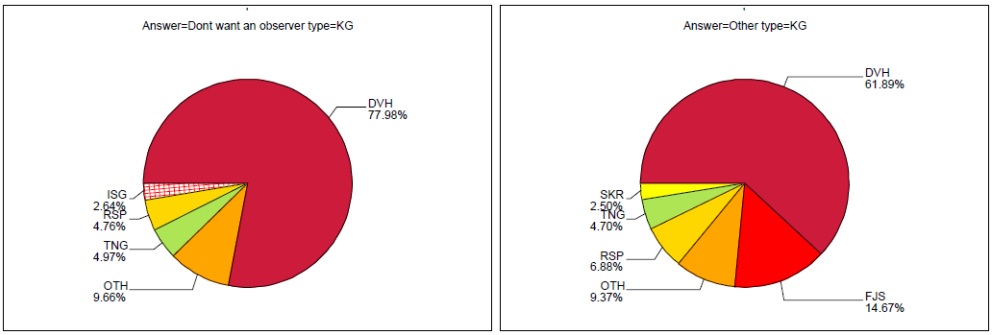


Figure 3.14. Species composition in the landings in Kattegat for the vessels not willing to bring observers and for the rest of the fleet.

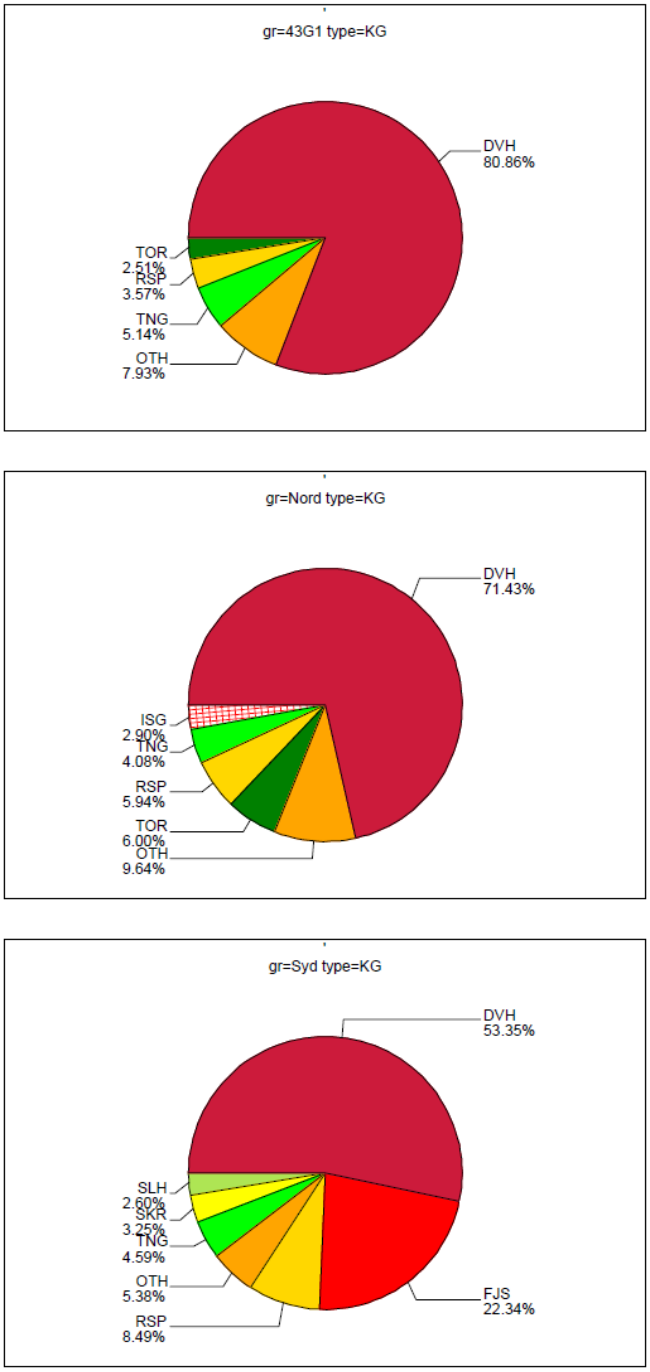


Figure 3.15. Species composition in the landings in Kattegat by area.

3.7 Quality indicator table and potential end-users

The quality indicator table is aimed at investigating potential bias caused by non-successful contact attempts, improving the national sampling efforts, and documenting and providing a meaningful and transparent overview of the quality of the sampling.

The group agreed on the usefulness of the quality indicator table for different potential end-users. Possible end-users would include, stock assessment working groups, auditors of annual reports (DCF/STECF/RCGs), EU commission. At the national level the quality indicators would be of use to ministries, national administrations, and fisheries as well as for in-house evaluation at national fishery institutes.

For stock assessment purposes, it was recognized that part of the information has to be completed at the stock coordinator level, and that the national fishery institutes would provide data on the sampling scheme and its operation.

In line with the discussion within the study group the quality indicator concerning the non-response rate and the industry declined rate has be modified to include the total number of vessels contacted in the year and the six response categories outlined in section 3.3.

The number of trips where the stock occurred in the discards, and the landings has been omitted, because it was felt that discard estimates were for the sampled fleet, and not conditional on the catch of the stock; if the stock is not caught then the discards are by definition zero. If the stock is caught by the fleet then all sampled trips (not just those where the species was recorded) are valid samples.

Table 3.8 Modified quality assurance report for regional assessment data from at-sea sampling, based on the WKPICS 2 report (ICES 2012 b, Table 4.1., page 50). Sections in green are likely to be completed by the national fisheries institutes, those in yellow are more likely to be completed by the stock coordinators.

AT-SEA-SAMPLING					
Stock - Species - Area - Year (e.g. Cod - North Sea - 2011)					
	Country A			Country B	Country C
	Design			Design	
	Implemention			Implemention	
Importance: Contribution to stock landing	40			60	
Sampling / design effect/diagnostic for randomness... (Description according to best practice)					
Sampling design	probability based discard sampling			quota sampling of catches	
Primary sampling unit	Vessel			Trip	
Sampling frame	quarterly vessel list			annual vessel list	
Periodicity	ca. 1 sample per week during fishing season			1 sample per month	
Contact protocol	yes			no	
Sampling manual available	under preparation				
...					
Strata from the sampling frame	Fleet 1	Fleet 2	Fleet 3	...	...
	e.g. active gear (Trawler)	e.g. passive gear	e.g. seine netters		
Importance: Contribution to national landing	75%	20%	5%		
Importance: Contribution to national discards	95%	1%	4%		
Quality indicator					
Total number of vessels in the fleet	60	300	5		
Number of trips sampled onboard of vessels	30	20	0		
Number of unique vessels sampled	5	17	0		
Total number of trips conducted by the fleet	1000	8000	6		
Age key quality indicator (e.g. Mean number of age samples per trip sampled)	100	50	0		
Total number of vessels contacted in the year	81	77	not determined		
Not available	32	48	not determined		
No contact details	1	0			
No answer	0	0			
Observer decline	9	7			
Industry decline	9	2			
Successful sample	30	20			
Goodness of fit					
Bias 1: Spatio-temporal coverage	tested and considered all right				
Bias 2: Vessel selection	smaller vessels rejected observers				
Bias 3: ...	comment				
Precision levels of e.g. parameter a, b, ...					
e.g. CV, variance, relative sampling error					
e.g. Input data for XSA model:					
maturity at age					
stock weight					
catch weight					
catch at age					

4 On-Board Sampling and Estimation

The way the catch is handled and processed on-board a vessel, and the protocol used by the at-sea observer determines which fish, of all those caught, end up in the sample. In theory any fish in the catch has a finite probability of being sampled, and this probability can be estimated. The inverse of these sampling probabilities is the sample weight which is more familiar as the raising factors used to scale the sample up to the trip. But the exact nature of the numbers used in these ratios can be important, as are all the levels in the multistage sampling hierarchy that has been used to select the individual fish (or shellfish) in the sample. The use and importance of sample weights in design based estimation was considered at WKPICS 2 (ICES 2012b). Here we assess the extent to which such sample weights can be calculated using present on-board sampling practices. Section 4.1 will introduce the use of sample weights and section 4.2 will use case studies of various different on-board sampling situations to consider the diversity of handing practices and sampling protocols. Each case study presents a worked example calculation of sampling probabilities and sampling weights. In addition the sampling protocol for the Norwegian reference fleet is included as is a short study on variation in age composition estimates with different otolith collection practices. In section 4.3 we summarize the important points arising from the case studies, discuss the uncertainties involved in the estimation process and consider tentative best practice guidelines. Finally in section 4.4 we assess the extent to which the regional database data exchange format, and its envisaged modifications, can accommodate all the recorded data of the worked examples.

4.1 Sampling Probabilities and Sampling Weights

Sampling probabilities π are ratios n/N expressing the probability of selecting one or more events to sample n, from all the available events N. The sample weight ω = N/n is the inverse of the sampling probability and is used to scale counts[1] from the sample to the population total (Lohr 2010, Lumley 2010). The sampling probability for ith sample is π_i and the sample weight ω_i. So if we had a simple random sample of 40 fish from a known population of 2000, then the sampling weight for each of the 40 fish is:

$$\omega_i = \frac{N}{n} = \frac{2000}{40} = 50$$

or, considered another way, each fish in the sample is representative of 50 fish in the total population. Hence in our sample of 40 fish if we had 10 fish aged 3 (so that $n_{age=3} = 10$) then the estimate of the population of 3 year old fish would be:

$$\widehat{N}_{a=3} = \omega_i \, n_{age=3}$$

so that

[1] Note that we are scaling counts in the sample up to the population, the mean and variance from the sample are direct estimates of the population mean and population variance respectively. The standard error of the sample mean is an estimate of the standard deviation of the sample and can therefore be used to construct confidence intervals for the estimate of the population mean.

$$\widehat{N}_{a=3} = \frac{2000}{40} \times 10 = 500$$

Hierarchical multistage sampling requires that the sampling probabilities at each stage of the hierarchy are measured (or estimated); the product of the sampling weights is then the overall weight for the sample.

4.1.1 Direct sampling for length (age or weight)

In the case of at-sea sampling directly for length (or age or weight) a typical hierarchy for on-board sampling might consisted of:

h hauls within a total *H* for the trip

u sampling units within a total *U* units for the haul

f fish from a total of *F* fish in the sampled units

where the "sampling units" for the haul may be boxes, baskets, time, weight etc, whatever unit is used to estimate the total catch and the total sample for the haul.

Direct sampling means that, at the lowest level of the sampling hierarchy, *all* the individuals in the sample have the measure taken, so direct sampling for lengths means that all fish in the sample are measured, direct sampling for ages means that all the fish in the sample are aged, direct sampling for weights means that all the fish in the sample are weighed. In the case of lengths then the sampling weight for a number of fish of length *l* from haul *h* would be:

$$\omega_{h,l} = \frac{total\ hauls}{hauls\ sampled} \times \frac{total\ units}{units\ sampled} \times \frac{total\ fish}{fish\ sampled}$$

and the estimate of the total number of fish of length *l* from haul *h* is:

$$\widehat{N}_{h,l} = \omega_{h,l} n_{h,l}$$

where $n_{h,l}$ is the number of fish of length *l* from haul *h* that were measured, and $\widehat{N}_{h,l}$ is the estimate of the total number of fish of length *l* from haul *h*. The total estimate of fish for the trip would be summed over all hauls and for all lengths:

$$\widehat{N}_t = \sum_{l=1}^{l=L} \sum_{h=1}^{h=H} \widehat{N}_{h,l}$$

Exactly the same applies if the sample is a *direct* sample for age:

$$\omega_{h,a} = \frac{total\ hauls}{hauls\ sampled} \times \frac{total\ units}{units\ sampled} \times \frac{total\ fish}{fish\ sampled}$$

So that it is the otolith that is collected from all the fish in the sample so "fish sampled" is the number sampled for age, so the numbers-at-age estimate is:

$$\widehat{N}_{h,a} = \omega_{h,a} n_{h,a}$$

Exactly the same principle applies to weight:

$$\omega_{h,w} = \frac{total\ hauls}{hauls\ sampled} \times \frac{total\ units}{units\ sampled} \times \frac{total\ fish}{fish\ sampled}$$

so that fish sampled is the number weighed; but that what is usually of interest is the estimated weight rather than a number at weight.

$$\widehat{W}_{h,w} = \omega_{h,w} w_{h,w}$$

where $w_{h,w}$ is the measured weight of n fish (weighed collectively or singularly).

4.1.2 Length Stratified sampling

Length stratified sampling is the collection of additional details of the individual fish conditional on its length. So length stratified sampling for age is where all the fish are measured for length and then some have their otolith collected depending on their length. In a similar way length stratified sampling for weight is where all fish are measured for length and some are weighed depending on their length.

In the case where at least one otolith is collected for each length class encountered on the sampled hauls the sampling probabilities would include the additional ratio of the number of fish of length l measured over the number of fish of length l that are aged:

$$\widehat{N}_{h,a|l} = \frac{total\ hauls}{hauls\ sampled} \times \frac{total\ units}{units\ sampled} \times \frac{total\ fish}{fish\ sampled} \times \frac{fish\ @\ length}{ages\ @\ length} \times n_{h,a|l}$$

4.2 Case Studies

To illustrate on-board sampling practices and how they translate to the calculation of sample weights we use the following case studies:

- Spain – Mixed demersal trawler operating in North Spanish fishing grounds ICES area VIII with examples of discards of hake and black mouth catsharks.
- Latvia – Gillnetter operating in the Baltic with examples of discarded cod.
- Scotland –Mixed demersal trawler operating in the North Sea ICES area IV with examples of discards of haddock
- Sweden – *Pandalus* trawler in the Skagerrak ICES area III with an example of cod discards.
- Scotland – Small *Nephrops* trawler operating in inshore waters off the west of Scotland ICES area VI with discards of *Nephrops*
- Portugal – Set longliners fishing for demersal species in ICES area X with an example of blackspot sea bream discards
- Denmark – *Nephrops* trawler in the Kattegat with an example of cod discards

Each of these case studies includes a description of the fishery, the on-board sampling protocols, a worked calculation of sampling weights.

In addition the sampling protocols used for the Norwegian reference fleet are shown in section 4.2.8. While these do not include worked calculations of sampling probabilities they highlight some of the type of protocols needed to ensure robust probability based sampling. Such protocols are as applicable to dedicated at-sea observers as to self-sampling.

Finally a study of variation in the age composition estimates with differing otolith collection scenarios is presented in section 4.2.9

4.2.1 Spain mixed demersal trawler

4.2.1.1 Short description of the protocol

The Spanish at-sea sampling programme is aimed at providing catch and discards estimates for the demersal and pelagic fish species. The onboard sampling scheme for the demersal species is stratified into several métier based strata. Currently the sampling effort is mainly on bottom-trawling fisheries both at North Spanish fishing grounds and west Ireland and Gulf of Biscay areas. For this example one métier is considered within the Spanish bottom otter trawl fleets operating in the ICES Subareas VIII and IX targeting a mix of demersal species in the North Spanish waters 'OTB_DEF_55_0_0' A trip of a bottom trawl in this métier would generally last 3 days and typically consist of 4 to 5 hauls per day.

For each haul an estimate of the total catch is made in kilograms, based on the total volume of the bottom trawl codend by the skipper or a crew member based on the amount of the fish in the hopper tank. The catch is sorted into species by the crew along a conveyor. The retained fish is saved and sorted into fish boxes. Several species (hake, monkfish) can be graded by sizes and some gutted. The observer samples lengths of the retained fish.

Total retained catch is calculated by a census of fish boxes and multiplying by the mean weight of an individual species commercial box. Total discards for the haul are estimated by the skipper taking into account the retained fish and the amount of the gear codend.

The crew fills one or more baskets of discards by collecting the species (all species of fish and invertebrates) before they would be dumped out to the sea by the conveyor belt. A sample of around 20 kg, depending of the size of discarded species, is collected. The discard sample is weighed by the observer using a balance.

All fish species of the discard sample are sorted and identified to species level or to genus-family level. All fish and commercial crustaceans in the sample are measured for length (a subsample is made when there are large numbers of small species).

1) Examples from an observer trip

   See Figures below.

2) Calculation of the sampling probabilities in the demersal trawl Spanish example from number at length to haul.

Estimating the numbers at length for Hake, (in Spanish Merluza) *Merluccius merluccius*. We have 13 hauls, and 12 are sampled (Figure 4.1), it was estimated that for haul 12 there were a total of 375 kilos of discards, and the at-sea observer collected 13.5 kg which were sampled (Figure 4.2). In total there were 4 hake in the discard sample which all got measured, and of those 4 fish the individuals were 29, 31, 32 and 33cm in length (Figure 4.4). The combined sample weights give an overall sample weight of 30.09. Therefore each measured individual of 29cm represent 30 fish in the discards from that haul; and for the total haul we estimate 120 Hake were discarded, 30 individuals of each of the four length classes (Table 4.1). The calculation being:

$$\frac{Total\ hauls}{hauls\ sampled} \times \frac{Total\ discards\ weight\ kg}{sampled\ discards\ weight\ kg} \times \frac{Total\ fish}{fish\ measured} \times n\ @\ length$$

for the hake of 29cm on haul 12 this gives:

$$\frac{13}{12}\times\frac{375}{13.5}\times\frac{4}{4}=\frac{19500}{648}=30.09\times 1\ @\ 29cm=30\ hake\ at\ 29cm$$

Table 4.1. Measured length frequency for Hake and the estimated numbers at length discared.

Hake	Length class cm					
Haul 15	29	30	31	32	33	
	Measured number at length					Total
	1		1	1	1	4
	Estimated numbers at length					Total
	30	0	30	30	30	120

Similarly estimating the numbers at length for Blackmouth catshark *Galeus melastomus* (in Spanish Bocanegra); in total there were 24 Blackmouth catshark in the discard sample (Figure 4.2) which all got measured (Figure 4.6), and of those 3 fish the individuals were 26cm in length. Therefore each measured individual of 26cm represent 30.09 fish in the discards from that haul; we estimate there were 90 catsharks of 26cm discarded in the haul 12 and estimating the entire sampled length frequency and summing over the length classes gives an estimate of 752 individuals (table 4.2).

The calculation for the Blackmouth catsharks is:

$$\frac{13}{12}\times\frac{375}{13.5}\times\frac{24}{24}=\frac{117000}{3888}=30.09\times 3\ @\ 26cm=90\ catsharks\ at\ 26cm$$

Table 4.2. Measured length frequency for Blackmouth catshark and estimated numbers at length discarded on haul 12.

Blackmouth catshark	Length class cm																							
Haul 15	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	49	50	51	52	53	54	55	100	
	Measured number at length																							Total
	1		2	1	3	3		4	2	2	1		2	1		1					1		1	25
	Estimated numbers at length																							Total
	30	0	60	30	90	90	0	120	60	60	30	0	60	30	0	30	0	0	0	0	30	0	30	752

4.2.1.2 Uncertainties around the estimates

The estimate of the total discarding fraction is the difference between the estimate of the total catch and the recorded weight of the retained fraction. The total catch estimate made for the skipper or the crew. The total amount of discards is not collected together in baskets but it is dumped out by an automatic conveyor belt.

4.2.1.3 Collection of weight data

The whole of the discard sample is weighed by the observer using a hand scale. It is then sorted by species. For those species for which there is not a good length/weight relationship the species sorted sample is weighed. The weight of the main commercial species is obtained afterwards using the species weight-length relationship available in the software database (from at-land biological samples and surveys). The total weight of the discard sample by species (weighed onboard and calculated by length-weight relationships) must sum the weight of the discard sample collected by the ob-

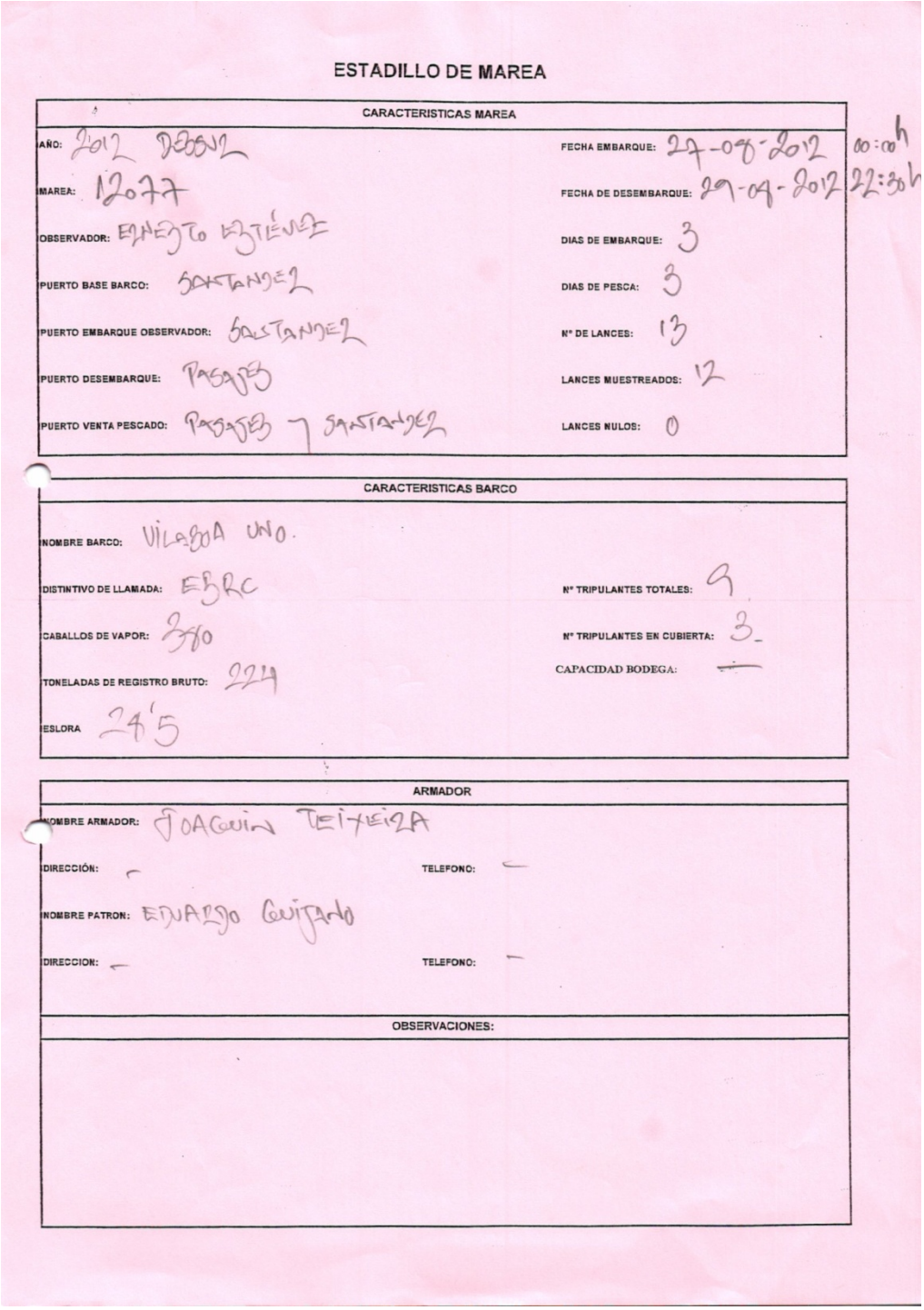
served. This method provides more accuracy in weight of main commercial species and also permits a check on errors in weights measuring at-sea.

4.2.1.4 Collection of Age data

Otoliths are sampled for some discard undersized individuals of the main commercial species depending on requirements of IEO-Ageing Programme.

4.2.1.5 Discard Data Usage

Discard data will be contribute in ICES assessment WGs. Only some WGs are using discard data for a number of stock assessment (WGHMM). Also the data are used to comply with data call requirements using the FishFrame Exchange Format.



ESTADILLO DE MAREA

CARACTERISTICAS MAREA

AÑO: 2012 DESDE 2012 — FECHA EMBARQUE: 27-09-2012 00:00h

MAREA: 12077 — FECHA DE DESEMBARQUE: 29-09-2012 22:30h

OBSERVADOR: ERNESTO REITÉNEZ — DIAS DE EMBARQUE: 3

PUERTO BASE BARCO: SANTANDER — DIAS DE PESCA: 3

PUERTO EMBARQUE OBSERVADOR: SANTANDER — Nº DE LANCES: 13

PUERTO DESEMBARQUE: PASAJES — LANCES MUESTREADOS: 12

PUERTO VENTA PESCADO: PASAJES Y SANTANDER — LANCES NULOS: 0

CARACTERISTICAS BARCO

NOMBRE BARCO: VILABOA UNO.

DISTINTIVO DE LLAMADA: EBRC — Nº TRIPULANTES TOTALES: 9

CABALLOS DE VAPOR: 380 — Nº TRIPULANTES EN CUBIERTA: 3

TONELADAS DE REGISTRO BRUTO: 224 — CAPACIDAD BODEGA: —

ESLORA 24'5

ARMADOR

NOMBRE ARMADOR: JOAQUIN TEIXEIRA

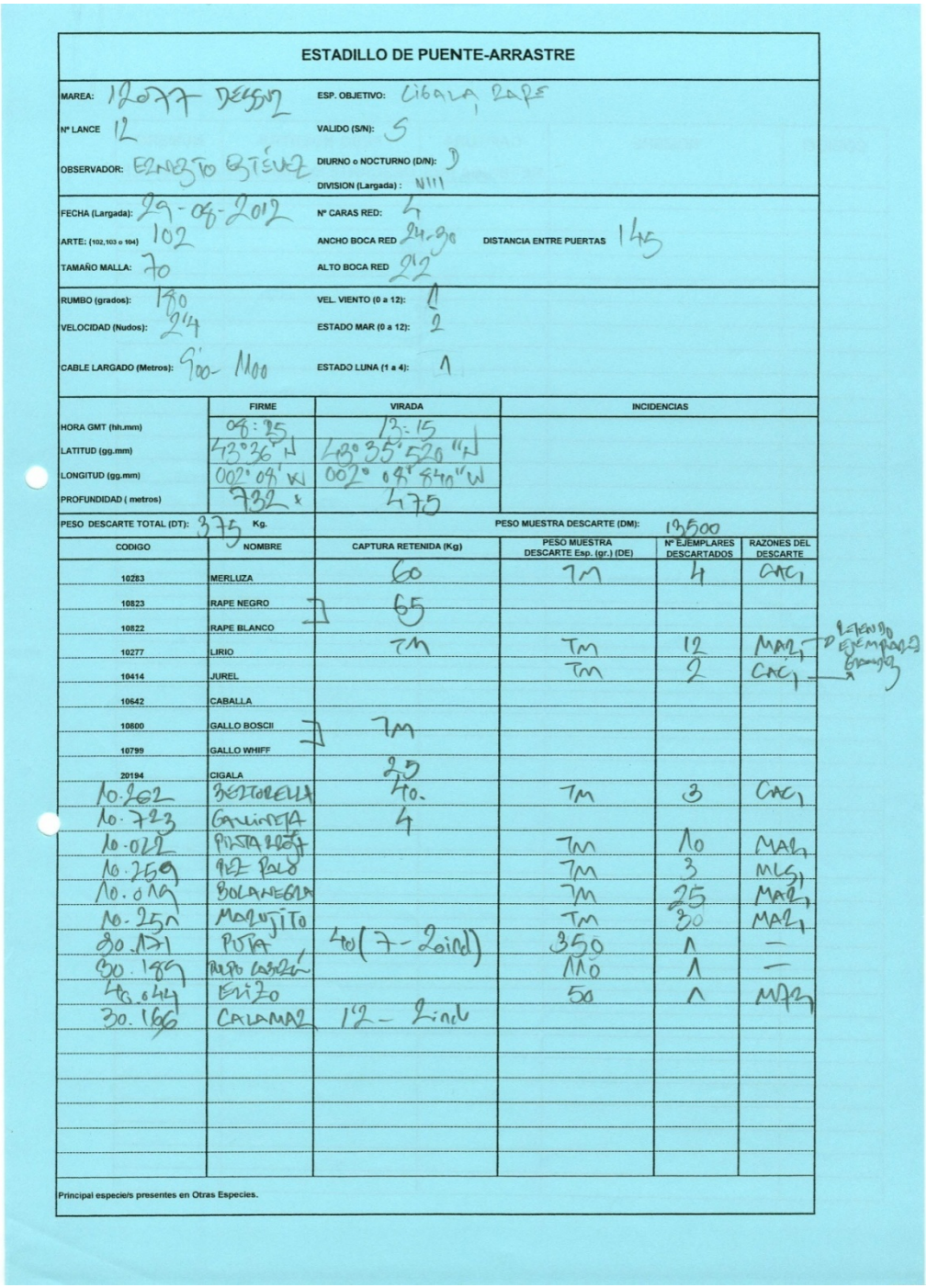
DIRECCIÓN: — TELEFONO: —

NOMBRE PATRON: EDUARDO QUIJANO

DIRECCION: — TELEFONO: —

OBSERVACIONES:

Figure 4.1. Spanish Discards ICES Sampling Onboard Programme Trip Form. The total number of hauls for the trip was 13 of which 12 were sampled.



ESTADILLO DE PUENTE-ARRASTRE

MAREA: 12077 DEGSU2 — ESP. OBJETIVO: CIGALA, RAPE
Nº LANCE 12 — VALIDO (S/N): S
OBSERVADOR: ERNESTO GUTIÉRREZ — DIURNO o NOCTURNO (D/N): D
DIVISION (Largada): VIII
FECHA (Largada): 29-05-2012 — Nº CARAS RED: 4
ARTE: (102,103 o 104) 102 — ANCHO BOCA RED 24,90 — DISTANCIA ENTRE PUERTAS 145
TAMAÑO MALLA: 70 — ALTO BOCA RED 22
RUMBO (grados): 180 — VEL. VIENTO (0 a 12): 1
VELOCIDAD (Nudos): 2'4 — ESTADO MAR (0 a 12): 2
CABLE LARGADO (Metros): 900 - 1100 — ESTADO LUNA (1 a 4): 1

	FIRME	VIRADA	INCIDENCIAS
HORA GMT (hh.mm)	08:35	13:15	
LATITUD (gg.mm)	43°36' N	43°35'520 N	
LONGITUD (gg.mm)	002°09' W	002°08'840 W	
PROFUNDIDAD (metros)	732 x	475	

PESO DESCARTE TOTAL (DT): 375 Kg. — PESO MUESTRA DESCARTE (DM): 13500

CODIGO	NOMBRE	CAPTURA RETENIDA (Kg)	PESO MUESTRA DESCARTE Esp. (gr.) (DE)	Nº EJEMPLARES DESCARTADOS	RAZONES DEL DESCARTE
10283	MERLUZA	60	TM	4	CAC1
10823	RAPE NEGRO	65			
10822	RAPE BLANCO				
10277	LIRIO	TM	TM	12	MAR1
10414	JUREL		TM	2	CAC1
10642	CABALLA				
10800	GALLO BOSCII	TM			
10799	GALLO WHIFF				
20194	CIGALA	25			
10.262	BESUGUELLA	40.	TM	3	CAC1
10.723	GALLINETA	4			
10.022	PINTA ROJA		TM	10	MAR1
10.259	RAZ PALO		TM	3	MLG1
10.019	BOLANEGRA		TM	25	MAR1
10.250	MARUJITO		TM	30	MAR1
30.171	PUTA	40(7-2ind)	350	1	—
30.189	PEZ LAGARTO		110	1	—
45.042	ERIZO		50	1	MAR1
30.166	CALAMAR	12 - 2ind			

Principal especie/s presentes en Otras Especies.

Figure 4.2. Spanish Discards ICES Sampling Onboard Programme Haul Form. The total estimate for the discards was 375kg and the sample was 13500g (13.5kg). There were 4 hake and 24 black-mouth catsharks in the sample.

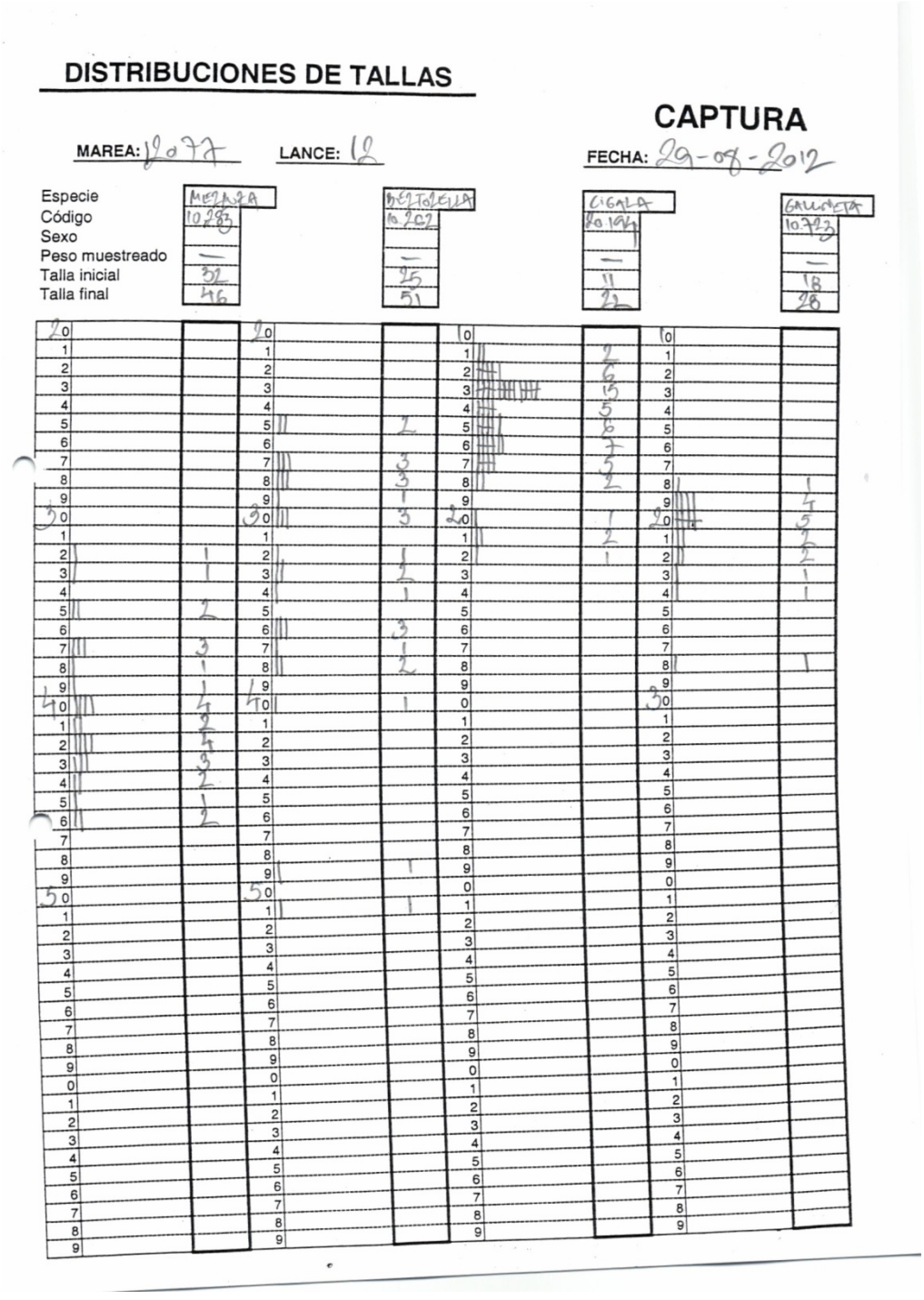


Figure 4.3. Spanish Discards ICES Sampling Onboard Programme Commercial Catch Form. Hake example. Length frequency of the sample of the retained section of the catch.

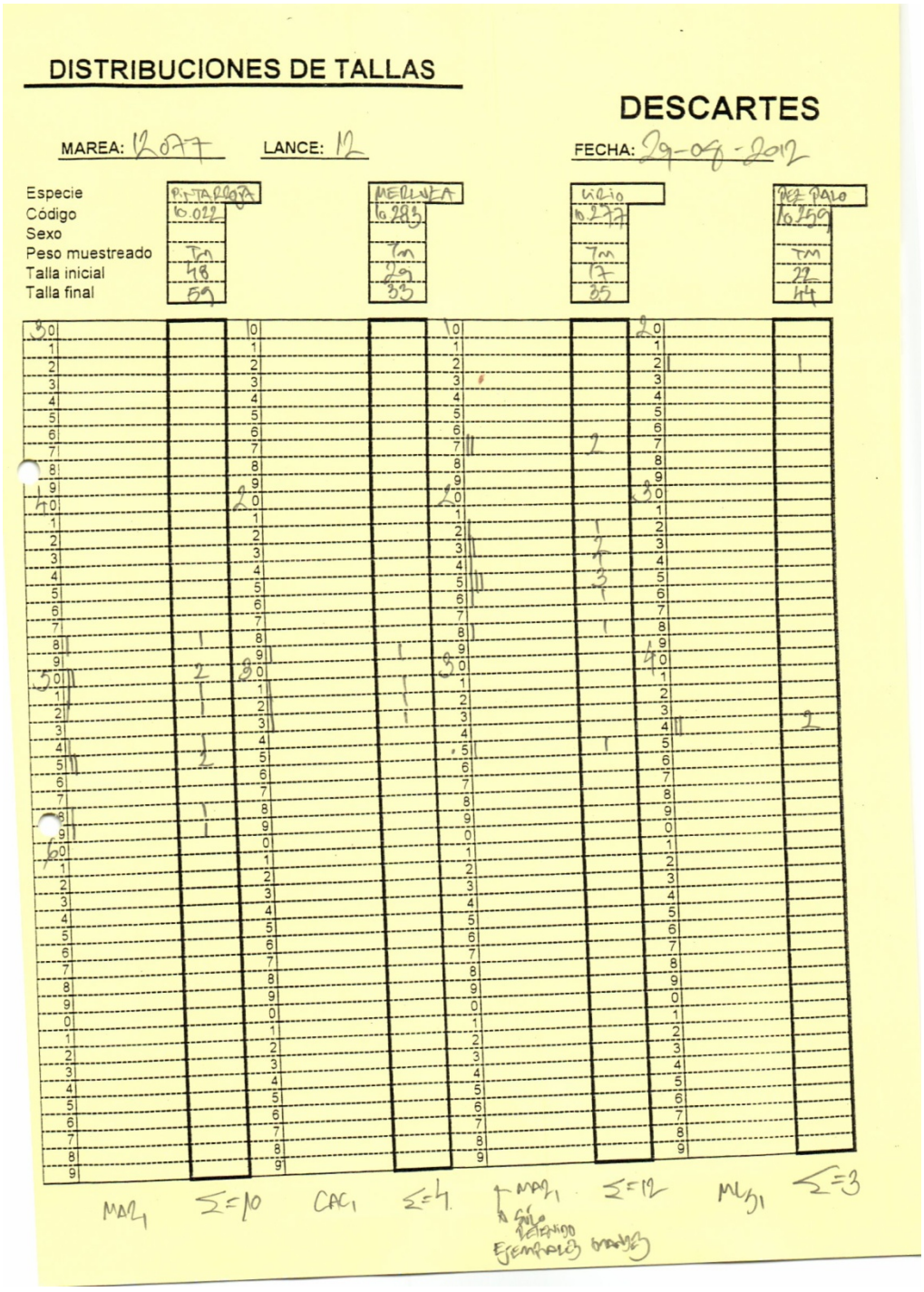


Figure 4.4. Spanish Discards ICES Sampling Onboard Programme Discard Form showing the measured length frequencies of the sample of the Hake discards.

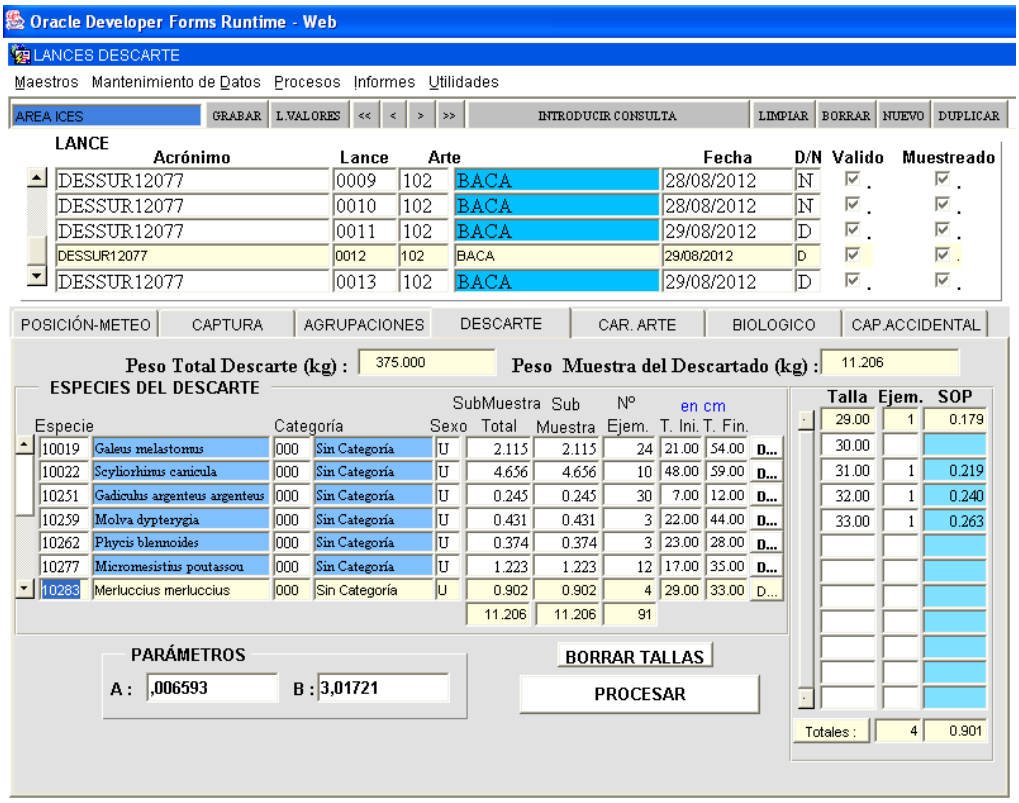


Figure 4.5. Spanish Discards ICES Sampling Onboard Programme Discard Database showing the measured length frequency for the Hake

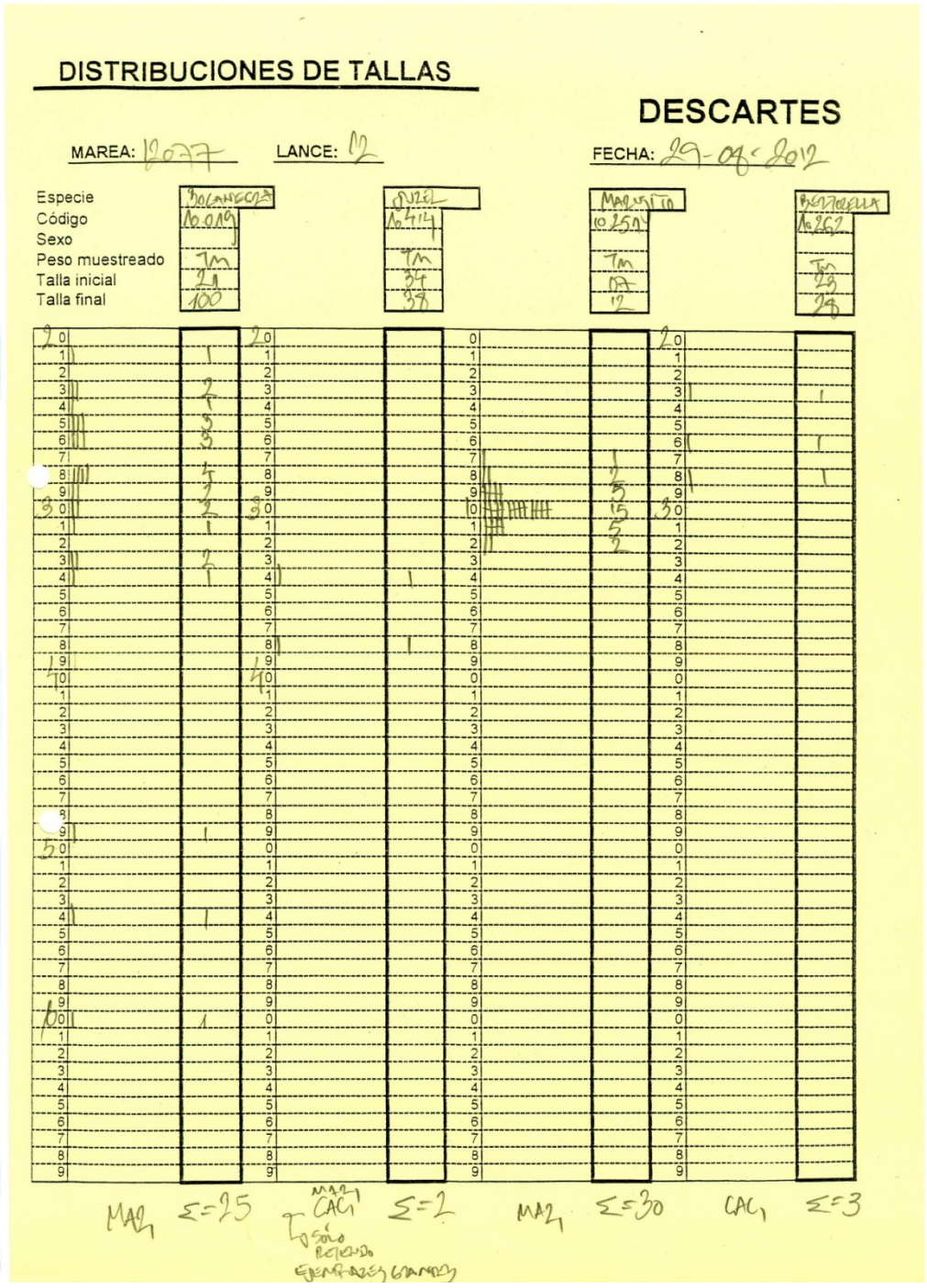


Figure 4.6. Spanish Discards ICES Sampling Onboard Programme Discard Form showing the measured length frequencies of the sample of the Blackmouth catfish discards.

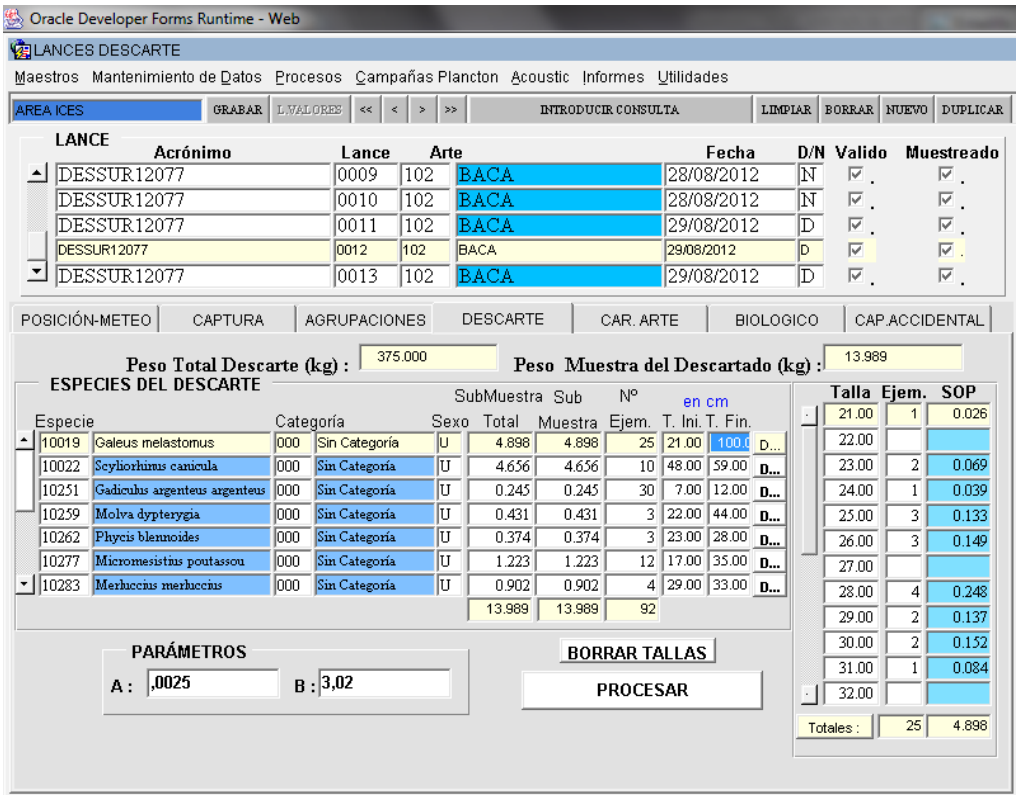


Figure 4.7. Spanish Discards ICES Sampling Onboard Programme Discard Database showing the length frequency of the Blackmouth catshark example.

4.2.2 Latvian Gillnet fishery

Sea sampling protocols for cod directed fishery with gillnets in the Baltic are recorded on a number of forms:

- Gillnet fishery form – This contains information about a single fishing act, and records the trip number, ship register number, the gear and its parameters, information about the location from which the sample is taken, the duration and information about the catch by species; the catch category weight in kilograms and numbers of fish, and the number of boxes for landing.
- Fish biological analysis form – This form contains the main information from the Gillnet fishery form, fish code and information about catch category, the sample weight and the biological information for individual fish; length, full weight, sex, maturity and otoliths. Otoliths are collected and returned in a book.
- Fish length measurements form – This form contains the main information from the Gillnet fishery form, fish code and information about catch category, sample weight and length information for individual fish. The form has two additional columns for sex and maturity. Very often for the landing of cod as well as the length, the sex and maturity stage is also noted. For all flatfish the length and sex is recorded.

The Gillnet fishery form contains the finalized information by species and catch categories weights. Biological and length measurements forms contain information about species weight in kg and sample weight in kg taken. The same sample can be distributed between the biological analysis and length measurements forms.

All discarded cod are measured and weighted, except in the case when the discard is very large (more than 200 kg), in which case a subsample weight is taken. All subsamples are weighted using "Danish fishers's weights". The sorting of fish into catch categories is made by the fishers. The subsample weight can also be calculated using average weights in 1 cm group:

mean weight in 1cm group X measured fish number in length class

For each fishery act the length frequency by species and catch category are recorded. The number of landed cod is calculated using information about boxes prepared for landings. The cod weight in one box is fixed number and the number of fish in one box is also known. The coefficient used for the conversation from gutted to the full weight for the cod is 1.17.

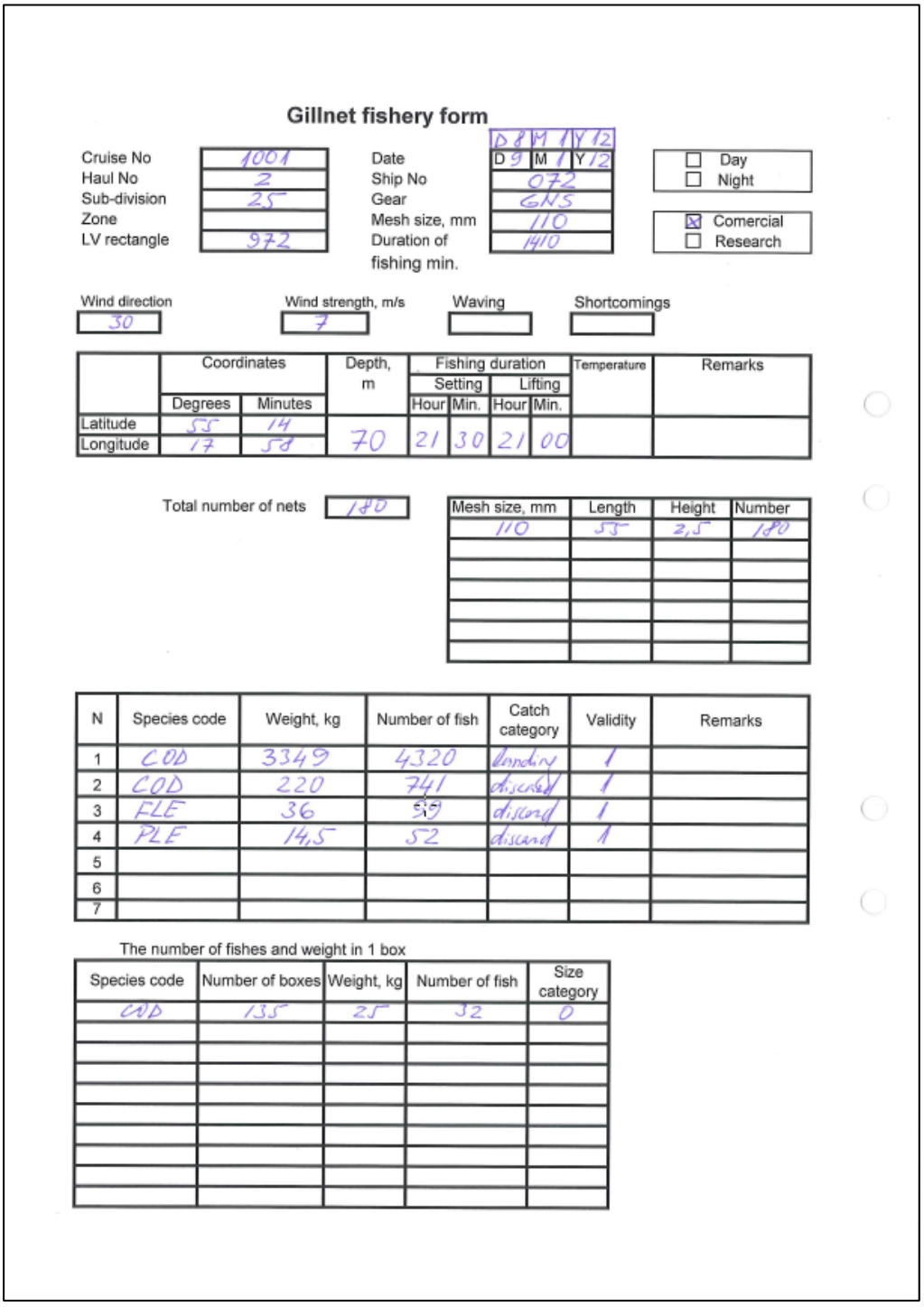
From the example of haul 2 in cruise 1001 Figure x the number of landed cod is therefore the number of boxes (135) X the number of fish in 1 box (32) = number in haul (4320):

$$\frac{Total\ Boxes}{Boxes\ measured} = \frac{135}{1} \times 32\ fish\ =\ 4320\ retained\ cod\ from\ haul\ no\ 2$$

The number of discarded cod is calculated using the ratio of total weight 220kg to sample weight 54kg (Figure 4.8). There were a total of 182 cod in the sample 116 of which are recorded in the length measurement form (Figure 4.9) and 66 in the biological analysis form (of which 45 are shown Figure 4.10). giving:

$$\frac{discard\ weight\ kg}{subsample\ weight\ kg}\ =\ \frac{220}{54} = 4.07\ \times 182\ cod\ @\ length = 741\ discarded\ cod\ for\ haul\ no\ 2$$

For each trip, for each subdivision age length key (SD ALK) is prepared. Biological analysis is made in the sea and depending on the weather electronic or helix scales are used. During the biological analyses 30 fish from each 5 - centimetre group are analysed for each subdivision. Using the ALK from each trip the numbers by age groups is later calculated.



Gillnet fishery form

Cruise No	1001	Date	D 8 M 1 Y 12	☐ Day	
Haul No	2	Ship No	072	☐ Night	
Sub-division	25	Gear	GNS		
Zone		Mesh size, mm	110	☒ Comercial	
LV rectangle	972	Duration of fishing min.	1410	☐ Research	

Wind direction	Wind strength, m/s	Waving	Shortcomings
30	7		

	Coordinates		Depth, m	Fishing duration				Temperature	Remarks
				Setting		Lifting			
	Degrees	Minutes		Hour	Min.	Hour	Min.		
Latitude	55	14	70	21	30	21	00		
Longitude	17	58							

Total number of nets: 180

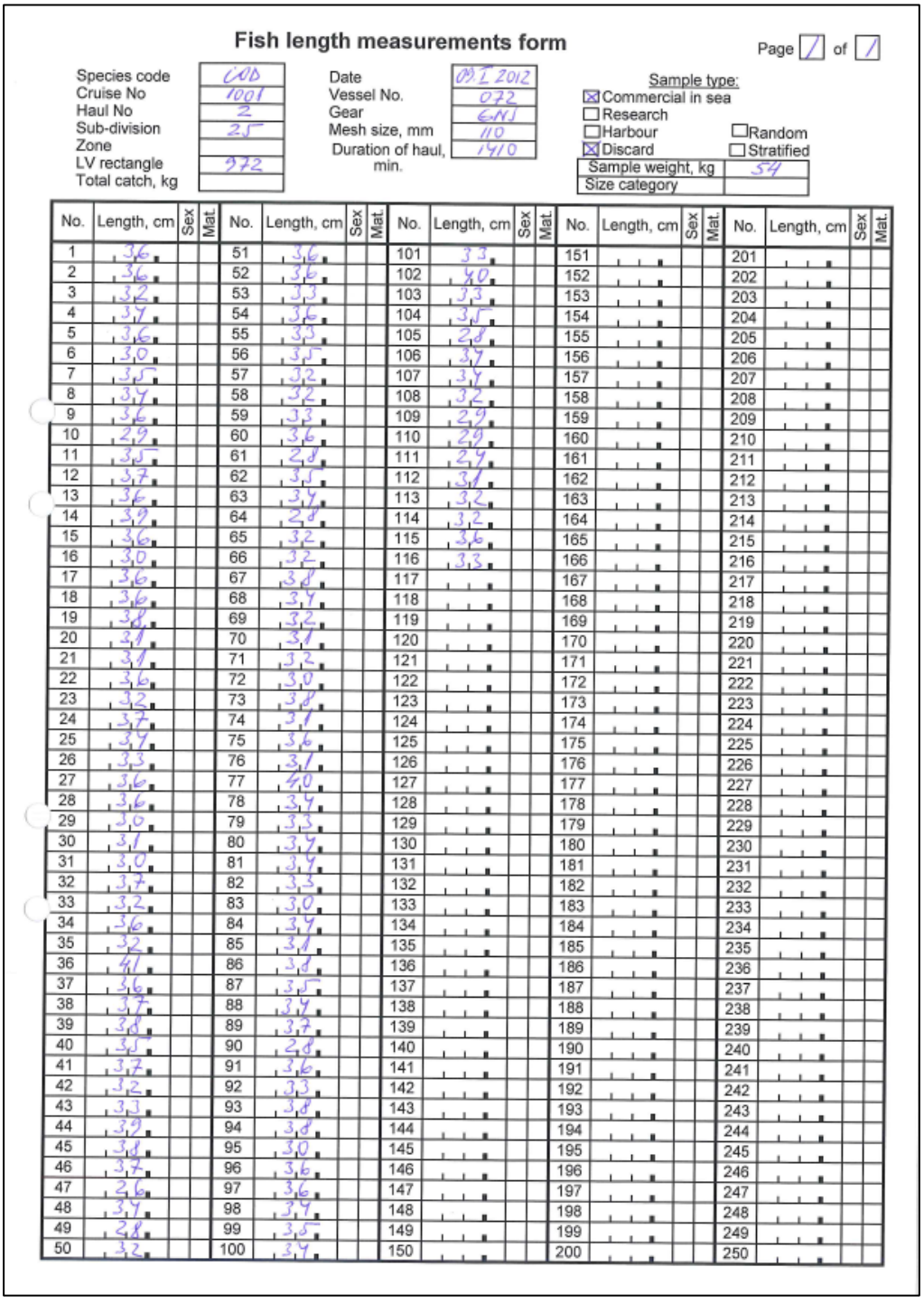
Mesh size, mm	Length	Height	Number
110	55	2,5	180

N	Species code	Weight, kg	Number of fish	Catch category	Validity	Remarks
1	COD	3349	4320	landing	1	
2	COD	220	741	discard	1	
3	FLE	36	39	discard	1	
4	PLE	14,5	52	discard	1	
5						
6						
7						

The number of fishes and weight in 1 box

Species code	Number of boxes	Weight, kg	Number of fish	Size category
COD	135	25	32	0

Figure 4.8 . Gillnet fishery form showing the weight of the retained and discarded sections of the catch, 3349 kg and 220kg, the number of boxes of the retained and the weight and number of fish in a sampled box.



Fish length measurements form

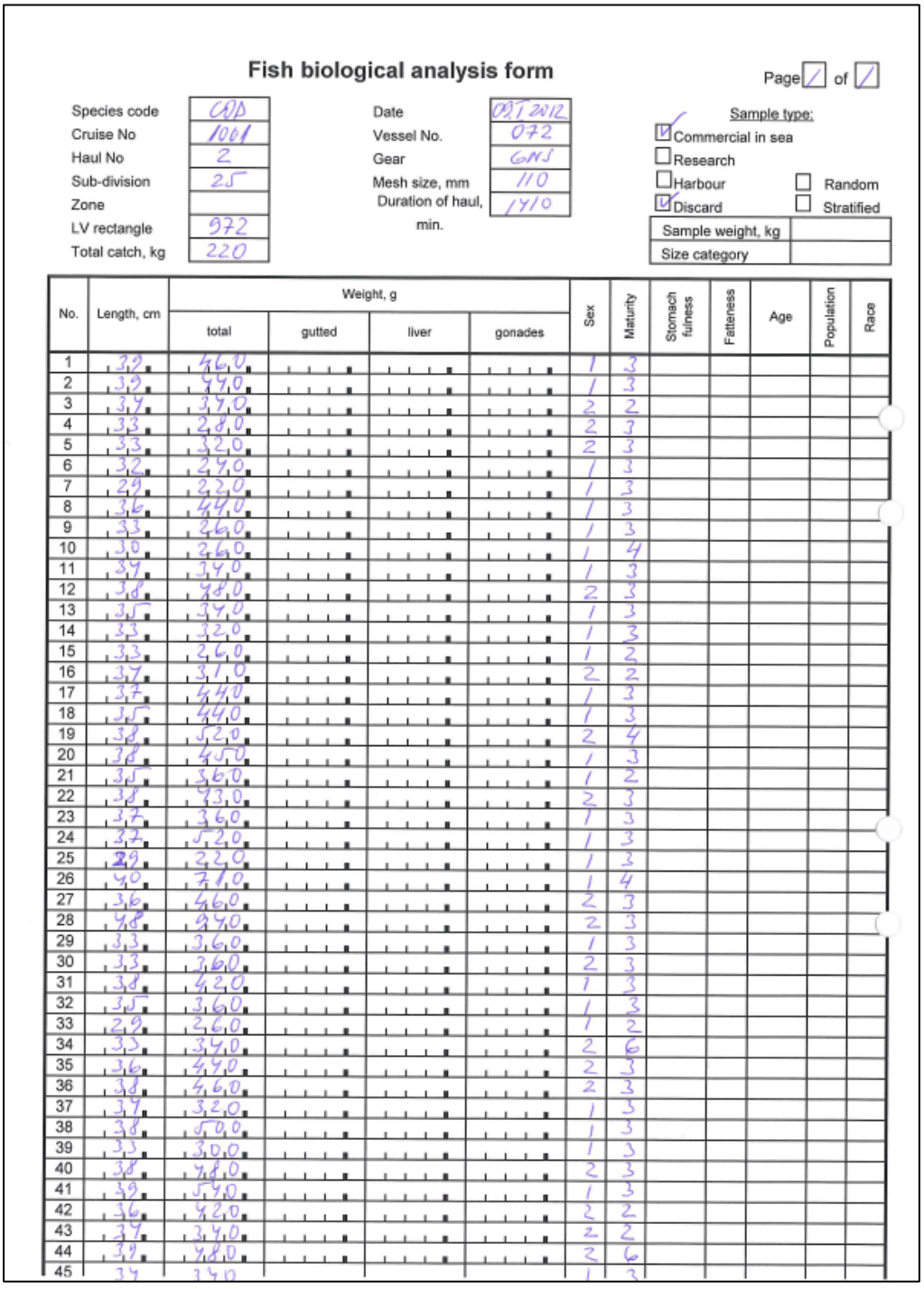
Page 1 of 1

Species code	COD
Cruise No	1001
Haul No	2
Sub-division	25
Zone	
LV rectangle	272
Total catch, kg	
Date	09.I.2012
Vessel No.	072
Gear	GNS
Mesh size, mm	110
Duration of haul, min.	1410

Sample type:
☒ Commercial in sea
☐ Research
☐ Harbour ☐ Random
☒ Discard ☐ Stratified
Sample weight, kg: 54
Size category:

No.	Length, cm	Sex	Mat.	No.	Length, cm	Sex	Mat.	No.	Length, cm	Sex	Mat.	No.	Length, cm	Sex	Mat.	No.	Length, cm	Sex	Mat.
1	36			51	36			101	33			151				201			
2	36			52	36			102	40			152				202			
3	32			53	33			103	33			153				203			
4	37			54	36			104	35			154				204			
5	36			55	33			105	28			155				205			
6	30			56	35			106	37			156				206			
7	35			57	32			107	34			157				207			
8	34			58	32			108	32			158				208			
9	36			59	33			109	29			159				209			
10	29			60	36			110	29			160				210			
11	35			61	28			111	29			161				211			
12	37			62	35			112	31			162				212			
13	36			63	34			113	32			163				213			
14	39			64	28			114	32			164				214			
15	36			65	32			115	36			165				215			
16	30			66	32			116	33			166				216			
17	36			67	38			117				167				217			
18	36			68	34			118				168				218			
19	34			69	32			119				169				219			
20	31			70	31			120				170				220			
21	31			71	32			121				171				221			
22	36			72	30			122				172				222			
23	32			73	38			123				173				223			
24	37			74	31			124				174				224			
25	34			75	36			125				175				225			
26	33			76	31			126				176				226			
27	36			77	40			127				177				227			
28	36			78	34			128				178				228			
29	30			79	33			129				179				229			
30	31			80	34			130				180				230			
31	30			81	34			131				181				231			
32	37			82	33			132				182				232			
33	32			83	30			133				183				233			
34	36			84	34			134				184				234			
35	32			85	31			135				185				235			
36	41			86	33			136				186				236			
37	36			87	35			137				187				237			
38	37			88	34			138				188				238			
39	38			89	37			139				189				239			
40	35			90	28			140				190				240			
41	37			91	36			141				191				241			
42	32			92	33			142				192				242			
43	33			93	34			143				193				243			
44	32			94	38			144				194				244			
45	38			95	30			145				195				245			
46	37			96	36			146				196				246			
47	26			97	36			147				197				247			
48	34			98	34			148				198				248			
49	28			99	35			149				199				249			
50	32			100	34			150				200				250			

Figure 4.9. The Fish length measurement form showing the length of 116 measured cod.



Fish biological analysis form

Page 1 of 1

Species code	COD
Cruise No	1001
Haul No	2
Sub-division	25
Zone	
LV rectangle	972
Total catch, kg	220

Date	07 2012
Vessel No.	072
Gear	GNS
Mesh size, mm	110
Duration of haul, min.	1410

Sample type:
- [x] Commercial in sea
- [ ] Research
- [ ] Harbour
- [ ] Random
- [x] Discard
- [ ] Stratified

Sample weight, kg	
Size category	

No.	Length, cm	Weight, g				Sex	Maturity	Stomach fulness	Fatteness	Age	Population	Race
		total	gutted	liver	gonades							
1	32	460				1	3					
2	32	440				1	3					
3	34	370				2	2					
4	33	280				2	3					
5	33	320				2	3					
6	32	240				1	3					
7	29	220				1	3					
8	36	440				1	3					
9	33	260				1	3					
10	30	260				1	4					
11	34	340				1	3					
12	38	480				2	3					
13	35	340				1	3					
14	33	320				1	3					
15	33	260				1	2					
16	37	370				2	2					
17	37	440				1	3					
18	35	440				1	3					
19	38	520				2	4					
20	38	450				1	3					
21	35	360				1	2					
22	38	430				2	3					
23	37	360				1	3					
24	37	520				1	3					
25	29	220				1	3					
26	40	710				1	4					
27	36	460				2	3					
28	48	940				2	3					
29	33	360				1	3					
30	33	360				2	3					
31	38	420				1	3					
32	35	360				1	3					
33	29	260				1	2					
34	33	340				2	6					
35	36	440				2	3					
36	38	460				2	3					
37	34	320				1	3					
38	38	500				1	3					
39	33	300				1	3					
40	38	480				2	3					
41	39	540				1	3					
42	36	420				2	2					
43	37	340				2	2					
44	39	480				2	6					
45	34	340				1	3					

Figure 4.10. Fish biological measurement form showing the length, sex and maturity of 45 (of a total of 66) measured cod.

4.2.3 Scottish mixed demersal trawler

The at-sea sampling scheme for the demersal species is stratified into three strata, one consists of the larger demersal trawlers, one consists of vessels that habitually target *Nephrops* on offshore fishing grounds, and the third consists of smaller vessels targeting *Nephrops,* and increasingly squid, mainly operating on inshore fishing grounds. The latter two types of vessels may not land much, if any, demersal fish but can discard substantial quantities.

A trip of a larger demersal vessel would generally last a week and typically consist of 4 to 5 hauls per day. The at-sea observer would sample all the hauls.

For each haul an estimate of the total catch is made, based on the size of the hopper into which the catch is emptied, and the number of "lifts" – the number of times the hopper was filled from the contents of the net. This estimate is often compared with that of the skipper and is converted by the observer into units of "baskets" a basket being ~ 32kg. The catch is sorted into species by the crew as it passes out of the hopper along a conveyer, the retained fish being removed from the conveyer by the crew and graded by size. Some size grades may be gutted. The observer fills one or more baskets of discards from the end of the conveyer by collecting the fish of all species left on the conveyer (Picture 4.1). Discarded benthos (octopus etc.) are not collected and collection generally starts when the catch starts to be processed.

All the fish in one or more baskets of discards are identified to species and measured for length (Picture 4.2). An otolith is collected from the first 3 individuals of each length class encountered over the course of the trip (Picture 4.3) for the main commercial species (cod, haddock, whiting, saithe). Otolith collection starts with the first haul but will cease when three otoliths have been collected for the length class, unless the vessel moves a substantial distance to a new fishing area, in which case otolith collection will resume. The haul from which the otoliths are collected is not recorded.

A tally of the boxes of all the retained fish is made for each haul and again converted, by the observer, into units of baskets. The total discards for the haul are estimated as the difference between the estimate of the total catch and the tally of the retained fraction. For each haul the ratio of:

$$\text{estimated total discard } (n \text{ baskets})_h \,/\, \text{sampled discards } (n \text{ baskets})_h$$

is used to scale the measured length frequency of the sample to that of the total catch for haul h. To estimate the numbers at length for the trip the scaled length frequencies are summed over all hauls. To estimate the numbers-at-age for the trip an unweighted age length key, compiled from all the otoliths collected for the trip, is used to convert numbers at length to numbers-at-age.

For the landed fraction of the catch length frequencies, by sorted size category, for the main commercial species (cod haddock whiting and saithe) are collected for the trip. Age samples are generally not collected from the landed fraction of the catch, nor are the length frequencies used in the estimation of the landed numbers-at-age, this is based on an onshore market sampling programme.

Picture 4.1. Discarded fish are collected once the crew has sorted and removed the retained fraction.

Picture 4.2. Fish are identified to species and measured

Picture 4.3. Otoliths from the first 3 individuals of each length class encountered during the trip are collected.

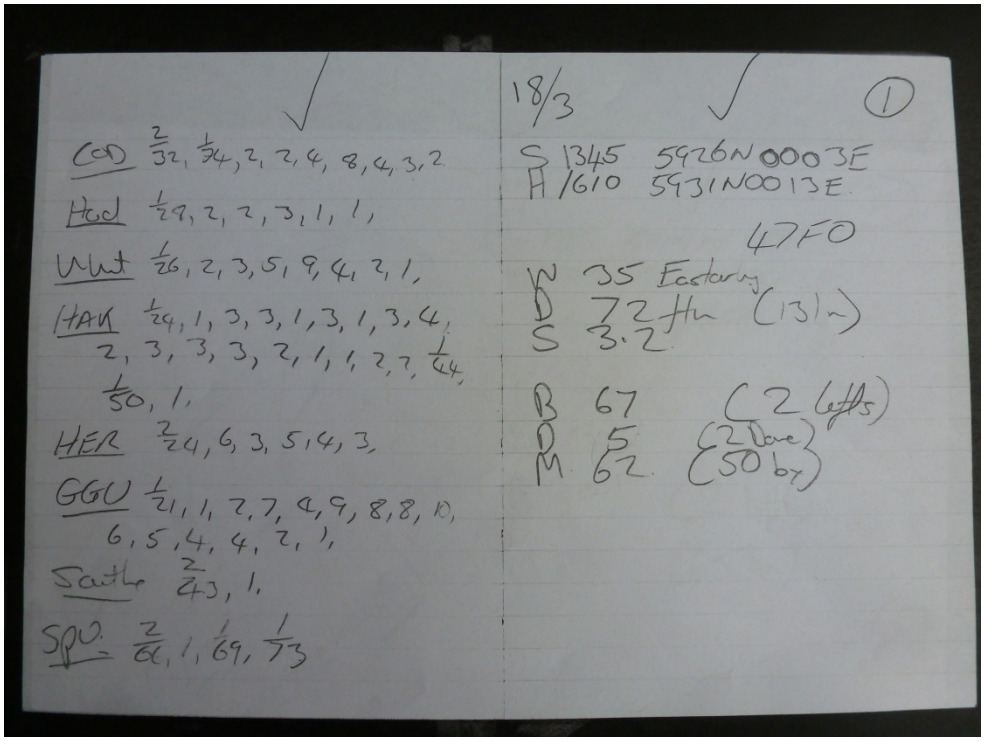


Figure 4.11. Example of the transcribed haul details. Haul number, start time and position, end time and position, windspeed and direction, depth, and speed the haul are recorded at the top of the right page. The length frequencies of the discarded fish by species are on the left page. Estimate of the total catch ("B 67" = 67 bulk), the discarded ("D 5" = 5 discards), the sample ("2 Done"), and the marketable ("M 62" = 62 marketable) all expressed in baskets are on the lower right page.

Estimation of sampling probabilities and sampling weights

Estimating the numbers at length for the demersal trawl example (Figure 4.11). On this particular example there are 8 hauls brought on-board the vessel (the vessel was one of a pair team which made 13 hauls in total, the other hauls being taken by the

partner vessel), all of which are sampled. It was estimated that for haul one there were a total of 5 baskets of discards, and the at-sea observer collected two baskets which were sampled. In total there were 10 haddock in the two baskets which all got measured, and of those 10 fish 3 individuals were 31cm in length. The combined sample weights give an overall sample weight of 2.5. Therefore each measured individual of 31cm represent 2.5 fish in the discards from the first haul; we estimate there were 7.5 haddock of 31cm discarded in the first haul.

$$\frac{8\ hauls}{8\ hauls} \times \frac{5\ baskets}{2\ baskets} \times \frac{10\ fish}{10\ fish} \times 3\ @\ length38cm\ = \frac{400}{160} \times 3\ = 7.5\ fish\ at\ 31cm$$

The complete sampling probabilities and sample weight by haul for the trip are shown in table 4.3, the measured length frequencies by haul in table 4.4 and the estimated length frequencies in table 4.5.

Table 4.3. Number of baskets discarded and sampled by haul, the sampling probability and the sample weights and the total number of haddock measured and the estimate of the total number discarded.

Haul Number	Estimated Number of baskets discarded	Number of baskets sampled	Sampling probability	Sample weight	Total haddock measured	Estimate of haddock for the haul
2	5	2	0.400	2.500	10	25.00
4	9	1	0.111	9.000	11	99.00
6	9	2	0.222	4.500	3	13.50
7	23	3	0.130	7.667	0	0.00
8	7	2	0.286	3.500	12	42.00
11	10	3	0.300	3.333	2	6.67
12	10	1	0.100	10.000	0	0.00
13	8	2	0.250	4.000	76	304.00
Total					114	490.17

Table 4.4 . The measure length frequency for haddock by haul.

	Numbers at length								
Haul Number	27	28	29	30	31	32	33	34	Total
1		1	2	2	3	1	1		10
3	1	1	3	5		1			11
5				1	1	1			3
7									0
9			1	3	3	3	2		12
11				1	1				2
12									0
13			10	20	23	16	2	5	76
Total	1	2	16	32	31	22	5	5	114

Table 4.5 The estimated total discards for haddock by haul.

	Numbers at length								
Haul Number	27	28	29	30	31	32	33	34	Total
1	0	2.5	5	5	7.5	2.5	2.5	0	25
3	9	9	27	45	0	9	0	0	99
5	0	0	0	4.5	4.5	4.5	0	0	13.5
7	0	0	0	0	0	0	0	0	0
9	0	0	3.5	10.5	10.5	10.5	7	0	42
11	0	0	0	3.33	3.33	0	0	0	6.67
12	0	0	0	0	0	0	0	0	0
13	0	0	40	80	92	64	8	20	304
Total	9	11.5	75.5	148	118	90.5	17.5	20	490

Length stratified sampling for age.

In order to calculate the sample weights for estimating numbers-at-age using length stratified sampling of otoliths, continuing the example from figure 5.11, we would assume that of the 3 fish encountered that were 31cm long two have their otoliths collected, and that (subsequently we determine that) one is age 1 year and one is age 2 years then the example becomes for the age 1 fish:

$$\frac{8\ hauls}{8\ hauls} \times \frac{5\ baskets}{2\ baskets} \times \frac{10\ fish}{10\ fish} \times \frac{3\ @31cm}{2\ @31\ cm} \times 1\ @\ age1\ @length\ 31cm\ = \frac{1200}{320} \times 1\ = 3.75$$

and for the age 2 fish:

$$\frac{8\ hauls}{8\ hauls} \times \frac{5\ baskets}{2\ baskets} \times \frac{10\ fish}{10\ fish} \times \frac{3\ @38cm}{2\ @30\ cm} \times 1\ @\ age2\ @length\ 38cm\ = \frac{1200}{320} \times 1\ = 3.75$$

So the estimate for the number discarded in the haul is still 7.5 fish of 31cm, but we now estimate that 3.75of those are age 1 and 3.75 are age 2.

However the Marine Scotland at-sea sampling protocols used at present do not record from which haul the otoliths are collected, nor do we collect at least one otolith from each sampled haul for each encountered length class, so it is not possible to generate sample weights for ages as $\frac{fish\ @\ length}{ages\ @\ length}$ is undefined when ages@length = 0. Rather an unweighted age length key is compiled consisting of all the otoliths collected for the trip. This assumes that fish of the same length from all hauls have the same age composition. Additionally as otolith collection begins with the first fish encountered for each length, and ceases when three otoliths are collected, there is a potential bias in that the ages of fish encountered early in the trip are more likely to be collected than fish encountered later in the trip.

4.2.4 Swedish *Pandalus* trawler in the Skagerrak

The trip in the example is conducted with a bottom trawl with a mesh size of 35mm, a 19mm sorting grid and a fish retention device with a 120mm selection panel, which

allows the large fish to pass over the grid and enter the trawl and the small fish to be let out through the panel. For this example the trip consists of 2 hauls and 1 was sampled. The recording form is shown in figure 4.12.

The catch typically consists of a mix of *Pandalus borealis* (Northern pink shrimp), large fish and fish small enough to pass through the grid.

The trip is sampled for:

- Amount of discards and landings in weight for all species
- Length distributions for all species (discards and landings)
- Biological parameters: individual length, weight and age for cod and plaice discards. Biological data are collected by length stratified sampling where two individuals by cm length class is sampled by trip.

Data are used for: Biological data are used by assessment working groups for age based stock assessment. Total weight of discards is used by WGMIXFISH for producing mixed fisheries advice and is also submitted to STECF. Discard data are also used nationally for scientific and management purposes, in terms of information of species composition, discard rate etc.

Before the catch is worked up it is split in two fractions;

1) A mix of Pandalus and fish, both above and under MLS. This fraction is here referred to as "the prawn lift".

2) Unwanted small round fish that is separated from the rest of the catch in the trawl before it is brought on board. This fraction would on a fishing operation without observers not be brought on board but is brought in here and kept separate from the rest of the catch, for sampling purposes. This fraction is here referred to as "The fish lift".

The two discard fractions are kept separate in the sampling and the discard weights/number of fish measured are raised separately for each fraction.

Working up the catch:

The "prawn lift"

-The prawn lift is sorted into landings and discards by the crew. All discards are collected in baskets and the total number of baskets is noted.

-A subsample of three baskets is sorted by species and weighed to retrieve the subsample weight by species. All species in the subsample are measured for length. If the subsample contains a very large number of individuals for a species, that species is subsampled a second time.

The factor for estimating the total weight or number at length of a discarded species in each discard fraction in the haul:

$$Discard\ weight, haul\ = \frac{Total\ no\ baskets}{Sampled\ baskets} \times Subsample\ weight\ discard$$

In this case, the subsample of three baskets from the "prawn lift" contained 1,4kg of cod and the total number of baskets in the "prawn lift" fraction was 3.75:

$$Total\ discard\ weight\ cod, prawn\ lift, haul\ 1 = \frac{3{,}75}{3} \times 1.4 = 1.75kg$$

Since all specimens of cod in the subsample were measured for length, the same raising factor is applied to the number of fish at every length class in the subsample to

achieve the total number at length in the fraction. In this case, the subsample contained 1 fish of 27cm, 1 of 37cm and 1 of 40cm. To raise the number of fish at 27 cm:

$$Number\ of\ cod, 27cm\ in\ the\ prawn\ lift, haul\ 1 = \frac{3{,}75}{3} \times 1 = 1.25\ fish$$

For species that are sampled for biological parameters, two individuals by cm length class are sampled by trip. This is done in conjunction with the length measurement of the subsample and the first two individuals encountered by length class in the procedure are sampled. Unless the weather conditions are good, the fish used for biological sampling is brought back to the lab for sampling. In that case the whole subsample of the species is brought back so the length measurements for the length distribution and the biological sampling can be carried out at the same time.

The Age-Length Key is constructed by pooling several sampled fisheries in the same area by quarter.

The "fish lift"

The fish lift consists entirely of discards and the sampling procedure follows the procedure of the discard fraction of the "prawn lift". The fish is collected in baskets and the total number of baskets is noted. A subsample of three baskets is sorted by species and measured for lengths.

In this case the total number of baskets in the fraction was 7.5 and the subsample was 3 baskets. The subsample contained 1 specimen of cod with a weight of 0.014 kg and a length of 13cm:

$$Total\ discard\ weight\ cod, fish\ lift, haul\ 1 = \frac{7.5}{3} \times 0.014\ = 0.035kg$$

Raising to the trip:

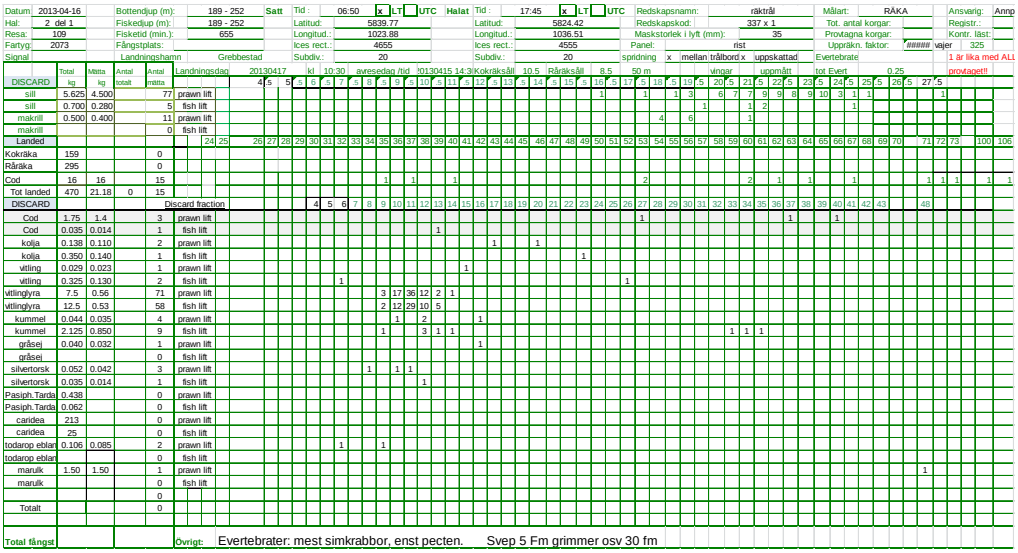
Each discard fraction is raised separately to the trip, in this case consisting of 2 hauls whereof one haul was sampled.

Example: Discard weight of cod in the two fractions for both hauls

$$Kg\ cod, prawn\ lift = \left(\frac{2\ hauls\ total}{1\ haul\ sampled} \times \frac{3.75\ baskets\ total}{3\ baskets\ sampled} \times 1.4\ kg\right) + \left(\frac{2\ hauls\ total}{1\ haul\ sampled} \times \frac{0}{0} \times 0\right) = 3.5\ kg$$

$$Kg\ cod, fish\ lift = \left(\frac{2\ hauls\ total}{1\ haul\ sampled} \times \frac{7.5\ baskets\ total}{3\ baskets\ sampled} \times 0.014\ kg\right) + \left(\frac{2\ hauls\ total}{1\ haul\ sampled} \times \frac{0}{0} \times 0\right) = 0.07\ kg$$

Total weight of discard cod in the trip = 3.5 + 0.07 = 3.57 kg



Datum:	2013-04-16		Bottendjup (m):	189 - 252	Satt	Tid :	06:50	x	LT	UTC	Halat	Tid :	17:45	x	LT	UTC	Redskapsnamn:	räktrål	Målart:	RÄKA	Ansvarig:	Annp
Hal:	2 del 1		Fiskedjup (m):	189 - 252		Latitud:	5839.77					Latitud:	5824.42				Redskapskod:	337 x 1	Tot. antal korgar:		Registr.:	
Resa:	109		Fisketid (min.):	655		Longitud.:	1023.88					Longitud.:	1036.51				Maskstorlek i lyft (mm):	35	Provtagna korgar:		Kontr. läst:	
Fartyg:	2073		Fångstplats:			Ices rect.:	4655					Ices rect.:	4555				Panel:	rist	Uppräkn. faktor:	##### vajer	325	
Signal			Landningshamn	Grebbestad		Subdiv.:	20					Subdiv.:	20				spridning	x mellan trålbord x uppskattad	Evertebrate		1 är lika med ALL	

					Landningsdag:	20130417	kl	10 30	avresedag /tid	20130415 14:30	Kokräkskäll	10,5	Råräkskäll	8,5	50 m	vingar	uppmätt	tot Evert	0,25	provtaget!!!
DISCARD	Total kg	Mätta kg	Antal totalt	Antal mätta																
sill	5.625	4.500		77	prawn lift															
sill	0.700	0.280		5	fish lift															
makrill	0.500	0.400		11	prawn lift															
makrill				0	fish lift															
Landed																				
Kokräka	159			0																
Råräka	295			0																
Cod	16	16		15																
Tot landed	470	21.18	0	15																
DISCARD					Discard fraction															
Cod	1.75	1.4		3	prawn lift															
Cod	0.035	0.014		1	fish lift															
kolja	0.138	0.110		2	prawn lift															
kolja	0.350	0.140		1	fish lift															
vitling	0.029	0.023		1	prawn lift															
vitling	0.325	0.130		2	fish lift															
vitlinglyra	7.5	0.56		71	prawn lift															
vitlinglyra	12.5	0.53		58	fish lift															
kummel	0.044	0.035		4	prawn lift															
kummel	2.125	0.850		9	fish lift															
gråsej	0.040	0.032		1	prawn lift															
gråsej				0	fish lift															
silvertorsk	0.052	0.042		3	prawn lift															
silvertorsk	0.035	0.014		1	fish lift															
Pasiph.Tarda	0.438			0	prawn lift															
Pasiph.Tarda	0.062			0	fish lift															
caridea	213			0	prawn lift															
caridea	25			0	fish lift															
todarop eblan	0.106	0.085		2	prawn lift															
todarop eblan				0	fish lift															
marulk	1.50	1.50		1	prawn lift															
marulk				0	fish lift															
				0																
Totalt				0																
Total fångst					Övrigt:	Evertebrater: mest simkrabbor, enst pecten. Svep 5 Fm grimmer osv 30 fm															

Figure 5.12. Example of a Swedish on board sampling form, filled out after the trip. (Showing page 1 of 2)

4.2.5 Scottish small Nephrops trawler

The at-sea sampling programme for *Nephrops* aims to assess the discard and landed fractions of the catch. The size of vessels on which at-sea observers operate varies considerably. The example here is from a small vessel on a two day trip, the trip consisting of two hauls in total both of which are sampled.

For each haul the total catch is emptied onto the deck and put in baskets by the crew (Picture 4.4). The crew will then start to sort each basket into retained categories and discards. A count of the number of baskets for the total catch is made and two possible methods are used to estimate the raising factors for the discarded component of the catch; a basket method and a time method.

For the basket method the observer collects approximately 200 individual *Nephrops* from the discards as the baskets are sorted and the number of baskets sorted sufficient to provide that sample is recorded. The ratio of:

total baskets of the catch/ sorted baskets sufficient for ~ 200 individuals

is used to scale the length frequency of the sample to that of the total catch.

The time method is similar to the basket method except that the observer records the time taken for the crew to sort the entire catch, and the time required to sort sufficient of the catch to provide a sample of approximately 200 individuals. If the number of sorters does not remain constant this is adjusted for. The ratio of:

total time to sort the catch / time to sort sufficient baskets for ~200 individuals

is used to scale the length frequency of the sample to that of the total catch for the haul.

The basket and the time method can be used simultaneously to provide alternative estimates of the raising factor.

The collection of individual *Nephrops* for the sample does not necessarily relate to the individual's position in the net, because the whole catch is transferred to baskets and the order the baskets are sorted by the crew can be arbitrary. The sample of discarded *Nephrops* collected by the observer are sorted into male, female, and females with eggs (berried) categories and the carapace length of each individual is measured. These length frequencies are recorded onto a PDA (personal digital assistant).

For the estimation of the numbers of the retained section of the catch for each haul, the observer collects and measures ~ 200 individuals form each of the retained size classes – tails, small, medium, large etc. and (subsequently) a length weight relationship is used to estimate the weight of each of the categories in the sample . The number of baskets or part baskets for each category for each haul is recorded by the observer. The weight of the retained categories for the trip is obtained from crew, or at the processor after landing. This category weight is then proportioned according to the known number baskets by category and haul, to give an estimate of the weight of the category for the haul:

$$\widehat{W}_{c,h} = W_{c,t}\frac{b_{c,h}}{\sum_h b_{c,h}}$$

where is the weight for the category for the trip and is the number of baskets for the category, for the haul.

The ratio of the estimated weight of the category to the weight of the sample is used to estimate the numbers by category and haul:

$$\widehat{N}_{c,h} = \frac{\widehat{W}_{c,h}}{w_{c,h}} n_{c,h}$$

and the total for the trip are the sum over the hauls:

$$\widehat{N}_{c,t} = \sum_{h} \widehat{N}_{c,h}$$

Estimation of numbers at length

For the length frequencies of male *Nephrops* recorded on the example trip the calculation of the sample weights for each haul is:

$$\omega_h = \frac{H}{h} \times \frac{U}{u} \times \frac{I}{i}$$

where we use the subscript I and i for individuals measured, as *Nephrops* are not fish. The actual vales (table 4.7) yield sample weights of 4.0, and 5.5 for the two hauls. The haul weights are then applying to the measured numbers at length (table 4.8) to give the estimates for numbers by haul and length (table 4.9):

$$\widehat{N}_{h,l} = \omega_h \, n_{h,l}$$

Which are summed over hauls and lengths:

$$\widehat{N}_{t} = \sum_{h} \sum_{l} \widehat{N}_{h,l}$$

to give the estimated discard numbers for the trip; 613 male *Nephrops*.

Table 4.7. The sampling weights for each haul.

	Total Hauls	Hauls sampled	Total units	Units sampled	Total individuals	Individuals sampled	Sample weights
Haul 1	2	2	14	3.5	68	68	4.00
Haul 2	2	2	11	2	62	62	5.50

Table 4.8 The measured numbers at length for each haul.

	Length class cm																		
	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	
	Measured number at length																			Total
haul 1	1						2	6	9	5	15	9	4	7	7		2		1	68
haul 2					2	2	4	5	9	9	12	7	4	2	3	2	1			62
Total	1	0	0	0	2	2	6	11	18	14	27	16	8	9	10	2	3	0	1	130

Table 4.9. The estimated total numbers by length and haul, and for the trip.

	Length class cm																		
	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	
	Estimated numbers at length																			Total
haul 1	4	0	0	0	0	0	8	24	36	20	60	36	16	28	28	0	8	0	4	272
haul 2	0	0	0	0	11	11	22	28	50	50	66	39	22	11	17	11	6	0	0	341
Total	4	0	0	0	11	11	30	52	86	70	126	75	38	39	45	11	14	0	4	613

Picture 4.4 A *Nephrops* catch on the deck being shovelled into baskets prior to sorting into discarded and retained size categories.

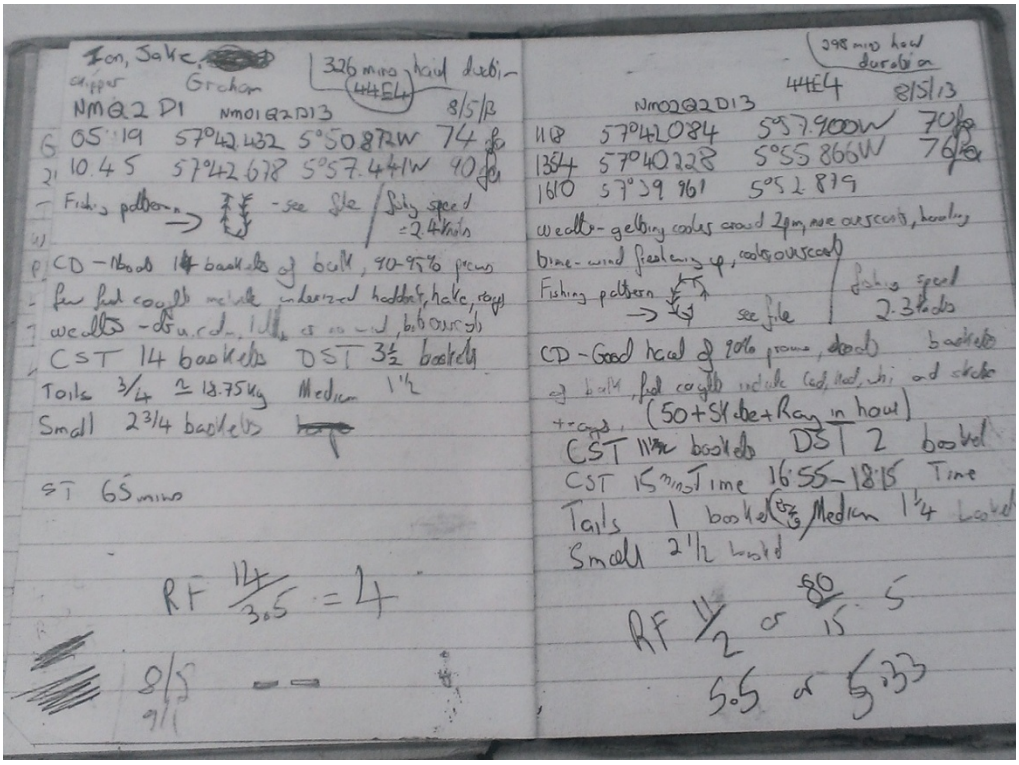


Figure 5.13. Example of the transcribed haul details for *Nephrops* sampling. The left page details the first haul, the right page the second haul, the total for this particular trip. General haul details; crew names, duration, date, times, position and a sketch of the fishing track are at the top of the page. This is followed by notes about the catch. "CST 14 baskets" are the total number of baskets for the catch, "DST 3 ½ baskets" is the number of baskets sorted to provide the discard sample. The number of baskets of the retained categories "tails, medium, small" is recorded below this. The raising factor used for the first haul "RF 14/3.5=4" is the ratio of total baskets to sorted baskets. For the second haul "15 Time 16:55-18:15 Time" are the collection time and the total sorting time respectively "RF11/2 or 80/15" and "5.5 or 5.33" shows alternative methods for estimating the raising factor; one baskets, the other using minutes of sorting time to minutes of collection time. The carapace lengths of the *Nephrops* in the sample are recorded directly to a PDA.

4.2.6 Portugal – Set longliners fishing for demersal species

4.2.6.1 Short description of the protocol

Sampling for discards covers both set longliners fishing for demersal fish (LLS_DEF_0_0_0) and handliners fishing for finfish (LHM_FIF_0_0_0). The Azorean fishing fleet operates exclusively in ICES area X. The example given is for the set longliner fleet. The boats overall length can differ from <10m (open deck most of them) to 24m, which will consequently be reflected in the number of days at sea and sets per trip (1 per day). All sets are sampled for catch and discards. It is considered to be a mixed fishery since it can present a species composition of more than 20 different species in one single set.

Catch is sorted by the crew and the at-sea observer makes an estimation of the total retained catch both in number and weight (Kg). From the retained catch the target species is measured as well as all the species the observer is able to cover. If it is not possible to measure all individuals a subsample of a minimum of 50 individuals is taken and raised to the set level by a raising factor (sampling level). Whatever the case, coverage percentage of each species is recorded.

All specimens being discarded are identified to the species, measured for length on a wooden measuring board to the nearest centimetre, and reason for discarding is recorded. For elasmobranchs sex is also recorded. At-sea observers target for counting and measuring all specimens discarded (100% coverage) if this situation is not possible the coverage percentage (sampling level) is recorded for the set, the options being: 0%, 25%, 50% or 75%. In these situations, the observer will measure a subsample from all species discarded which will be raised to the set level by a raising factor based on the coverage percentage. If the observer isn't able to measure all the specimens he/she attempts to count them all.

Samples and subsamples are not weighed on board so weight-length relationships are used to obtain the total weight for the discards. The choice of the parameters used in these relationships always takes into account estimations from specimens captured in Azores. This is only a problem for those species with low presence or rare occurrence in the catches, and for those the a and b parameters are chosen from the available literature based on closeness for taxonomic, geographical area, number of observations, length used, coefficient of determination (r^2) and sexual differentiation.

On shore, the sampling team present at the harbours must sample landings of the trip sampled by the observer. Their first goal will be the length frequencies sorted by size category for the target species, sampling should then continue through all other species required for a concurrent sampling scheme 1.

The Azorean demersal set longliners example: direct sampling for lengths

In the example given, the trip was conducted by a vessel belonging to the VL2440 segment and LLS_DEF_0_0_0 métier. This trip consisted of 7 days at sea and 6 sets took place all being sampled.

Only one observer is present except during training. Data are registered on paper forms and inserted by the observer in the database, which is later validated through cross-check for incorrect lengths measures, wrong species codes, dates and hours, etc. The observer estimates of the retained catch, by species, is also checked by summing quantities of all the sets from one trip and comparing this with the landed weight to detect overestimation/shortfalls on the estimations.

Calculation of the sampling probabilities from number at length to haul

Sampling units in the Azorean case study consists of the coverage percentage of the number of individuals measured in each set. So for estimating the numbers at length for the demersal set longliner example we have a total of 6 sets, all of which are sampled. For set 78 the at-sea observer counted that there were a total of 16 blackspot sea bream (*Pagellus bogaraveo*) – GOR code in the example - discarded and all got measured (Figure 4.14 and 4.15). Of those 16 fish, 6 individuals were 26 cm in length. Since 100% coverage of discarded fish was achieved the overall sample weight equals 1, meaning that no estimation occurred for this set.

$$\frac{6\ sets}{6\ sets} \times \frac{100\ coverage\%}{100\ coverage\%} \times \frac{16\ fish}{16\ fish} \times 6\ @\ length26cm\ =\ \frac{9600}{9600} \times 6\ =\ 6\ fish\ at\ 26cm$$

If set 79 of this same trip was taken for this example then the observer did not count all fish discarded, rather the coverage represented 25% of the total, within which there were a 12 blackspot sea bream (*Pagellus bogaraveo*) discarded that were measured. Of those 12 fish 1 individual was 26 cm in length (Figure 4.16 and 4.17). So for the same total of 6 sets, the combined sample weights for set 79 give an overall sample weight of 4 meaning that 4 blackspot sea breams of 26 cm length were estimated to be discarded in the second set.

$$\frac{6\ sets}{6\ sets} \times \frac{100\ coverage\%}{25\ coverage\%} \times \frac{12\ fish}{12\ fish} \times 1\ @\ length26cm\ =\ \frac{7200}{1800} \times 1\ =\ 4\ fish\ at\ 26cm$$

The estimation of sampling probabilities and sample weight for the trip, by set, can be found in table 4.10, the measured length frequencies for the trip, by set, in table 4.11 and the estimated length frequencies for the trip, by set, in table 4.12.

Table 4.10. Coverage percentage, the number of individuals discarded and measured, the sampling probability, the sample weight, and the estimate of the total number of blackspot sea bream discarded by set.

Set number	Coverage percentage	Number of measured individuals discarded	Sampling probability	Sample weight	Estimate of blackspot sea bream
78	100	16	1	1	16
79	25	12	0.25	4	48
80	25	3	0.25	4	12
81	100	1	1	1	1
82	100	3	1	1	3
83	100	4	1	1	4
Total		39			84

Table 4.11. The measured length frequency of blackspot sea bream by set.

		Length class (cm)										
Set number	Coverage percentage	25	26	27	28	29	30	31	32	33	34	Total
78	100	3	6	4	2			1				16
79	25	1	1	2	1		2	1	1	1	2	12
80	25	1	2									3
81	100			1								1
82	100	1	2									3
83	100		1	1				1			1	4
Total		6	12	8	3	0	2	3	1	1	3	39

Table 4.12. The estimated total discards of blackspot sea bream by set.

		Length class (cm)										
Set number	Coverage percentage	25	26	27	28	29	30	31	32	33	34	Total
78	100	3	6	4	2	0	0	1	0	0	0	16
79	25	4	4	8	4	0	8	4	4	4	8	48
80	25	4	8	0	0	0	0	0	0	0	0	12
81	100	0	0	1	0	0	0	0	0	0	0	1
82	100	1	2	0	0	0	0	0	0	0	0	3
83	100	0	1	1	0	0	0	1	0	0	1	4
Total		12	21	14	6	0	8	6	4	4	9	84

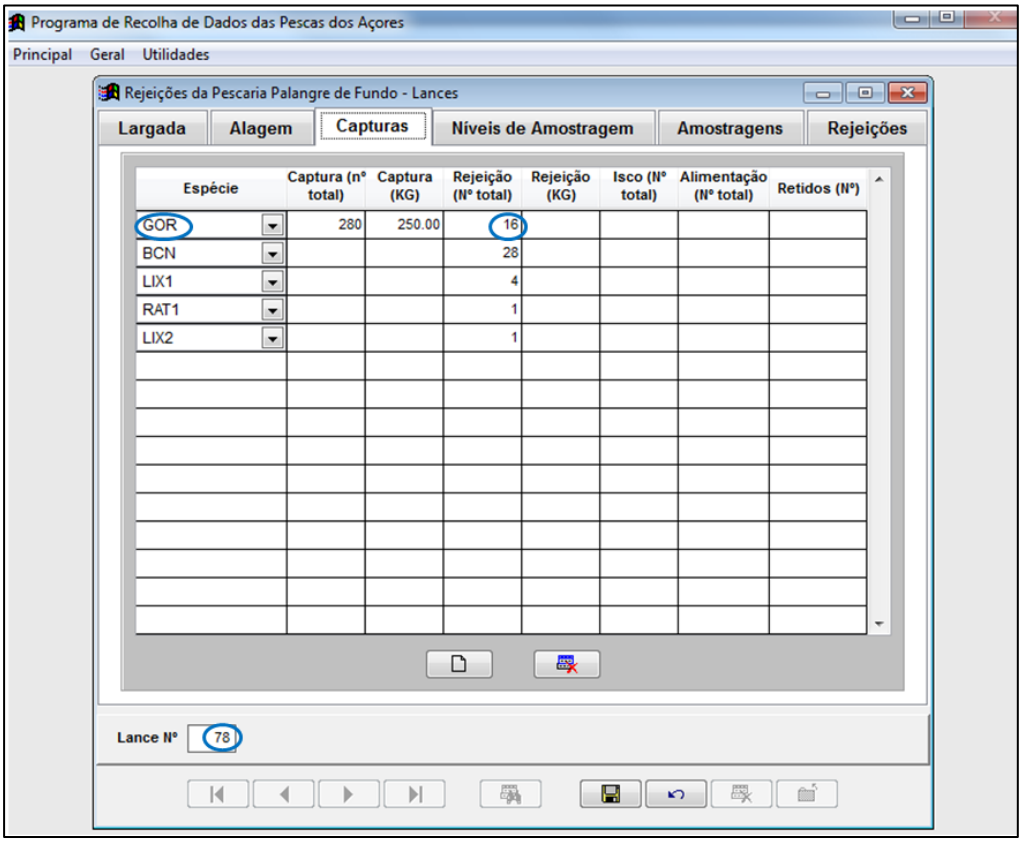


Figure 4.14. Screenshot showing the number of blackspot sea bream discarded in set number 78.

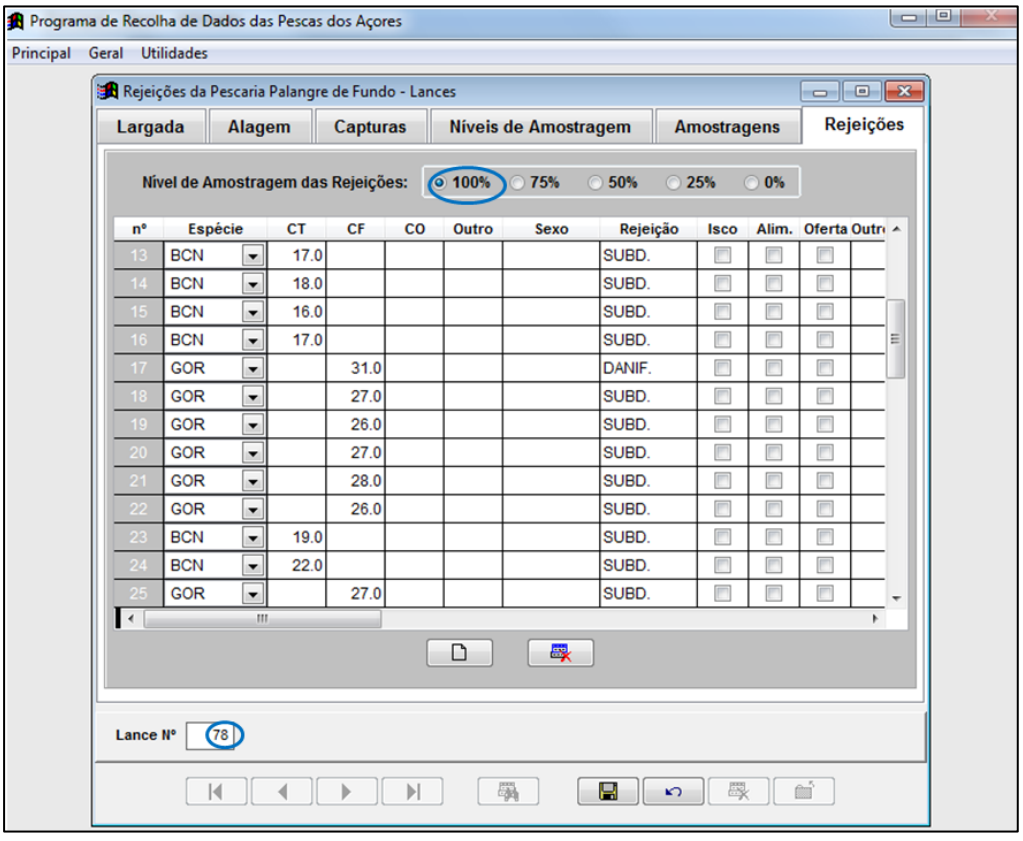


Figure 4.15. Screenshot for set number 78 showing the sampling coverage and some of the recorded length measurements.

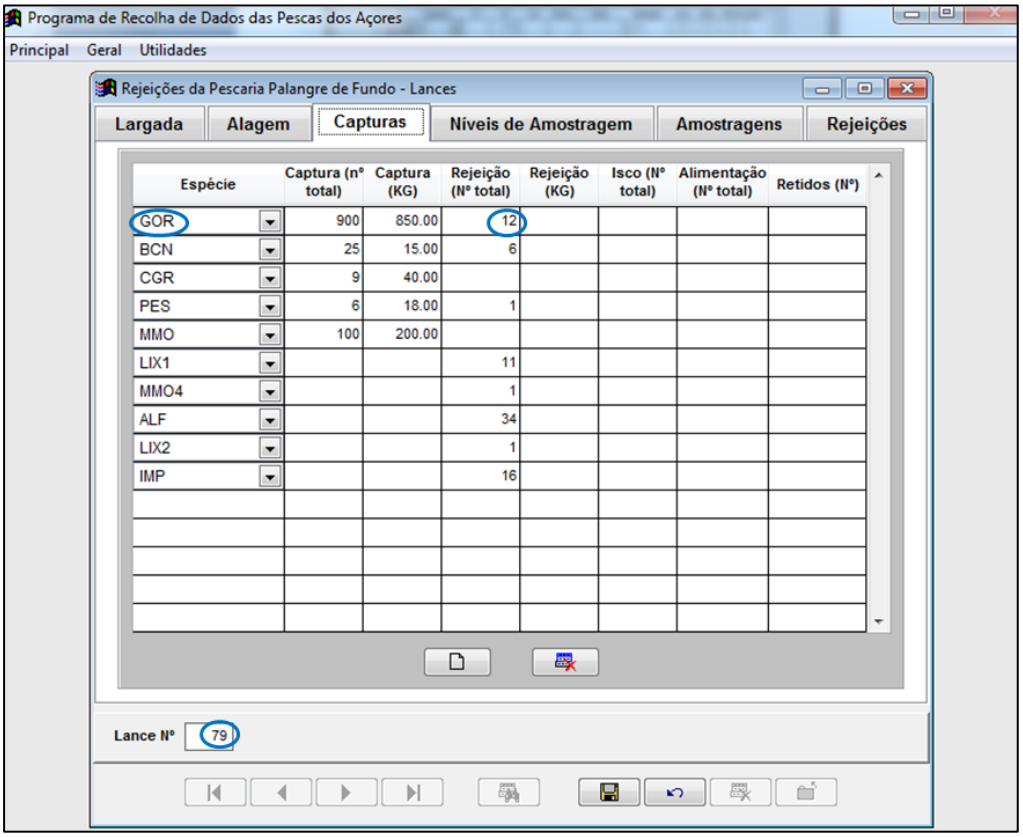


Figure 4.16. Screenshot showing the number of blackspot sea bream discarded in set number 79.

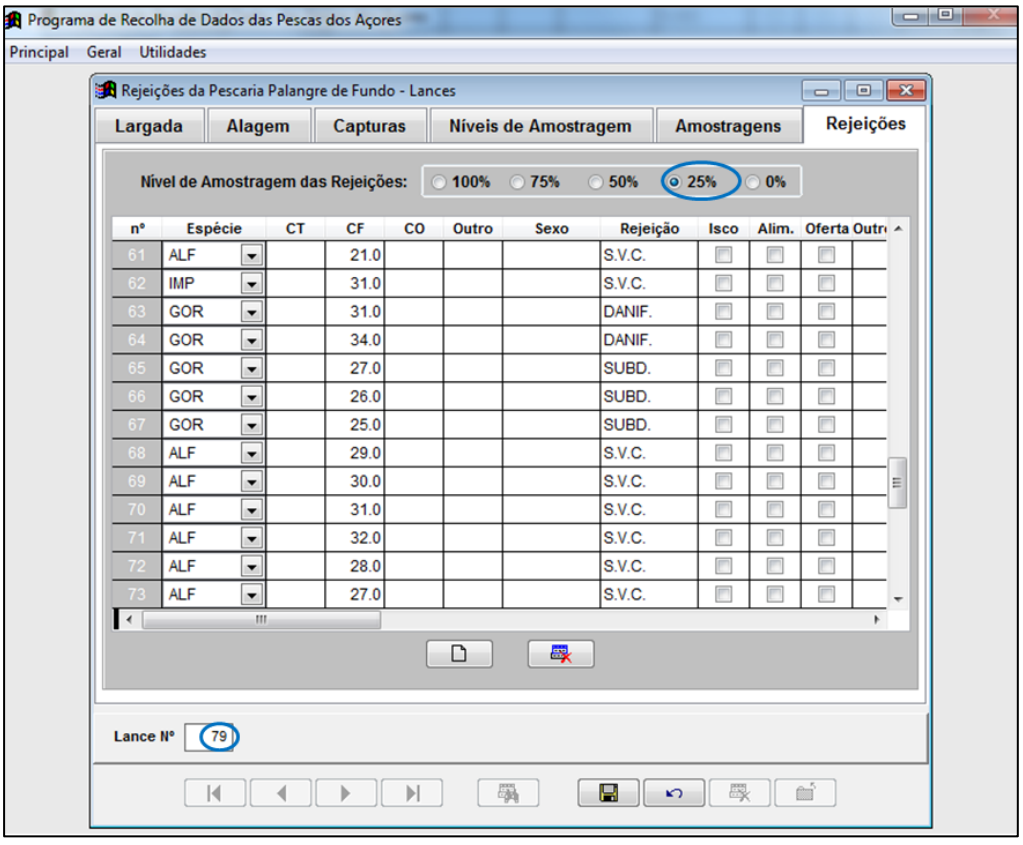


Figure 4.17. Screenshot for set number 79 showing the coverage level and some of the recorded length measurements.

Uncertainties around the estimates

Total catch is estimated for sets where the volume of fish caught is big and counted if volume of fish caught is in small quantities.

At-sea observers at the Azorean Discards Sampling Programme aim for 100% coverage of all individuals discarded in all sets sampled. This means that total number of the individuals discarded are counted and measured by the observer. When a set is not covered 100%, the observer makes an estimate of the percentage coverage of the discards in that particular set. In these cases it entails some uncertainties since the estimate of the coverage percentage is observer dependent.

An uncertainty also exists regarding identification to species level, especially for elasmobranchs group, or when a rare specimen is caught. Observers are encouraged to bring these individuals to the lab for expert identification but if, for some reason, this procedure is not possible, they are instructed to take photos. However, there are still situations where none of the previous procedures are possible to accomplish and on those cases the specimens will end up in a broader category. For example, if a non-identified octopus was incidentally thrown overboard or was too damaged to be identified, it will be identified as "not identified mollusc".

Weight collection and usage

Weight is not collected at-sea for any species discarded instead weight-length relationships are used to estimate weight and these are used for calculating total weight discarded by the fleet by set/trip/quarter/year.

Age collection and usage

Collection of structures for age reading (otoliths) occurs for undersized individuals of some of the main commercial species.

4.2.7 Danish Nephrops trawler in Kattegat

Sampling protocol

Number of observer on-board: Always a single observer.

Recording of the trip: E.g. vessel identifier, time for departure and arrival and log-book number are recorded to easily identify the trip in the logbook register.

Recording of hauls (Total number of hauls): All hauls (invalid and valid) are recorded with e.g. coordinates, set and haul time and valid and not sampled, then the landings are sometimes recorded.

Sampling of hauls (Sampled number of hauls): The observer is instructed to sample as many hauls as possible. In practice the observer will sample in a way which fits in the routines on-board - 1 haul per day on trip with high amount of discard and/or species diversity or each 2nd on trips with smaller and less complex catches. Depending on the catch and possibilities on a particular trip the observer decides on how to work up the catch – 1 being the optimal solution. All species in the retained and discarded fraction of the catch are weighed and measured for length

All species are weighed, but only the discarded species are measured for length.

All species are weighed.

Trash – rubbish of human origin such as plastic, metal in the haul is also recorded.

Estimation of the weights at the species list level:

The fisher decides which fish are going to be discarded.

Estimated weight of total catch: an estimate made by the skipper and/or observer – considered an uncertain estimate. After introduction of the random selection, and thereby an increase in number of vessels sampled, this estimate has become more uncertain.

Estimated weight of retained catch: Count number of boxes – considered a good estimate.

Discarded catch: In the protocol two methods are described. Count number of baskets with known mean weight or estimate the weight - a very common way:

$$\text{Estimated weigth of total discard} = \text{Estimated weight of total catch} - \text{Estimated weight of retained catch}$$

Subsampling: This is very much up to the observer. In the protocol there is some guidance. The subsamples are weighed with a spring balance.

Collections of lengths: Sampling directly for lengths. Measuring board is used to measure all the fish species. Caliper is used for the *Nephrops*. All discarded species are measured for length – and if time then the retained species are also measured for length.

Collection of ages and weights on the individual level: On short trips, such as in Kattegat the protocol is to collect 1 fish per cm-group per trip. The numbers differ between the length of the trips. The fish which have been selected for aging are brought back to the lab and weighed as well. The fish are collected in such a way that it is possible to link the individual fish to a specific haul.

In theory it means that we have a full ALK per trip for all discarded species we collect age on. In practice this is not always the case. On longer trips the single fish are often collected close to the end of the journey due to difficulties in storing them.

The faith of the Figures collected: Weight of discard of all species are used in a variety of ways and presented in national reports. CANUM (catch numbers-at-age) go to the assessment for the main fish species. Numbers at length of *Nephrops* are used in assessment.

Collected data and raising to the trip level

Calculating relevant Figures for discarded cod at the trip level:

The example of a *Nephrops* trawler in the Kattegat is shown in Figure 4.18 to Figure 4.22; The trip (Figure 4.18) consisted of two hauls, one of which was sampled (Figure 4.19), all cod in the discards were weighed collectively giving a weight of 10.8kg (Figure 4.20), and measured (Figure 4.21). A subsample of 37 fish were collected (and returned to shore) from which individual weights and ages were taken (Figure 4.22).

For the first haul the sample weight for the cod is:

$$\omega_{h=1} = \frac{2\ hauls\ in\ total}{1\ haul\ sampled} \times \frac{10.8\ kg\ total}{10.8\ kg\ sampled} \times \frac{127\ number\ total}{127\ number\ sampled} = 2$$

For the second haul the sample weight for the cod is:

$$\omega_{h=2} = \frac{2\ hauls\ in\ total}{1\ haul\ sampled} \times \frac{0\ kg\ total}{0\ kg\ sampled} \times \frac{0\ number\ total}{0\ number\ sampled} = 0$$

and so the cod numbers for the trip are

$$\widehat{N}_t = \sum_{h=1}^{h=2} \omega_h\ n_h\ = (2 \times 127\ cod\ measured) + (0 \times 0) = 254\ individual\ cod$$

and the discard weight is

$$\widehat{W}_t = \sum_{h=1}^{h=2} \omega_h\ w_h\ = (2 \times 10.8kg\ cod\ weight) + (0 \times 0) = 21.6kg$$

The sample weight for numbers at lenth, using 19cm as an example, would be:

$$\omega_{h=1,l=19cm} = \frac{2\ hauls\ in\ total}{1\ haul\ sampled} \times \frac{10.8\ kg\ total}{10.8\ kg\ sampled} \times \frac{127\ number\ total}{127\ number\ sampled} = 2$$

and again $\omega_{h=2,l=19cm} = 0$.

So the number of 19 cm cod for the trip are

$$\widehat{N}_{t,l=19cm} = \sum_{h=1}^{h=2} \omega_{h,l}\ n_{h,l}\ = (2 \times 18\ cod\ @19cm) + (0 \times 0) = 32\ individual\ cod\ at\ 19cm$$

For a length stratified sample of ages the sampling weight for aged fish of 19cm long would be:

$$\omega_{h=1,l=19cm,a} = \frac{2\ hauls\ in\ total}{1\ haul\ sampled} \times \frac{10.8\ kg\ total}{10.8\ kg\ sampled} \times \frac{127\ number\ total}{127\ number\ sampled} \times \frac{18\ fish\ @\ 19cm\ that\ are\ measured}{2\ fish\ @19cm\ that\ are\ aged} = 18$$

and these fish were both age 1, so the age of the 19 cm cod for the trip are

$$\widehat{N}_{t,l=19cm,a=1} = \sum_{h=1}^{h=2} \omega_{h,l,a}\ n_{h,l,a}\ = (18 \times 2\ aged\ cod\ @19cm) + (0 \times 0) = 32\ age\ 1\ cod\ at\ 19cm$$

If the sample of aged fish were selected at random from those measured the sample weight for each aged fish would be:

$$\omega_{h=1,a} = \frac{2\ hauls\ in\ total}{1\ haul\ sampled} \times \frac{10.8\ kg\ total}{10.8\ kg\ sampled} \times \frac{127\ fish\ measured}{37\ otoliths\ collected} = 6.864$$

and so each of the sampled ages would represent 6.864 fish so the age composition of the sample would be

$$\widehat{N}_{t,a} = \sum_{h=1}^{h=2} \omega_{h,l,a}\ n_{h,l,a}\ = (6.864 \times 37\ aged\ cod\ ) + (0 \times 0) = 254\ aged\ cod$$

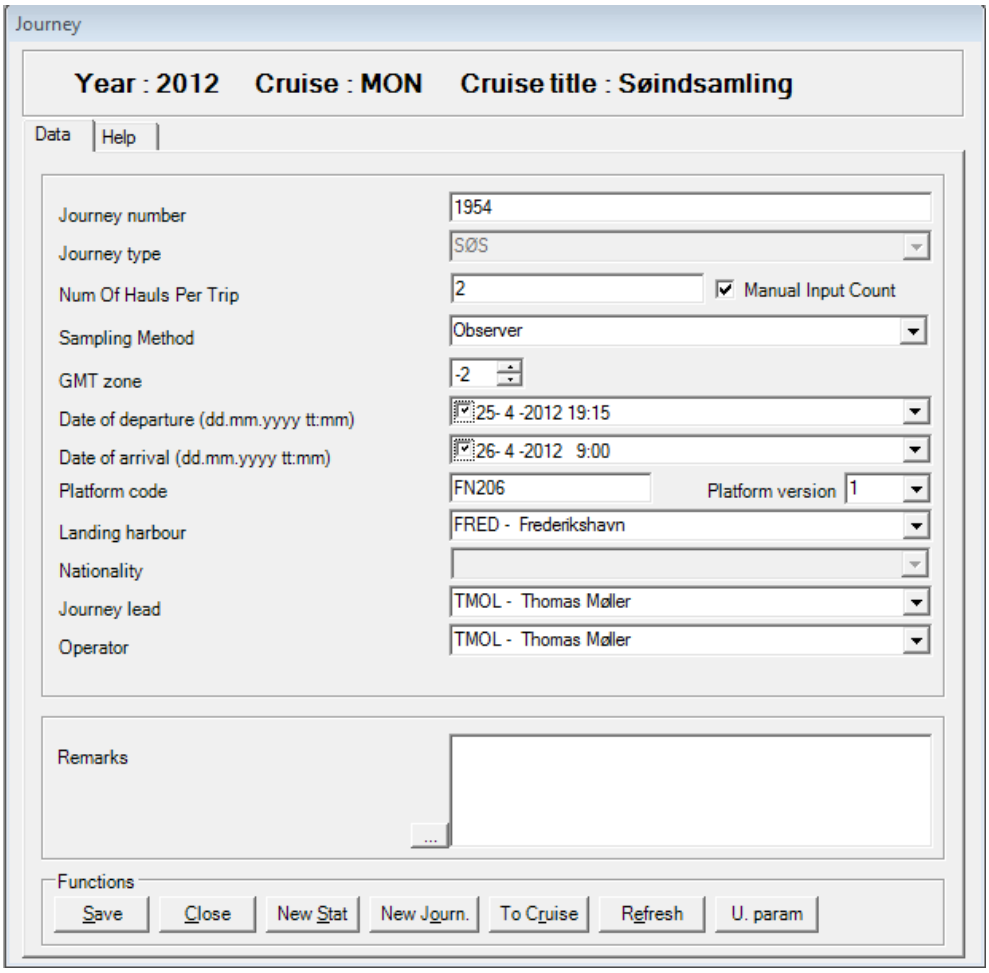


Figure 4.18: Screenshot from the Danish database. Data collected at the trip level.

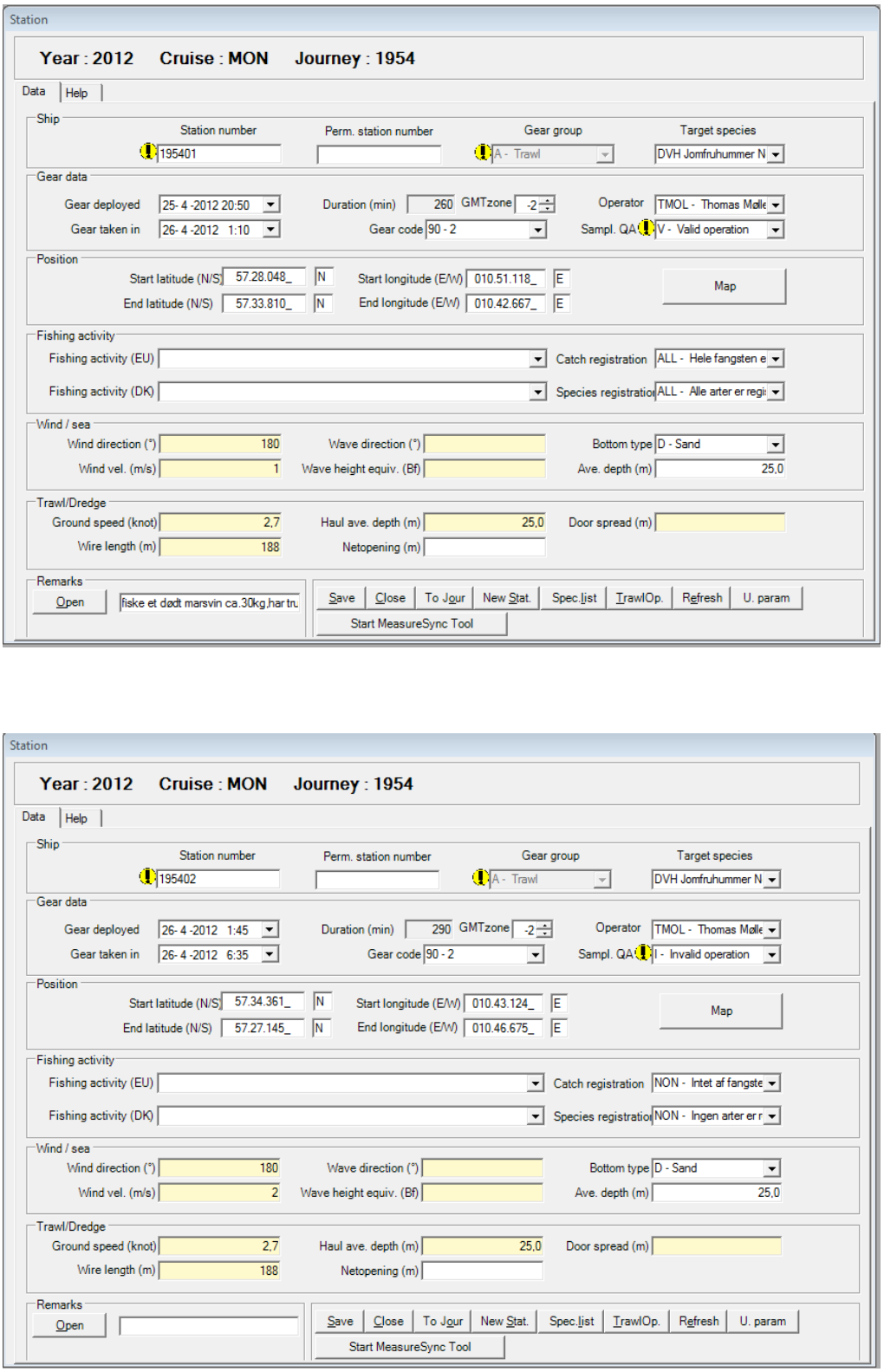


Figure 4.19: Screenshot from the Danish database. Data collected at the haul level. 1st haul valid, second haul invalid.

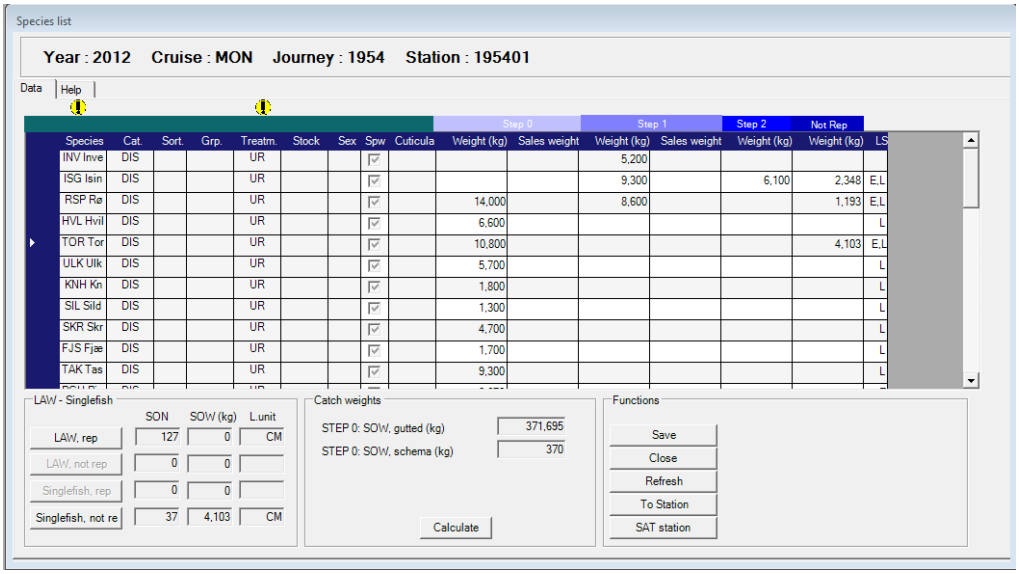


Figure 4.20: Screenshot from the Danish database. Data in the species list level for the 1st valid haul. Sample weight for discarded cod is given in the line marked with an arrow.

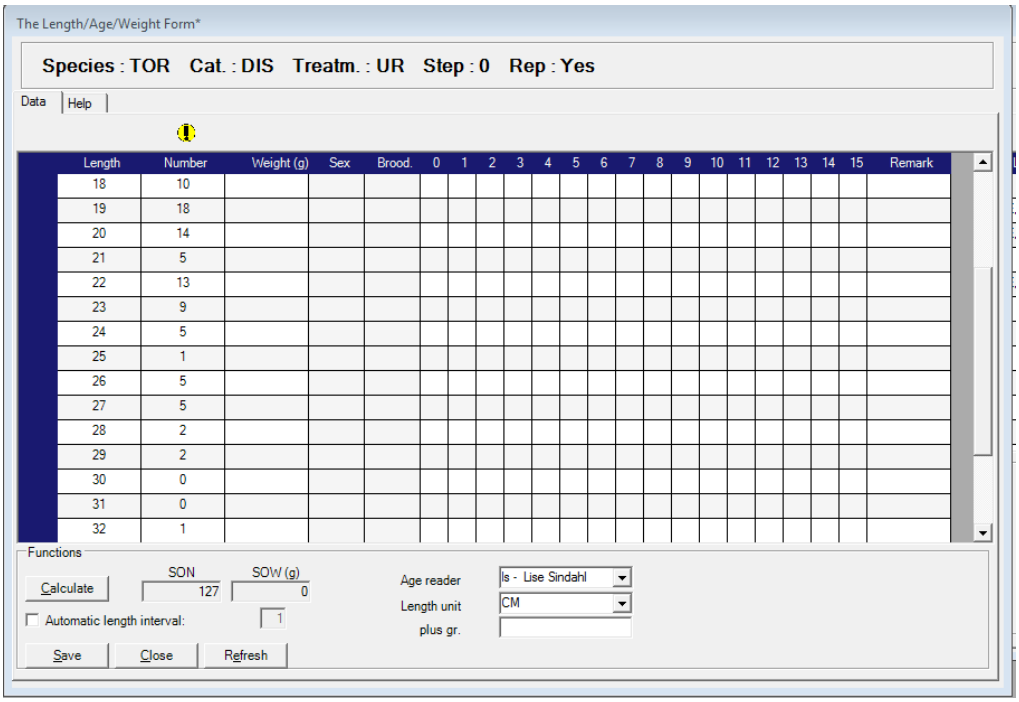


Figure 4.21: Screenshot from the Danish database. The length distribution of discarded cod in the subsample.

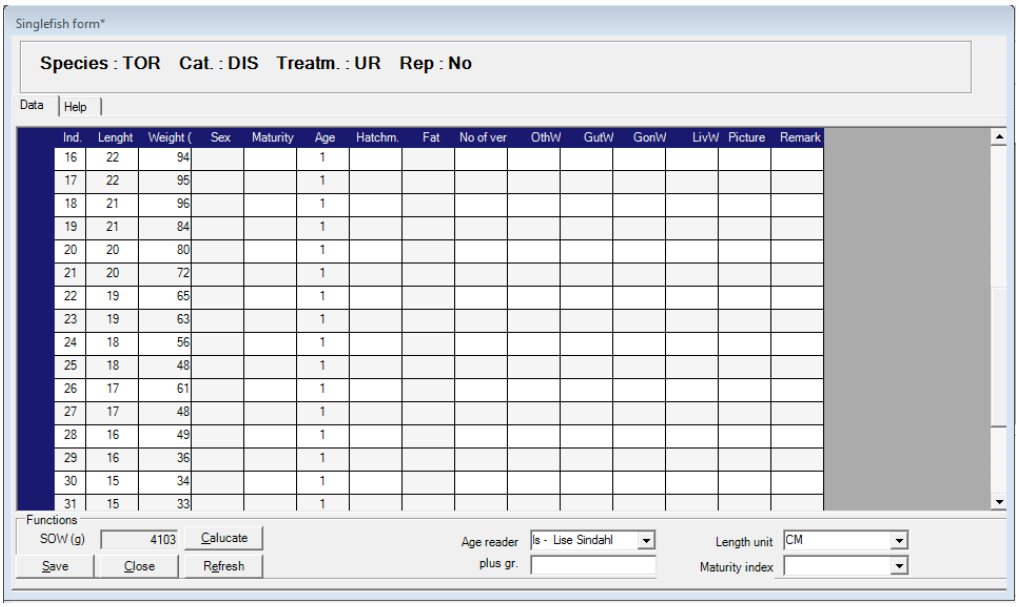


Figure 4.22: Screenshot from the Danish database. Information collected for the none-representative collected single fish of discarded cod.

4.2.8 Sampling protocols of the Norwegian high seas Reference fleet

A high seas Reference fleet was established as an alternative to an Observer Program in 2000 with 6 vessels. By 2013 the fleet comprises 20 coastal vessels (mainly gillnetters, 9–15 m long) and 19 high seas vessels representing demersal and pelagic trawlers, purse-seiners, longliners, Danish seine and gillnetters. The objective is to have a Reference Fleet that is representative of the Norwegian fishing fleet.

The sampling "design" represents multistage self-sampling of fish where the primary sampling units (PSUs) are the individual vessels, and individual trips are the secondary sampling units (SSUs). Sampling of lower level units involves subsampling of the catches of individual fishing operations, and random sampling of fish. Crew members onboard the RF vessels are trained to conduct self-sampling following IMR's protocols and are required to record detailed catch reports electronically.

Catch composition

Each bottom trawl haul, Danish seine haul and purse-seine cast shall be entered in an electronic catch reporting. For longlines/ gillnets, a catch reporting should be done for one representative snood/ panel per day, including its position, as well as for the day's total catch with a position representative of the day's fishing. The whole catch, including the bycatch and discards, shall be recorded in the electronic reporting.

On board length measurement – weighing – otolith sampling

Sampling from bottom trawlers:

Variance-component analyses have been used to quantify the sources of variability using mean length of the samples as the parameter analysed (e.g. Pennington and Helle 2011). For all fishing fleets, demersal and pelagic, it is the number of boats that limits the attainable precision. Because of differences in catch composition between boats, and for each boat between sample days, a large sample of fish does not imply a large amount of information about the composition of the entire commercial catch. The conclusion is that 20-30 fish in each sample is sufficient. Hence, each week, seven length measurements shall be taken for each species. A representative length distri-

bution of all species from the total catch incl. discards from a haul/ cast/ snood/ panel should be recorded, up to a maximum of 30 fish per species. The general rule is one sample per day for each of the demersal species. Each sample shall be weighed. An effort should be made to spread the sampling on both night and day catches.

Regular weekly otolith samples, one sample of 20 fish, are to be taken for cod, haddock, saithe and ling. A regular otolith sample of 20 fish is also to be taken every two weeks for redfish and Greenland halibut.

Sampling from pelagic vessels:

Herring, blue whiting, capelin, sprat, mackerel and horse mackerel are defined as being pelagic species. The length and weight of 50 fish shall be measured from every second haul/cast. At least 50 fish shall be frozen from the alternate hauls/ casts from which no such measurements are taken. Hence, all catches are sampled in one way or the other.

Pelagic hauls/casts where the entire catch composition has been registered should be given a special quality code. Some vessels with on-board production are able to do so. For most of the pelagic vessels it will be necessary to sort out, register and measure the bycatch when delivering to the onshore processing plant. In these cases the length of all taken as bycatch and discarded species in a haul/ cast/ snood/ panel should be measured, up to a maximum of 30 fish per species.

Otoliths or shells are collected from the frozen samples in the laboratory on land.

Sampling from shrimp trawlers using sorting grids

Shrimp samples shall be taken daily when a vessel is fishing for shrimp. A shrimp sample involves the contents of one bucket (approx. 10 litres) of the catch in a trawl haul being sorted and weighed by species each day. The lengths of all 0-group fish in the sample (which will be discarded) are to be measured. At present, the lengths of 300 shrimp are to be measured.

Counting king crabs

For each trawl haul of king crab, the number caught shall be recorded, preferably by sex (only male crabs are kept, female crabs and undersized crab are released/discarded).

For longlines and gillnets, the number per snood and for the day's catch shall be recorded (preferably by sex). This should be entered on a separate form, or on an Excel spreadsheet.

Recording marine mammals and seabirds in the catch

All marine mammals and seabirds caught must be recorded in the electronic reporting, in the same way as species of fish. Wallcharts/booklets have been made to provide help to determine the species.

Detailed sampling instructions

Sampling from trawling – Danish seine – purse-seine

Fish are taken from different locations in the haul/ cast. This can be done by distributing the sampling across 2-4 hatches that lead the fish out from the fish tank. In other words, and/ or depending on what is possible, approx. 1/3 of the total sample should be taken from the first part of the catch from the haul in question, approx. 1/3

should be taken when around half of the catch has been brought on board and approx. 1/3 from the end of the catch.

Special rules for pelagic fishing

Fish must be selected for sampling when the cast/ haul is being pumped on board. A sample of this kind must contain at least two random samples of fish taken during the pumping process itself. The sample should be taken in conjunction with the weight samples that the vessel uses when reporting its catch to Norges Sildesalgslag (the marketing organization for pelagic fish).

Discarded bycatches are to be recorded as the total weight of each species. Instead of recording this on board, the bycatch can be recorded when the catch is delivered to the onshore processing plant. The onshore processing plant generally sorts out any bycatch and directs it into separate tanks, sometimes together with off-cuts of the target species. The sampler can take a representative sample of approx. 100 kg from this tank, sort it by species, record the weight and quantity of each species, and finally multiply/scale this up to the total weight of the entire bycatch sorted out by the processing plant. The sampler must subtract the weight of guts and off-cuts from the tank content before raising the bycatch Figures.

Scales are used to determine the age of spring-spawning herring (otoliths for the other species). It is hence important to take samples for freezing at an early stage during pumping to avoid losses of scales on the herring.

Sampling from gillnets

It is important to take a sample from a gillnet that has the same mesh size as the rest of the gillnets used by the vessel. Fleets of gillnets with different mesh size should be reported and sampled separately – of practical reasons if mesh size differs by more than 10 mm.

Sampling from longlines

The size of fish on longlines often varies between the shallowest and the deepest end of the snood. The fish that are to be measured must therefore be taken from the first, middle and final part of the snood.

4.2.9 Variability of age composition estimates arising from otolith collection practices and age length key construction.

A study was conducted in November 2011 on a Scottish demersal trawler to investigate the variability of numbers of age estimates of the discard fraction depending on differing otolith collection protocols and methods of applying age length keys.

Length stratified sampling for age, where one otolith was collected for each cm length class encountered, was conducted for haddock, whiting and saithe for each of the 14 hauls that made up the fishing trip. From this otolith collection first numbers-at-age were estimated for each haul using the sample weights derived from the number of fish sampled. These totals were summed over hauls to enable a "true" numbers-at-age estimate to be obtained for the trip. This "true" numbers-at-age estimate was compared with numbers-at-age estimates derived from ALKs constructed by pooling the otoliths collected in various subsampling scenarios:

1) Unweighted ALK constructed from all otoliths but pooled over the hauls within the trip.
2) ALK constructed from the first three hauls, and with subsequent outliers added.
3) ALK constructed from the first five hauls, and with subsequent outliers added.
4) ALK constructed from alternate hauls starting with the first, with subsequent outliers added.
5) ALK constructed from alternate hauls starting with the second, with subsequent outliers added.

The estimated numbers by age class, and the proportions at age are shown in table 4.13 and numbers-at-age are plotted in Figure 5.23. The estimated numbers at the model age for haddock were lower for all the scenarios involving pooled ALKs, the greatest by -10.8% (5075 v 5690 fish at age 2). Likewise for whiting all pooled ALK estimates reduced the modal numbers-at-age estimate the greatest by -18.8% (from 756 to 614). For Saithe three of the five estimates reduced the numbers at the model age (the greatest being by 25.2% from 159 to 119) and two of the five increased the model age (the greatest by 6.2% from 159 to 169). The numbers-at-age estimates for the peripheral age classes were adjusted accordingly, hence for the three species considered together these were increased upwards in 13 of the 15 scenarios considered.

The number of otoliths collected and read to generate these estimates were 366 for length stratified sampling of the three species from every haul, 91 when otolith collection was only from the first three hauls, 136 when otolith collection was from the first five hauls, and 162 and 144 when otolith collection was from the seven odd or even numbered hauls respectively.

Table 4.13. Discard numbers-at-age and proportions at age calculated using sample weights, and from pooled ALKs using various otolith collection scenarios.

		N at age calculated using sample weights by haul		Unweighted ALK pooled over the trip		Unweighted ALK collected over first 3 hauls		Unweighted ALK collected over first 5 hauls		Unweighted ALK collected over every other haul (odd)		Unweighted ALK collected over every other haul (even)	
Species	Age	Numbers	Proportion	Numbers	Proportion	Numbers	Proportion	Numbers	Proportion	Numbers	Proportion	Numbers	Proportion
Haddock	1	58	0.01	277	0.05	213	0.04	187	0.03	107	0.02	416	0.07
	2	5690	0.96	5313	0.90	5522	0.93	5610	0.95	5590	0.95	5075	0.86
	3	44	0.01	47	0.01	179	0.03	105	0.02	102	0.02	0	0.00
	4	95	0.02	197	0.03	0	0.00	0	0.00	0	0.00	390	0.07
	5	13	0.00	18	0.00	0	0.00	12	0.00	0	0.00	34	0.01
	6	14	0.00	62	0.01	0	0.00	0	0.00	115	0.02	0	0.00
	Total	5914	1	5914	1	5914	1	5914	1	5914	1	5915	1
Whiting	1	77	0.05	95	0.07	100	0.07	100	0.07	111	0.08	73	0.05
	2	756	0.53	657	0.46	695	0.49	662	0.47	614	0.43	745	0.53
	3	407	0.29	472	0.33	538	0.38	577	0.41	461	0.33	447	0.32
	4	99	0.07	111	0.08	74	0.05	44	0.03	128	0.09	114	0.08
	5	42	0.03	33	0.02	0	0.00	0	0.00	55	0.04	0	0.00
	6	34	0.02	47	0.03	8	0.01	33	0.02	45	0.03	36	0.03
	Total	1415	1	1415	1	1415	1	1416	1	1414	1	1415	1
Saithe	1	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
	2	16	0.05	21	0.06	8	0.02	32	0.10	14	0.04	26	0.08
	3	149	0.45	141	0.43	194	0.59	167	0.51	135	0.41	148	0.45
	4	159	0.48	161	0.49	116	0.35	119	0.36	169	0.52	154	0.47
	5	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
	6	4	0.01	5	0.02	10	0.03	10	0.03	10	0.03	0	0.00
	Total	328	1	328	1	328	1	328	1	328	1	328	1

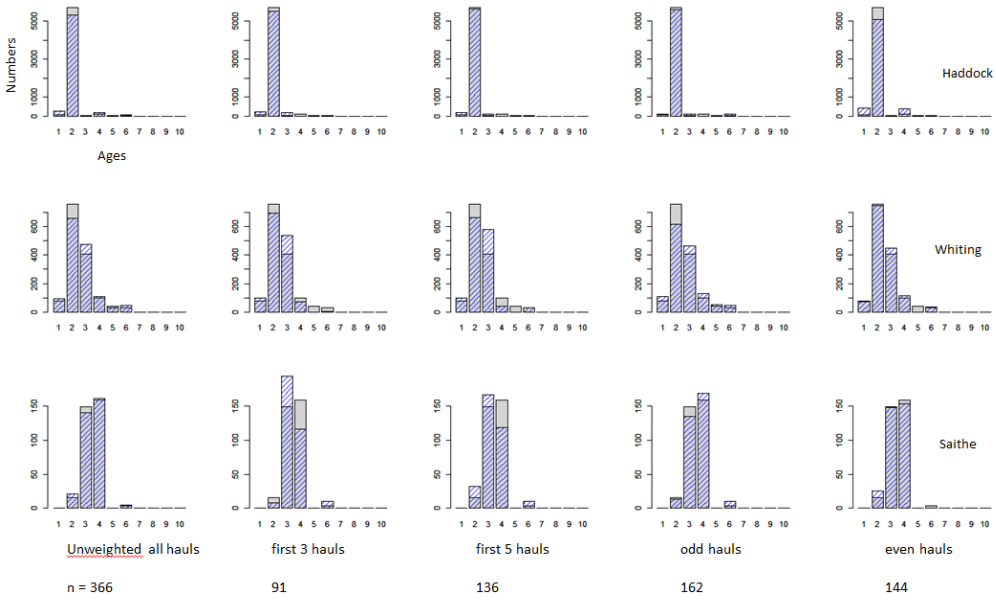


Figure 4.23. The estimated discard numbers-at-age for three species of fish based on the application of a pooled ALK and differing otolith collection scenarios. The solid grey bars are the numbers-at-age calculated using sample weights derived from otolith collection from each age class encountered for all hauls, and thus is the best estimate of the "true" age distribution for the trip. The number of otoliths collected under each scenario is given at the bottom of each column.

4.3 Discussion

Diversity and Protocols

There is considerable diversity in the on-board sampling practices and this diversity arises because of the specific fishery. This diversity is related to the handling of the catch on board and is further influenced by the volume of the catch and the diversity of the catch composition. As a result of this diversity it is often difficult to have a strict protocol for sampling at sea covering different fisheries (vessel types etc). Moreover even for well-defined fisheries rigid protocols cannot always be followed because the observer needs to be adaptable to the situation encountered.

4.3.1 Collection metrics

Counts, measures of length, collection of age structures, weights of individual and groups of fish, sex of individual fish (and shellfish) and the maturity of individual fish (and shellfish) are all collected in the examples. The vast majority of fish in the samples are identified to species and measured, though invertebrate bycatch may not be counted or identified.

Length

Length measures are taken using a wooden or metal measuring boards or a measuring ruler fixed to a board. Callipers are used in the shellfish example. In most of the case studies the length of all the fish in the sample was usually measured, though there are some instances were a subsample is measured for length and a count made of the total number.

Age

Ages were collected as otoliths either extracted on-board and returned in books, or packets, or whole fish were saved on-board, returned to shore, and the otoliths extracted onshore. In one example the discard sample was split with some fish being measured for length and for others the sex, maturity and age was determined. This was the closest approximation to direct sampling for age. In all the other case studies where otoliths were collected it was through length stratified sampling. In some cases only otoliths for some of the length classes, generally the smaller ones, were collected. In all the examples ages were only collected for some of the species encountered.

Weight

Weights were taken at-sea for some individual fish, species sorted groups of fish or mixed species groups of fish. A spring balance, or electronic spring balance were used. Some examples return the discard sample to shore and it is weighed there. Two examples took no on-board weights. All the other "weights" used in the estimation process were obtained by being estimated by the observer, by being obtained from the skipper or crew, or by being obtained from the vessel records.

4.3.2 The collection of the sample

In the Azorean example there was usually no need to take a sample of the total discards as it was possible to measure or count all the discarded fish. In this case study however a sampling fraction could be recorded if the observer was not able to sample the entire catch. In all other case studies a fraction of the total discards were sampled, necessitating the use of ratios to estimate the proportion of the sample to the total discards.

In all the case studies it was the crew that sorted the catch into a discard fraction and a retained fraction, with the discard fraction being sampled by the observer. (This may not always be the case. There are situations where the observer takes a sample from the unsorted catch and determines which fish would be discarded based on the length, or size, of the fish, see SGPIDS 2 ICES 2012a for an example for a pelagic trawler).

In most of the case studies it was actually quite difficult to determine the method used to collect the sample of the discarded fraction, and this is probably due to the fact that in all but one case observers work alone on-board and, while protocols exist, the situations on-board often dictate the way samples are collected. In most examples it was the case that all hauls or sets were generally sampled if circumstances allowed. There were no examples of systematic or random sampling of hauls.

In all the case studies for a haul, or a set of nets, the sorting of the fish was a sequential process e.g. as nets were retrieved, or during the sorting of fish on a conveyer belt, or in baskets. In some cases the observer was given the discard sample by the crew, in other cases the observer collects the sample themselves. In one case the collection protocol is to start collecting the sample when the second basket of the catch is available, collect three baskets spread out through the catch, making efforts to avoid the very last part of the sorted catch. In most cases the space to store the discard sample was limited constraining the amount of the discard fraction can be collected at any one time. Collecting a sample from the fish left on a conveyer can be arbitrary as there is often no clear way to determine how many fish will be discarded and when they will arrive.

4.3.3 Quantifying total discards

The total discards was quantified in various ways, in some examples it was possible for the total discards to be collected in its entirety and put in boxes or baskets and then these boxes or baskets were counted. In other cases the total discards were estimated by the skipper of the vessel. In other cases the estimate of the total discards was derived from the difference between a count of the retained fraction of the catch and an estimate of the total catch. In the Swedish example the total discards consists of separate fractions both of which were put in baskets and counted. Where this was not possible one section was estimated by the observer.

In the case studies the units used to quantify the ratio of sampled discards to total discards included baskets, boxes, weights and time. Conversions from one unit to another was common e.g. box weights were converted to baskets based on a nominal basket weight, or the length frequency was converted to a weight using a weight length relationship.

4.3.4 The calculation of sample weights

Numbers at length
Species-specific numbers at length can be estimated in all the examples using sample weights that respect the sampling hierarchy. There are different levels in the uncertainty around these estimates (see section 4.3.5).

Numbers-at-age
In all the case studies where numbers-at-age were estimated it was the case that a pooled ALK was formed at the level of the trip or some higher aggregation. Only in the Danish example would it have been possible to calculate sample weights for an age sample as the product of the sampling probabilities in the hierarchical selection

process using the existing protocols. In the other cases, as a minimum, the haul of set from which the otolith was collected would have to be recorded.

Weights

In the cases studies where fish or shellfish weights were actually collected it was for two distinct purposes: First it was as a means of quantifying the weight of the discard sample as a whole or by species. Second it was as a "biological variable" on individual fish. It is only in the second case that the calculation sample weights would appear to be of relevance and in none of the case studies were sample weights used. The construction of weight length relationships was not specifically addressed though it was apparent that there is considerable diversity in the location, collection period, and origin of some of data used to derive weight length relationships.

4.3.5 Measurement errors and uncertainties in sample weights.

By measurement errors we mean the ability to precisely quantify the total discard fraction and any sample taken from it. These measurement errors, were they to be estimated, would manifest themselves as variability of the derived estimate.

Numbers at length

It was apparent from the case studies that measurement errors in the estimation of discard numbers at length are related to the size of the catch and the diversity of the species composition in the catch. In the examples where the discards were relatively few and occurred at a rate where they could be quantified by the observer there was no need take a sample and it was often possible to obtain a very precise estimate of discard numbers. The intermediate case was where sampling of the total discards was required but where the total discards could be collected into baskets or boxes and these counted or weighed. Here the element of measurement error will be in the number and diversity of fish in a box or basket; the number of boxes or baskets can be known with some certainty. The most uncertain estimates are likely to occur where catches are large and diverse and the total discards are too numerous to be collected in their entirety. Here the total discards are estimated in various ways and it is in these estimate that most measurement error will occur.

Based on the basic formula for calculating the hierarchical sampling weight that was applicable in the majority of the case studies:

$$\omega_{h,l} = \frac{total\ hauls\ or\ sets}{hauls\ or\ sets\ sampled} \times \frac{total\ units}{units\ sampled} \times \frac{total\ fish}{fish\ sampled}$$

it is the estimate of "total units" where measurement error will be most pronounced. The extent of these uncertainties will depend, as discusses above, how the units are defined. Units based on counts are likely to be preferable to units based on weight particularly where these are estimates. The other type of unit recorded in the case studies was time which, where it is applicable, has considerable merit as time can be more accurately measured at-sea than is generally possible with weight. However time is only applicable if the sorting or collection process is sequential and the rate at which it proceeds is more or less constant.

Of the other ratios in the formula the ration of "total hauls or sets" and "hauls or sets sampled" where known in all the case studies and, as these are counts, there will be little measurement error associated with them. The ratio of "total fish" and "fish sampled" will likewise be relatively error free if it is based on the counts of individuals (providing the number of individuals is not too large). However where either of these measures are based on weights there will be additional measurement error associated with the estimate. The advantage of weight is that it can be far quicker to

weigh a group of fish rather than count them. A weight also allows a total discard weight to be estimated. From counts of fish the discard weight cannot be estimated directly, it can only be obtained from a weight length relationship from fish that have been measured. None of the case studies attempts to quantify these measurement errors.

Numbers-at-age
Additional uncertainties and potential biases in the estimation of numbers-at-age will be due to the application of an age length key pooled over hauls within the trip or at some higher aggregation. The scale of this problem is difficult to assess. The subsampling study conducted on a Scottish trawler (section 5.2.9) shows that the numbers-at-age estimates can differ quite substantially using a pooled ALK and depending on the subsampling scenarios. It suggested that in the majority of cases the use of a pooled ALK will result in the modal age being underestimated, potentially by as much as 25%, and that the numbers in the peripheral age classes will be overestimated. How these would manifest in the assessment models is unclear.

Weights
Additional uncertainties in the estimation of mean weight at length or age will be due to the level at which weight length relationships are applied. This is likely to involve similar issues to the use of pooled age length keys, though it is the case that there are generally a number of opportunities to cross reference derived weights with measured weights.

4.3.6 Bias

Bias is a measure of the extent to which an estimate derived from the sample differs from the unknown "true" value of the population from which the sample is drawn. Bias was briefly considered by the subgroup and from the case studies it was apparent that the potential for bias in the on-board sampling could be ascribed to two sources: first the lack of, or inability to, apply probability based selection procedures for collection of samples on-board; second any systematic measurement error, such as in the use of uncalibrated weights.

4.3.7 Conclusions

The case studies highlighted a number of best practice guidelines for on-board sampling.

Sample weights
Calculation of sample weights for numbers at length presents no difficulty for the case studies presented. However this is not the case with age samples or weight samples. Age length keys and weight length relationships need to be used with care, and their use informed by the sampling practices used to collect the age structures and weights. In order to calculate a sample weight for an age or weight sample then, as a minimum, the sample has to be identifiable to a haul, not simply to the trip.

Measurement error
It is apparent that estimates of discards can be inherently difficult to obtain and that the larger and more diverse the discard the more uncertain the estimate is likely to be. That said it is generally preferable to quantify, rather than estimate, the total discards fraction and the sampled discards where this is possible. Counts, weights and time measures are generally to be preferred being preferable to observer or skipper estimates. There would seem to be potential to explore methods of quantifying on-

board estimates of variance or estimating uncertainties. These could include estimating the range of the total discards, and\or calculating a measure of variance based on replicate samples.

Sampling
The probability based selection protocols for the collection of the on-board sample is an area where innovative practices and improvements could be made. Subsampling using ad-hoc methods is a potential source of bias that is difficult to quantify. The practice of international observer exchanges and having refresher trips with paired observers was ideas considered.

4.4 Implications for the data exchange format of the RDB-FishFrame

The regional database (RDB), formerly FishFrame, has a data exchange format for commercial sampling data (Jansen et al 2008). As it is a basic principle that a database should house raw data, rather than derived data, the need to revise this format to accommodate different national sampling practices has been recognized by the steering group of the regional database and some of the envisaged new fields required were proposed at the RDB workshop III in November 2012 (ICES 2012c). Here we consider the different metrics used in the case-studies in relation to the CS data exchange format. The CS data exchange format consists of linked tables relating to the trip (TR) the haul (HH) the species (SL) the length distribution (HL) and the age and weight of individual fish (CA). The fields of the HH, SL, and HL tables, and envisaged additions are shown in Figure 4.24.

4.4.1 Species list record (SL)

If the regional database is to hold raw data collected on-board then the current variables - weight and subsample weight - are not enough. In the majority of the examples presented here weights are not gathered on-board, but derived through, for example, weight length relationships. The case studies had examples of other units, such as baskets or time being used to estimate the sampling probabilities, and from which weight was derived. Therefore the group emphasizes the importance of introducing the following suggested variables:

Total units - e.g. total number of baskets.

Units sampled – e.g. sampled number of baskets.

Sample unit category – e.g. Baskets.

Weight derivation – How the units measured were converted to weight.

Further, the presented examples point out that 'Total unit' often is an uncertain estimate – or rather depending on method the estimate can range from very accurate to quite uncertain. If all the discard is put in baskets, then the estimate will be quite accurate, compared to situations where the discard is total landed weight subtracted from the skippers estimated total weight in the haul. Therefore the group suggests one more variable:

Estimation method – how do you estimate the total unit? i.e. is it weighted/estimated by crew/estimated by observer/count.

In order to estimate a sample weight, if it is the case that only a subsample of the fish in the sampled units that have been recorded as 'CS.SL.Unit sampled' are measured then a new variables in CS.SL is needed:

'Total number in subsample' – the total number of individuals measured or counted in the subsample.

The rationale for this is explained more fully in section 4.4.3.

4.4.2 Length record (HL)

The length record (HL) holds the data, which have been sampled for directly. RDB-FishFrame has been developed based on the assumption that it is always the length of the species that is the target of the direct sampling. In all the presented examples this is indeed the case.

The suggested new variables in the HL record

Measure

Unit of measure

Number at unit of measure

are for those cases were you are measuring something other than lengths e.g. the width.

4.4.3 Calculating sampling probabilities up to the trip

Sampling directly for lengths

The exchange format and estimation process in the RDB has been set up to handle the case where you sample directly for length and apply the ages indirectly through an ALK. This also seems to be the case in a lot of the at-sea sampling programs – in the 5 examples presented in this report this is the case.

With the current exchange format the sampling weights for each sampled haul (ω_h) would be

$$\omega_h = \frac{CS.TR.Number\ of\ sets/hauls\ on\ trip}{\sum CS.HH.Sampled\ number\ of sets/hauls\ on\ trip} \times \frac{CS.SL.Weight}{CS.SL.Subsample\ weight}$$

With the above suggested new variables ('unit total'/'unit sampled') the sampling weights for each sampled haul (ω_h) would be

$$\omega_h = \frac{CS.TR.Number\ of\ sets/hauls\ on\ trip}{\sum CS.HH.Sampled\ number\ of sets/hauls\ on\ trip} \times \frac{CS.SL.Total\ units}{CS.SL.Unit\ sampled}$$

The first being equivalent to the latter if units in 'CS.SL.Total units' and 'CS.SL.Unit sampled' is weight.

In all of the presented case studies all the fish in the 'CS.SL.Unit sampled' are measured for length, but if only a subsample of the fish in the 'CS.SL.Unit sampled' are measured then a third term in the calculation of the sampling weights for each haul (ω_h) is needed – together with a new variables in CS.SL – 'Total number in subsample'

$$\omega_h = \frac{CS.TR.Number\ of\ sets/hauls\ on\ trip}{\sum CS.HH.Sampled\ number\ of\ sets/hauls\ on\ trip} \times \frac{CS.SL.Total\ units}{CS.SL.Unit\ sampled} \times \frac{CS.SL.Total\ number\ in\ subsample}{\sum CS.HL.Number\ at\ length}$$

Estimating weight per trip ($\widehat{W}_t$), numbers per trip ($\widehat{N}_t$) and numbers at length per trip ($\widehat{N}_t(l)$) for a given species would then be

$$\widehat{W}_t = \sum w_h \times CS.SL.Subsample\ weight_h$$

$$\widehat{N}_t = \sum w_h \times \sum CS.HL.Number\ at\ length_h$$

$$\widehat{N}_t(l) = \sum w_h \times CS.HL.Number\ at\ length\ at\ CS.HL.Length\ class\ l_h$$

Sampling age

With the estimation process implemented in RDB at present all collected ages form an unweighted pooled ALK based on the stratification chosen in the processing. So a key element needed in a revised estimation process within the RDB would be to respect different sampling strategies for age collection by marking the sampling strategy in the estimation process or the exchange format. This would need to be able to accommodate the situation where the sampling of different vessels may dictate that different sampling strategies are used within the same sampling frame/domain of interest. Given the diversity in the presented case studies it seems likely that the sampling strategies for age collection could differ within a sampling frame/domain of interest and therefore a mark in the CS.CA seems appropriated. If sampling strategy is know it will be possible to handle different strategies even within a trip.

The options to fill in the new variable 'CS.CA. Sampling Strategy' could be something like the following;

'Sampling directly for ages',

'Sampling age per length group per haul',

'Sampling age per length group per trip',

'Sampling age for an ALK'

and probably more.

There would be a need for an appropriated way of handling missing ages for situations where an ALK were used.

Sampling age for an ALK

For this strategy all the needed variables are there. There could be some stratifications of the ALK not covered by the current processing, but that is out of the scope here.

Sampling age per length group per trip

The same as applying an ALK on numbers at length for the trip $\widehat{N}_t(l)$

Sampling age per length group per haul

It is possible to link the CS.CA record to the CS.HH record through 'CS.CA.Station number'. It is not mandatory to fill in the 'CS.CA.Station number' if it is not possible to link the collected ages to a specific haul.

Calculating numbers-at-age ($\widehat{N}_t(a)$) when sampling age per length group per haul

$$\widehat{N}_t(a|l) = \sum w_h \times \left(\widehat{N}_t(l) \times \left(\frac{count(distint\ CS.CA.Single\ fish\ number\ (id)\ at\ CS.CA.Age\ l_h)}{count(distint\ CS.CA.Single\ fish\ number\ (id)\ at\ CS.CA.Age\ a|l_h)} \right) \right)$$

Sampling directly for ages

For this strategy it will be necessary to link the CS.CA directly to the CS.SL – either through the CS.HL or directly – to enable the calculation of the sampling weights for each haul (ω_h). This is not possible with the current exchange format. The following variables are missing in CS.CA;

Subsampling category

Sex – the current 'CS.CA.Sex' is equivalent to 'CS.HL.Individual sex'

If the link is present then numbers-at-age ($\widehat{N}_t(a)$) will be

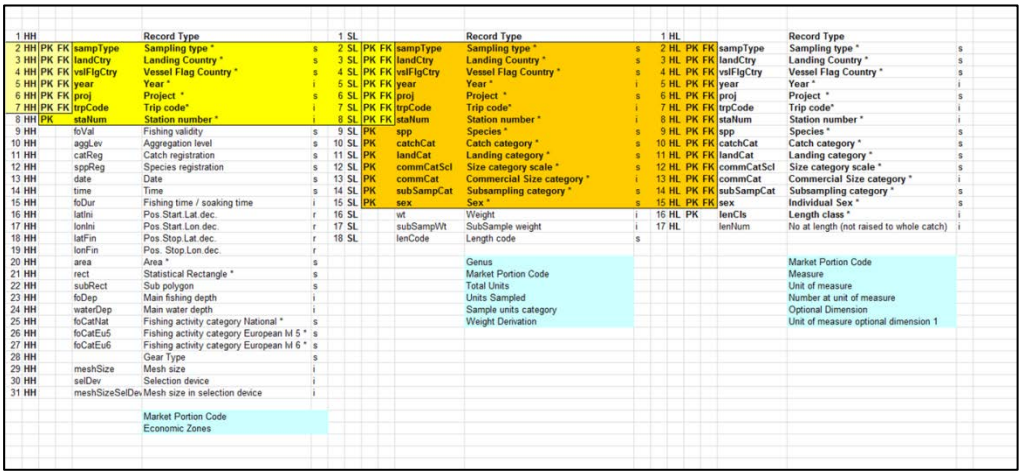
$$\widehat{N}_t(a) = \sum w_h \times (count(distint\ CS.CA.Single\ fish\ number\ (id)\ at\ CS.CA.Age\ a_h))$$

Estimation from the trip to the total

Once we have an estimate of the numbers per trip, the next stage is to raise the estimates to the total for a sampling frame/domain of interest. This requires that a sampling weight is calculated for the current trip, which would be the inverse of the sampling probability of selecting the given trip. Any and all other trips that contribute to the estimate for the frame of domain would likewise have their own sample weights, though if the selection scheme was a simple one they may be the same or very similar. To calculate sample weights in the RDB will be a major task, as it would require detailed knowledge of the selection process for each sample, therefore it has been suggested to include 'CS.TR.Sampling probability' (or 'CS.TR.Sampling weight') in the exchange format. Post stratification weights can also be calculated to adjust for known imbalances in the sample data (see GATS 2010). Sampling weights for trips and post stratification weights are beyond the scope of this study group and will not be considered further.

A commonly used alternative to the use of directly calculated sampling weights is to use an auxiliary variable to raise from the trip to the total. An "auxiliary variable" could be for example the landings of the vessel for the trip, and is the value that is summed for all the samples and used to raise the estimates from the samples up to the total for all the vessels in the stratum. So the auxiliary variable has to be a value that can be calculated for the fleet e.g. from the logbooks. In the current exchange format "days at sea" is one possible auxiliary variable though others can be used and some may be more appropriate than others depending on the nature of the fishery and the reasons for discarding (Fernandes *et al* 2011). Scottish discard estimates, for

example, are raised using the total landed weight of a group of demersal fish and *Nephrops*. Again, auxiliary variables are beyond the scope of this study group and will not be considered further.



1	HH			Record Type		1	SL			Record Type		1	HL			Record Type	
2	HH	PK	FK	sampType	Sampling type *	2	SL	PK	FK	sampType	Sampling type *	2	HL	PK	FK	sampType	Sampling type *
3	HH	PK	FK	landCtry	Landing Country *	3	SL	PK	FK	landCtry	Landing Country *	3	HL	PK	FK	landCtry	Landing Country *
4	HH	PK	FK	vslFlgCtry	Vessel Flag Country *	4	SL	PK	FK	vslFlgCtry	Vessel Flag Country *	4	HL	PK	FK	vslFlgCtry	Vessel Flag Country *
5	HH	PK	FK	year	Year *	5	SL	PK	FK	year	Year *	5	HL	PK	FK	year	Year *
6	HH	PK	FK	proj	Project *	6	SL	PK	FK	proj	Project *	6	HL	PK	FK	proj	Project *
7	HH	PK	FK	trpCode	Trip code*	7	SL	PK	FK	trpCode	Trip code*	7	HL	PK	FK	trpCode	Trip code*
8	HH	PK		staNum	Station number *	8	SL	PK	FK	staNum	Station number *	8	HL	PK	FK	staNum	Station number *
9	HH			foVal	Fishing validity	9	SL	PK		spp	Species *	9	HL	PK	FK	spp	Species *
10	HH			aggLev	Aggregation level	10	SL	PK		catchCat	Catch category *	10	HL	PK	FK	catchCat	Catch category *
11	HH			catReg	Catch registration	11	SL	PK		landCat	Landing category *	11	HL	PK	FK	landCat	Landing category *
12	HH			sppReg	Species registration	12	SL	PK		commCatScl	Size category scale *	12	HL	PK	FK	commCatScl	Size category scale *
13	HH			date	Date	13	SL	PK		commCat	Commercial Size category *	13	HL	PK	FK	commCat	Commercial Size category *
14	HH			time	Time	14	SL	PK		subSampCat	Subsampling category *	14	HL	PK	FK	subSampCat	Subsampling category *
15	HH			foDur	Fishing time / soaking time	15	SL	PK		sex	Sex *	15	HL	PK	FK	sex	Individual Sex *
16	HH			latIni	Pos.Start.Lat.dec.	16	SL			wt	Weight	16	HL	PK		lenCls	Length class *
17	HH			lonIni	Pos.Start.Lon.dec.	17	SL			subSampWt	SubSample weight	17	HL			lenNum	No at length (not raised to whole catch)
18	HH			latFin	Pos.Stop.Lat.dec.	18	SL			lenCode	Length code						
19	HH			lonFin	Pos. Stop.Lon.dec.												
20	HH			area	Area *						Genus						Market Portion Code
21	HH			rect	Statistical Rectangle *						Market Portion Code						Measure
22	HH			subRect	Sub polygon						Total Units						Unit of measure
23	HH			foDep	Main fishing depth						Units Sampled						Number at unit of measure
24	HH			waterDep	Main water depth						Sample units category						Optional Dimension
25	HH			foCatNat	Fishing activity category National *						Weight Derivation						Unit of measure optional dimension 1
26	HH			foCatEu5	Fishing activity category European lvl 5 *												
27	HH			foCatEu6	Fishing activity category European lvl 6 *												
28	HH				Gear Type												
29	HH			meshSize	Mesh size												
30	HH			selDev	Selection device												
31	HH			meshSizeSelDev	Mesh size in selection device												
					Market Portion Code												
					Economic Zones												

Figure 4.24 The current RDB-FishFrame data exchange format for commercial fisheries sampling (so called CS data) showing the fields of the HH, SL and HL tables in columns. The suggestions for new variables are highlighted in blue.

5 Integration of the reporting of protected endangered and threatened species (PETS)

As a representative of WGBYC, Bram Couperus gave a presentation on the work carried out at WGBYC.

The content of the presentation consisted of two parts. First, WGBYC considered the contribution of SGPIDS in 2012 (ICES 2012a)– an overview of the actual recording of PETS in national sampling schemes at haul- and sample level, as well as a list of "major" and "minor" issues – very valuable. WGBYC generally agreed with the issues brought up by SGPIDS. The major issue that the DCF sampling is not designed to estimate PETS is true but this should not be a reason not to collect data on PETS: these are rare by definition and are being caught incidentally. Taking into account the current approaches to implement an Ecosystem Based Management to Fisheries and the EU Marine Strategy Framework Directive that seeks to achieve a Good Environmental Status for the marine areas within the EU by 2020, every effort should be made to collect as much information as possible about PETS bycatch in commercial fisheries. One instrument to achieve this could be the DCF.

As a second issue, part of work on the additional questions from the European Commission was presented: a tool to test the relative coverage of DCF sampling in relation to the need for monitoring of Protected and endangered species (PETS), developed at the Workshop on Bycatch of Cetaceans and other Protected Species (WKBYC). It combines indices of abundance (presence/absence) of species groups with risk for bycatch by métier, fleet effort and (planned) under the DCF (WKBYC, 2013).

The group agreed that although the DCF is not designed for the sampling of PETS, it still gives valid information to identify "hotspots", area/seasons of relative high bycatch. It was noticed that in such a case, the objective of monitoring not necessarily the estimation of numbers taken. Even in case with extreme low bycatch rates (for example the harbour porpoise in the German Baltic), monitoring of bycatches still is an indication that bycatch incidents are rare and that the abundance of the species in the area is very low. In these cases interpretation and raising of the data should be treated with uttermost care. In line with WGBYC the group noticed the potential of Remote Electronic Monitoring (REM) to increase observer effort. In running projects, there may be a need to alter the conFigureuration of the systems on board vessels and to change the sample speed: for large, rare items in the catch, more footage should be checked, but with a higher sample rate.

The group had a brief discussion on the work carried out at WKBYC and approved of the approach. It expressed the need to fill in gaps of the tool and increase the resolution of the indices (for example more categories than just "presence/absence" in abundances). It was pointed out that the comparison of effort in different métiers by means of days at sea is not adequate; for example the actual soaking time of gillnets is much higher than for pelagic trawls for the same number of days at sea. The group was aware however of the limitation of the available data. Although in general in field studies it is possible to use adequate parameter, but if (by)catch rates are to be raised to fleet level, the only effort data at hand is days at sea. In general days at sea is at least a unit that can be used to combine different types of métiers, despite its flaws.

Adoption of more broadly defined sampling strata as envisaged under DC MAP would present no problem to the monitoring of PETS. The identification of hotspots for bycatch from the raw sampling data would in most instances be at a grosser scale;

the identification of hotspots by métier would require post stratification of the samples. The adoption of probability based sampling with improvements in sampling coverage and the ability to identify non-response bias in the sampling data would be as beneficial to the monitoring of PETS as to any other aspect of at-sea sampling.

As an additional source of information, the use of bycatch data from fishery surveys was mentioned.

The group revisited last year's list of major and minor topics and concluded that the fact that most countries do not have the species codes for a lot of PETS, which causes data not to be stored in national databases, is probably the most important issue that should be solved at short term. In addition some other parameters of importance were considered. They are presented in table 6.1. The majority of the parameters, for example date, time and geographical position, are not expected to cause any problems, as they are required in any fishery research database for the proper sampling of the content of the net and bycatch of PETS includes in principle nothing more than the sampling of another species(group). Three parameters in particular are highlighted in table 5.1, as they are considered essential to recording of PETS (or rare species). Institutes are encouraged to add these fields and entry codes. Additional fields may be added for the coverage of more details, depending on regional differences in protocols and training.

The database interface should contain as mandatory:

(1) ***Checkbox for sampling on haul level*** of incidental bycatch: this may for example consist of inspection of the codend when at opening and/or a scan for rare species during processing of the catch. This field enables the output of hauls or sets with zero bycatches. The exact definition of sampling at haul level may lead to additional fields: for example an indicator of percentage of coverage or a description of the actual observer action carried out.

(2) ***List of species codes***: hierarchical so that it is possible to enter species on genus -, family – or order level. Table 5.2 gives a list of suggested species for which codes should be generated in the National databases. It is supposed that the National databases have codes for all fish species, including elasmobranchs and the species protected under the Habitat Directive. Considering birds, cetaceans and turtles – of which all species are protected – the list is not exhaustive, but rather gives the species that may show up some time in the catch in the Northeast Atlantic. It was noticed that not allspecies which are included in the AFIS List of Species for Fisheries Statistics Purposes http://www.fao.org/fishery/collection/asfis/en . WGBYC will contact the administrator of this list for an update. The institutes that carry out discards monitoring programmes, should include in their sample protocol to bring home rare specimens for identification and make sure that the data manager create input codes for the species if it is not yet on the list.

(3) ***Acoustic Deterrent Devices (ADD's or "Pingers")*** which are used in set-net fishery (and in some cases pelagic trawl) to deter harbour porpoises and dolphins. Several field may be added to this to record further details.

Table 5.1 PETS monitoring parameters to be stored in national databases.

Need to know	Further details
Date	
Time	
Geogr position	
Gear type level 6	
Meshsize for set-nets	
Haul ID	
Check box for sampling at haul level	Inspection opening codend; scan of the catch during handling; % of coverage
Species codes	See table 5.2
Number of specimens	
Pingers Y/N	Brand; type; distance to nearest pinger; battery check

Table 5.2. List of rare, protected or endangered species – other than fish – for which National databases should create input codes. The list is not exhaustive and it is encouraged to add codes if necessary. Names and taxonomic codes have been taken from the FAO List of Species for Fisheries Purposes http://www.fao.org/fishery/collection/asfis/en

English_name	Synoniem	Scientific_name	TAXOCODE	3A_CODE
Marine turtles nei		Testudinata	531XXXXXX030	TTX
Green turtle		Chelonia mydas	5310700502	TUG
Hawksbill turtle		Eretmochelys imbricata	5310701701	TTH
Loggerhead turtle		Caretta caretta	5310701801	TTL
Leatherback turtle		Dermochelys coriacea	5310100101	DKK
Toothed whales nei		Odontoceti	422XXXXXX	ODN
Dolphins nei		Delphinidae	42204XXXX	DLP
Harbour porpoise		Phocoena phocoena	4220500201	PHR
White-beaked dolphin		Lagenorhynchus albirostris	4220402803	BWD
Atlantic white-sided dolphin		Lagenorhynchus acutus	4220402804	DWH
Risso's dolphin		Grampus griseus	4220401201	DRR
Bottlenose dolphin		Tursiops truncatus	4220402901	DBO
Common dolphin		Delphinus delphis	4220400601	DCO
Killer whale		Orcinus orca	4220402201	KIW
Long-finned pilot whale		Globicephala melas	4220400402	PIW
Aquatic mammals nei		Mammalia	499XXXXXX037	MAM
Mediterranean monk seal		Monachus monachus	4060300101	SMM
Harbour seal	Common Seal	Phoca vitulina	4060300502	SEC
Larga seal	Spotted Seal	Phoca largha	4060300507	SST
Ringed seal		Pusa hispida	4060300503	SER
Grey seal		Halichoerus grypus	4060301101	SEG
Divers nei		Gaviidae		
Red-throated Diver		Gavia stellata	5660100104	BWF
Black-throated Diver		Gavia arctica	5660100102	BWC
Grebes nei		Podicipedidae		
Little Grebe		Tachybaptus ruficollis		
Great Crested Grebe		Podiceps cristatus	5680100102	HHZ
Northern Gannet		Morus bassanus	5670300102	MVB
Cormorants nei		Phalacrocoracidae	56702XXXX	ITV
Great Cormorant		Phalacrocorax carbo	5670200103	ISY
European Shag		Phalacrocorax aristotelis	5670200102	ISW
Ducks, geese and swans nei		Anatidae	56201XXXX	TZH
Tufted Duck		Aythya fuligula	5620100301	DKI
Common Pochard		Aythya ferina		
Greater Scaup		Aythya marila	5620100302	DKJ
Common Eider		Somateria mollissima	5620101101	EGF
Long-tailed Duck		Clangula hyemalis	5620100601	GCZ
Black Scoter	Common Scoter	Melanitta nigra	5620100802	WOY
Hooded Merganser		Lophodytes cucullatus		
Smew		Mergellus albellus		
Red-breasted Merganser		Mergus serrator	5620100902	GWC
Goosander		Mergus merganser	5620100901	GWA
Auks nei		Alcidae	56705XXXX	HBB
Common murre	Common Guillemot	Uria aalge	5670500401	UQT
Razorbill		Alca torda	5670500501	HBW
Black Guillemot		Cepphus grylle	5670500301	HBO
Atlantic Puffin		Fratercula arctica	5670500101	FPA

6 References

Ajiad, A., Aglen, A., Nedreaas, K. and Kvamme, C. 2007. Cod bycatches in the Barents Sea shrimp fishery during 1983-2005. NAFO SCR Doc. 07/86. Serial No. N5472. 8 pp.

Aldrin, M., Mortensen, B., Storvik, G., Nedreaas, K., Aglen, A., and Aanes, S. 2012. Improving management decisions by predicting fish bycatch in the Barents Sea shrimp fishery. – ICES Journal of Marine Science, 69: 64–74.

Anon. 2013. Norwegian fishing vessels, fishermen and licenses 2012. Directorate of Fisheries, Bergen, Norway. ISSN 1503-1276; 86 pp. http://www.fiskeridir.no/english/statistics/norwegian-fisheries/norwegian-fishing-vessels-fishermen-and-licenses

Cook, R. 2003. The magnitude and impact of by-catch mortality by fishing gear. In Responsible fisheries in the Marine ecosystem (edited by Sinclair and Valdimarsson). FAO and CABI Publishing .pp: 219-233.

European Union. 2008. Council Regulation (EC) No 199/2008 of 25 February 2008 concerning the establishment of a Community framework for the collection, management and use of data in the fisheries sector and support for scientific advice regarding the Common Fisheries Policy. Official Journal of the European Union L 60:1-12.

Fernandes, P.G, Coull, K., Davis, C., Clark, P., Catarino, R., Bailey, N., Fryer, R. and Pout, A. 2011. Observations of discard in a Scottish mixed demersal trawl fishery. ICES Journal of Marine Science 68(8) 1734-1742.

Garcia, E. 2007. The northern shrimp (Pandalus borealis) offshore fishery in the Northeast Atlantic. Advances in Marine Biology, 52: 147–266.

Gillett, R. 2008. Global study of shrimp fisheries. FAO Fisheries Technical Paper, 475. 354 pp.

Global Adult Tobacco Survey (GATS). 2010. Sample Weights Manual, Version 2.0. Atlanta, GA: Centers for Disease Control and Prevention.

ICES 2009. Report of the ICES Workshop on methods for to evaluate and estimate the precision of fisheries data used for assessment (WKPRECISE). ICES CM 2009 / ACOM:40

ICES 2010a. Report of the Planning Group on Commercial Catches, Discards and bio-logical Sampling (PGCCDBS), 1-5 March 2010, Lisbon, Portugal. ICES CM 2010/ACOM:39, 174pp.

ICES 2010b. Report of the ICES Workshop on methods for merging métiers for fishery-based sampling (WKMERGE). ICES CM 2010 / ACOM:40

ICES. 2011a. Report of the Study Group on Practical Implementation of Discard Sampling Plans (SGPIDS 1). ICES 2011 /ACOM:50

ICES 2011b. Report of the Workshop on Practical Implementation of Statistical Sound Catch Sampling Programmes (WKPICS 1), 8-10 November 2011, Bilbao, Spain. ICES CM 2011/ACOM:52

ICES 2012a. Report of the Study Group on Practical Implementation of Discard Sampling Plans (SGPIDS 2). ICES 2012 /ACOM:50

ICES 2012b. Report of the Workshop on Practical Implementation of Statistical Sound Catch Sampling Programmes (WKPICS 2), 6-9 November 2012, Copenhagen. ICES CM 2012/ACOM:54

ICES 2012c. Report of the Workshop for the Regional Data Base 3. 20-23 November 2012, Copenhagen, Denmark.

ICES. 2013. Report of the Planning Group on Commercial Catches, Discards and Bio-logical Sampling (PGCCDBS 2013), 18–22 February 2013, Belfast, Northern Ireland. ICES CM 2013/ACOM: 49. 128 pp.

Jansen, T., Degel, H., Håkansson, K., Egekvist, J., Dalskov, J. & Köster, F.W. 2008. FishFrame 5.0: A web based datawarehouse application for management, access and integration of fisheries and stock assessment data. ICES CM 2008/R:26

Lohr, S. 2010. Sampling: design and analysis 2nd Ed. Brooks/Cole, Boston.

Lumley, T. 2010. Complex surveys, a guide to analysis using R. John Wiley & sons New Jersey.

Moser, C.A. & Kalton, G. 1979 Survey methods in social investigation. Gower Publishing Ltd, Aldershot, England.

Pennington, M., Burmeister, L. M., and Hjellvik, V. 2002. Assessing the precision of frequency distributions estimated from trawl-survey samples. Fishery Bulletin US, 100: 74–81.

Pennington, M., and Helle, K. 2011. Evaluation of the design and efficiency of the Norwegian self-sampling purse-seine reference fleet. – ICES Journal of Marine Science, 68: 1764–1768.

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Annex 2: Agenda

Agenda

SGPIDS 3 will address these TORs using three work themes. Each theme will be addressed by a subgroup and through plenary presentation and discussion.

Theme 1. From Populations to Sampling Frames

The whole premise of survey sampling is to select, with known probability, individuals from a population. Samples collected in this way can then be used to make inferences about the population. For the fleet based fisheries sampling schemes envisaged under the DCMAP the populations we are concerned with are the vessels doing the fishing, and the fishing trips they make over a given period of time. Having a clear understanding of the size and activities of these populations is a prerequisite to devising a sampling design, being able to set up sampling strata, being able to specify a sampling frame and being able to produce unbiased estimates about the population.

This theme will be concerned with:

- Identifying the "populations" and "study populations" for which we need to produce estimates, using lists of vessels and trips obtained from a national vessel register, or census logbook and sales slip information.
- Stratification of national vessel lists into sampling frames.
- Comparison of existing sampling frames with national lists.
- Allocation of the available sampling effort between strata (to achieve domain coverage, cost-effective sampling, for logistical reasons and to maximize precision)
- Allocation of sampling effort within the stratum (to achieve a sampling plan that will provide representative sampling opportunities over time).
- Specifying exactly the primary sampling unit (PSU) given the sampling plan.
- Recording of the quality indicators for this stage of the sampling design.
- Looking ahead to a template for a regional sampling programme.

Participants will need

National vessel registers listing all vessel with identifiers, and pertinent "vessel type" information to enable them to be grouped into distinct fleets.

and/or

Logbook or sales slip information at the trip level for the national fleet or some clearly defined group of vessel within the national fleet conducting a particular fishery.

The additional information either from the vessel registers or from the trips ideally would include things like ports of operation, length, power, main gear types (or métier) used, average trip duration, predominant fishing areas, main fishing seasons etc. The more auxiliary information available the more informed the stratification can be.

Theme 2. Vessel selection and the calculation of non-response and refusal rates

Probability based selection (random sampling or systematic random sampling) is fundamental to a design based estimate. Without it none of the assumptions of the

estimates hold, you cannot calculate a measure of variance and you have no way of assessing bias. For an at-sea sampling programme the selection of the vessel is therefore critical to the whole process. This theme deals with the placing of an at-sea observer on a fishing vessel (though the principles apply equally to obtaining a sample from a vessel in a self-sampling scheme or from a reference fleet). It will build on the work of SGPIDS 2012 (ICES 2012a) (section 4.2) in the calculation of a standard non-response and refusal rate and the WKPICS 2 quality indicators (table 4.1).

This theme will consider:

- Ways of identifying which vessels are available to be selected.
- Practical ways of randomizing the selection of the available sampling units (vessel/trips)
- Recording the selection process, using contact logs, selection forms etc
- Calculating non-response and refusal rates to allow between nation comparisons
- Linking samples to populations and ways of identifying non-response bias.
- The reporting of non-response and refusal rates.
- Analysis of the different distribution of the vessels refusing to have observers (VMS/ landing composition etc.)
- Comparison on the landing pattern between observer and non-observer trips by fleet segment / métier.

Participants will need

Used examples of probability based selection protocols for the selection of vessels/trips.

Worked examples of non-response and refusal rate calculations.

VMS data from vessels refusing compared to vessels with observers.

Theme 3. On-board sampling and estimation.

The way the catch is handled and processed on-board a vessel, and the protocol used by the at-sea observer determines which fish, of all those caught, end up in the sample. In theory any fish in the catch has a finite probability of being sampled, and this probability can be estimated. The inverse of these sampling probabilities is the sample weight which is more familiar as the raising factors used to scale the sample up to the trip. But the exact nature of the numbers used in these ratios can be important, as are all the levels in the multistage sampling hierarchy that has been used to select the individual fish (or shellfish) in the sample.

This theme will:

- For the different examples provided document the different on-board sampling protocols, in particular the extent of the diversity, or similarities, in the examples.
- Calculate the sampling probabilities and the sample weight for the different examples.
- Access the extent to which the RDB exchange format (and envisaged modifications) can accommodate all the recorded data of the worked examples.

Participants will need

Examples of the actual on-board raw data collected while sampling (e.g. notebooks or recording sheets), for as wide a range of species and vessel types as possible e.g. fin-fish sampling, shell fish sampling, landings and discards, CCTV coverage and the sampling of the footage, returned samples or data from self- sampling and reference fleets.

A knowledge (or brief description) of the on-board catch handing practices and sampling protocol used to obtain the sample - i.e. how the samples are collected, and what is actually counted, what is actually measured, what is collected (e.g. otoliths), what is actually recorded.

Annex 3: Recommendations

Recommendation	Adressed to
1. SGPIDS recommends that national at-sea sampling programmes are encouraged to set up appropriate sampling frames for at-sea sampling based on vessel lists, and supplementary data such as logbooks and sales notes. Additionally vessels should be selected using a probability based selection mechanizm, that when a vessel is contacted the vessel's "next trip" is the criteria used to define the responses to the selection attempt, and that equal effort be expended to secure a trip for each selection attempt within the same stratum. As a minimum the responses to selection attempts should be classified into one of the six contact categories (Not available, No contact details, Observer decline, No answer, Industry decline, Successful sample) to enable standardization of non-response and refusal rate calculations.	PGCCDBS National correspondence
2. SGPIDS recommends national at-sea sampling programmes facilitate the recording of the bycatch of protected and endangered species (PETS) by including (in addition to accepted at-sea data) a check box for recording if sampling for PETS bycatch at haul level occurred, a check box for recording the use of Pingers and that the appropriate species codes (listed in table 6.2 SGPIDS report) are included in recording forms and national databases.	PGCCDBS National correspondence
3. SGPIDS recommends that a number of additional fields (see section 5.4) will need to be added to the RDB data exchange format if raw, as opposed to derived, data are to be recorded in the database and if sample weights are to be correctly calculated from the data collected during on-board sampling.	RDB-SG ICES data centre

Annex 4: The vessel selection procedure for the English and Welsh at-sea observer programme

The following is a condensed version of the protocol used for selecting vessels in the English and Welsh observer programme 2013.

Drawlists are drawn up from the fleet register of fishing vessels 7m in length expected to fish from a particular group of ports in the coming quarter based on their activity last year. Excel files are produced with a file name based on a Port region and quarter e.g. **NorthSeaDrawlistsQtr1.xlsx**

For each gear group, vessel group (size) and sub region (list of ports) there is a drawlist on a worksheet. These files and drawlists map to a target matrix that provides the number of trips required.

Each file provides detailed information on the actual draw when it was done, who did it and what 'seed' was used to produce the random lists. No random function is truly random and the Microsoft function used allows you to repeat exactly the same 'random' selection if necessary if you have the 'seed'.

The drawlists themselves relate to the vessel size and gear segment (e.g >=10m Beam trawlers) fishing from that group of ports.

The list includes every over 7m English and Welsh vessel that was officially recorded fishing in that quarter last year predominantly using a gear within that gear group – landing to those ports. They will only be listed if they were fishing then and are currently still licensed. To help with contacts a **lookup** table of the registered owners is provided on another worksheet in the file.

The drawlist provides the vessels in the order in which they must be approached and sampled. On the worksheet there is a line for each vessel. As well as the vessel details (the **RSSNo**, **PLN**, **Name** and **Overall Length**), some history is also provided. This history includes the activity of the vessel in the same quarter last year (**Main Port, Number of Trips** and he **Average Trip Length**) and also includes information if its been sampled before (How many times that vessel has had an observer onboard, the date its was last observed, the trip reference number and the observer). All this information gives provenance and helps an observer manage their expectations and provides a reference to any health and safety concerns a previous observer may have had.

The vessel selection process is recorded next to this information. Details are recorded by the observer:

1. **FO** – Observer ID
2. **FirstDate** – The date the observer selected that vessel.
3. **Comments** – Any comments qualifying the success including the trip code if successful
4. **Contact** – Has contact been made with the skipper or owner - "Yes" or "No"? It needs to be clear whether the skipper/owner was contacted before a decision was made.
5. **Contact Name** – The final and best contact for that vessel.
6. **Contact Number** – The telephone number used (if they are happy for other observers to use it).

7. **Number of Calls** – The number of calls to make that trip, up to 5 (not necessarily to that final contact). For any number beyond that just use ">5"
8. **Response** – Response code (See below).

Responses	Description
1	Observer rejected (e.g. safety reasons…). Use if the vessel is unavailable or unsampleable for reasons discerned without consulting the skipper/owner. Or if after making the arrangements the observer decides not to go.
2	No. The owner\skipper does not want to be contacted again this sampling year. This should be used for any hard "Nos"- a clear indication that they do not want to cooperate.
3	No. An owner\skipper refusal. Unavailable on this occasion but can be contacted again. This covers a number of reasons including – number of berths; inconvenience; not fishing.
4	Untraceable. After a reasonable amount of effort the vessel has not responded to calls or the observer is unable to find a contact number.
5	Yes. This should only persist if the vessel is sampled.
6	Off draw success. Sampled for convenience. This covers industry requests; associated RandD trips and best available vessel for training. This should only be used after consultation with Team leader or Project Manager.

9. **Final Date** – Completion date for the selection whether successful or not. An Observer ID and a blank FinalDate indicates that that observer is still trying to arrange a trip. Once the observer is tired of trying or has sampled the vessel they should make 'close' that selection by populating the field.

SUMMARY PROCESS.

(This process is the process currently being used and will be revised following the advise from this Study Group. This process allows vessels to be put on hold and revisited if they are unavailable at that instant)

1. Based on what sampling is still required. Go to the Drawlist in the relevant file.
2. Review the responses and comments for those vessels that have already been selected to see if any need to be revisited. (These were the instructions prior to this SG and are yet to be revised)
3. If they do, re-book the vessel using the second Observer slot.
4. If the second Observer slot has been used with limited success create a 3rd Observer slot.
5. If they don't need revisiting, book the first available vessel in that list by putting your ID against it.
6. Whether 1st, second or 3rd Observer, book the vessel out by inserting your initials in the FO field and record the date.
7. Update the fields on the Drawlist.

8. Once you have 'tired' of trying to contact the vessel you should make that vessel available to others you should sign off by populating the FinalDate field.
9. If an arranged trip falls through then revise the response. The response 5 should only persist if the vessel is successfully sampled.

Frequently Asked Questions

6) The vessel is currently not using the gear that the drawlist is referring to.

If we have targets for the gears the vessel is currently using then sample it anyway. These lists are based on the official records for that vessel. This may occur more regularly with some of the under 10m vessels when a lot of the statistics come from sales notes and only some landings need to be reported. Errors may be made by merchants and the MMO when interpreting and processing these data.
In these instances if you are sure about that vessels activity and the gear is irrelevant to our current programme qualify your original selection with the 'Response ' = 1 (Observer rejected) add a comment and move to the next vessel. If you are unsure - approach the vessel and only consider it if it is fishing in any of our targeted gear groups.

7) The vessel on the list has only 1 trip recorded against this geartype last year?

A vessel will only appear once in these drawlists. The number of trips recorded last year could be indicative of the quality of the details. If there is only 1 or 2 trips recorded for that vessel then either that vessel hardly put to sea or the MMO have had to deal with summary information (see ***1)*** above).

In these instances if you are sure about the vessels current activity and it being irrelevant then qualify your original selection with the 'Response ' = 1 (Observer rejected) add a comment and move to the next vessel. If you are unsure but can easily trace the vessel - approach the skipper/owner and only consider it if it is fishing in any of our targeted drawlists.

8) What do I do if I've reached the bottom of the drawlist and there are no more vessels?

Select the vessels in turn, if you reach the bottom of the drawlist without meeting the target then -

1. If you know of a vessel that is currently fishing that gear group but is not on that list then approach them for a trip.
2. If its not obvious and you can't find out who may be fishing that métier contact the project manager and they will provide you with a list of vessels that did fish in that métier last year That list will include the vessels that have already been struck off.

If the additional vessels will not be fishing in that métier over the remainder of the quarter then work through them to find one that will take you and sample them anyway.

3. In both cases, manually add the vessel to the drawlist you are sampling and comment on the selection with a note referencing the draw list they originally appeared on.

4. Book the reallocated vessel out in both this drawlist and the drawlist in which it originally resided. Use the 'Response' 6 to qualify the selection.

If you reach the bottom of this standby list without meeting the target move to an adjacent or more appropriate métier (it should relate to the fisheries these vessels may be working in instead). If this is not obvious then contact the project manager or team leader for advice.
What ever is decided make a note of the decision at the bottom of the list.

9) ***What if an arrangement fails?***
If working locally then edit the response on the spreadsheet accordingly. Response 5 should only persist if the trip was successful. Try and arrange a date for later in the quarter – if you are available. Either reopen the booking, move to the second Observer columns, or offer the opportunity to someone else.
The opportunities to revisit a port when working away from home may be limited and costly so if a prearranged trip falls through, the observer should consult the drawlist and consider selecting and approaching the next vessel for that port. Use the 'Response' 6 to qualify the selection.

10) The vessel is operating out of a non English port.
If fishing out of a non English port then please consult with the project manager.

11) I have been approached by the industry who want to take me to sea to show me something.
Please consult with the project manager and or group manager before committing to a trip. There are considerable benefits in supporting these requests but we need to consider each in turn. If a decision is made to go the vessel needs to be found or added to the appropriate drawlist and annotated with a response and justification.

12) What is a reasonable amount of effort when trying to contact a vessel
Don't leave messages unless the skipper knows you and is likely to respond. The amount of effort required will depend on how available the skipper or owner are. If you have a contact but the vessel is at sea for a week then you may need to wait a week before you have a chance of a response.
This whole process does rely on your using common sense, your time wisely and putting in a reasonable amount of effort trying to contact unfamiliar skippers and owners.
For guidance:

- Do not leave messages unless you know the skipper will return the call.
- Do not leave messages with more than 3 skippers in the same drawlist. You can continue to approach vessels below these 3 but don't leave messages.
- If you have a contact number, limit the number of attempts to contact an individual to a minimum of 3 calls and limit it to a period of 48 hours for a response. This assumes the time of day or week you are calling is reasonable. If unsuccessful move on.
- If you do not have a contact number after 3 unsuccessful attempts at getting one - move on. Please comment on who you have tried so anyone following on can try other sources.