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REPORT OF THE WORKSHOP ON DISCARD RAISING PROCEDURES

6–9 FEBRUARY 2007

SAN SEBASTIAN, SPAIN

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Conseil International pour l'Exploration de la Mer

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Contents

1 Executive summary

Since 2002 the European Union requires member states to collect discard data under the Data Collection Regulation (DCR, EC Regulations No 1543/2000, No 1639/2001 and No 1581/2004). Consequently most countries collect discard data, but lack guidance in raising discard data. A workshop on discard raising procedures was proposed in 2006 by the ICES PGCCDBS, where a common raising procedure would be applied to a set of data covering a maximum of different fisheries, sampling programmes and regions. The objective was to establish, if not a common methods for raising, at least a set of common best practise to be used to raise discard data. In the process, countries would have a chance to learn how to resolve specific raising issues related to their fisheries, but also to apply (new) methods to provide national discards estimates.

The terms of reference of the meeting were to a) identify and summarise the concerns countries have in relation to raising procedures; b) review the data structures commonly used at a national and international level and agree on a common format for analysis purpose; c) apply several raising procedures to a discard dataset made available by different countries; d) compare the results between raising methods and fisheries, identifying the advantages and limitations of each procedure.

A specific chapter of the report summarises the concerns regarding the raising of discard data. These concerns were divided into several section: general concerns, concerns related to knowledge of the population, to multistage sampling, to raising by sampling unit (hauls and trips), to raising by landing, to raising by effort (days at sea, fishing hours, effort for passive gears) and to fisheries with "extreme" behaviours.

It was agreed that the common data exchange format should applied to raised data only and should be flexible to adapt to future changes in the fleet/métier aggregation criteria, the different sampling strata used by different countries in different regions, and also to different end-users needs. The proposed format includes a field for major geographical regions (e.g. Mediterranean, NAFO, etc) and also one for already established area definitions (ICES and FAO). In addition, two codes for fleet/métier aggregation are considered: one based on the regional level of the future DCR fleet/metier matrix and the other code based on national aggregation level. The data exchange format is divided into three forms: overall and effort information; length distributions and age distributions. However, it was agreed that it is fundamental for the end-user to specify clearly the objective for which the data is going to be used, and consequently the (dis)aggregation level needed to carry out such analysis.

Most countries participating in the workshop made data available for analysis. The comparison between raising procedures was limited to a simple estimator and to ratio estimators. The auxiliary variables considered were number of fishing trips, landings of target species and fishing hours; and also two additional variables (total landings–all species summed, and fishing days) when the previous ones were not available/applicable. The results show that particular methods under- or overestimate discard estimates systematically. Specifically, there is an ascending tendency to overestimate discards from trips to landings to effort variables used in the raising procedure. Regarding the precision of the raised discard estimates, there is a descending order of precision from fishing hours to trips to landings variables, i.e. fishing hours providing the most precise raised discard estimates.

Finally the workshop concluded that there is a systematic method to assess, compare and finally choose a procedure to raise discards. This procedure was compiled as a key (Discard Raising Procedure Key), where two major issues/characteristics (representativeness and quality) have to be assessed, followed by a subset of decisions that lead to a final choice of procedure. It is essential to apply different raising procedures and compare the resulting discards estimates, as unforeseen problems with the data may only appear through the

comparison of different procedures. Ideally the chosen raising procedure should be unbiased, precise and simple.

Raising Procedure Key

1. Is the sampling **representative** (mean length of vessels and mean auxiliary variable sampled compared to the population, see section 4)?

Yes	Raise by trips and go to 2
No	DON'T raise by trips and go to 2

2. Has the **quality** of the data used for raising been established (no misreporting and availability, see section 4)?

Yes	Go to 3
No	Go to 6

3. Are the discard and auxiliary variable linearly related (significant relationship and positive slope)?

Yes	Raise by all variables and go to 4
No	Go to 6

4. Compare the results of the different raising procedures:

Similar (<10-20% difference)	Go to 5
Dissimilar (>10-20% difference)	Go to 1*

   *and find the cause of the difference!

5. Choose a method that is the least biased (trips if applicable, ratio if regression passes trough origin or variable with less concerns) and most precise (compare CV's).

6. When there is no suitable raising procedure then identify the problem, identify the population sampled (different stratification/sampling?) and start again!

   Go to 1

2 Introduction

2.1 Rational for WKDRP

Since 2002 the European Union requires member states to collect discard data under the Data Collection Regulation (DCR, EC Regulations No 1543/2000, No 1639/2001 and No 1581/2004). Consequently most countries collect discard data, but lack guidance in raising discard data. The raising of discard estimate from the sample to the whole stratum is usually made either by landings or by effort variables. It is not unusual for these procedures to provide very different results. Not only different countries use different raising procedures, leading to different estimates, but this raised data is then pooled to provide the basic data for stock assessment. The outcome of stock assessment is very sensitive to raising procedures results, i.e. to different discard estimates. For example, the North Sea plaice assessment predicted a 60% increase in the landings for next year when the discard estimates where reviewed to a 8.5% increase (EC, 2006c). This example also illustrates the problem of uncertainty in discard estimates, resulting in high uncertainty of the assessment advice. In conclusion, there is the need for agreed methodologies for raising procedures and also for calculating precision in discard estimates.

In 2003 a group of scientists got together to discuss issues relating to sampling strategies and its statistical implications. The ICES Workshop on Discard Sampling Methodology and Raising Procedures (hereafter called the Charlottenlund workshop; ICES, 2004) established the different statistical formulas to calculate discard estimates and its precision at population level, considering a simple estimator and a ratio estimator. However, the workshop did not have data available to determine which estimator would provide the best estimate (unbiased and most precise). In other words, the workshop was not able to do a practical test of the recommended statistical formulas, and these formulas are based on several assumptions that in practice might not be met in several sampling programmes and fisheries.

For these reasons, a workshop on discard raising procedures was proposed in 2006 by the ICES PGCCDBS (ICES, 2006). In this workshop common raising procedures would be applied to a set of data covering a maximum of different fisheries, sampling programmes and regions, in order to establish, if not a common methods for raising, at least a set of common best practise to be used to raise discard data. In the process, countries would have a chance to learn how to resolve specific raising issues related to their fisheries, but also to apply (new) methods to provide national discards estimates.

2.2 Participants

A list of participants' contact details is given in Annex I.

Urich Berth	Germany
Lisa Borges (chair)	Netherlands
Aina Carbonell	Spain
Grant Course	UK
Henrik Degel	Denmark
Wim Demaré	Belgium
Jochen Depestele	Belgium
Rob Enever	UK
Ana Fernandes	Portugal

Isabel Gonzalez	Spain
Włodzimierz Grygiel	Poland
Ryszard Grzebielec	Poland
John Haralabous	Greece
Edwin van Helmond	Netherlands
Claude Merrien	France
Colin Millar	UK
Kay Panten	Germany
Nélida Pérez	Spain
Tiit Raid	Estonia
Andrew Revill	UK
Katja Ringdahl	Sweden
Jon Ruiz	Spain
Sonia Sanchez	Spain
Ivo Sics	Latvia
Romas Statkus	Lithuania
Joel Vigneau	France

2.3 Terms of Reference

The group met in San Sebastian, Spain, from February 6th to the 9th 2007, with the following Terms of Reference:

a) To identify and summarise the concerns countries have in relation to raising procedures.
b) Review the data structures commonly used at a national and international level and agree on a common format for analysis purpose.
c) Apply several raising procedures to a discard dataset made available by different countries.
d) Compare the results between raising methods and fisheries, identifying the advantages and limitations of each procedure.

2.4 Approach taken by the workshop

The workshop was divided into two subgroups on the afternoon of the first day: one subgroup discussed a common format for discard data exchange, while the other started analysing the data. The data exchange format subgroup reported on the results the next day. In the remaining days of the meeting the group worked on the analysis of discard data, specifically on the exploratory data analysis and the raising of discards sampled to population level.

3 Exchange discard data format

Most countries have experienced an increased number of requests for discard data by external end-users, each request usually in a different format. This means that each national laboratory has had to develop a specially designed extraction and aggregation procedure for each request,

with a significant use of manpower. A common format for future data request, that holds all the necessary information related to discards, would certainly save time and increase the quality of the data delivered. At the same time, an international exchange form provides a common format between national data that will allow for different levels of data aggregation (e.g. area, species or stock) specific to different analysis (e.g. stock assessments).

The group decided that the data exchange format should be flexible to adapt to future changes in the fleet/metier aggregation criteria, the different sampling strata used by different countries in different regions, and also to different end-users needs. Furthermore, it was agreed that it is fundamental for the end-user to specify clearly the objective for which the data is going to be used, and consequently the (dis)aggregation level needed to carry out such analysis.

The data exchange format agreed considers raised data only. Estimating raised discards requires specific knowledge of the fishery in question. This knowledge is usually only held in the country from which the data came from, and thus discards should be raised at national/regional levels. Therefore an international exchange data format should only be applicable to raised data.

The data aggregation level caused discussion over issues such as area, fleet/metier and temporal coverage. The group agreed that the format should include a field for major geographical regions (e.g. Mediterranean, NAFO, etc) and also to have the facility to incorporate already established area definitions (ICES and FAO). This will allow different data aggregation levels that are specific to different geographical regions. In addition, two codes for fleet/metier aggregation are considered in the format: one based on the regional level of the future DCR fleet/metier matrix and the other code based on national aggregation level. The first code provides a base for comparison between countries, while the second allows for detailed information regarding the metier definition considered in each national discard sampling programme.

The data exchange format is divided into three forms:

- Type 1. This form holds overall information and effort information
- Type 2. This form holds information about length distributions
- Type 3. This form holds information about age distributions

The three forms are based on the same strata definition established by rows 1 to 9. All tables include precision level estimates in the form of coefficients of variation (CV). All appendices related to the exchange data format can be found in Annex 2.

Record type 1 Meta and effort information.

Order	NAME	TYPE*	M/O**	RANGE	COMMENTS
1	Record type	A	M		Fixed value: ME.
2	Region	N	M	1-4	1=Baltic, 2=North Sea and Western Arctic, 3=North East Atlantic, 4=Mediterranean.
3	Country	A	M	See Appendix I	EU countries: Codification Standards and definition of Standard Outputs for EC 1639/2001 data. Table 21 Non-EU countries: Added to above in appendix I.
4	Year	N	M	1900 to 3000	
5	Fleet	A	M		Future DCR matrix fleet segmentation
6	Fishery activity	A	M	See Appendix VI + DCR matrix***	Regional level of the future DCR matrix*** or depending on request.
7	National stratification code	A	O		Sub-stratification of Fishery activity (variable 6). Only required if the national stratification is on lower level than the regional level of the future DCR matrix (or the level requested). See appendix VII for definition.
8	Season	N	M	1, 2, 3 See Appendix II	Month, quarter or year depending on Region and request.
9	Area	A	M	See Appendix III	Div (ICES), SD (ICES), Sub-area (GFCM), FAO or dependent on request.
10	Total landing	N	M		Tons. Sum of landings including all species in the stratum defined by variable number: 2, 3, 4, 5, 7 and 8.
11	Origin of discard estimation data	N	M	See Appendix IV	Observer sampling scheme, Self sampling (in code)
12	Number of trips	N	M		For the total fleet in the strata in question as defined by variables number 2, 3, 4, 5, 7 and 8
13	CV(number of trips)	N	O		Coefficient of Variation of estimate on number of trips. Census="0"
14	Fishing days	N	O		Number of days where fishing has been conducted
15	CV(Fishing days)	N	O		Coefficient of Variation of estimate on number of fishing days. Census="0"
16	KW* days	N	O		Sum of (Engine size * days of fishing)
17	CV(KWatt days)	N	O		Coefficient of Variation of effort estimate. Census="0"
18	Effort unit (alternative 1)	A	O		Effort specific measures for groups of Fishing Activities (see appendix VIII for explanation)
19	Effort (alternative 1)	N	O		
	CV (alternative 1)	N	O		Coefficient of Variation of estimate on effort (alternative 1). Census="0"
20	Effort unit (alternative 2)	A	O		Effort specific measures for groups of Fishing Activities (see appendix VIII for explanation)
21	Effort (alternative 2)	N	O		
22	CV (alternative 1)	N	O		Coefficient of Variation of estimate on effort (alternative 2). Census="0"
23	Applicable for other strata	A	M	0, 1	Yes=1, No=0
24	Raising procedure used	A	M	See Appendix V	In code

* A=Alphabetical, N=Numerical
** M=mandatory, O=optional.
*** DCR matrix is to be finalised in near future (Reference of preliminary matrix: STECF: SGRN-06-03 (draft)).

Record type 2 (Weight and Length information).

Order	NAME	TYPE*	M/O**	RANGE	COMMENTS
1	Record type	A	M	WL	Fixed value
2	Region	N	M	1-4	1=Baltic, 2=North Sea and Western Arctic, 3=North East Atlantic, 4=Mediterranean.
3	Country	A	M	See Appendix I	
4	Year	N	M	1900 to 3000	
5	Fleet	A	M		Future DCR matrix fleet segmentation
6	Fishery activity	A		See Appendix VI + DCR matrix***	Regional level of the future DCR matrix*** or depending on request.
7	National stratification code	A	O		Sub-stratification of Fishery activity (variable 6). Only required if the national stratification is on lower level than the regional level of the future DCR matrix (or the level requested). See appendix VII for definition.
8	Season	N		1, 2, 3 See Appendix II	Month, quarter or year depending on Region and request.
9	Area	A	M	See Appendix III	Div (ICES), SD (ICES), Sub-area (GFCM), FAO or dependent on request.
10	Species code	N	M		TSN Codes http://www.ices.dk/datacentre/reco/qryspec.asp
11	Catch category	A	M	Landing, discard	
12	sex	A	O		F, M, U.
13	Validity code	N	M	1, 2	1 =length distribution, 2=only weights information available
14	Raised weight	N	M		Sum of weights (landing or discard) in stratum defined by variable numbers: 2, 3, 4, 5, 7, 8, 9, 10, and 11. In kg
15	Length code	N	O	0, 1, 2, 3	Class: 0.5cm=0; 1cm=1; 1mm = 2.
16	Length class	N	O	1 to 999	In mm. Identifier: lower bound of size class, e.g. 650 for 65-66cm.
17	No at length.	N	O	1 to 999	Length classes with zero should be excluded from the record
18	$CV_{(No\ at\ length)}$	N	M		Coefficient of Variation of number at length estimate

* A=Alphabetical, N=Numerical
** M=mandatory, O=optional.
*** DCR matrix is to be finalised in near future (Reference of preliminary matrix: STECF: SGRN-06-03 (draft)).

Record type 3 (age information).

Order	NAME	TYPE*	M/O**	RANGE	COMMENTS
1	Record type	A	M	AG	Fixed value
2	Region	N	M	1-4	1=Baltic, 2=North Sea and Western Arctic, 3=North East Atlantic, 4=Mediterranean.
3	Country	A	M	See Appendix I	EU countries: Codification Standards and definition of Standard Outputs for EC 1639/2001 data. Table 21 Non-EU countries: Added to above in appendix I.
4	Year	N	M	1900 to 3000	
5	Fleet	A	M		Future DCR matrix fleet segmentation
6	Fishery activity	A		See Appendix VI + DCR matrix***	Regional level of the future DCR matrix*** or depending on request.
7	National stratification code	A	O		Sub-stratification of Fishery activity (variable 6). Only required if the national stratification is on lower level than the regional level of the future DCR matrix (or the level requested). See appendix VII for definition.
8	Season	N		1, 2, 3 See Appendix II	Month, quarter or year depending on Region and request.
9	Area	A	M	See Appendix III	Div (ICES), SD (ICES), Sub-area (GFCM), FAO or dependent on request.
10	Species code	N	M		TSN Codes http://www.ices.dk/datacentre/reco/qryspec.asp
11	Catch category	A	M	Landing, discard	
12	age	N	M	0 to 50	Age group
13	Number in age group	N	M		Raised value in stratum defined by variable number: 2, 3, 4, 5, 7, 8, 9, 10 and 11.
14	Mean weight at age	N	M		g.
15	Mean length at age	N	M		mm.
16	CV(age)	N	M		Coefficient of Variation of the age estimate
17	CV(mean weight)	N	M		Coefficient of Variation of the mean weight estimate
18	CV(mean length)	N	M		Coefficient of Variation of the mean length estimate

* A=Alphabetical, N=Numerical
** M=mandatory, O=optional.
*** DCR matrix is to be finalised in near future (Reference of preliminary matrix: STECF: SGRN-06-03 (draft)).

4 Concerns regarding the raising of discard data

4.1 General concerns

There are general issues associated to the raising of discard data: a) raising variable, b) equal strata between sampling and population, c) variance associated to multistage sampling, d) assumption of random sampling and e) low sampling levels. Firstly, any raising procedure requires knowledge of its related quantity (effort or landings) at the population level. This quantity usually originates from logbooks and/or other official fisheries statistics. In order to get sound estimates of discards it is important that the variable used is as reliable as possible. It is also a prerequisite for raising discards that the same strata can be defined in samples and at the population level. Furthermore, sampling of discards, and as a consequence also the raising of discard data, is done at multiple stages and that all stages includes variance. Allen *et al.* (2002) considered six stages, namely the vessels, trips, hauls, boxes, fish length and fish age. Usually, however, the trip is considered as the primary sampling unit. Additionally, in most cases random sampling is assumed when describing the statistical properties of raised discard data but this assumption might not be correct. It is also important to realize that heterogeneity in discard pattern is high in many fisheries (see Annex 3–exploratory analysis). Due to financial reasons the sampling level is however low in most sampling programmes, which might cause unrepresentativeness of sampling and underestimates the heterogeneity of the population (see Charlottenlund Workshop Report (ICES, 2004) and Section 7 - discussion).

4.2 Concerns related to knowledge of the population

Information from logbooks or other official sources of data are not always present or available. It is thereby not always possible to get estimates at population level of landings or effort. However, even when the information from logbooks is available it is sometimes considered unreliable.

Other concerns expressed by countries relate to difficulties in proper identification and segmentation of fisheries activities/sampling strata. There are difficulties in two different levels. In some regions and for some fisheries, fishing activities (métier) have still not been defined on a regional level. On the other hand, many countries cannot obtain landing and different effort information (trips, fishing hours, fishing days, etc.) at the same level of stratification as the samples. This is specifically an issue in some regions/countries where different fleets (for example crustacean trawl and demersal fish trawl fleets), which have different discarding behaviour, cannot be separated in the official statistics.

4.3 Concerns related to multistage sampling

The raising of discard data is usually discussed in terms of raising the sampled hauls and trips to the population level. It is important to remember that discard sampling is a multistage sampling with at least six sampling stages, from vessels to the ageing of fish (Allen *et al.*, 2002). A working document made available to the meeting (Vigneau *et al.*, 2007) showed that the relative size of the subsample measured in a haul affected the variance of the species catch weight estimated for that haul. These findings suggest that it is preferable to sample a few hauls exhaustively instead of trying to sample all the hauls during a trip, with some exceptions.

4.4 Concerns related to raising by sampling unit

4.4.1 Hauls

The number of hauls made by the fisheries (population) is not available in most countries. If this information was available then a two-stage estimator could and should be used to take into account the variability between hauls within a trip and between trips (Cochran, 1963). This two-stage estimator would also have an advantage because it can take into account the different fishing activities that may occur within a trip (namely in polyvalent fisheries).

4.4.2 Trips

Trips are the primary sampling unit in most discard sampling programmes and therefore total number of fishing trips is considered an unbiased estimator. If official statistics are available, the number of trips made by the population is relatively easy to obtain. Trips are also generally considered less sensitive to misreporting than other raising variables. However, if trips are calculated from auction sales, as is the case in some countries, the number of trips could be underestimated since trips with zero landings will not be registered. Number of trips could also be affected by area and gear misreporting. Another aspect is that in some cases a trip will cover more than one fishing activity/sampling strata. In such cases, following the recommendations from the EC (2006a), one trip should be assigned to each sampling strata. However, trips separation should be made in the same way at the population level.

In practice, trips might not be the most precise estimator, particularly in low sampling levels. In addition, if the discard samples are not representative of the population (biased sampling programme), which is more likely to occur in low sampling levels, trips will give biased discard estimates. Nevertheless, trip information is needed to calculate variance of ratio estimators so the issues discussed above are of particular importance to all other raising procedures described below.

4.5 Concerns related to raising by landing

If landings are misreported (by area, species, season, gear, etc.) in the official statistics, raising by landings will underestimate (or overestimate) discards. Raising by landings could also prove troublesome for specific gears, such as pair trawls since two vessels are involved in the fishing operations and both might report the total landings.

When raising by landing, either the total landing (all species summed) or the target species landing should be used, as these variables are less sensitive to species specific misreporting. More importantly, it has been shown that a ratio estimator using species landings as the auxiliary variable is biased in small sample sizes, and can give unrealistically high estimates when species landings are small (Stratoudakis *et al*, 1999). It can not also be used to raise discards from non-commercial species. In some cases however, there is difficulties in identifying a group of target species, e.g. several fisheries in the Mediterranean where species diversity is high and landings are somewhat constant between species.

4.6 Concerns related to raising by effort

4.6.1 Days at sea

There are multiple ways to estimate the number of days at sea at the population level, as well as at the sampling level. Estimates could be based on, for example, the difference between the dates of arrival/departure of a fishing trip, the fishing dates entries in logbooks, or by the division of fishing hours by 24, etc. This means that the definition of a day at sea can differ between countries (sometimes also between fisheries within countries). In order to get a proxy for the fishing capacity of a sampling strata/fishing activity, kWdays or HPdays (horse power

days) are frequently used. This requires access to an updated fleet register with vessels characteristics, which is not always available in all countries.

4.6.2 Fishing hours

Fishing hours is the most precise estimate of effort at sampling level. However, fishers tend to write the same number of fished hours every day even if it differs in reality (under or over reporting). Furthermore, fishing hours is not a mandatory field in the European logbooks, and consequently not all countries have access to this variable at the population level.

4.6.3 Effort for passive gears

There are several different effort units for passive gears such as total net length, soaking time, number of hooks, etc. and again different countries may consider different units (EC, 2006a). Furthermore, not all variables are available from logbooks.

4.7 Concerns related to fisheries with "extreme" behaviours

In certain fisheries, such as in pelagic trawl and some Mediterranean trawl fisheries, extreme discards values (high or low) occur sporadically. These extreme sporadic values cause high sample variance and difficulties in raising data. The solution could be to increase sampling and use present/absent models (binomial, point processes and marked point processes….).

5 Methods

5.1 Raising methods considered

Several methods of estimating discards were initially considered by the workshop, namely from simple and ratio-estimators to Bayesian and other model-based estimators. However, only one modelling study was available to the workshop (working document by Millar & Hirst, 2007), but the model used was not ready to be applied to other data. Furthermore, more sophisticated methods generally require more knowledge of the factors causing variability in discards (ICES ASC 2006), a knowledge that is unavailable in several fleets/countries, but also due to the limited time available in the workshop. For these reasons the group limited the analysis to a simple estimator and to ratio estimators.

The auxiliary variables considered in the analysis were chosen based on the bias/precision they might give, but also on their availability by the majority of the countries/fleets. Therefore, three main variables were used:

- number of fishing trips
- landings of target species
- fishing hours

Furthermore, two additional variables (total landings – all species summed, and fishing days) were considered, either by countries that did not had the previous three variables available, and/or that had already used them to raise discards.

The first step in the process of raising discard data is to raise the discard sampled to trip level (i.e. within a trip) if the numbers of hauls sampled are a fraction of the total of numbers of hauls that occurred in a trip. Furthermore, the number of hauls sampled includes all hauls sampled, i.e. including the hauls that were sampled but where the species analysed was not discarded (inclusion of zero values). The next step is then to calculate an average discard amount per trip and the variance sampled, which will then be raised to population levels. The formulas used are the ones given in the Charlottenlund Workshop Report (ICES, 2004) and Vigneau (2006) considering a simple estimator (raising using number of trips) and a ratio estimator (raising using effort or landings variables).

5.2 Data available

Most countries participating in the meeting made their national data available to the workshop. However, only a subset of the data made available was used in the analysis, since the objective of the analysis was to study a diversity of fleets (not a maximum of fleets), but also due to problems in the analyses and/or data. The workshop used data from 20 metiers ranging from gillnets and trawl, from the Mediterranean to the Baltic (Table 5–1). The data were also considered according to seven major geographical areas, the areas considered by EC (2006b): Arctic (ICES Subareas I and II) and Baltic Sea (Division IIIb-d), North Sea (Division IV, Subdivision IIIa and VIId), North East-Atlantic North (Division V, VI, XII, XIV), North-East Atlantic Centre (Division VII, except VIId), North-East Atlantic South (Division VIII, IX, X, CECAF) and Mediterranean.

Table 5–1–Data made available by country and used in the workshop.

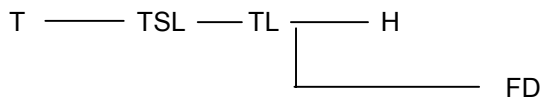
Country	DATA AVAILABLE Fleets/métiers	DATA USED Fleets/métiers	Auxiliary variable
Belgium	1	Beam trawl	total landings, trips, fishing hours
Denmark*	57	Bottom trawl	total landings, target species landings, trips
England	>50	Beam trawl	trips, fishing hours
Estonia			
France	12	Bottom trawl, fixed nets, pelagic trawl	total landings, target species landings, trips, fishing hours
Germany*	9	Beam trawl, fixed nets, pair trawl, pelagic trawl	target species landings, fishing hours
Greece	2	Bottom trawl	total landings, trips
Latvia	1	Fixed nets	target species landings, trips
Lithuania	5	Bottom trawl, fixed nets, pelagic trawl	total landings, trips
Netherlands	2	Beam trawl, pelagic trawl	total landings, trips
Poland	3	Bottom trawl, fixed nets, longline, pelagic trawl	total landings, fishing hours, fishing days
Portugal	2	Bottom trawl	total landing, trips
Scotland	5	Bottom trawl	total landings, trips
Spain	12	Bottom trawl, pair trawl	total landings, target species landings, trips
Sweden	7	Bottom trawl	total landings, target species landings, trips, fishing hours

*** The coefficients of variation were not used in the analysis.**

6 Results

6.1 Comparison between discard estimates

The comparison between the discard raised by different raising procedures shows that all methods give different median values (Figure 6-1). However, the ratio estimator using fishing days as the auxiliary variable clearly overestimate discards when compared to total landings. Nevertheless, these results are only based in three metiers (Figure 6-2). The ratio estimator using fishing hours tends to overestimate discards when compared to all other raising variables, the most significant discrepancy being against total landings. When compared to trips, all raising methods tend to overestimate discards, with highly variable individual results. In summary, there is a general ascending order (from left to right) of overestimating discards of the form:



Considering each gear group, it is clear that fishing day overestimation is obtained for gears (pelagic trawl, longline and fixed nets) that may not have a relationship between discards and this type of fishing effort. The same may be true also in fixed nets where discards are underestimated by fishing hours compared to target species landings, but show no clear tendency with total landings. The differences in discard estimates from bottom trawl seems to follow the general picture given above, while pair trawl and beam trawl discards are clearly overestimated by fishing hours compared to target species landings. Total landings seem to overestimate discard compared to trips in the majority of gears, except for beam trawl (Figure 6-3).

Regarding geographical areas, the general picture given above is respected except in the Baltic Sea where target species landings underestimates discards compared to trips, and in the North Sea where fishing hour overestimates compared to trips. An example of regions that follow the general picture are the North-East Atlantic South where landings variables generally overestimate discards compared to trips, and in the Mediterranean where total landings usually overestimates discards compared to trips (Figure 6-4). Finally, taking into account the years sampled, there is no clear pattern in the differences between estimates of different raising procedures (Figure 6-5).

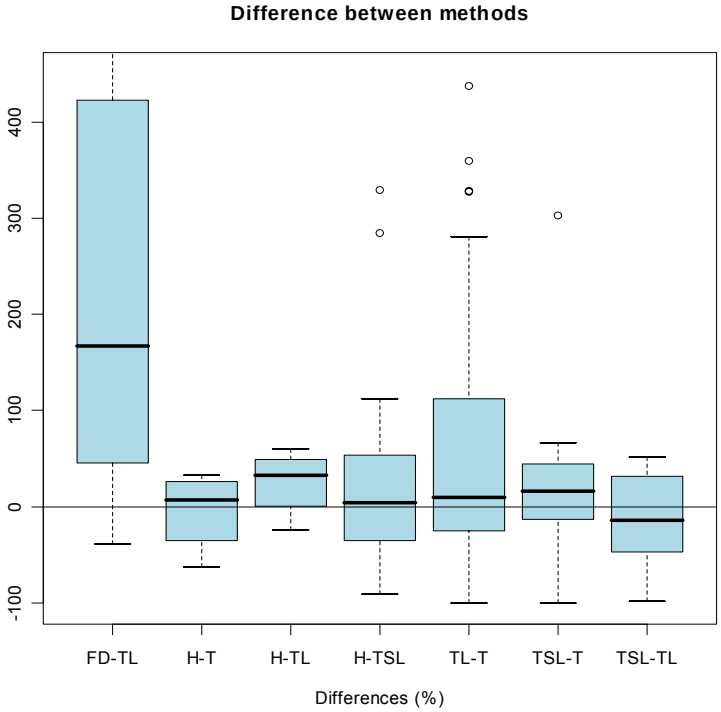


Figure 6-1– Box-plot of the differences of discards estimates between raising procedures relative to the first procedure (e.g. a positive value in TL-T refers to a higher discard estimated by TL compared to T). H–fishing hours, FD–fishing days, TL–total landings, TSL–target species landings and T–trips.

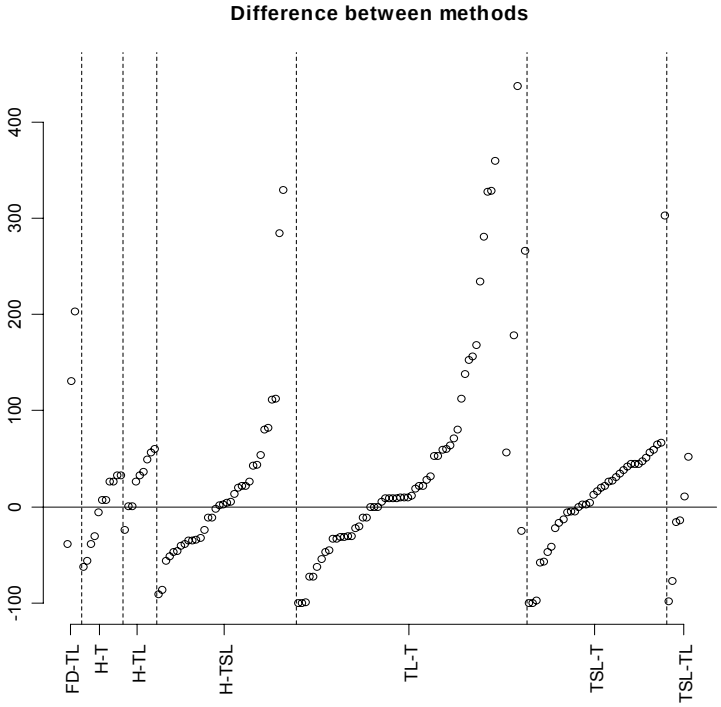


Figure 6-2– Scatterplot of the differences of discards estimates between raising procedures relative to the first procedure (e.g. a positive value in TL-T refers to a higher discard estimated by TL compared to T). H–fishing hours, FD–fishing days, TL–total landings, TSL–target species landings and T–trips.

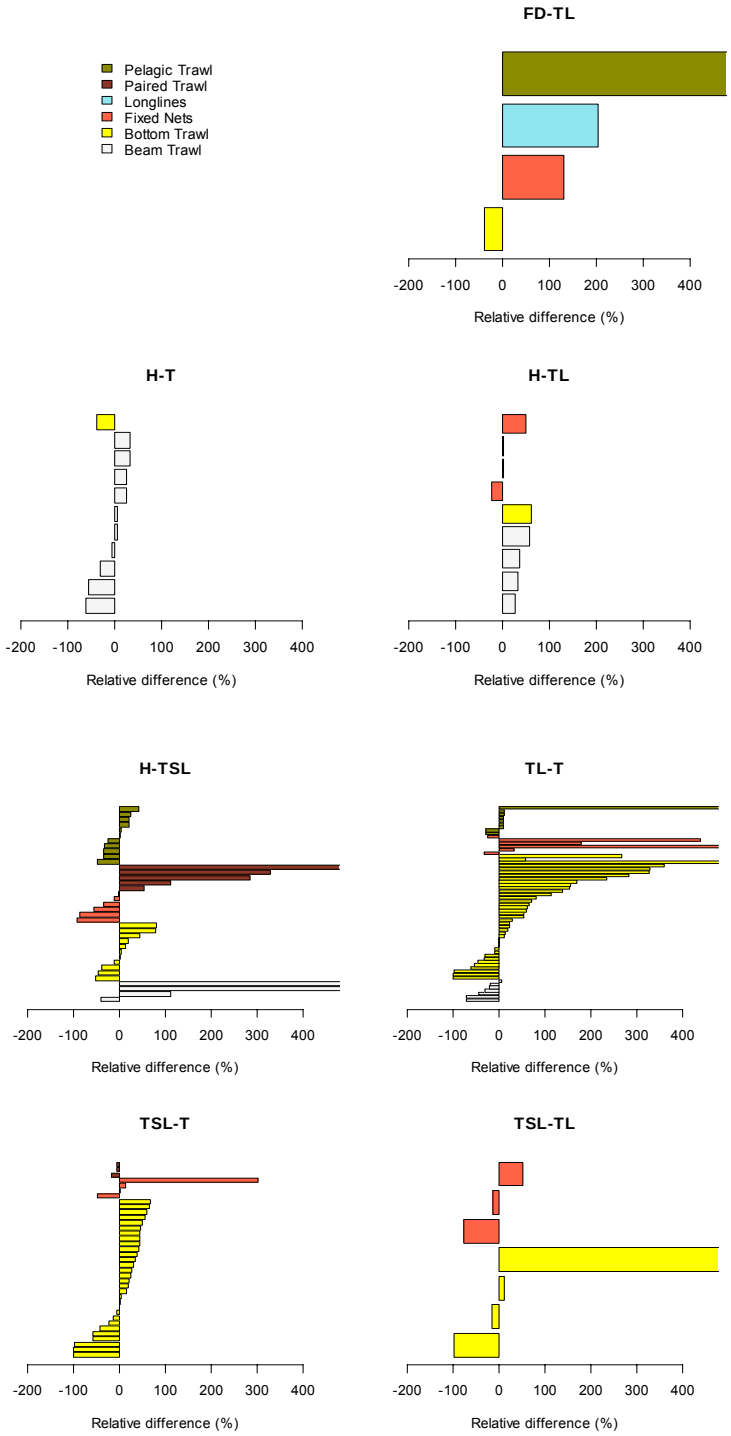


Figure 6-3– Bar-chart of the difference of discards estimates between raising procedures relative to the first procedure by fishing gear group (e.g. a positive value (on the right of y-axis) in TL–T refers to a higher discard estimated by TL compared to T). H–fishing hours, FD–fishing days, TL–total landings, TSL–target species landings and T–trips.

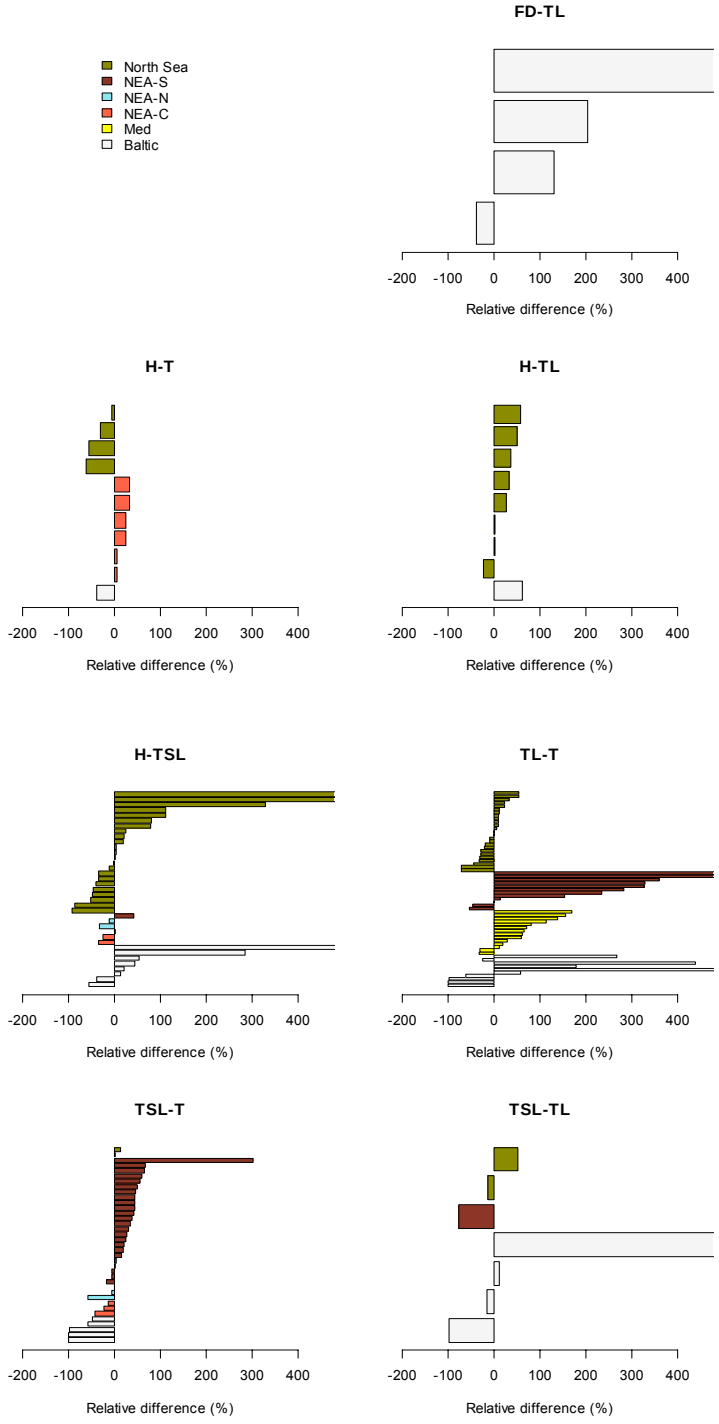


Figure 6-4– Bar-chart of the difference of discards estimates between raising procedures relative to the first procedure by geographical area (e.g. a positive value (on the right of y-axis) in TL-T refers to a higher discard estimated by TL compared to T). H–fishing hours, FD–fishing days, TL–total landings, TSL–target species landings and T–trips.

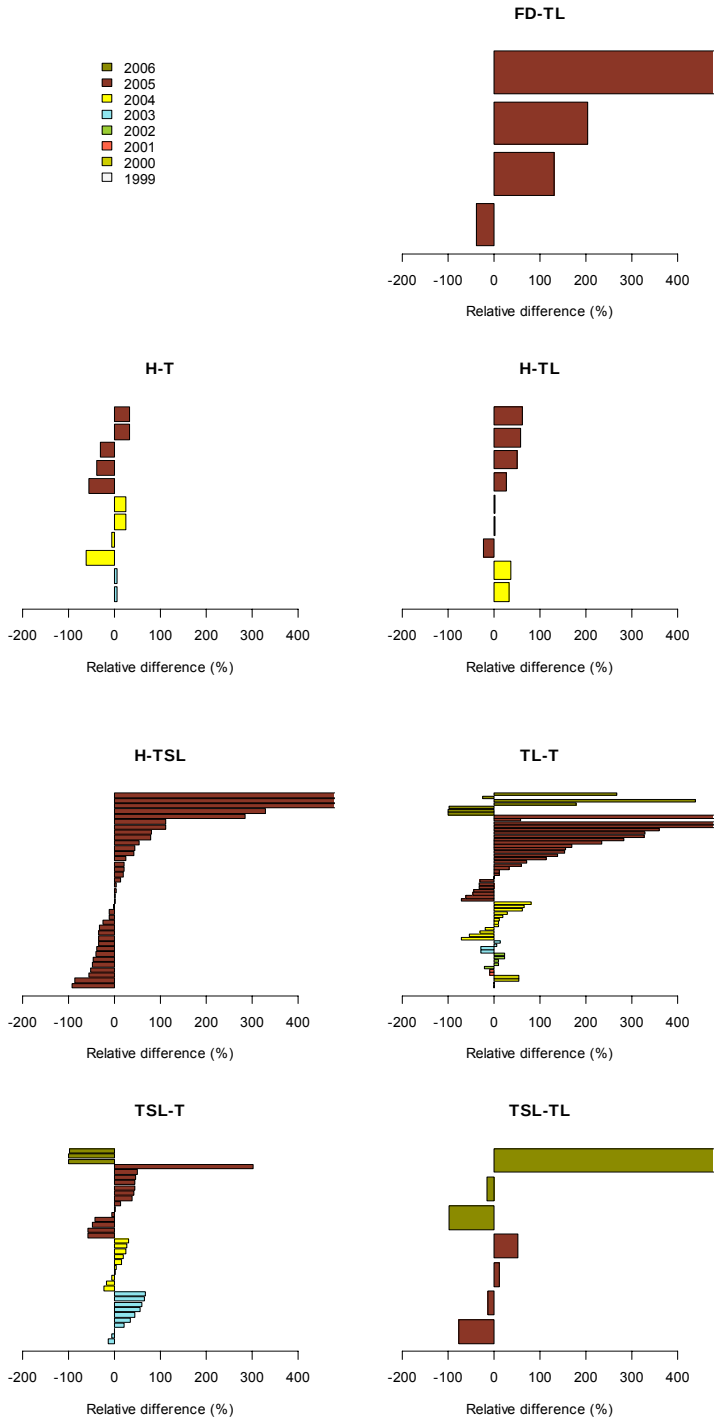
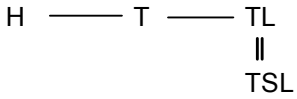


Figure 6-5– Bar-chart of the difference of discards estimates between raising procedures relative to the first procedure by year (e.g. a positive value (on the right of y-axis) in TL-T refers to a higher discard estimated by TL compared to T). H–fishing hours, FD–fishing days, TL–total landings, TSL–target species landings and T–trips.

6.2 Comparison between coefficients of variation

The ratio of the coefficients of variation show that fishing days provides estimates that are more variable than total landings, while the opposite is true for fishing hours against trips and, in some degree with total landings. All other variables combinations do not show a clear pattern, giving equally variable results (Figure 6-6; Figure 6-7). In summary, taking into

account comparisons of methods of more than 4 case studies, the general picture from more precise (left) to less precise (right) is of the form:



Regarding the division of the CV ratios by gear group, the previous mentioned pattern of more precise estimates obtained with fishing hours correspond to beam trawlers. Total landings provide less precise estimates compared to trips in bottom trawl and beam trawl. Paired trawls, although based on very few case studies, shows an inverse pattern than the general picture, i.e. target species landings and total landings are more precise than trips (Figure 6-8). When geographical area is considered, the general picture given above is also shown, and the pattern of total landings being less precise than trips is not as pronounced as the one seen for bottom trawl and beam trawl, except in the North-East Atlantic South (Figure 6-9). Finally, there is no apparent inter annual variation between raising procedures precision (Figure 6-10).

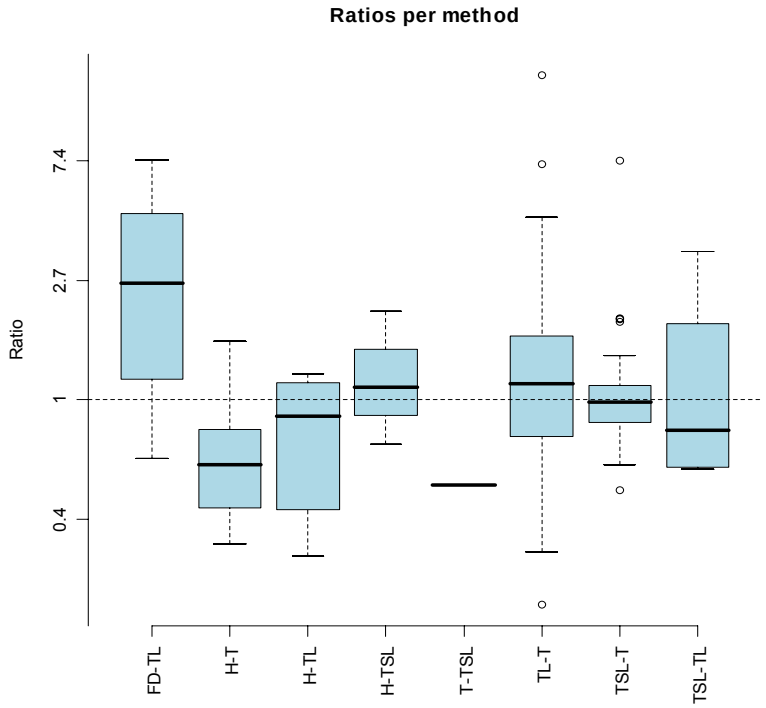


Figure 6-6– Box-plot of the ratio between the coefficients of variation (CV) of the raising procedures (log scale). H–fishing hours, FD–fishing days, TL–total landings, TSL–target species landings and T–trips.

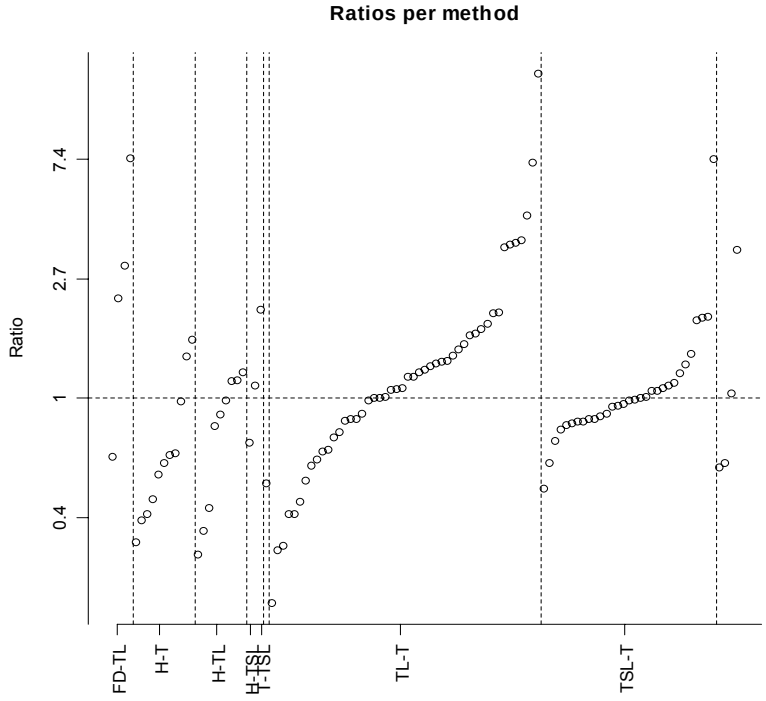


Figure 6-7– Scatterplot of the ratio between the coefficients of variation (CV) of the raising procedures (log scale). H–fishing hours, FD–fishing days, TL–total landings, TSL–target species landings and T–trips.

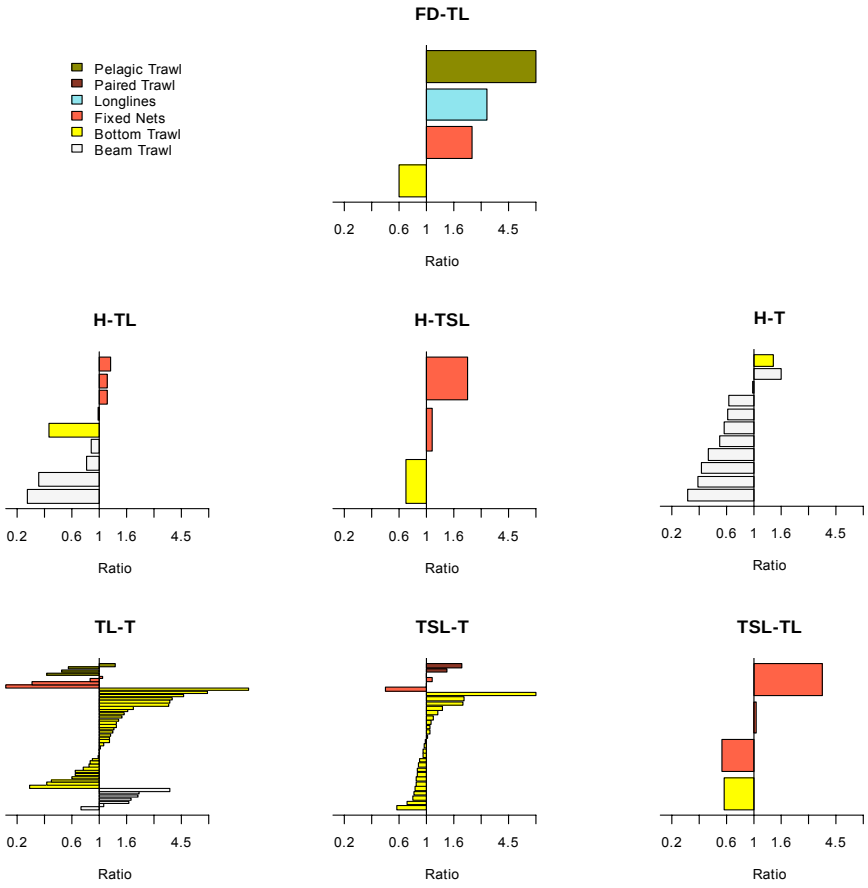


Figure 6-8– Bar-chart of the ratio between the coefficients of variation (CV) of the raising procedures by fishing gear group (log scale). H–fishing hours, FD–fishing days, TL–total landings, TSL–target species landings and T–trips.

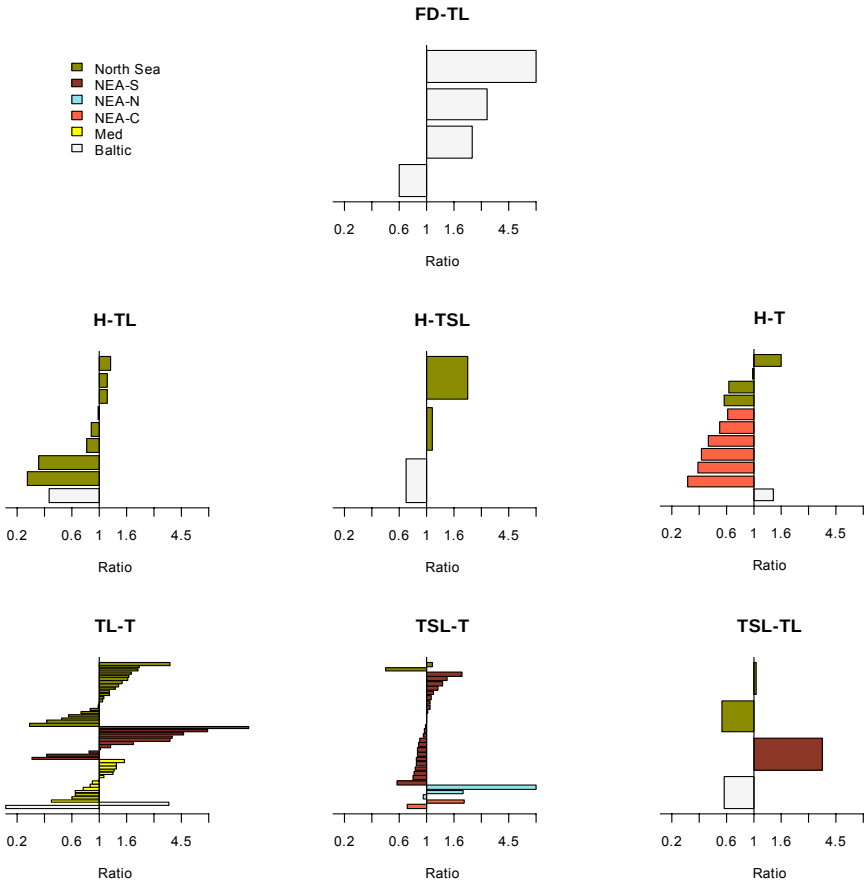


Figure 6-9– Bar-chart of the ratio between the coefficients of variation (CV) of the raising procedures by geographical area (log scale). H–fishing hours, FD–fishing days, TL–total landings, TSL–target species landings and T–trips.

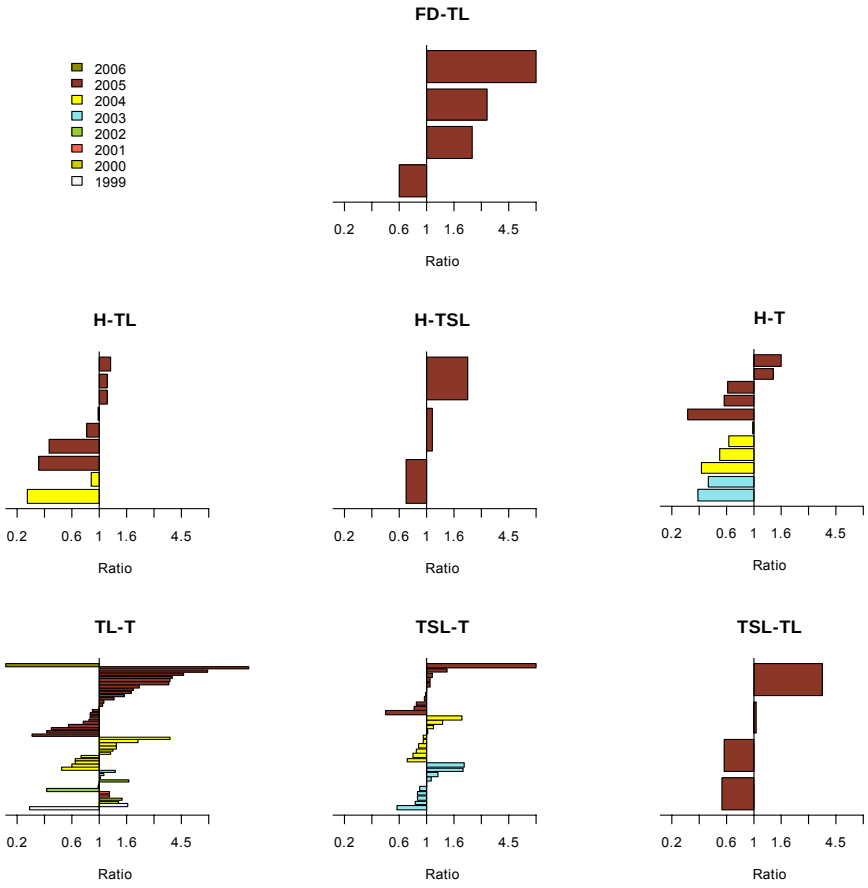


Figure 6-10– Bar-chart of the ratio between the coefficients of variation (CV) of the raising procedures by year (log scale). H–fishing hours, FD–fishing days, TL–total landings, TSL–target species landings and T–trips.

6.3 Comparison between coefficients of variation and correlation of auxiliary variable

The analysis of the correlation between discard and the auxiliary variable used to raise shows an expected result for fishing hours and targeted species landings: the more correlated discards are to the auxiliary variable the more precise is the raised estimate. However, total landings show no relationship between the correlation and the final precision of the estimates (Figure 6-11).

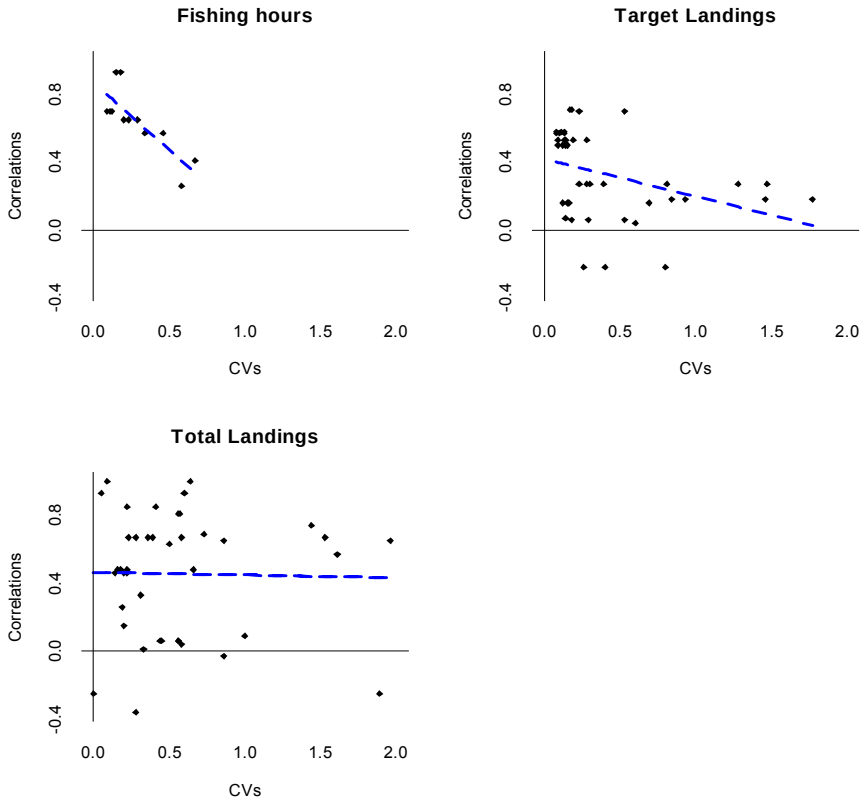


Figure 6-11– Scatterplot of the coefficients of variation (CV) of the raised discard estimates against the corresponding correlation value between discards and auxiliary variable used, by auxiliary variable (fishing hours, total landings and target species landings).

7 Discussion

The appropriate estimator in a given situation depends primarily on the use to be made of the estimate, either to include in the catch estimates for **stock assessment** purposes, to understand the causes of discarding, or for example to implement an ecosystem approach to fisheries management. In the DRC framework the estimates are ultimately to be used in stock assessment, and in this perspective an estimator that is consistent, although not necessarily the most precise, gives the best estimates. By consistency it is referred to both between strata and countries. However, the best raising procedure(s) should be used to provide national discard estimates, regardless of the issue of maintaining consistency. If, in the future, something changes (such as introduction of a new catch limit) that makes the chosen raising procedure inappropriate (see below for more details), then there is two possibilities to estimate national discards. The first one refers to a situation where several methods can be used to raise the data. In this case the group recommends the recalculation with a different suitable procedure of the whole discard time-series for consistency purpose, since different procedures give different estimates. However, if there is only one method available to raise discards but it is no longer applicable, then the raising of the time-series of discards should be made with two methods (each one suitable to a different part of the discard time-series). It is the group's opinion that the implications of these changes in raising procedures (and resulting differences in discards estimates) in a discard time-series should be discussed at the stock assessment working groups.

The discussion of discard raising procedures cannot be unlinked from the discussion between **bias and precision**. It is the group opinion that the least biased raising procedure should be the one used for estimating discards, even if it implies an increase in variability of the final estimate. By definition, a simple mean estimator is unbiased if the samples come from a random sampling programme (Cochran, 1963). However, as described previously in Section 4 (concerns) discards programme may not be random, and a biased sampling programme will lead to a biased estimate when a simple mean is used (raising by trips). Nevertheless, ratio estimators are biased in the order of 1/n (Cochran, 1963), where n is the number of samples (usually considered to be the number of trips sampled). This bias is negligible when sample size is large (larger than 30 to 50 samples), a level of sampling rarely reached by a DCR discard programme. However, the ratio estimator is unbiased if the regression of discards and the auxiliary variable used is a straight line trough the origin. In this case, the ratio estimator is better than the mean estimator because it is less sensitive to non-random sampling schemes. Yet, the majority of the regressions studied in the workshop do not go trough the origin (Annex 3–exploratory analysis). Another aspect is that small sample sizes of highly heterogenic data may produce unrealistic optimistic results regarding precision, simply because of the probability of sampling "normal" behaviour is high, and therefore a small sample would probably include only the "normal" behaviour.

It is the group's opinion that there is a systematic method to assess, compare and finally choose a procedure to raise discards. This procedure is compiled below as a key, where there are two major issues/characteristics (representativeness and quality, questions 1 and 2, respectively) that have to be assessed, followed by a subset of decisions that lead to a final choice of procedure (Table 7-1).

Table 7-1– The Raising Procedure Key–process of choosing a method/auxiliary variable to raise sample discards to population level. It also provides guidance of what to do when there are several suitable procedures and when there is no appropriate procedure.

Raising Procedure Key

1. Is the sampling **representative** (mean length of vessels and mean auxiliary variable sampled compared to the population, see section 4)?

Yes	Raise by trips and go to 2
No	DON'T raise by trips and go to 2

2. Has the **quality** of the data used for raising been established (no misreporting and availability, see section 4)?

Yes	Go to 3
No	Go to 6

3. Are the discard and auxiliary variable linearly related (significant relationship and positive slope)?

Yes	Raise by all variables and go to 4
No	Go to 6

4. Compare the results of the different raising procedures:

Similar (<10-20% difference)	Go to 5
Dissimilar (>10-20% difference)	Go to 1*

   *and find the cause of the difference!

5. Choose a method that is the least biased (trips if applicable, ratio if regression passes trough origin or variable with less concerns) and most precise (compare CV's).

6. When there is no suitable raising procedure then identify the problem, identify the population sampled (different stratification/sampling?) and start again!

   Go to 1

The Raising Procedure Key may result in several methods being suitable to raise discards (Option 5). In this case the discard estimates of the different procedures should be compared and assessed based on the bias of the estimates (choose the simple mean estimator–trips–if applicable, ratio estimator if regression passes trough the origin); by the precision of the estimates (choose the one with the smaller CV); based on the practical knowledge of the fishery, the sampling programme and the data (see Section 4 concerns); or simply by being the easiest to calculate. Conversely, if the selected raising procedures give very different results (Option 4), this might indicate that the sampling is not representative (see further below for some examples) or that the data are not qualitative. The latter might, for example, occur when one of the auxiliary variables was (unforeseeable) misreported (at the population level). In the case of Option 5, the raising procedure key should be followed again in order to pinpoint the unforeseen problem with the data or sampling and finally choose the appropriate raising method. Finally, if at the end of the key there is no suitable method (Point 6), the discard data sampled cannot be raised to population levels. However, the data should not be simply dismissed. Apart from providing qualitatively and quantitatively information regarding discards of the fleet sampled, it also provides vital information in order to improve the sampling programme. Namely, it may give evidence for a different stratification, or might simply show that the fleet sampled is only a fraction of the population (and in this case the

raising procedures key may be used gain, now considering a subpopulation of the original population).

If the discard sampling effort is biased, i.e. if it is not **representative** of the fishery activity that is targeting, then the estimated discards raised using number of fishing trips will be over or underestimated. If the fishing trips sampled are considerably longer than the fishing trips of the targeted fishery, and therefore the average discards per trip sampled are probably much higher than the average discard per trip in the fishery, then the discards raised using the total number of trips of the fishery are overestimated. If on the other hand the fishing trips sampled are considerably shorter than the targeted fishery trips, then the final estimated discards are underestimated. In a European reality, where discard sampling effort is small, the existence (or not) of proportionality between sampling and population fishery is an extremely important factor to be considered when choosing a raising method. Furthermore, ratio estimators will only provide meaningful discard estimates if the auxiliary variables used are linearly related to the amounts discarded. In pelagic fisheries and fixed nets, there is no relationship between effort variables and discards, and therefore if the sampling effort is biased, only landings variables are available to raise discards. Of these, only total landings (all species summed) is a good candidate to raise discards since the normal discard behaviour in most pelagic fishery (where the catch diversity is limited in terms of species and sizes) is to discard the species not targeted.

The group reiterates the fact that it is fundamental to apply different methods to raise discards and **compare** the results. The practical experience of the workshop is that comparing results from different methods may provide information about the data and the sampling scheme of aspects not previously known. Furthermore, when results from two or more methods differ strongly, it is a warning that something is wrong, either with the data, the sampling or the raising procedure (including raising variable issues). Additionally, as shown in the results of this workshop, particular methods under- or overestimate discard estimates systematically. This will in turn have implications when pooling data, for example for stock assessment purposes. Finally, the group was not able to determine if all raising procedures react in the same way to the same problem (for example in case of extreme behaviours). It is probable that different methods react differently and therefore might produce dissimilar results. Therefore it is the group's opinion that different methods should be applied and assessed every time a new discard estimate is produced (namely in each new year).

Finally, it is the group's opinion that the raising procedure used should be a **simple** one, so it can be applied, understood and tested by anyone, particularly in view of countries where there might be limited experience in discard sampling programmes and data. However, this does not preclude modelling options that can be available in the future to raise discards, and particularly since modelling can be extremely useful for fisheries with extreme discard behaviours (see Sub-section 4.7).

8 Conclusions

i) Do **exploratory analysis** of the sampled data before the start of the analysis, to check for mistakes and extreme discard behaviours.

ii) Check if the fishing trips sampled are **representative** of the fishing fleet, by comparing the mean length of the vessels sampled and the average of the auxiliary variable per trip against the same parameters at population level.

iii) Follow the **Raising Procedure Key** to choose a raising procedure specific to your data.

iv) Try **different procedures** (simple, ratio or models) when raising discards.

v) **Compare** the results between **procedures**.

vi) When **pooling discard data** from different raising procedures, take into account that different procedures give different results, and specifically that fishing hours will probably overestimate discards compared to total landings.

vii) Do **not apply the wrong method** to raise discards!

viii) **Unbiased** result/procedure is preferable than a precise one.

ix) In the future if information regarding hauls is available at population level, then a **second-stage estimator** should be used**.**

x) More investigation is needed for a better use of fishing days as a raising variable (e.g. ratio-to-size estimate) in the multistage sampling of discards.

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Annex 2: Appendices to the Exchange discard data format

Appendix I–Country codes

CODE	COUNTRY	CODE	COUNTRY
BE	Belgium	LV	Latvia
CY	Cyprus	LT	Lithuania
DK	Denmark	MT	Malta
DE	Germany	NL	Netherlands
EE	Estonia	PL	Poland
EL	Greece	PT	Portugal
ES	Spain	RU	Russia
FR	France	SI	Slovenia
IE	Ireland	FI	Finland
IL	Iceland	SC	Scotland
IT	Italy	SE	Sweden
		UK	United Kingdom

Reference: EU countries: Codification Standards and definition of Standard Outputs for EC 1639/2001 data.

Appendix II–Season codes

SEASON	CODE
Month	M
Quarter	Q
Year	Y

Appendix III–Area codes

AREA	CODE
Division (ICES)	DI
Sub-division (ICES)	SD
Sub-area (GFCM)	SA
Sub-area (FAO)	SF

Appendix IV–Origin of discard sampled data

ORIGIN	CODE
Observer sampling scheme	1
Self sampling	2

Appendix V–Raising procedure used

RAISING PROCEDURE		CODE
By Effort	Number of trips	E1
	Number of hauls	E2
	Number of days at sea	E3
	Fishing days	E4
	Fishing hours/soaking time	E5
	KWatt *days	E6
	KWatt *hours	E7
By Landings	All species	L1
	Target species	L2

Appendix VI–Fishing activity codes

The codes are constructed as (depending of level) a combination of one or more of the following parameters:

1) Gear
2) target species group and
3) minimum allowed mesh size according to regulation at any time
4) Indicating of selection device
5) Mesh size in selection device

Each parameter is separated with "_" (Underscore).

Codes for gear follows FAO gear codes.

Code for target species group are as follows:

TARGET SPECIES GROUP	CODE
Molluscs	MOL
Crustaceans	CRU
Demersal fish	DEF
Mixed crustaceans and demersal fish	MCD
Small pelagic fish	SPF
Deep-water species	DWS
Mixed demersal fish and deep water species	MDD
Finfish	FIF
Cephalopods	CPH
Large pelagic fish	LPF
Catadromous species	CAT
Glass eel	GLE

Code for mesh size is the minimum allowable according to EU technical regulations at the time of sampling.

Indication of selection device is: Not present = "0", Exit window ="1", Grid ="2".

Code for mesh size in selection device is according to EU technical regulations at the time of sampling.

Examples:

LEVEL 4 : OTB	(BOTTOM OTTER TRAWL)
Level 5 : OTB_DEF	(Bottom otter trawl targeting Demersal Fish)
Level 6 : OTB_DEF_110_1_120	(Bottom otter trawl having a minimum mesh size in codend of 110 mm targeting Demersal Fish mounted with exit window having a mesh size of 120 mm)

Appendix VII–Definition of link between DCR Matrix level used and National stratification of lower stratification level

If a national stratification on a lower level than the regional level in the DCR Matrix (or the one requested) is used it is necessary to indicate:

1) To which Fishery Activity does the national stratification refer?
2) What fraction of the raising factor used (landings or effort measure) can be accounted to the national stratification?

The parameter must be given in code:

Fraction_Fishing Activity (regional level in the DCR Matrix)

Example: 0.34_OTB_DEF

Apendix VIII–Alternative effort measures

If alternative effort measures (E.g. number of hooks, number of nets, meters of gillnet, etc.) are used these can be reported as alternative measures. Alternative effort measure is offered as additional measures. If standard effort measures are available these must be reported too.

Annex 3: Exploratory analysis

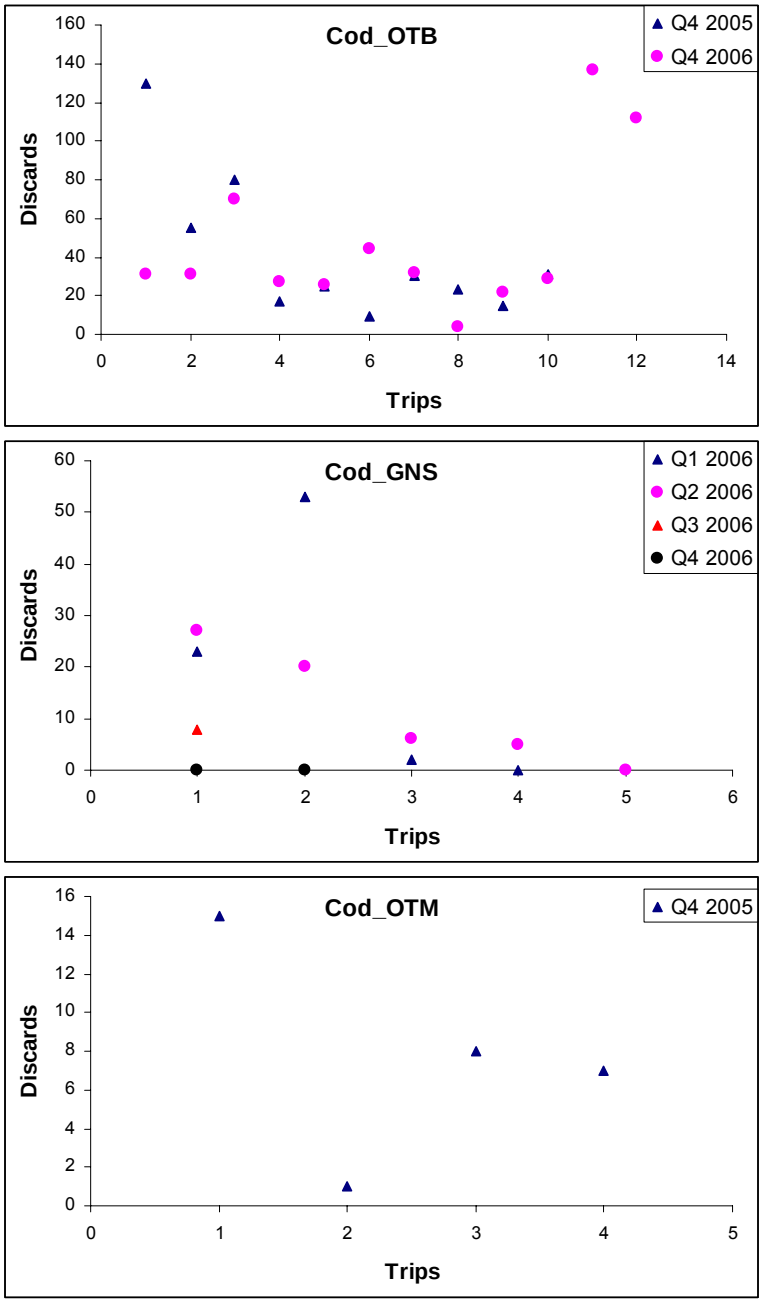


Figure XII– Scatterplot of cod and flounder discards per trip, quarter and year of a trawl (OTB), pelagic trawl (OTM) and gillnet (GNS) fleets in the Baltic Sea.

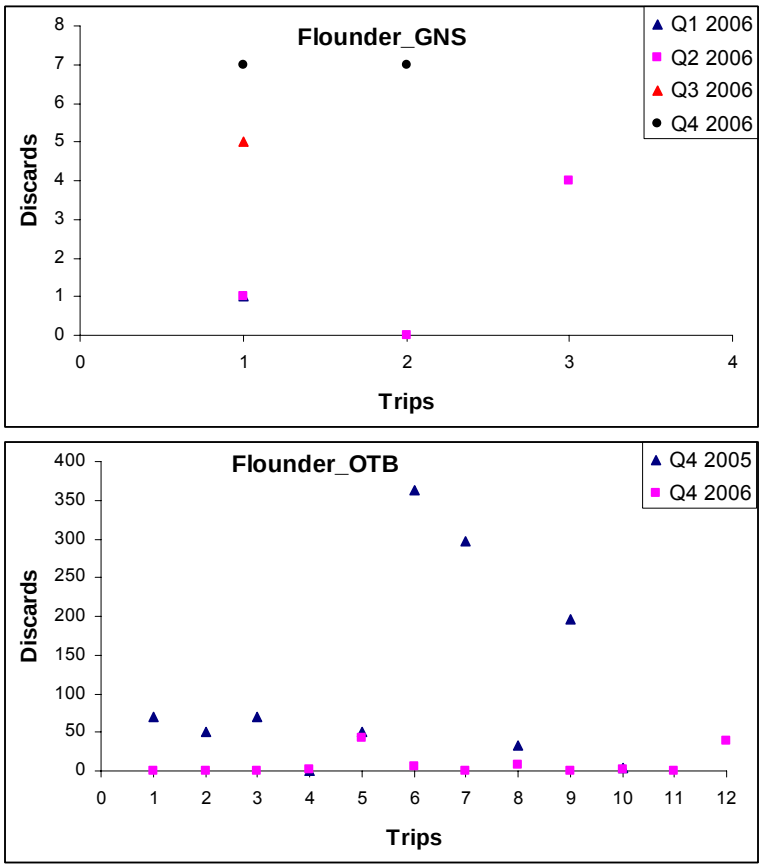


Figure I cont– Scatterplot of cod and flounder discards per trip, quarter and year of a trawl (OTB), pelagic trawl (OTM) and gillnet (GNS) fleets in the Baltic Sea.

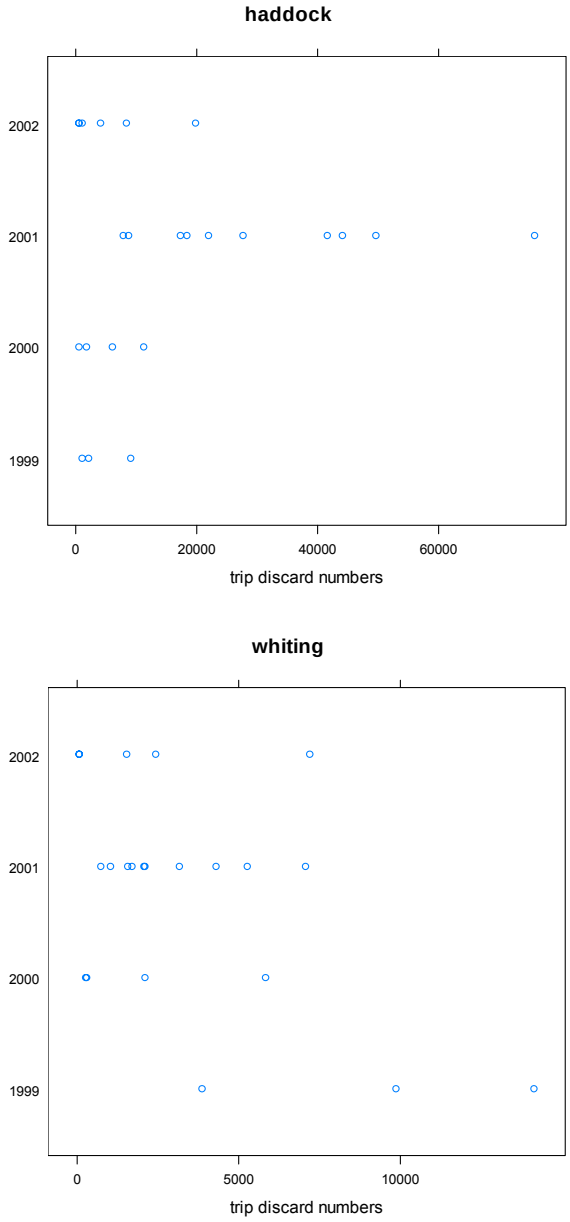


Figure XIII– Scatterplot of haddock and whiting discards per trip and year of a trawl fleet in the North Sea.

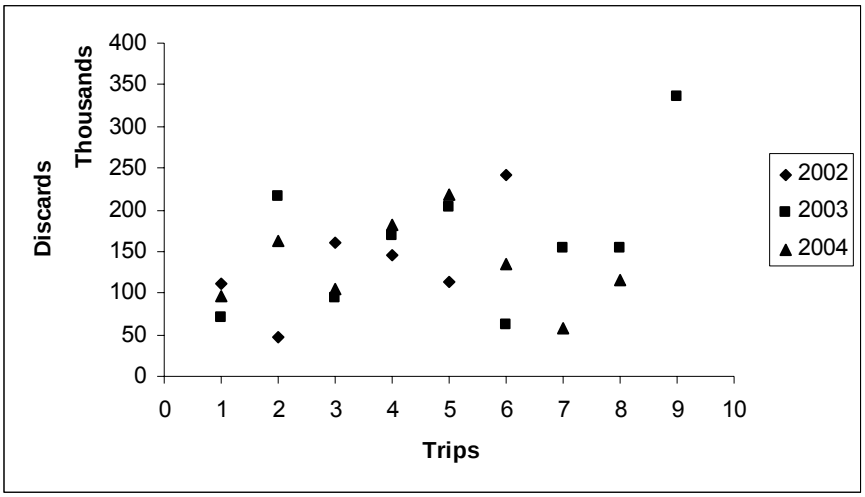


Figure XIV– Scatterplot of total discards per trip and year of a beam trawl fleet in the North Sea.

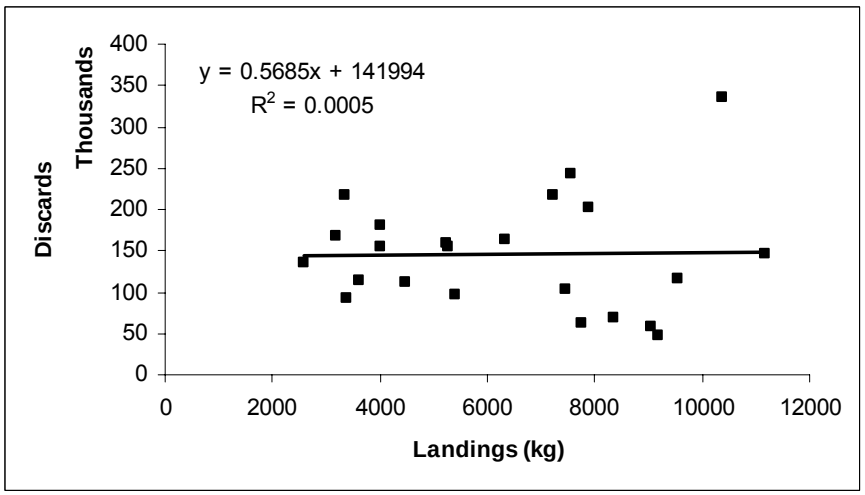


Figure XV– Scatterplot of the total discards vs. landings by trip of a beam trawl fleet in the North Sea; and linear relationships fitted without intercept.

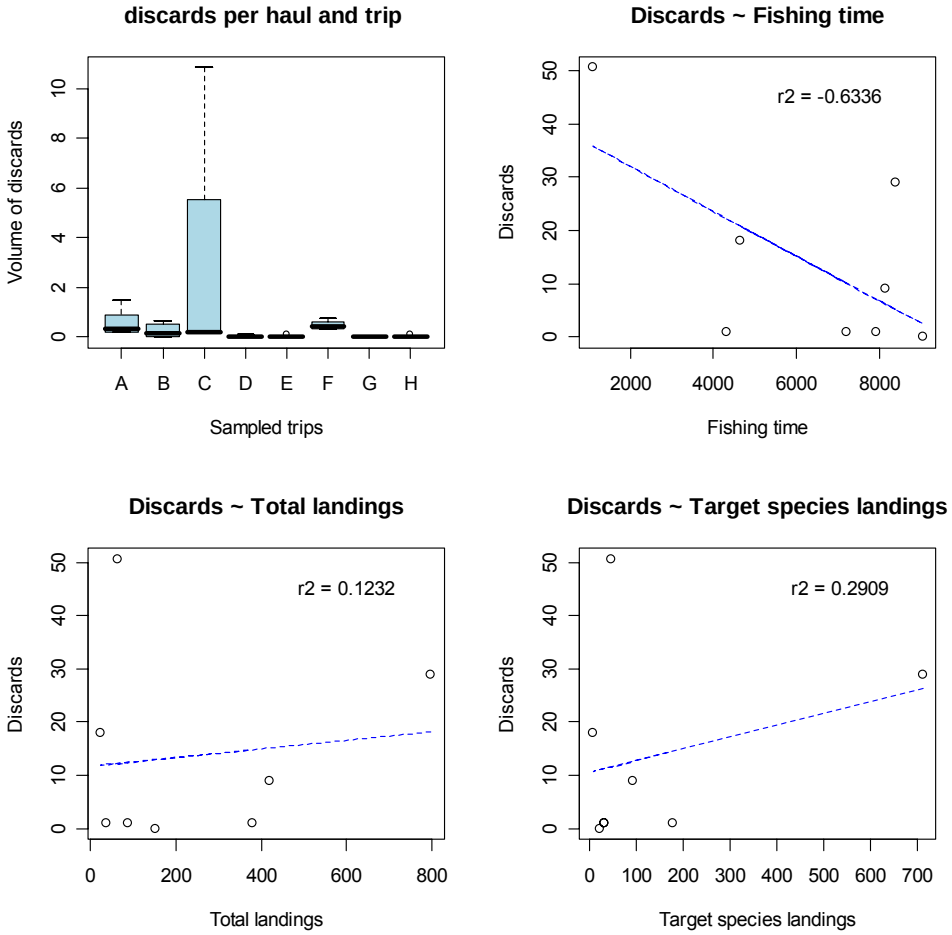


Figure XVI– Scatterplot of sole discards by gillnetters targeting sole in the Southern North Sea; and linear relationships fitted by auxiliary variable.

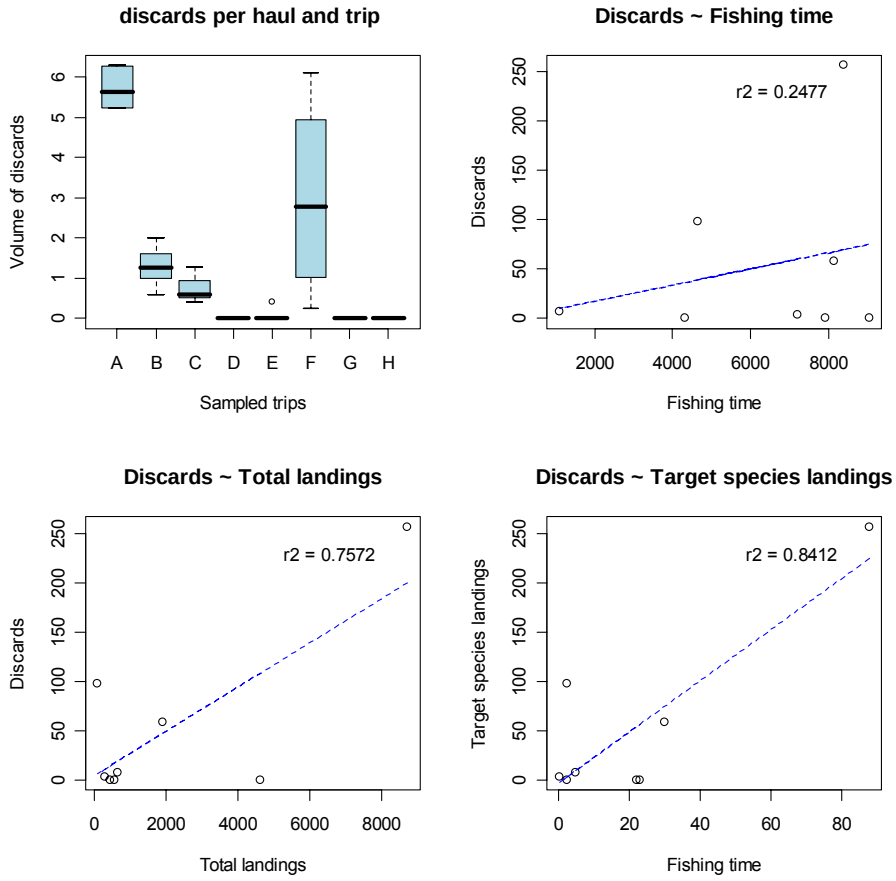


Figure V cont– Scatterplot of plaice discards by gillnetters targeting sole in the Southern North Sea; and linear relationships fitted by auxiliary variable.

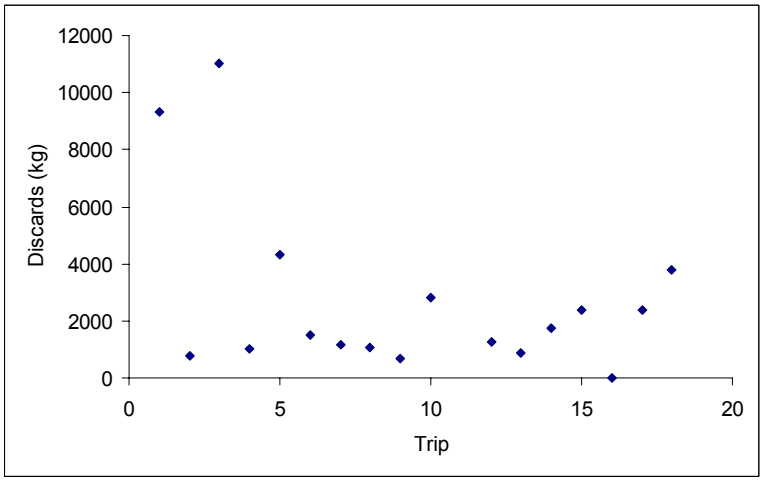


Figure XVII– Scatterplot of total discards by a beam trawl fleet in the Southern North Sea.

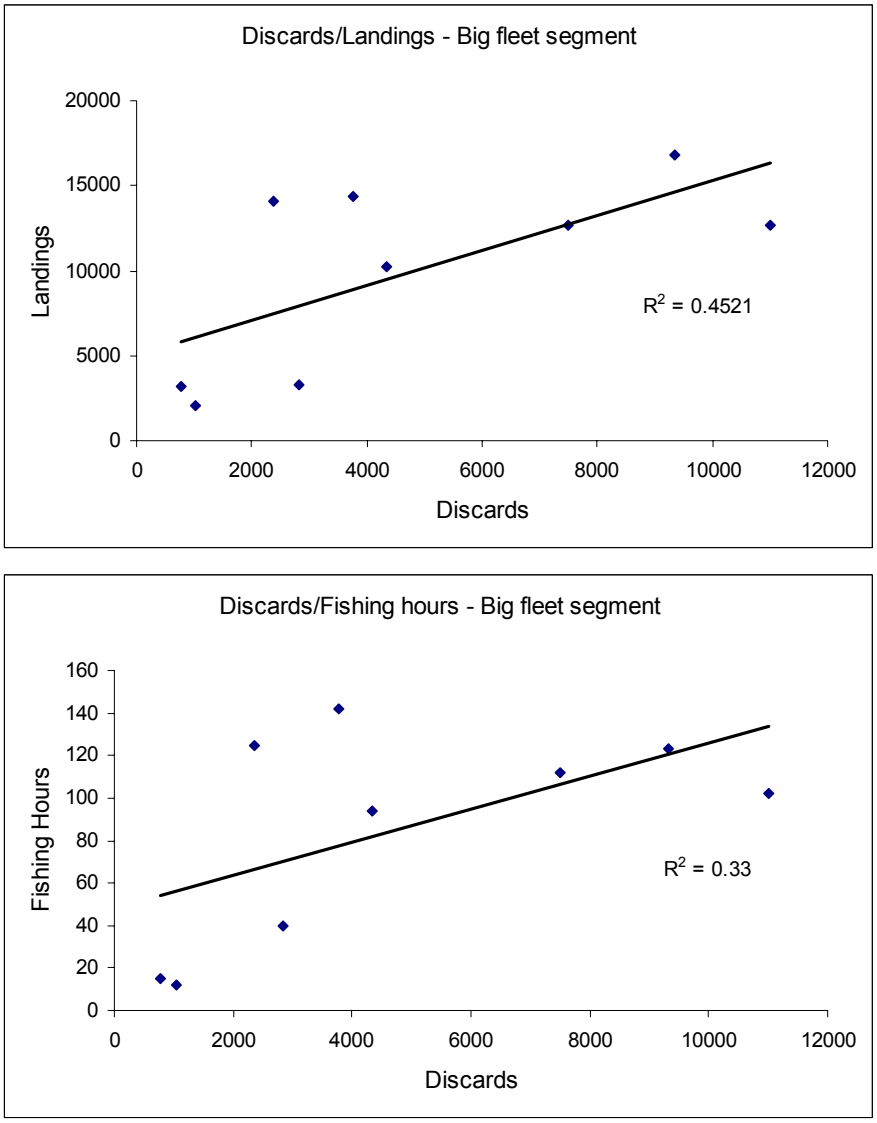
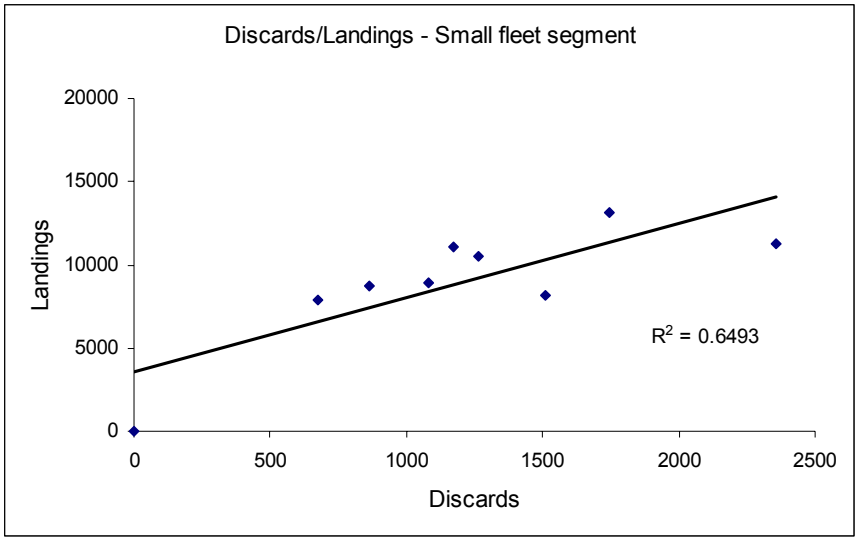


Figure XVIII– Scatterplot of the total discards vs. landings and fishing hours by trip of two beam trawl fleets in the Southern North Sea; and linear relationship fitted.



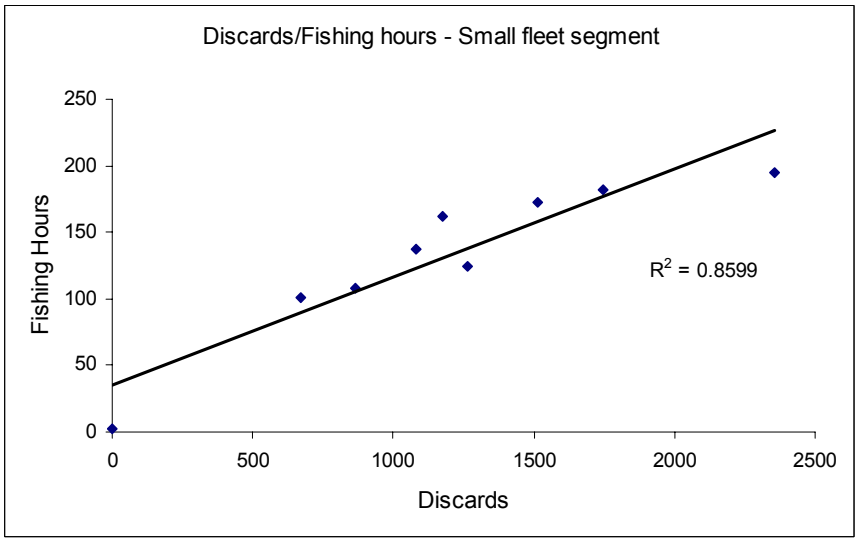


Figure VII cont.– Scatterplot of the total discards vs. landings and fishing hours by trip of two beam trawl fleets in the Southern North Sea; and linear relationship fitted.

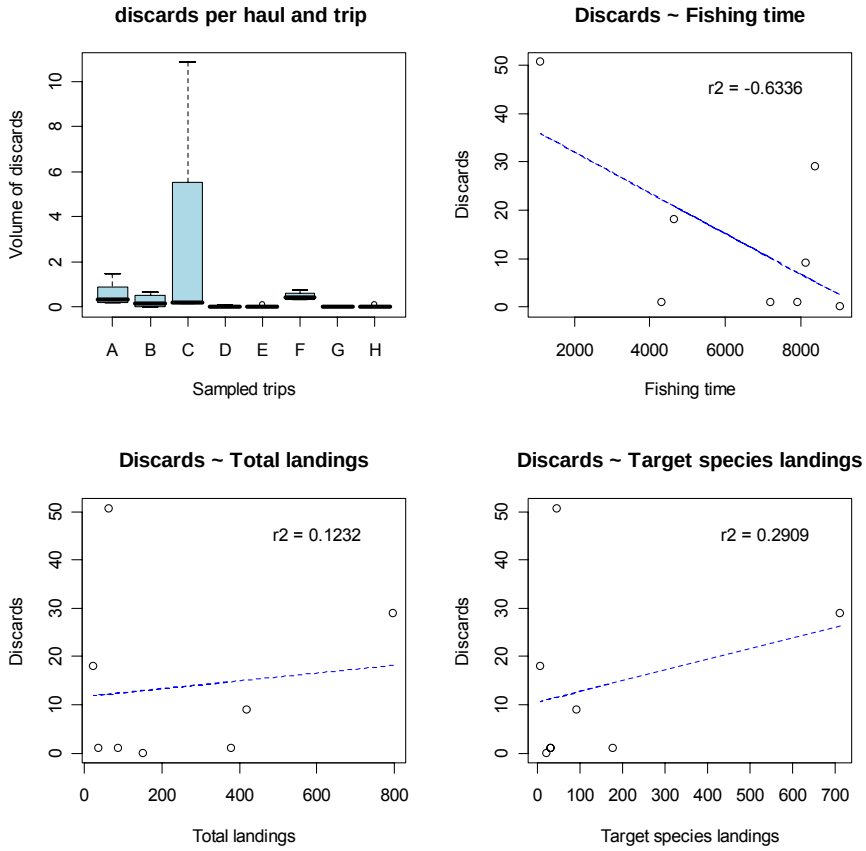


Figure XIX– Scatterplot of sole discards by gillnetters targeting sole in the North East Atlantic–Central; and linear relationships fitted by auxiliary variable.

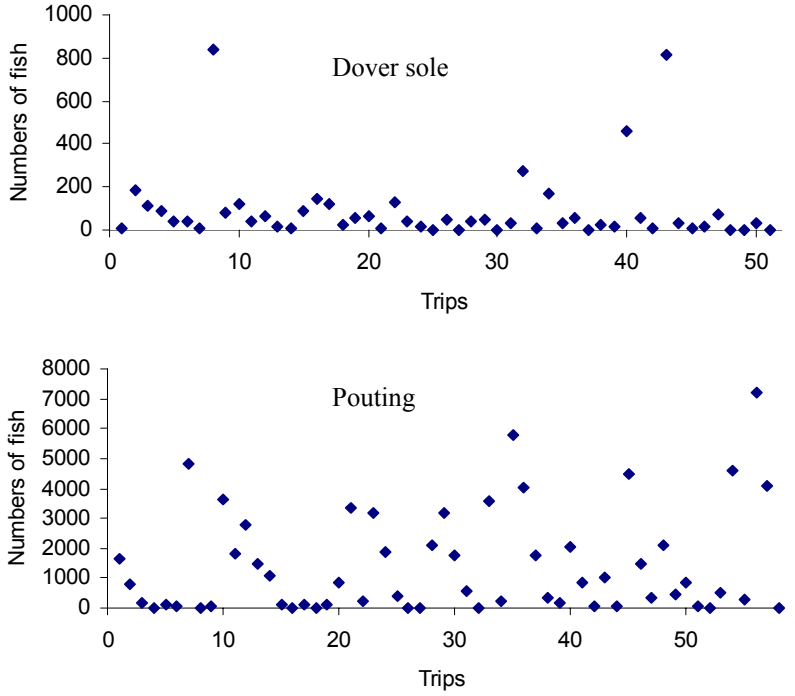


Figure XX– Scatterplot of Dover sole and pouting discards by a beam trawl fleet in the North East Atlantic–Central.

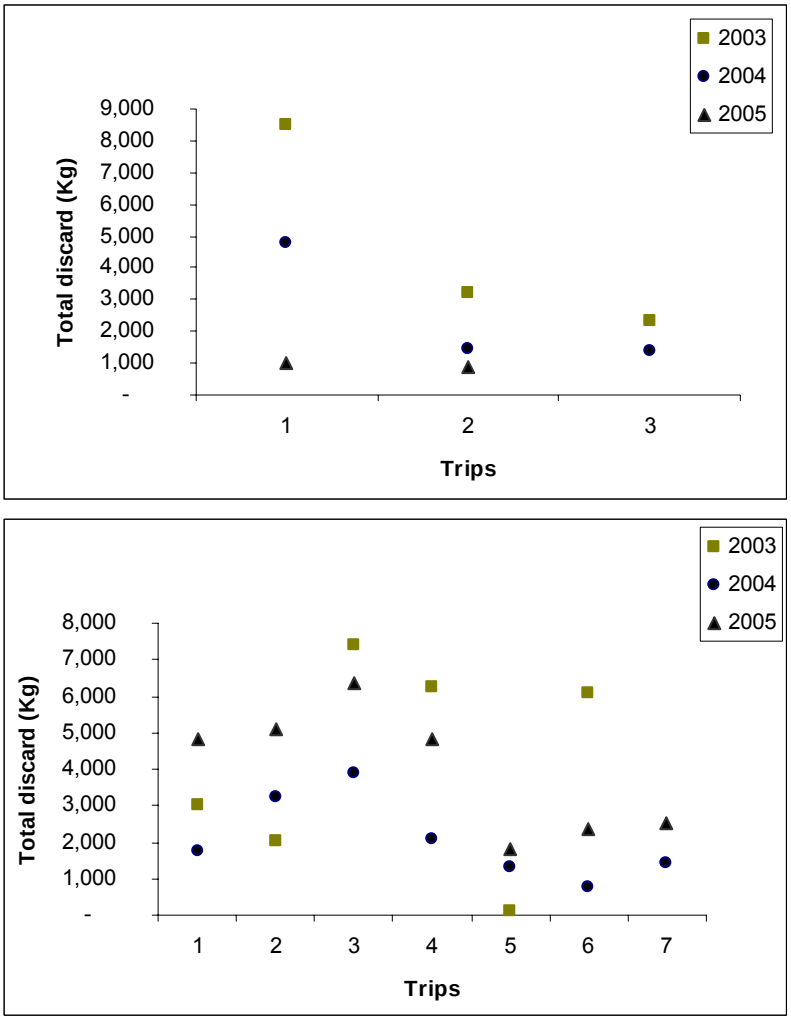


Figure XXI– Scatterplot of total discards by two trawl fleets (single - up and pair trawl–down) in the North East Atlantic–Central.

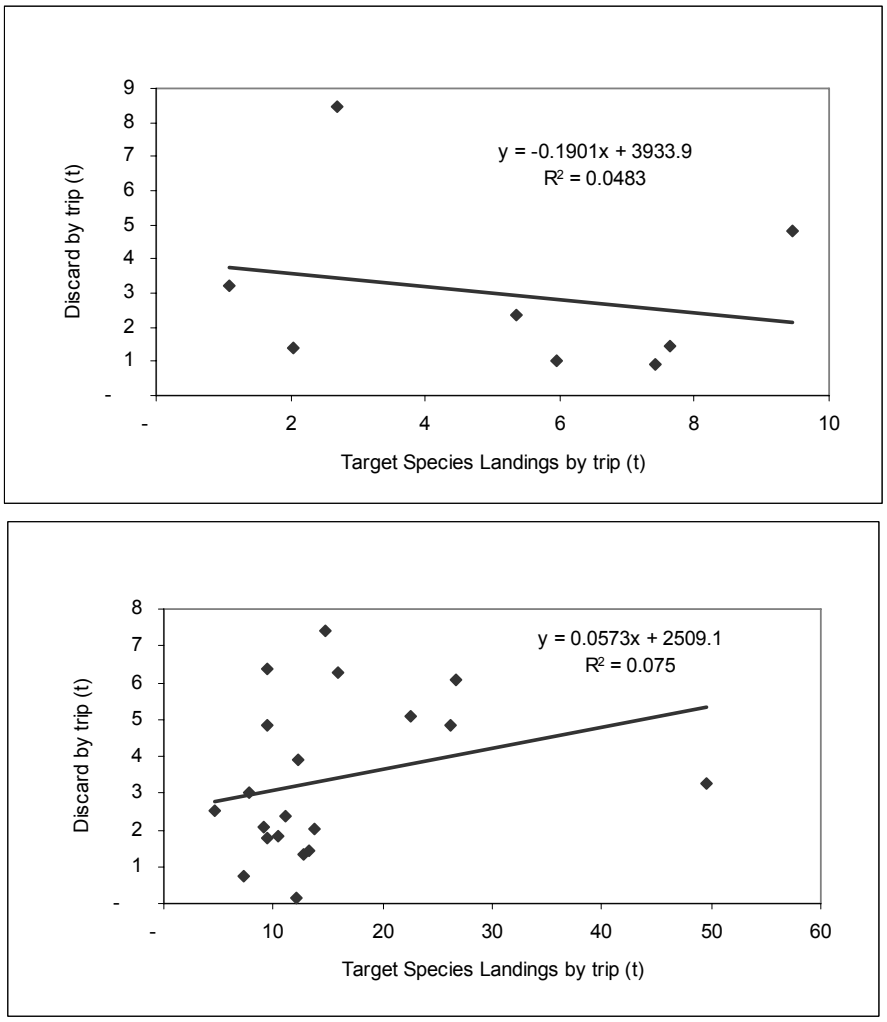


Figure XXII– Scatterplot of the total discards vs. landings by trip of two trawl fleets (single–up and pair trawl–down) in the North East Atlantic–Central; and linear relationship fitted.

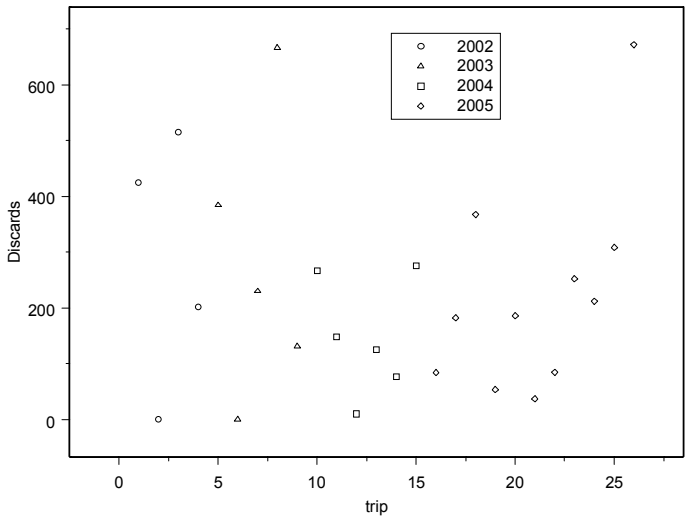


Figure XXIII– Scatterplot of the total discards per trip and year of a pelagic trawl fleet in the North East Atlantic.

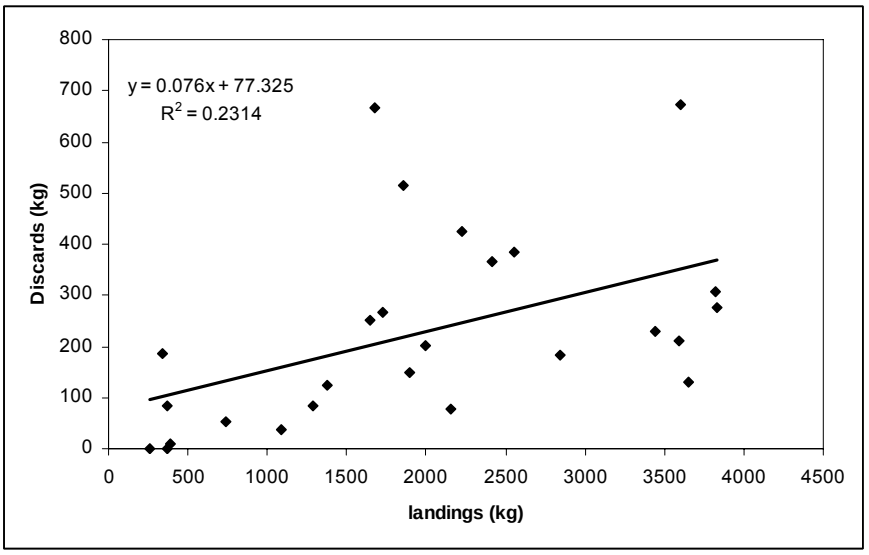


Figure XXIV– Scatterplot of the total discards vs. landings by trip of a pelagic trawl fleet in the North East Atlantic; and linear relationship fitted.

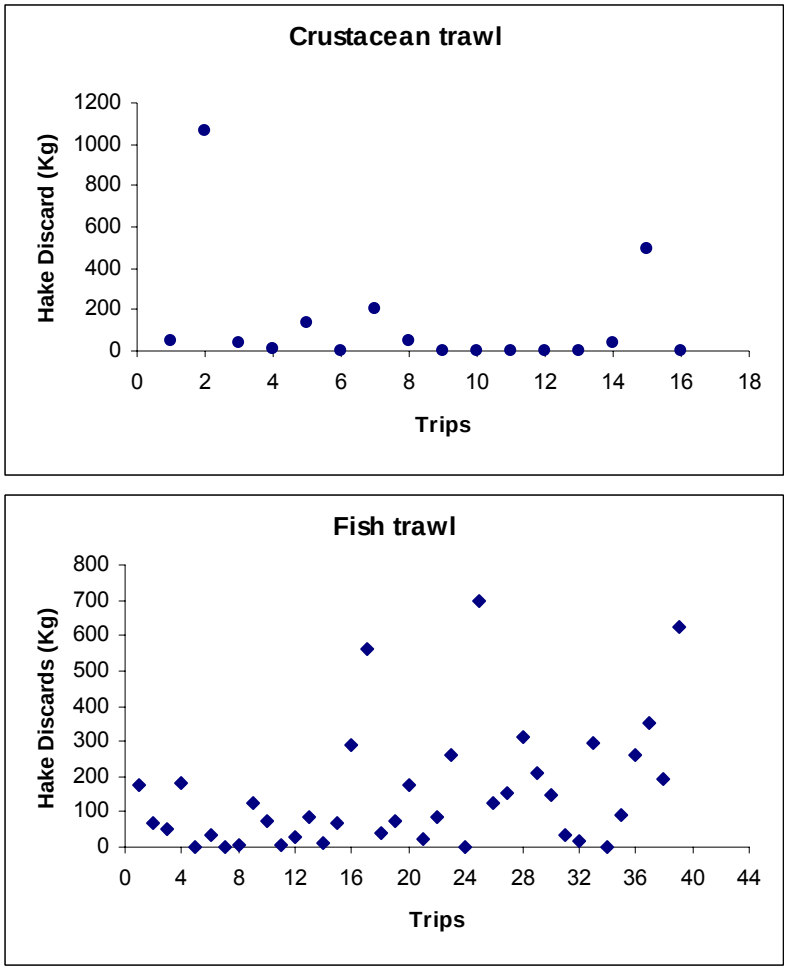


Figure XXV– Scatterplot of hake discards per trip of two trawl fleets in the North East Atlantic–Southern.

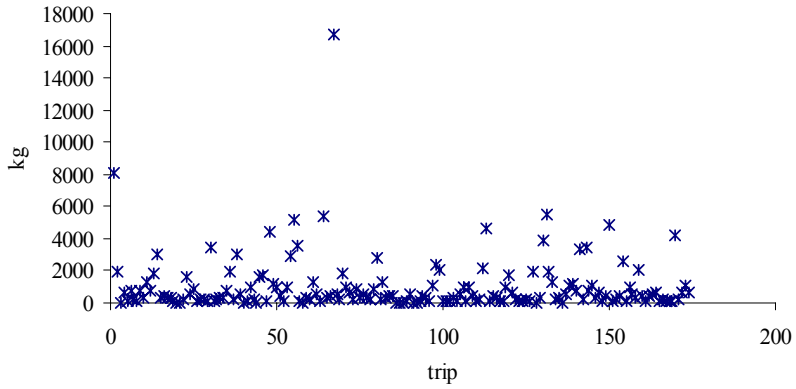


Figure XXVI Scatterplot of total discards per trip of a trawl fleet in the North East Atlantic–Southern.

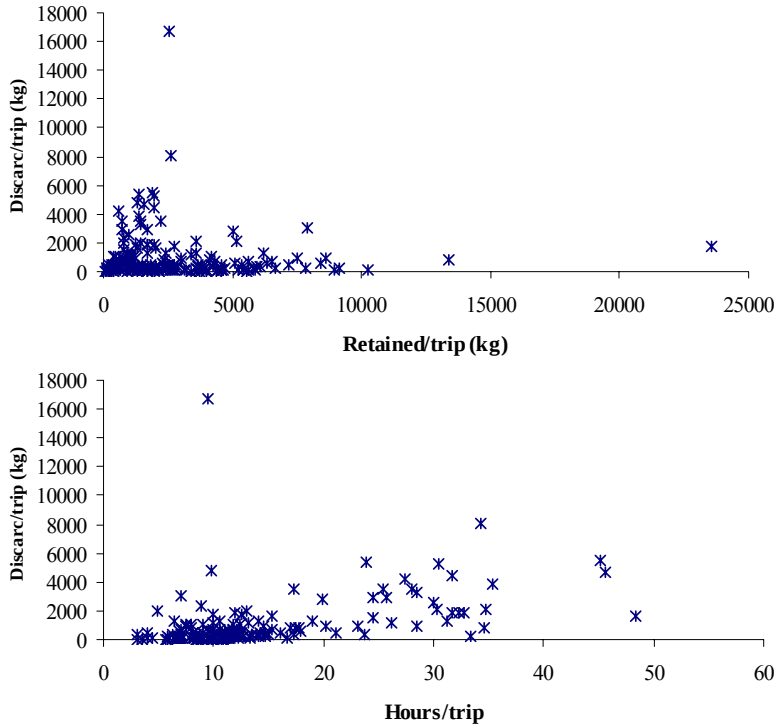


Figure XXVII– Scatterplot of total discards vs. landings and fishing hours by trip of a trawl fleet in the North East Atlantic–Southern.

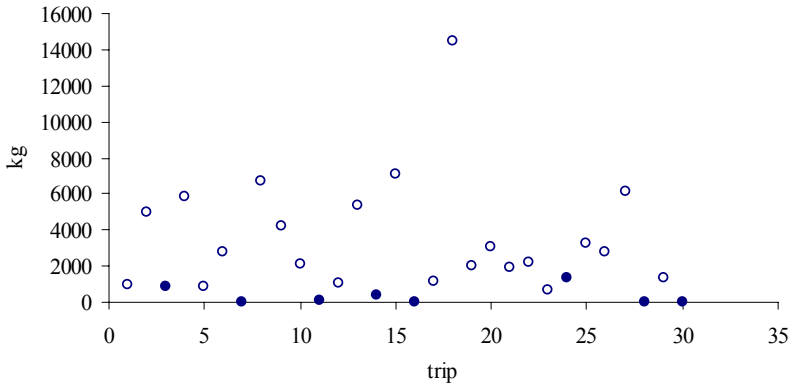


Figure XXVIII– Scatterplot of megrim discards per trip of a trawl fleet in the North East Atlantic–Southern.

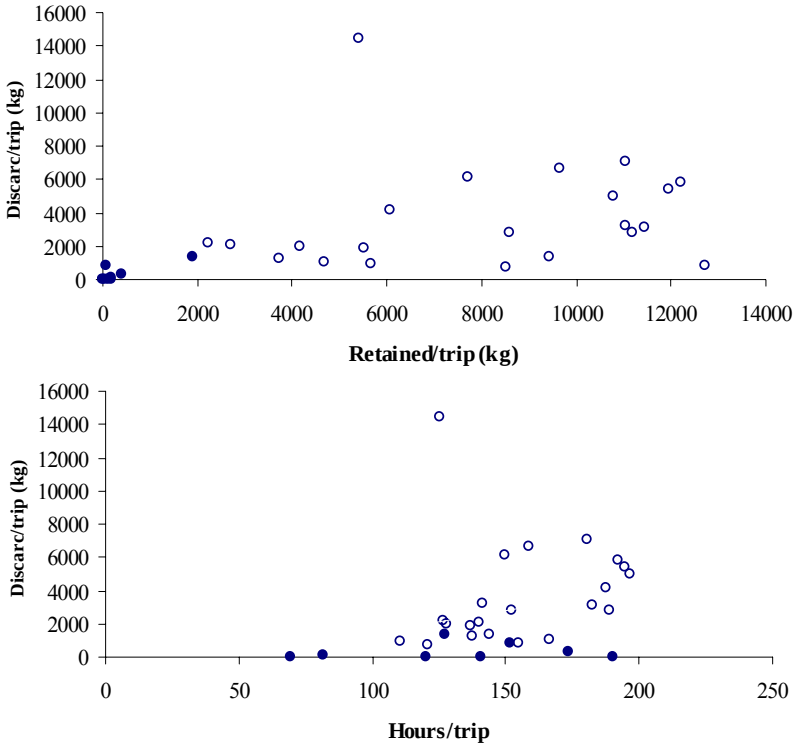


Figure XXIX– Scatterplot of megrim discards vs. landings and fishing hours by trip of a trawl fleet in the North East Atlantic–Southern.

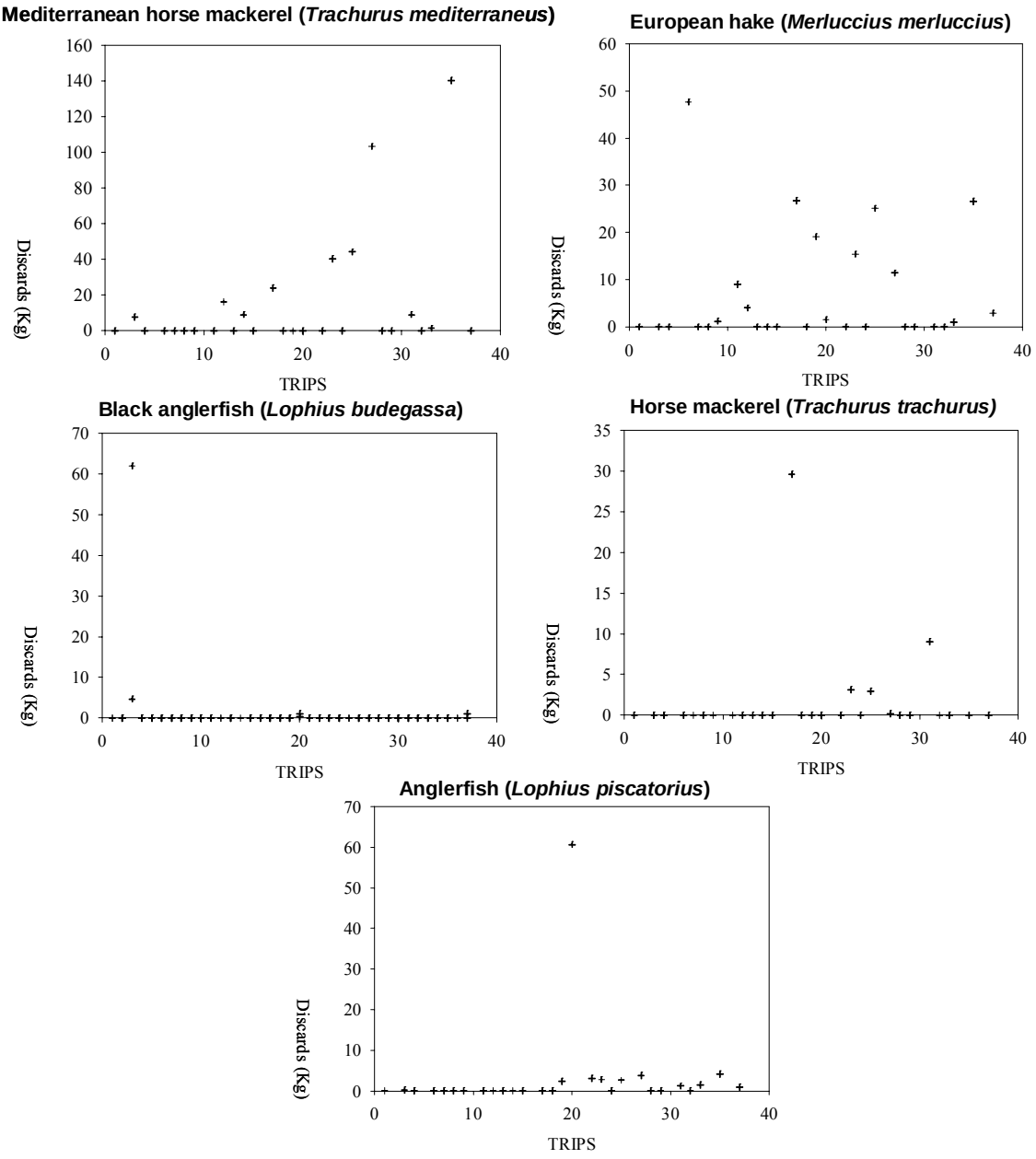


Figure XXX– Scatterplot of hake, anglerfish, black anglerfish, Mediterranean horse mackerel and horse mackerel discards per trip of a trawl fleet in the Mediterranean Sea.

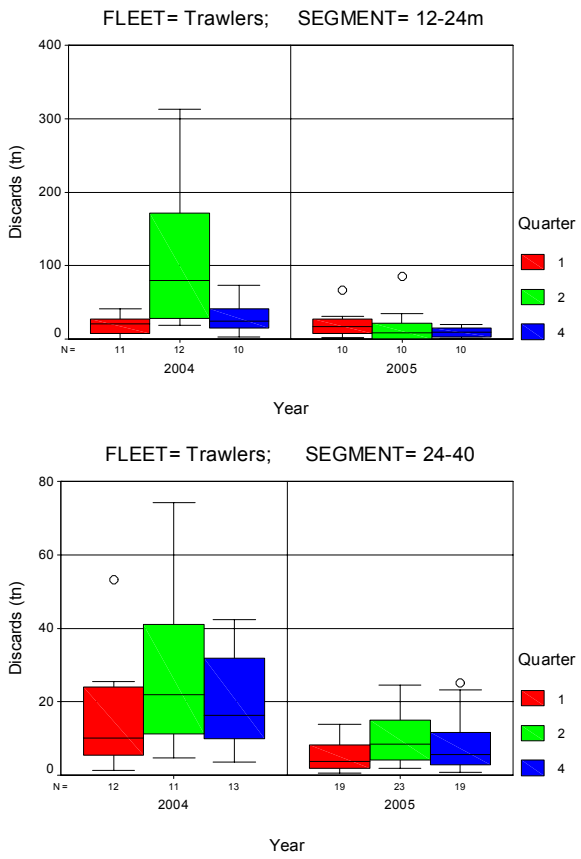


Figure XXXI– Box-plot of the discards per trip and year of two trawl fleets in the Mediterranean Sea.

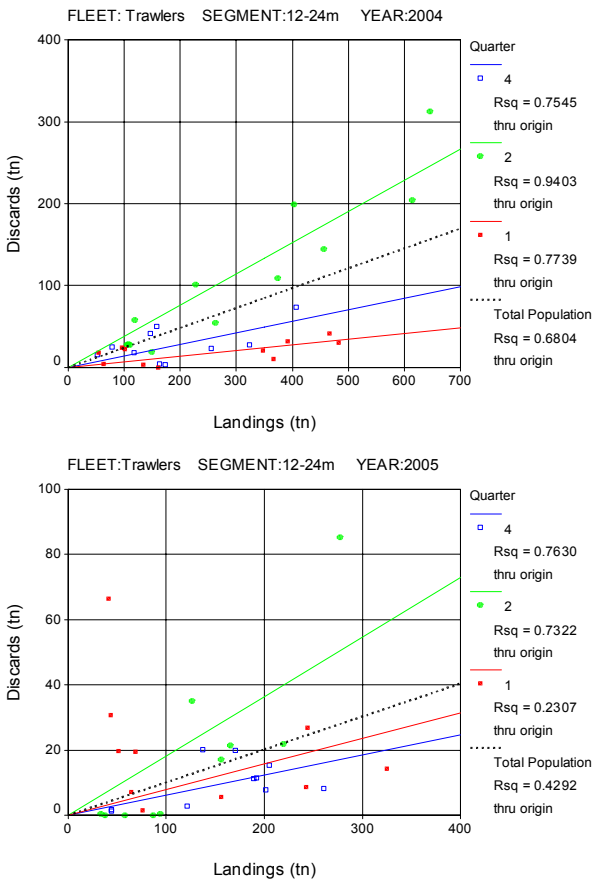


Figure XXXII– Scatterplot of the total demersal species' discards vs. landings by trip of two trawl fleets by year and quarter in the Mediterranean Sea; and linear relationships fitted without intercept.

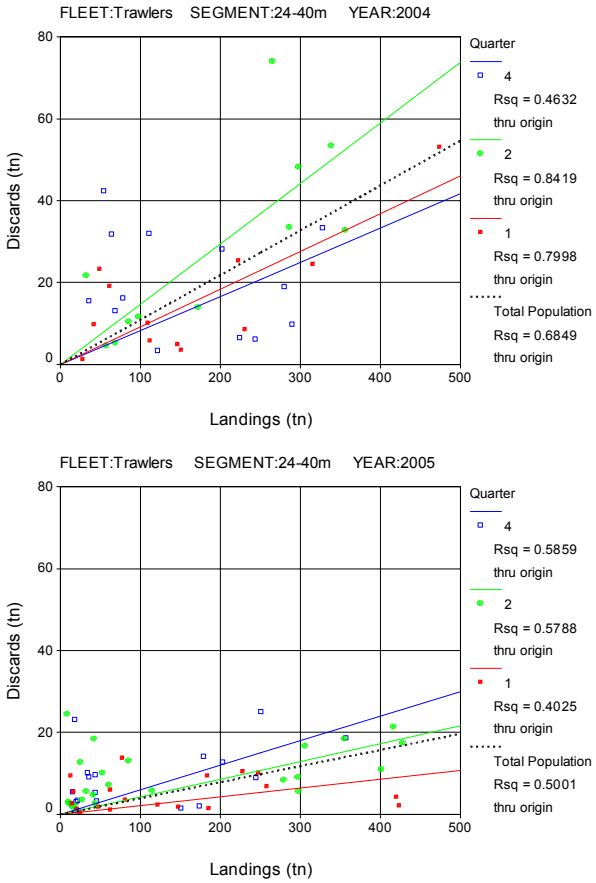


Figure XXXII cont.– Scatterplot of the total demersal species' discards vs. landings by trip of two trawl fleets by year and quarter in the Mediterranean Sea; and linear relationships fitted without intercept.

Annex 4: Recommendations

i) Do **exploratory analysis** of the sampled data before the start of the analysis, to check for mistakes and extreme discard behaviours.

ii) Check if the fishing trips sampled are **representative** of the fishing fleet, by comparing the mean length of the vessels sampled and the average of the auxiliary variable per trip against the same parameters at population level.

iii) Follow the **Raising Procedure Key** to choose a raising procedure specific to your data.

Raising Procedure Key

1. Is the sampling **representative** (mean length of vessels and mean auxiliary variable sampled compared to the population, see section 4)?

   Yes — Raise by trips and go to 2
   No — DON'T raise by trips and go to 2

2. Has the **quality** of the data used for raising been established (no misreporting and availability, see section 4)?

   Yes — Go to 3
   No — Go to 6

3. Are the discard and auxiliary variable linearly related (significant relationship and positive slope)?

   Yes — Raise by all variables and go to 4
   No — Go to 6

4. Compare the results of the different raising procedures:

   Similar (<10-20% difference) — Go to 5
   Dissimilar (>10-20% difference) — Go to 1*
   *and find the cause of the difference!

5. Choose a method that is the least biased (trips if applicable, ratio if regression passes trough origin or variable with less concerns) and most precise (compare CV's).

6. When there is no suitable raising procedure then identify the problem, identify the population sampled (different stratification/sampling?) and start again!

   Go to 1

iv) Try **different procedures** (simple, ratio or models) when raising discards.

v) **Compare** the results between **procedures**.

vi) When **pooling discard data** from different raising procedures, take into account that different procedures give different results, and specifically that fishing hours will probably overestimate discards compared to total landings.

vii) Do **not apply the wrong method** to raise discards!

viii) **Unbiased** result/procedure is preferable than a precise one.

ix) In the future if information regarding hauls is available at population level, then a **second-stage estimator** should be used**.**

x) More investigation is needed for a better use of fishing days as a raising variable (e.g. ratio-to-size estimate) in the multistage sampling of discards.