ICES WKSHARK3 REPORT 2017

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Report of the Workshop to compile and refine catch and landings of elasmobranchs (WKSHARK3)

20-24 February 2017

Nantes, France

ICES
CIEM
International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

H. C. Andersens Boulevard 44–46
DK-1553 Copenhagen V
Denmark
Telephone (+45) 33 38 67 00
Telefax (+45) 33 93 42 15
www.ices.dk
info@ices.dk

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Contents

Executive Summary

ICES WKSHARK3 made an overview of the available discards information and the common procedures to calculate population level estimates of discards removals for different countries were described. The potential issues related to sampling procedures for elasmobranchs were collated for the different sampling programs in the different countries. The available discards information was used to determine discards retention, i.e. the lengths and species composition of discards compared to the total catches.

The suitability of national programmes to inform on the by-catch of rare species was reviewed considering three demersal species that are rare throughout the ICES area (angel shark, white skate and guitarfish), three pelagic species that are uncommon in observer programmes (Basking shark, Porbeagle and Common thresher shark) and two demersal species that are locally rare (undulate ray in 7.b.j and starry smoothhound and 9.a). These species were also given particular attention in terms of potential issues related to sampling plans and procedures.

Finally, the available knowledge on the mortality caused by discarding of elasmobranchs depends on the survival of individuals in the catching process and the subsequent handling of the fish was reviewed.

1 Term of References

WKSHARK3 - Workshop to compile and refine catch and landings of elasmo-branchs

2016/2/ACOM39 A third Workshop to compile and refine catch and landings of elasmobranchs [WKSHARK3] will be established and co-chaired by Pascal Lorance (France) and Jan Jaap Poos (Netherlands) and at IFREMER, Nantes, France, 20–24 February 2017 to:

a) Evaluate current sampling programmes for discards to evaluate for which stocks there are sufficient data to allow for estimation of total discards, and to determine the optimal methods for raising discards data for stocks of interest;

b) Evaluate the suitability of existing national programmes for the estimation of discard rates and quantities for case-study elasmobranchs, considering their often seasonal and sometimes localised nature. Preliminary studies will focus on specified case-study species and metiers, representing species with contrasting levels and qualities of data, including: (i) porbeagle shark *Lamna nasus* (e.g. in net and trawl fisheries operating in the Celtic Sea), (ii) tope *Galeorhinus galeus*; (iii) spurdog *Squalus acanthias* in net and trawl fisheries; (iv) smooth-hounds *Mustelus* spp.; (v) skates, representing data-rich (e.g. thornback ray, cuckoo ray) and data-limited stocks (e.g. blonde ray) and (vi) deep-water squaliform sharks;

c) Examine the discard-retention patterns of elasmobranch species captured by (i) beam trawl, (ii) bottom otter trawl, (iii) gillnets and (iv) longlines;

d) Examine the suitability of existing national programmes to inform on the by-catch of rare elasmobranch species (e.g. basking shark and angel shark), and identify which areas, seasons and gears for which more informative data on discarding of rare species could be collected;

e) Review available studies to identify where there are existing data on the at-vessel mortality and post-release mortality of elasmobranch species by gear type and identify important data gaps

Participants should ensure that raw data from national observer programmes are brought to the meeting to facilitate analyses.

WKSHARK3 will report by 10 March 2017 for the attention of ACOM and WGEF.

2 Introduction

Provision of advice on elasmobranch stocks has become a challenging task for ICES since the first advice was provided in 2004. Currently, elasmobranchs account for about 18% of all the stocks for which ICES provides advice and this does not include all the elasmobranch stocks in the ICES area. The associated workload for stock coordinators is growing. Currently ICES provides advice on 55 elasmobranch stocks, and 17 countries report catch data, using a variety of species codes and names.

In 2016, the WKSHARK2 (ICES, 2016a) workshop was instigated by ACOM, to examine ways to explore the collation of landings data per stock, along with quality control. At WKSHARK2 progress was made to provide elasmobranch landings per country and stock, correcting for e.g. species misidentification. While the landings are an important part of the population removals, an overview of removals in terms of the discards (individuals that are caught but not retained on board) is lacking (ICES, 2016a).

Since a number of years the European Union requires member states to collect discard data. This discard data includes discards of elasmobranchs. However, given their low abundances, the amount of discards are expected to be low, and observations more sparse than for the commercial species for the fleets in which these elasmobranchs are discarded. Although most countries have collected discard data, this has not generally been used in the evaluations of stock status done by e.g. the ICES Working Group on Elasmobranch Fisheries (ICES, 2016b). This is in part because there have been no common procedures for making population level estimates for discarding from the observations. A further challenge occurs for populations which are not landed being either not commercial at least in some areas or being subject to conservations measures (landings bans) or 0 TAC. For these populations, discards procedure applied to large commercial stocks are not suitable, alternative methods for raising observed discards according to the fishing effort, the landings of all species combined and the landings of the target species were presented.

During ICES WKSHARK3 an overview was made of the available discards information and the common procedures to calculate population level estimates of discards removals for different countries were described (section 3). The potential issues related to sampling procedures for elasmobranchs were collated for the different sampling programs in the different countries (section 4). The available discards information was used to determine discards retention, i.e. the lengths and species composition of discards compared to the total catches (section 5).

Section 6 of the report provides an overview of rare species. Rarity includes two components: species that are rare in the ecosystem such as guitarfish which the area of distribution does not extend much in the northeast Atlantic and white skate or angel shark which exploitation rarefied during the 20th century and species that are not caught by current fisheries and are therefore rare in on-board observations. The suitability of national program to provide data on populations on these species and the areas, seasons, gears where these species are caught were examined. These species were also given particular attention in terms of potential issues related to sampling plans and procedures.

Finally, the mortality caused by discarding of elasmobranchs depends on the survival of individuals in the catching process and the subsequent handling of the fish. Section 6 of the report gives an overview of the state of knowledge (section 7).

The report thus aids ICES in the challenges it faces in advice provision for elasmobranchs in the near future: the inclusion of discards data and the need to consider survivorship of discards following from the EU landings obligation in addition to the application of new assessment methods following work by ICES WKLIFE.

WKSHARKS3 participants (a few participants are missing from this photo).

2.1 Participants

Annex 1 contains a list of participants

3 Overview of sampling programs and raising procedures

3.1 Introduction

To date, only limited information from observer programmes have been used by ICES WGEF in their assessment of stocks, although various aspects of such data have been presented occasionally (e.g. Silva et al., 2012, 2013).

There are several reasons why such data have not been utilised more widely, including potential issues of data quality (e.g. in relation to species identification) and potential issues regarding raising factors for less common species that may under- or overestimate catches). There is also the fundamental question of what the data would be used for: estimating dead removals from the stock or to examine temporal changes in catch (and effort) as a possible fishery-dependent indicator of stock size. In relation to the latter, as a proportion of the discards would be alive, catch data (landings and estimated discards) does not equate with 'dead removals' in assessment terms. Further information on discard survival is given in Section 6.

In recent years, there has been increased focus within the ICES advisory process to move from landings advice to catch advice, and to examine other metrics of stock status, including length-based indicators (LBI). Issues such as this led the ICES Working Group on Elasmobranch Fishes to recommend convening a dedicated workshop to better appraise the type and quality of national data available, and to consider whether such data would be appropriate for use in the assessment and advisory process.

Summaries of national data are provided in sub-section 3.2 below and the raising method by country are described in sub-section 3.3.

3.2 Summaries of national data

The sections below provide brief summaries of the national data available for the discards of elasmobranchs that may be collected during observer programmes or from industry-sampling and self-sampling programmes and logbook data.

In addition to the summary details below, the WKSHARKS3 workshop collated the following data in a common format.

Field	Description
Country	Three letter code
Year	YYYY
Season	Either Q1-Q4, or Year
Sampling_Prog	Type of sampling programme (e.g. observer, industry-sampling, self-sampling)
MetierLevel	3 to 6
Metier	e.g. OTB_DEF
ICES_Division	e.g. 4.c
Species	Valid scientific name
Type	e.g. nb.length, nb.length.sex, nb, wt, nb.wt
N_TripsSampled	The total number of trips sampled for that year, season, metier and Division
N_HaulsSampled	The total number of hauls or sets sampled for that year, season, metier and Division
N_TripsDisc	The total number of trips sampled in the sampling program for that year, season, metier, and Division in which the species was discarded
N_HaulsDisc	The total number of hauls or sets sampled in the sampling program for that year, season, metier and Division in which the species was discarded
N_TripsTotal	The total number of trips carried out for that year, season, metier and Division
N_HaulsTotal	The total number of hauls carried out for that year, season, metier and Division

The tables below provide summaries of the data collated in the common format described above. The temporal resolution as well as the type of data collected for elasmobranch species varies between countries (Table 3.1). The metier levels also differ as does the species list (not shown). The ICES Divisions covered by the sampling programmes are determined by the spatial extent of national fisheries. The number of fishing trips and fishing operations (trawl hauls or sets) varies strongly between countries (Table 3.2). The largest number of fishing operations was sampled for bottom trawls followed by nets and beam trawls (Table X3). The English Channel (ICES Division 7d and e) had by far the largest number of sampled fishing operations which is probably due the countries that provided data to WKSHARK3. The proportion of sampled hauls with discards is very small for most species in most gears (Table 3.3, Figure 3.1).

Considering the median of quarterly discard percentages by gear (percent of hauls with discards), the species with high percentages were *Galeus melastomus (*24% hooks and lines), (*Galeus* spp (25% bottom trawls) and *Scyliorhinus canicula* (58% beam trawls, 30% bottom trawls, 78% seines). For all other species the percentage of fishing operations was less than 20% and most of the time less than 0.5%.

Table 3.1 Summary of collated onboard discards observer data available to WKSHARKS3 by country. Sampling resolution and areas.

Country	Temporal resolution	Data type	Metier level (number of metiers)	ICES Divisions
Spain (Basque Country) - DCF	annual	weight	6 (3)	8.b
UK (England) - DCF	quarterly	numbers/length/sex	2, 3 or 4 (9)	2.a, 4.a, 4.b, 4.c, 5.b, 6.a, 6.b, 7.a, 7.b, 7.c, 7.d, 7.e, 7.f, 7.g, 7.h, 7.j, 7.k, 8.a, 8.b, 8.d
France -industry-sampling -DCF	annual quarterly	weight numbers/length/sex	4 (5) 5 (32)	8.b, 7.d, 8.a, 7.e 2.a, 4.a, 4.b, 4.c, 6.a, 6.b, 7.b, 7.c, 7.d, 7.e, 7.f, 7.g, 7.h, 7.j, 7.k, 8.a, 8.b, 8.c, 8.d
Ireland -DCF	quarterly	1995-2002: numbers/length >2003: numbers/length/sex	4 (10)	6.a, 6.b, 7.a, 7.b, 7.c, 7.f, 7.g, 7.h, 7.j, 7.k
Netherlands -self-sampling -DCF	quarterly quarterly	numbers/length numbers/length	6 (10) 6 (5)	4.b, 4.c 4.b, 4.c
Portugal - DCF	annual	OTB: numbers & weight other: numbers	3 or 6 (4)	9.a

Table 3.2 Summary of collated onboard discards observer data available to WKSHARKS3 by country. Sampling efforts are mean values per year all metiers combined. For Ireland no information on sampling effort was available.

Country	Years	Mean number of trips sampled per year	Mean number of hauls/sets sampled per year
Spain (Basque Country)	2013-2015	15	440
UK (England)	2002-2016	230	1647
France			
-industry-sampling	2016	not available	4529
-DCF	2011-2015	840	2905
Ireland	1995-2015	not available	not available
Netherlands			
-self-sampling	2011-2015	74	145
-DCF	2011-2015	10	172
Portugal	2004-2014	53	191

Table 3.3 Summary of collated onboard discards observer data available to WKSHARKS3 by ICES division and gear (metier level 3). Total number of sampled hauls or sets by gear and ICES division all countries combined (time period varies between countries, see table above). Information for Ireland missing.

ICES Divsion	Beam trawl	Bottom trawl	Dredges	Hooks and lines	Nets	Pelagic trawl	Seine	Traps	All gears
2.a	0	99	0	0	0	0	0	0	99
4.a	0	938	0	0	0	14	0	0	952
4.b	764	2195	51	2	249	0	78	13	3352
4.c	938	528	10	10	807	2	19	0	2314
5.b	0	0	0	0	4	0	0	0	4
6.a	0	0	0	504	25	0	0	0	529
6.b	0	0	0	0	5	0	0	0	5
7.a	0	0	0	0	0	0	0	0	0
7.b	0	0	0	0	0	1	0	0	1
7.c	0	0	0	0	0	3	0	0	3
7.d	614	2024	342	1	2373	79	86	0	5519
7.e	5201	5593	860	371	2485	111	142	247	15010
7.f	0	0	25	7	776	0	0	21	829
7.g	0	0	0	0	0	0	0	0	0
7.h	2167	0	0	3	662	2	28	0	2862
7.j	0	0	0	0	0	0	0	0	0
7.k	0	0	0	0	50	0	0	0	50
8.a	0	1156	0	530	1101	11	129	0	2927
8.b	0	1614	0	339	2137	20	46	0	4156
8.c	0	0	0	0	5	0	0	0	5
8.d	0	31	0	0	1	12	0	0	44
9.a	0	1999	0	50	49	0	0	0	2098
All areas	9684	16177	1288	1817	10729	255	530	281	40761

Table 3.4 Summary of collated onboard discards observer data. Median of the percent of hauls with discards per sampling strata (quarter/year and ICES Division) for each species and gear (metier level 3) all countries combined. ' 0' indicates values <0.5%; "-" indicates no data. The species list varies between countries. Sampling strata with fewer than 10 observations were excluded from calculation.

Species	Beam trawl	Bottom trawl	Dredge	Hooks and lines	Nets	Pelagic trawl	Seine	Traps
Alopias vulpinus	0	0	0	0	0	0	-	0
Amblyraja radiata	0	0	0	0	0	0	-	0
Apristurus laurussoni	0	0	0	0	0	0	-	0
Centrophorus squamosus	0	0	0	0	0	0	-	0
Centroscyllium fabricii	0	0	0	0	0	0	-	0
Centroscymnus coelolepis	0	0	0	0	0	0	-	0
Centroscymnus crepidater	0	0	0	0	0	0	-	0
Cetorhinus maximus	0	0	0	0	0	0	-	0
Dalatias licha	0	0	0	0	0	0	-	0
Dasyatis pastinaca	0	0	0	0	0	0	-	0
Deania profundorum	-	2	-	-	-	-	-	-
Dipturus batis complex	0	0	0	0	0	0	-	0
Dipturus nidarosiensis	0	0	0	0	0	0	-	0
Dipturus oxyrinchus	0	0	0	0	0	0	-	0
Elasmobranchii	-	1	-	-	-	-	-	-
Etmopterus princeps	0	0	0	0	0	0	-	0
Etmopterus pusillus	-	-	-	-	7	-	-	-
Etmopterus spinax	0	0	0	0	0	0	-	0
Etmopterus spp.	-	12	-	-	-	-	-	-
Galeorhinus galeus	0	0	0	0	0	0	0	0
Galeus melastomus	0	0	0	24	0	0	9	0

Species	Beam trawl	Bottom trawl	Dredge	Hooks and lines	Nets	Pelagic trawl	Seine	Traps
Galeus murinus	0	0	0	0	0	0	-	0
Galeus spp.	-	25	-	-	7	-	-	-
Hexanchus griseus	0	0	0	0	0	0	-	0
Isurus oxyrinchus	0	0	0	0	0	0	-	0
Lamna nasus	0	0	0	0	0	0	-	0
Leucoraja circularis	0	0	0	0	0	0	0	0
Leucoraja fullonica	0	0	0	0	0	0	7	0
Leucoraja naevus	0	5	0	0	0	0	0	0
Mustelus spp	0	1	0	0	1	11	0	0
Neoraja iberica	-	1	-	-	-	-	-	-
Oxynotus paradoxus	0	0	0	0	0	0	-	0
Prionace glauca	0	0	0	0	0	0	-	0
Pseudotriakis microdon	0	0	0	0	0	0	-	0
Pteroplatytrygon violacea	-	1	-	-	-	-	-	-
Raja brachyura	0	0	0	0	0	0	5	0
Raja clavata	0	6	1	0	0	0	0	0
Raja microocellata	0	0	0	0	0	0	0	0
Raja miraletus	-	3	-	-	-	-	-	-
Raja montagui	6	2	0	0	0	0	0	0
Raja undulata	0	0	0	5	0	0	12	0
Rajella fyllae	0	0	0	0	0	0	-	0
Rajella lintea	-	8	-	-	-	-	-	-
Rajidae	0	0	0	0	0	0	-	0
Scyliorhinidae	0	0	0	0	0	0	-	0
Scyliorhinus canicula	58	30	6	6	13	0	78	3
Scyliorhinus stellaris	0	0	0	0	0	0	7	0
Scymnodon ringens	-	1	-	-	-	-	-	-
Somniosus microcephalus	0	0	0	0	0	0	-	0

Species	Beam trawl	Bottom trawl	Dredge	Hooks and lines	Nets	Pelagic trawl	Seine	Traps
Somniosus rostratus	0	0	0	0	0	0	-	0
Squalus acanthias	0	0	0	0	0	0	7	0
Torpedo marmorata	0	0	0	0	0	0	-	0
Torpedo nobiliana	0	0	0	0	0	0	-	0
Torpedo torpedo	0	0	0	0	0	0	-	0

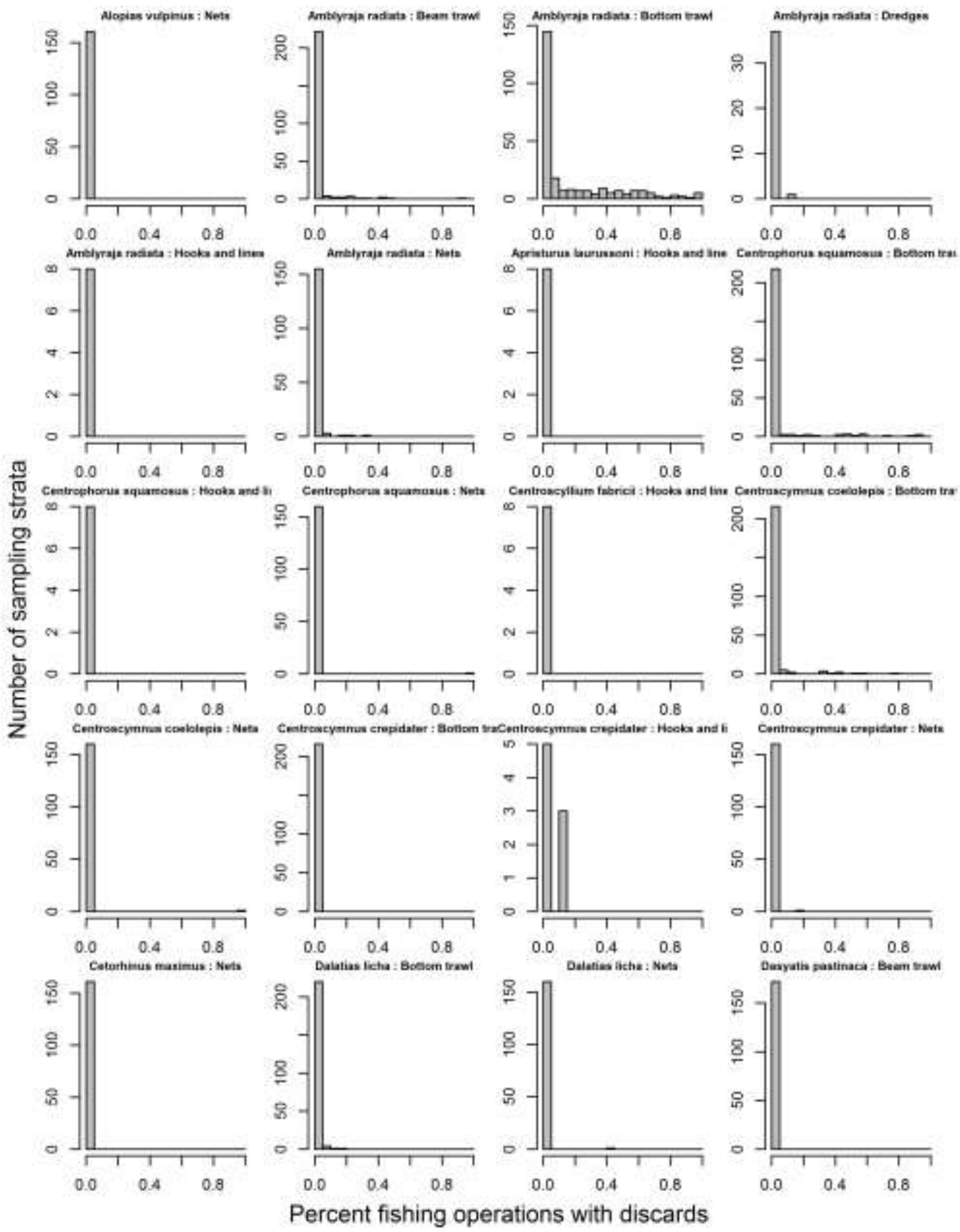


Figure 3.1 Histogram of the percent of observed hauls with discards by species and gear in a given sampling strata (quarter/year and ICES Division) all countries combined. Species-gears are shown if there were some recorded discards. Y-axis shows the number of sampling strata with estimates; sampling strata with less than 10 sampled fishing operations were excluded.

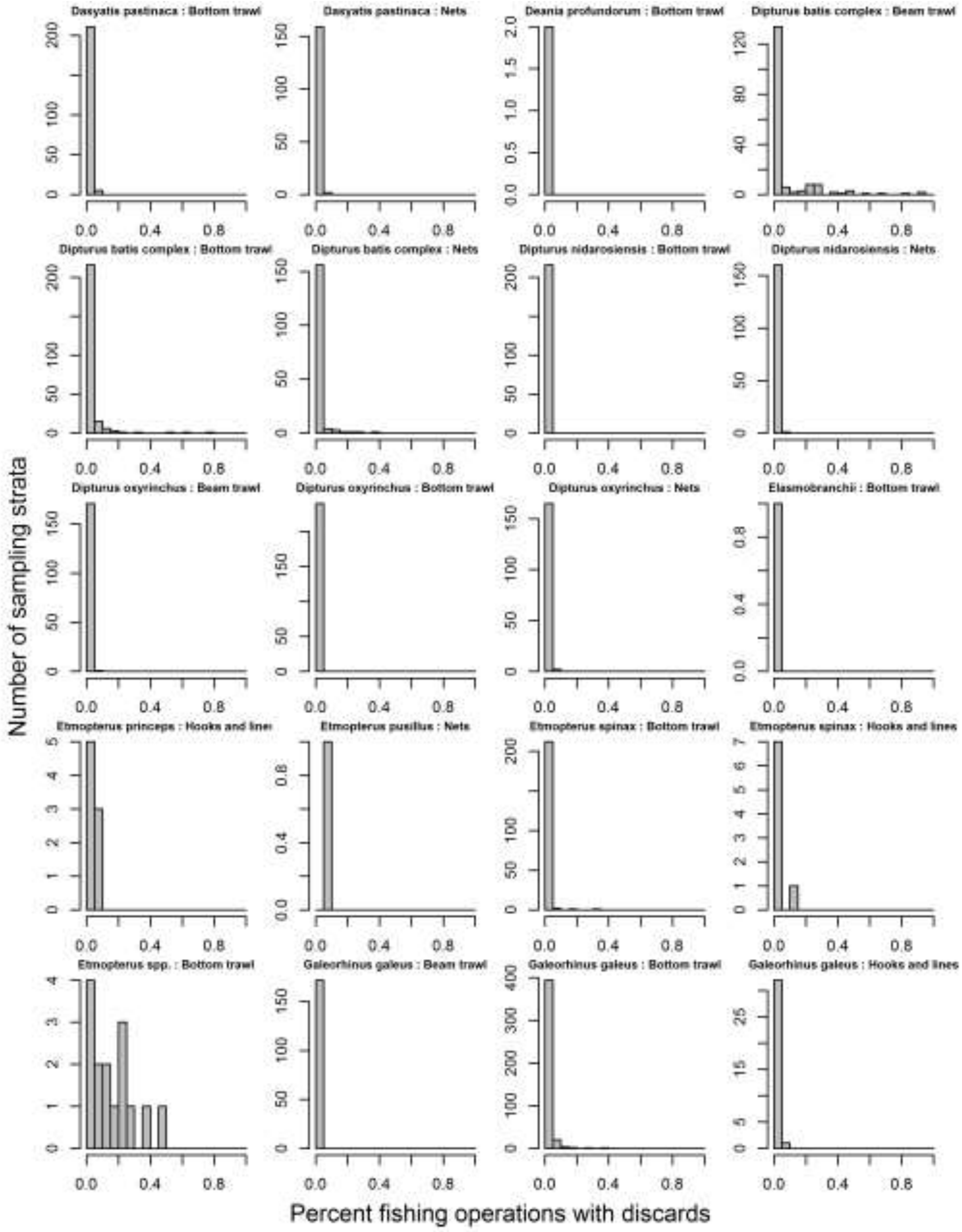
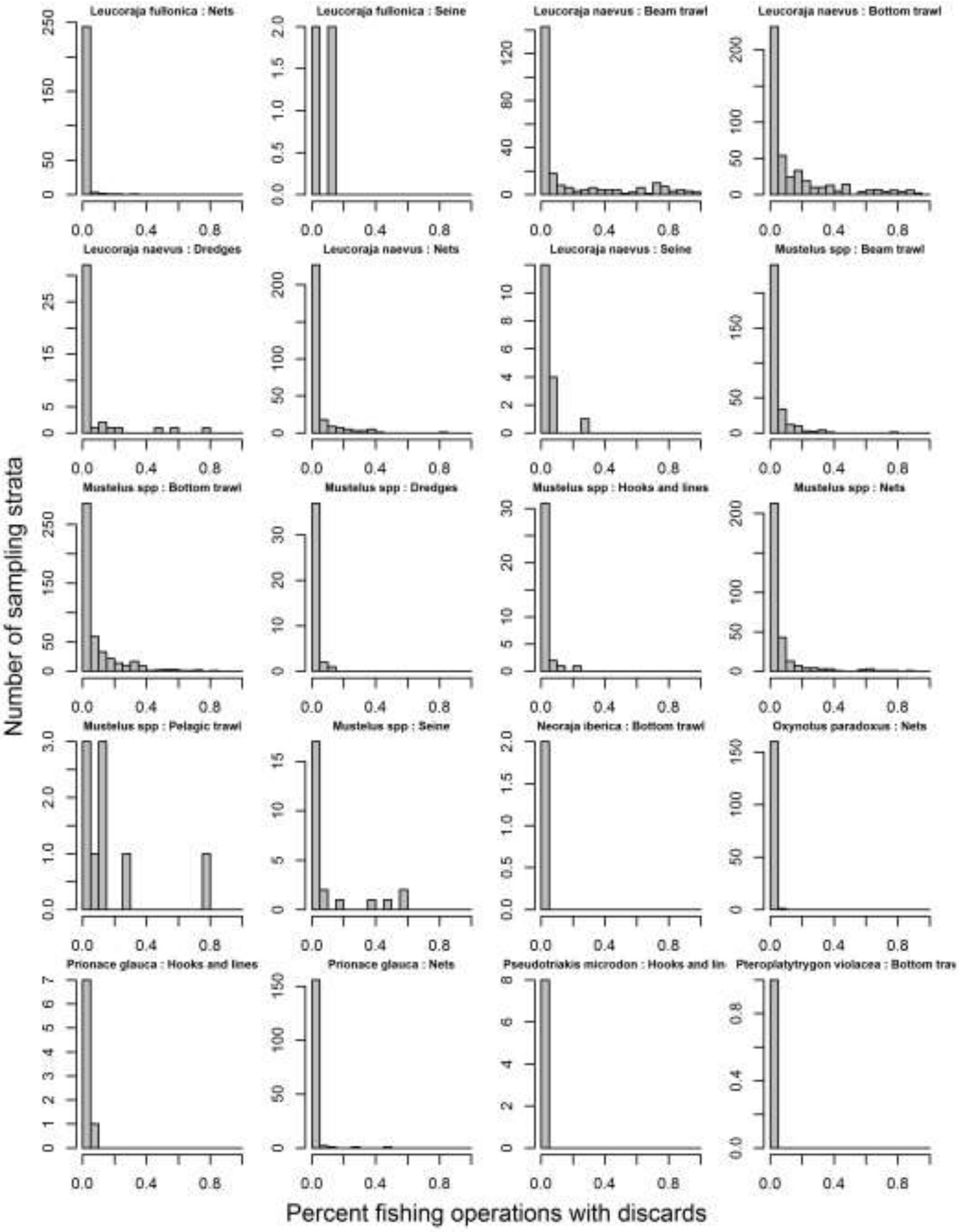


Figure 3.1 (continued)



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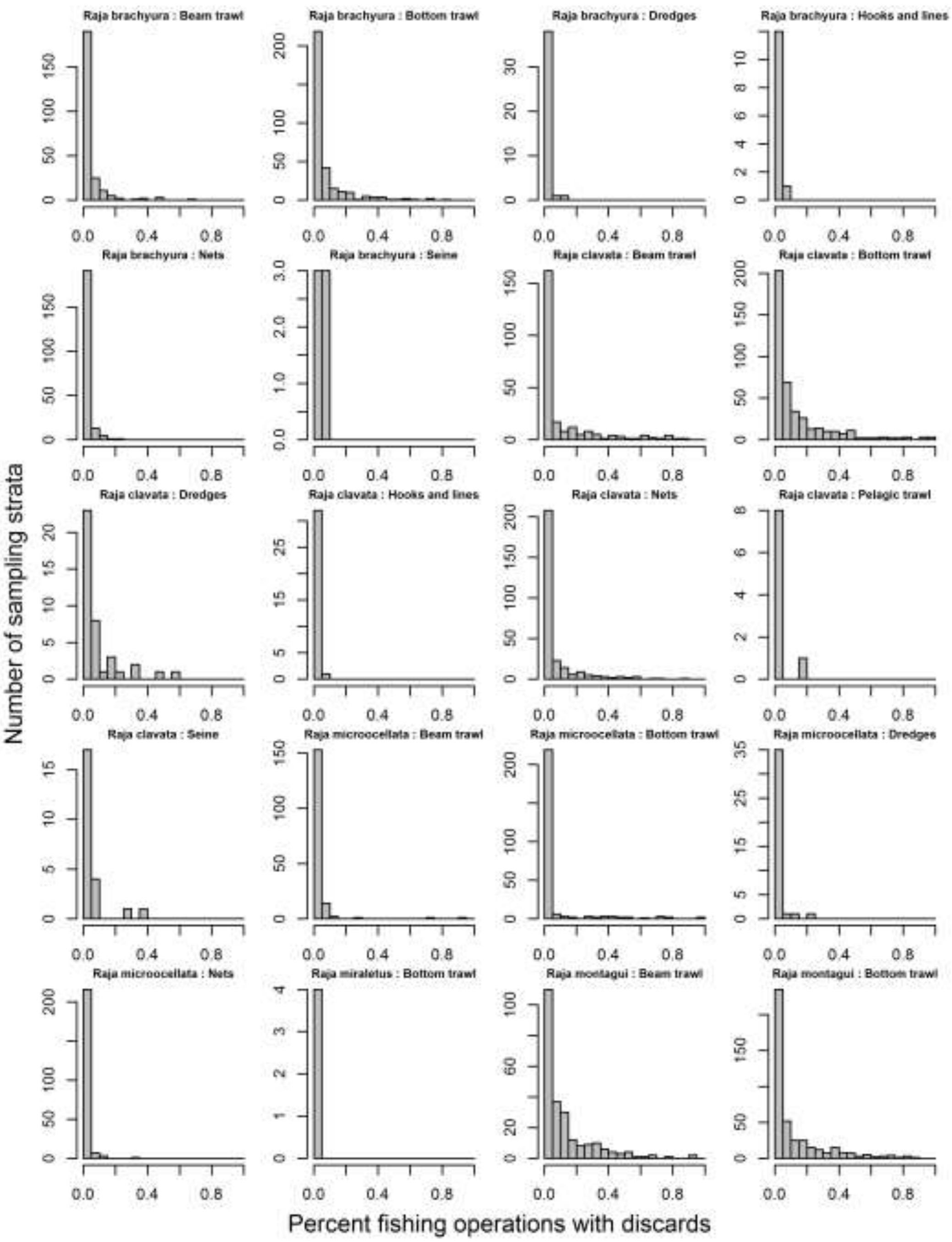


Figure 3.1 (continued)

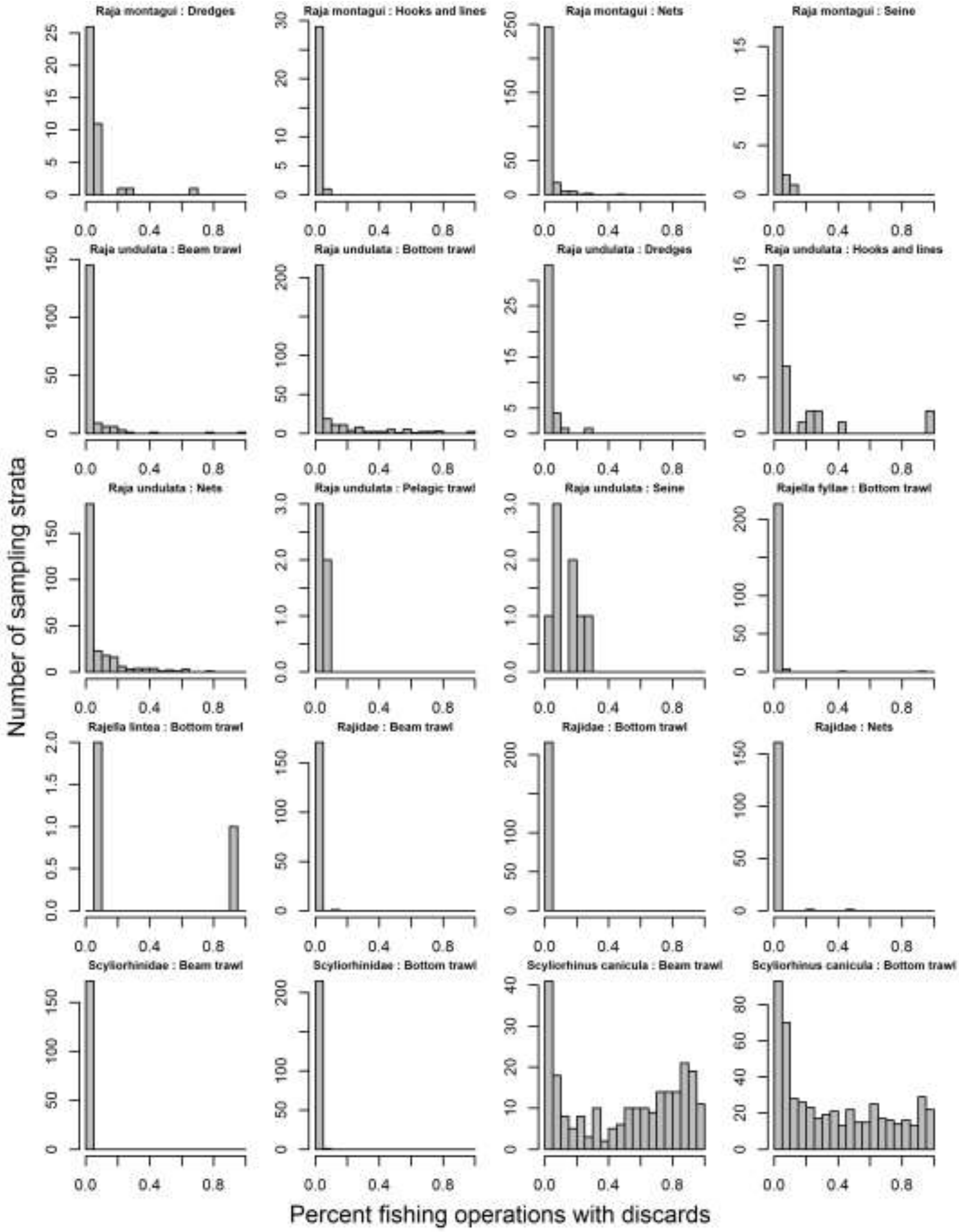


Figure 3.1 (continued)

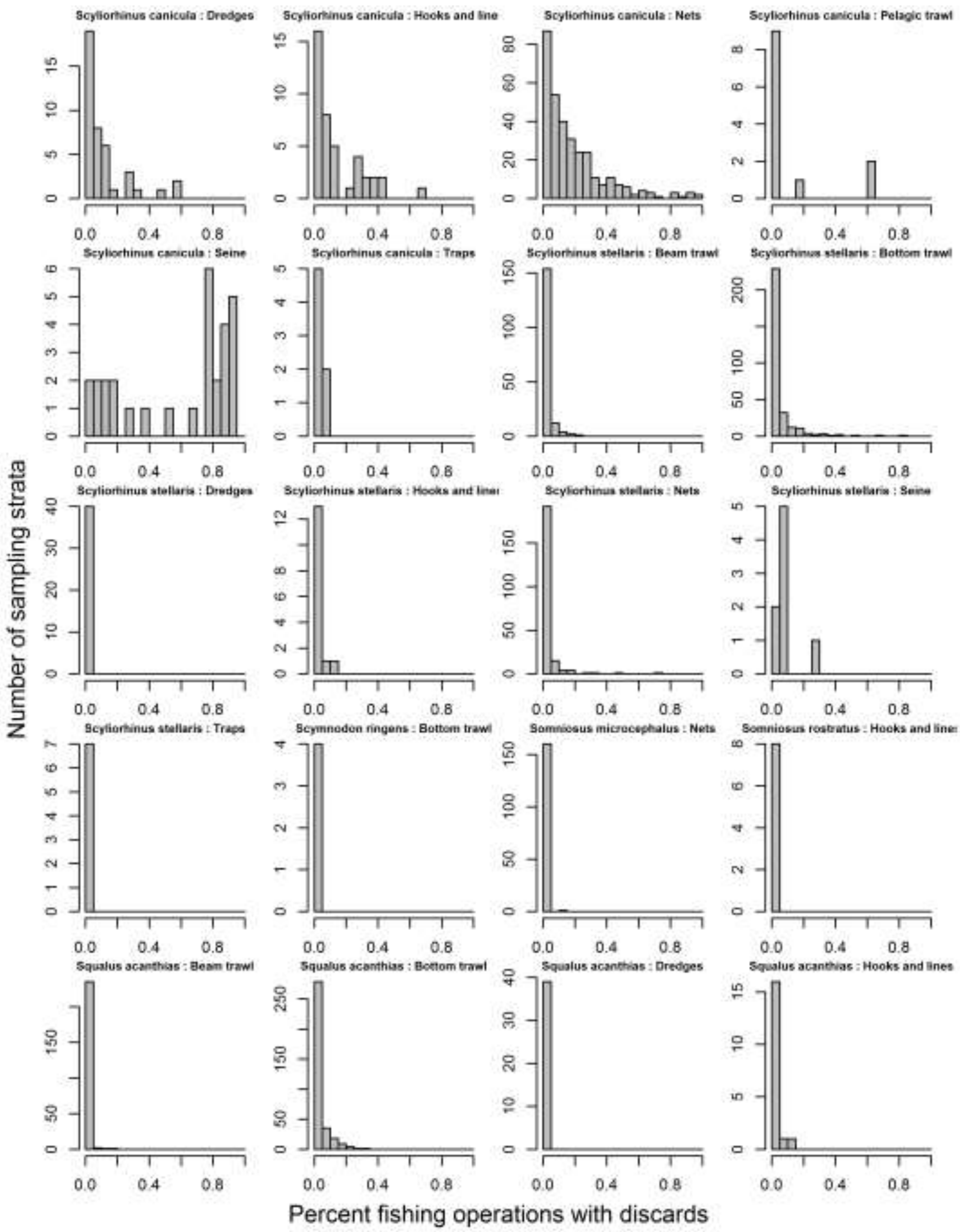
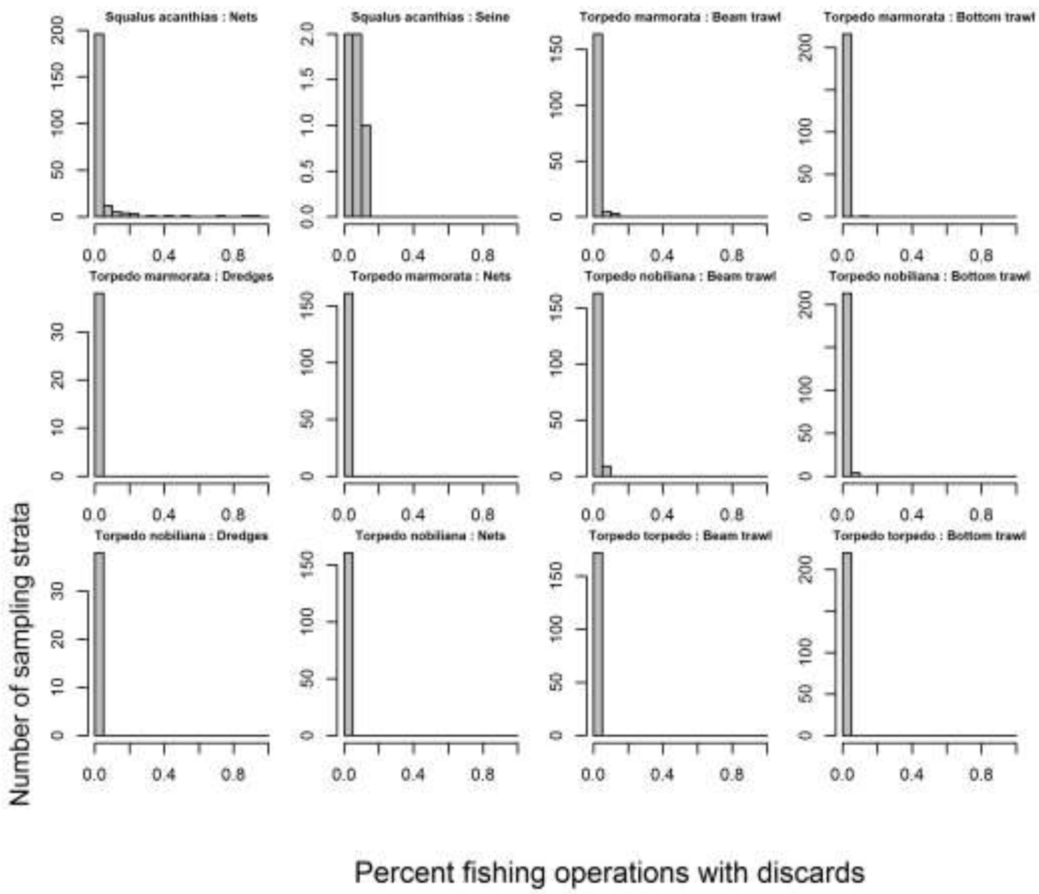


Figure 3.1 (continued)



3.2.1 Summary of UK (English) observer programme

Data for all elasmobranchs (and holocephalans) recorded during the English observer programme were examined and it was apparent that there were some instances where the maximum length observed was greater than may be expected. Whilst it is possible that some of these may be valid records of exceptionally large specimens, they could relate to either input or identification errors. There were also some taxa recorded that are considered either identification errors or coding errors. Summary data are provided in Tables 2.1 and 2.2, with these data also provided in the format described above.

Table 3.5: Summary of all elasmobranchs (and rabbitfish) recorded in CEFAS observer programmes (2002–2016) in shelf seas (excluding deep-water trips, see Table 3.6 and one trip to northern areas. Records in parentheses indicate questionable records, for which further data checks are on-going.

Code	Scientific name	Fate	Length range (cm)	No. of fish in sampled hauls							
				Beam trawl	Nephrops trawl	Otter trawl	Gill net	Dredge	Longline	Midwater Pair Trawl	Other
SGS	*Hexanchus griseus*	D	56-180	2	11	40	24	-	-	-	-
SGS	*Hexanchus griseus*	R	78-146	-	2	-	-	-	-	-	-
DCH	*Dalatias licha*	D	34-120	-	-	46	-	-	-	-	-
ESP	*Etmopterus princeps*	D	15-31	-	-	6	-	-	-	-	-
VBY	*Etmopterus spinax*	D	20-58	-	36	157	-	-	112	-	-
DGS	*Squalus acanthias*	D	17-122	388	12	596	2381	2	-	79	-
DGS	*Squalus acanthias*	R	41-128	151	15	1727	3672	-	-	-	-
ATH	*Alopias vulpinus*	D	210-210	-	-	-	1	-	-	-	-
BSK	*Cetorhinus maximus*	D	378-382	-	-	-	2	-	-	-	-
SMA	*Isurus oxyrinchus*	D	144-144	-	-	-	1	-	-	-	-
POR	*Lamna nasus*	D	90-252	-	-	-	66	-	-	8	-
POR	*Lamna nasus*	R	106-270	-	1	2	22	-	-	-	-
DBM	*Galeus melastomus*	D	13-(103)	6	153	496	37	-	1514	-	-
DBM	*Galeus melastomus*	R	53-69	-	-	75	-	-	-	-	-
LSD	*Scyliorhinus canicula*	D	8-(92)	383199	9210	220511	7756	244	423	6	147
LSD	*Scyliorhinus canicula*	R	21-(94)	13392	3668	96026	3253	3	30	-	20
DGN	*Scyliorhinus stellaris*	D	(10)-131	732	17	829	243	2	-	-	1
DGN	*Scyliorhinus stellaris*	R	23-142	13	5	248	121	-	-	-	14
DGH	*Scyliorhinidae*	D	83-92	1	-	2	-	-	-	-	-
GAG	*Galeorhinus galeus*	D	36-184	34	53	212	291	-	-	-	-

Code	Scientific name	Fate	Length range (cm)	No. of fish in sampled hauls							
				Beam trawl	Nephrops trawl	Otter trawl	Gill net	Dredge	Longline	Midwater Pair Trawl	Other
GAG	*Galeorhinus galeus*	R	59-193	-	3	63	333	-	-	-	-
SDS	*Mustelus asterias*	D	(14)-149	4143	497	8277	1402	38	44	2	4
SDS	*Mustelus asterias*	R	31-162	122	22	3528	2586	1	153	10	-
BSH	*Prionace glauca*	D	75-248	-	-	-	42	-	1	-	-
BSH	*Prionace glauca*	R	62-246	-	-	1	84	-	20	-	1
MER	*Torpedo marmorata*	D	13-(132)	488	-	3	6	3	-	-	-
MER	*Torpedo marmorata*	R	61-63	-	-	-	2	-	-	-	-
ECR	*Torpedo nobiliana*	D	16-130	291	-	5	5	3	-	-	-
ECR	*Torpedo nobiliana*	R	120-120	-	-	1	-	-	-	-	-
ELR	*(Torpedo torpedo)*	D	31-75	7	-	-	-	-	-	-	-
SYR	*Amblyraja radiata*	D	12-67	3884	8327	24247	32	6	-	-	-
SYR	*Amblyraja radiata*	R	27-72	6	32	188	3	-	-	-	-
SKT	*Dipturus batis*	D	15-250	6433	42	2207	343	-	-	-	-
SKT	*Dipturus batis*	R	20-146	555	13	106	196	-	-	-	-
RNS	*Dipturus nidarosiensis*	D	39-39	-	11	-	-	-	-	-	-
RNS	*Dipturus nidarosiensis*	R	119-119	-	-	1	-	-	-	-	-
LNS	*Dipturus oxyrinchus*	D	28-80	20	-	1	3	-	-	-	-
LNS	*Dipturus oxyrinchus*	R	50-122	20	-	1	8	-	-	-	-
SAR	*Leucoraja circularis*	D	14-42	22	-	426	-	-	-	-	-
SAR	*Leucoraja circularis*	R	58-94	6	-	2	-	-	-	-	-
SHR	*Leucoraja fullonica*	D	12-98	2215	-	143	34	-	-	-	-
SHR	*Leucoraja fullonica*	R	35-114	1095	-	32	124	-	3	-	-
CUR	*Leucoraja naevus*	D	10-79	55352	1799	9717	470	221	-	-	5

				No. of fish in sampled hauls							
Code	Scientific name	Fate	Length range (cm)	Beam trawl	Nephrops trawl	Otter trawl	Gill net	Dredge	Longline	Midwater Pair Trawl	Other
CUR	*Leucoraja naevus*	R	28-(96)	15813	408	4906	2628	3	-	-	2
BLR	*Raja brachyura*	D	9-109	3009	286	5898	93	83	-	2	-
BLR	*Raja brachyura*	R	(11)-120	3211	133	11766	1208	7	1	-	-
THR	*Raja clavata*	D	8-98	11149	2057	30680	2491	301	127	-	5
THR	*Raja clavata*	R	21-114	4159	687	25208	2970	26	414	-	7
SDR	*Raja montagui*	D	10-(121)	11520	590	12088	242	148	2	-	-
SDR	*Raja montagui*	R	27-(101)	3087	197	9025	970	6	10	-	-
PTR	*Raja microocellata*	D	12-(96)	1085	12	9226	165	17	-	-	-
PTR	*Raja microocellata*	R	37-(99)	886	-	13762	482	2	-	-	-
UNR	*Raja undulata*	D	15-106	1886	-	667	229	76	-	-	-
UNR	*Raja undulata*	R	21-102	242	-	254	1	-	-	-	-
RDS	*Rajella fyllae*	D	41-54	-	-	27	-	-	-	-	-
WSK	*Rostroraja alba*	R	66-83	-	21	-	-	-	-	-	-
SKA	*Rajidae*	D	25-65	26	-	1	1	-	-	-	-
SKA	*Rajidae*	R	89-107	2	-	3	-	-	-	-	-
SGR	*Dasyatis pastinaca*	D	35-108	35	-	49	6	-	-	-	-
SGR	*Dasyatis pastinaca*	R	69-69	1	-	-	-	-	-	-	-
SRB	*(Batoidimorpha)*	R	21-21	1	-	-	-	-	-	-	-
SKX	*Selachiomorpha*	D	25-25	6	-	-	-	-	-	-	-
SKX	*Selachiomorpha*	R	53-69	2	-	-	-	-	-	-	-

Table 3.6: Summary of all elasmobranchs recorded in CEFAS observer programmes (2002–2006) in six trips observed for deep-water fisheries.

				No. of fish measured (raised to haul)		
Code	Scientific name	Fate	Length range (cm)	Gill net	Longline	Otter trawl
SGS	*Hexanchus griseus*	D	69-169	4	5	5
SGS	*Hexanchus griseus*	R	112-169	123	-	2
CSQ	*Centrophorus squamosus*	D	31-138	466	1	133
CSQ	*Centrophorus squamosus*	R	78-146	6375	25372	-
CSF	*Centroscyllium fabricii*	D	47-86	1764	145	-
ESP	*Etmopterus princeps*	D	34-83	-	1169	-
VBY	*Etmopterus spinax*	D	49-59	-	10	-
PUS	*Centroscymnus coelolepis*	D	42-137	109	-	60
PUS	*Centroscymnus coelolepis*	R	76-137	4018	1400	-
CMS	*Centroscymnus crepidater*	D	35-108	2	312	80
CMS	*Centroscymnus crepidater*	R	72-108	23	-	-
GSK	*Somniosus microcephalus*	D	170-280	2	-	-
SOR	*Somniosus rostratus*	D	95-156	-	34	-
SOR	*Somniosus rostratus*	R	132-179	2	-	-
SSK	*Oxynotus paradoxus*	D	39-79	3	-	-
DCH	*Dalatias licha*	D	40-150	5	-	6
DCH	*Dalatias licha*	R	40-150	40	-	-
POR	*Lamna nasus*	R	219-219	1	-	-
DAL	*Apristurus laurussoni*	D	64-64	-	1	-
DBM	*Galeus melastomus*	D	27-67	1	-	32
DGM	*Galeus murinus*	D	37-45	-	14	-
FCK	*Pseudotriakis microdon*	D	46-200	4	9	-
FCK	*Pseudotriakis microdon*	R	145-257	62	-	-
BSH	*Prionace glauca*	D	153-160	1	1	-
ECR	*Torpedo nobiliana*	D	62-62	-	-	1
SYR	*Amblyraja radiata*	D	32-89	225	2	-
SYR	*Amblyraja radiata*	R	54-79	19	-	-
RNS	*Dipturus nidarosiensis*	D	67-127	4	-	1
RNS	*Dipturus nidarosiensis*	R	97-192	29	1	2

Table 3.7 Records of elasmobranchs recorded at sea by Irish Observer Programme (numbers). Includes both discards and landings 1995-2015. Lengths in italics indicate possible errors.

Species	Size range (cm)	Dredge	Gill- net	Trammel net	Otter trawl – bottom	Otter trawl – midwater	Pair Trawl – Bottom	Seine net	Beam trawl	Not recorded
Apristurus aphyodes	44-67				3					
Apristurus laursonii	36-67				5					
Breviraja caerulea	31-31				2					
Centrophorus granulosus	16-18				2					
Centrophorus squamosus	19-100				33					3
Centroscyllum fabricii	18-71				82					
Centroscymnus coelolepis	12-109				126					
Centroscymnus crepidator	13-80				132					
Dalatias licha	16-123				68					
Deania calcea	36-109				39					
Dipturus flossada	20-59				45					
Dipturus intermedia	28-74				87					
Rajella lintea	24-77				28					
Etmopterus princeps	24-45				7					
Etmopterus spinax	11-109				463					
Galeorhinus galeus	14-153		5		49			1	1	
Galeus melastomus	13-86				2310					
Galeus murinus	34-69				33					
Hexanchus griseus	64-92		1		40					
Lamna nasus	39-114		1		5					
Leucoraja circulcaris	19-62	2			33					
Leucoraja fullonica	22-72				79		1	1		2
Prionace glauca	44-117		3		3					
Dipturus batis	13-126	15			3415			15	59	4
Raja brachyura	6-999	12	10	157	1870	72		7	3424	7
Raja clavata	3-93	67	23		1794	1	1	7	214	2
Raja fyllae	23-60				11					
Raja microocellata	17-57				25				1	
Rajamontagui	10-96	424	83	5	4262	170		6	2928	16
Leucoraja naevus	10-83	158	21		8980	53	1	25	3149	27
Dipturus nidarosiensis	15-98				241					
Dipturus oxyrinchus	23-100				56				1	
Raja radiata	12-82				73					
Raja undulata	24-57	3			3				1	

Species	Size range (cm)	Dredge	Gill-net	Trammel net	Otter trawl – bottom	Otter trawl – midwater	Pair Trawl – Bottom	Seine net	Beam trawl	Not recorded
Rajidae	10-150	2		9	4458			317	1996	26
Scyliorhinus canicula	3-92	100	2330	10	40643	185	32	701	8071	61
Scyliorhinus spp.	2-121	3	17		15059		1	942	3057	254
Scyliorhinus stellaris	12-121	8	36		1186	8		4	366	35
Squalidae	25-101				13					
Squalus acanthias	1-130		17		2255	4		43	28	6
Torpedo nobiliana	32-97				14					

3.2.2 Summary of Basque (Spain) observer programme

The most important elasmobranchs catches of the Basque trawler fleet belongs to the metier OTB_DEF_>=70* (trips of the trawlers operating in the Bay of Biscay (Subareas ICES VIIIabd) with bottom trawling nets (baka) fishing mainly demersal species.)in subdivision 8b. This métier targets mainly demersal teleost but also catch several rays and sharks species, mainly *S. canicula, L. naevus* and *R. clavata*. In the period 2009-2015 *S. canicula* was the most discarded elasmobranch species. Other demersal elasmobranch species like smooth-hounds and black mouth catshark are also occasionally recorded. Discards of this species represents between the 31–74% of the total *S. canicula* catches. Between the 4–30% of total catches of *L. naevus* and between 0–14% of *R. clavata* were also discarded in the same period. A summary of the species recorded in the period 2013-2015 is shown in the Table 3.8

Table 3.8 Summary of all elasmobranchs recorded in the Basque (Spain)observer programme (2013–2015). Data in percentage of sampled individuals in each metier.

				No. of fish in sampled hauls			
Code	Scientific name	Fate	Length range (cm)	OTB_DEF_ >=70_0_0	OTB_DEF_ 100-119_0_0	OTB_MCF_ >=70_0_0	PTB_DEF_ >=70_0_0
SMD	Mustelus mustelus	D					
		R	101-61	100%	0%	0%	
SDS	Mustelus asterias	D	73-47	8%	0%	0%	92%
		R	90-73	100%	0%	0%	
SYC	Scyliorhinus canicula	D	74-11	62%	21%	12%	5%
		R	73-40	77%	0%	23%	
RJC	Raja clavata	D	58-25	94%	0%	0%	6%
		R	87-37	83%	17%	0%	
RJN	Leucoraja naevus	D	64-12	97%	3%	0%	0%
		R	80-24	100%	0%	0%	
RJU	Raja undulata	D	56	0%	0%	100%	0%
		R	56	0%	0%	100%	
RJM	Raja montagui	D					
		R	41-41	100%	0%	0%	
SHO	Galeus melasromus	D	70-14	97%	3%	0%	0%
		R					
ETX	Etmopterus spinax	D	40-38	0%	100%	0%	0%
		R					
DGS	Squalus acanthias	D	91-33	30%	57%	0%	13%
		R					
	Dipturus spp.	D	76	0%	100%	0%	0%
		R					

3.2.3 Summary of Portuguese observer programme

Data for all elasmobranchs recorded for the period 2003-2014 are summarized in Table 2.4, by fishery. *Etmopterus spp.* and *Galeus spp.* are the most frequently elasmobranch taxa sampled in the discards of otter trawl demersal fish fishery (OTB_DEF), otter trawl crustaceans fishery (OTB_CRU) and deep-water longline fishery (LLS_DWS), while S. canicula was the most frequently discarded species in the sampled hauls of set nets fishery (GNS/GTR_DEF).

Table 3.9: Summary of all discarded elasmobranchs recorded in IPMA DCF observer programme (2003–2014), by number of sampled specimens.

Code	Scientific name	Fate	Length range (cm)	No. of discarded specimens sampled			
				OTB_DEF	OTB_CRU	LLS_DWS	GNS/GTR_DEF
GUQ	*Centrophorus squamosus*	D	30-135	-	5	26	-
CYO	*Centroscymnus coelolepis*	D	35-93	-	4	15	-
CYP	*Centroscymnus crepidater*	D	48-100	-	-	26	-
CYY	*Centroscymnus cryptacanthus*	D	66	-	-	1	-
HXC	*Chlamydoselachus anguineus*	D	146	-	-	1	-
SCK	*Dalatias licha*	D	49-114	-	2	1	-
PLS	*Pteroplatytrygon violacea*	D	27-43	-	3	-	-
DCA	*Deania calcea*	D	22-105	1	100	17	-
SDU	*Deania profundorum*	D	25-31	-	3	-	-
RJO	*Dipturus oxyrinchus*	D	19-46	1	4	-	1
ETP	*Etmopterus pusillus*	D	30-50	-	-	244	2
ETX	*Etmopterus spinax*	D	31-37	-	-	1	4
SHL	*Etmopterus spp.*	D	10-58	40	500	980	-
SHO	*Galeus spp.*	D	10-86	115	2104	70	13
RJI	*Leucoraja circularis*	D	12-32	-	9	-	-
RJN	*Leucoraja naevus*	D	9-55	17	6	-	2
SMD	*Mustelus mustelus*	D	48	-	1	-	-
-	*Neoraja iberica*	D	14-32	-	5	-	-
BSH	*Prionace glauca*	D	62-230	-	-	44	-
RJH	*Raja brachyura*	D	13-89	20	3	-	4
RJC	*Raja clavata*	D	12-83	96	24	-	83
RJE	*Raja microocellata*	D	23	1	-	-	1
JAI	*Raja miraletus*	D	12-51	29	1	-	-
RJM	*Raja montagui*	D	20-56	20	3	-	19
RJU	*Raja undulata*	D	14-22	2	-	-	3
SKA	*Rajidae*	D	10-51	-	-	-	42
SYC	*Scyliorhinus canicula*	D	13-62	675	443	-	218
SYR	*Scymnodon ringens*	D	11-130	-	10	7	-
DGZ	*Squalus spp*	D	103	-	-	1	-
TTR	*Torpedo marmorata*	D	65	-	1	-	-
TTO	*Torpedo nobiliana*	D	29	-	1	-	-
TTV	*Torpedo torpedo*	D	25-29	-	4	-	-

3.2.4 Summary of the Icelandic observer programme

Elasmobranchs are currently not included in the Icelandic observer programme. Request was recently put in to get observers to record the most common elasmobranchs and that will hopefully happen next year in all metiers.

3.2.5 Summary of the 2016 French undulate ray industry-sampling programme

This industry-sampling of the undulate ray follows the 2016 species-specific TAC. Restriction to targeting and landing undulate ray (bycath only, landings limit of 20 kg per trip, total length between 78 and 97 cm) apply to vessels participating in the sampling.

Data (weight of the landings and discard, fishing effort) are collected for all trips (including those with no catch of undulate ray), fishing operations and catches. Under the French regulation, all fishing gears allowed to land the species are sampled. These include trawls and purse seines (TBB, OTT, OTB, PTB, SDN, PT, TBN, TBS, SSC, SPR, TB, SX, SV), gillnets (GN, GNS, GND, GNC, GTN, GTR, GEN) and long-lines (LL, LLS, LLD, LVS, LVD, LX) in the Bay of Biscay (8ab) and English Channel (7de from April to December 2016.

3.3 Raising methods

There are a number of different methods to get from the discards estimates per haul, or per trip, to the population level estimates of how much elasmobranchs are removed from the population by the metier, or fishery. Different countries use different methods, generally determined by the methodology used for the commercial species in these fisheries. Some countries can use several methods. In general, these "raising methods" use (i) the fraction of fishing effort to the total effort in the metier, (ii) the fraction of the landings of the focal species to the total landings of that species in the metier, or (iii), the landings of a number of commercially important species tot the total landings of those species. What follows are the descriptions of the different methods available and used in the different countries.

3.3.1 France

Discard estimation was carried out by ICES stock. Data were organised according to the standard data-exchange format for sampling, landings, and effort data from commercial fisheries (Jansen et al., 2009).

Three raising method were used:

- Method 1: raising discards of the stock to landings of the same stock,
- Method 2: raising discards of the stock to landings of all species
- Method 3: raising discards of the stock to fishing days

In methods 1 and 2, only discards were raised while in method 3 both landings and discards were raised, which allow comparing the raised landings to the reported landings.

A fishing trip may include several metiers, a subtrip represent Fishing Operations (FOs), which can be hauls for towed gears or sets for static gears, of the same metier carried out during a fishing trip. In on-board observations, FOs are allocated to the observed metier. In landings statistics, fishing trips are split in subtrips by metiers, ICES Division and day based on an estimation method. For all three methods, the raising includes the two first steps below:

Step 1: raising to the subtrip

x_j and y_j are landings and discards in the FO j of the subtrip i

The estimated total weight of landings and discards in the observed fishing subtrip i is:

$\hat{y_i} = \sum_{j=1}^{h} y_j \times \frac{H}{h}$ (eq. 3.1)

$\hat{x_i} = \sum_{j=1}^{h} x_j \times \frac{H}{h}$ (eq. 3.2)

Where: x_j and y_j are the landings and discards in FO *j* of subtrip *i*. *H* and *h* are the total and sampled numbers of FOs in subtrip *i*. For method 1, x_j and y_j are the landings and discards of the species, for methods 2 and 3 these are landings and discards of all species.

Step 2: Raising to the metier

Method 1 uses the ratio estimator of the landed weight of the stock as raising variable:

$$\hat{y}_{ratio} = X.\hat{R} = X.\frac{\sum_{i=1}^{n}\hat{y}_i}{\sum_{i=1}^{n}\hat{x}_i}$$ (eq. 3.3)

Where *X* is the reported landings of the stock for the metier and year (or smaller spatio-temporal strata).

Method 2 uses the ratio estimator of the landed weight of all species caught by the metier in the stock area.

$$\hat{y}_{ratio} = X.\hat{R} = X.\frac{\sum_{i=1}^{n}\hat{y}_i}{\sum_{i=1}^{n}\hat{x}_i}$$ (eq. 3.4)

Where *X* is the reported landing of all species for the metier in the stock area and year (or smaller spatio-temporal strata). Note that the formula is the same as in method 1 with *X*, *x* and *y* referring to all species and not to the studied species.

Method 3 uses the number of fishing days as raising variable:

$\hat{y}_m = D\frac{\sum_{i=1}^{n}\hat{y_i}}{\sum_{i=1}^{n}d_i}$ (eq. 3.5)

where *D* is the total (reported) number of fishing days for metier m in the stock area and year (or spatio-temporal strata), n is the number of sampled fishing trips in the stock area, d_i is the number of fishing days of trip *i*.

For method 2 and 3, the estimated discards includes all species, the estimated discard for the stock is obtained by applying the proportion of the stock in the total (all species) discards

$$\hat{y}_{s,m} = \hat{y}_{.,m} * \frac{y_{s,m}}{y_{.,m}}$$ (eq. 3.6)

Where $y_{s,m}$ and $y_{.,m}$ are the observed discards of the stock and of all species, $\hat{y}_{.,m}$ is one of the estimate on the estimate in eq. 4 or eq.5.

Step 3: sum over metiers occurring in the stock area. Estimates by metier in step 2 are simply summed up and there variance calculated (formulas not shown):

$$\hat{y}_s = \sum_{m=1}^{M} \hat{y}_{s,m}$$

where M is the number of metiers and $\widehat{y_s}$.is the raised discards for the stock.

For WKSHARKS3, methods 2 and 3 where applied to the 4 main metiers (DCF level 5) by stock only, representing usually 80% or more of the total landings and numbers of days. A further raising to either total landings or total days-fishing can be simply done.

For method 1, a more elaborate procedure was applied, where similar metiers were grouped in order to raise metier with lesser fishing activity for which on-board observations may be missing, this is a post stratification which has some impact on the final estimation. Method 1 is the raising method widely used for assessed stocks. Spatio-temporal stratification can be applied in all three methods.

Discard estimates from the self-sampling program fro the undulate ray (see section Issues with sampling (TOR b)), was carried out by ICES stocks for the last three quarters of 2016, similarly to the estimation applied to the DCF French on-bord observation data, using methods 2 and 3. For method 1, a stratification by area, quarter and gear (metier level 4) was applied.

3.3.2 The Netherlands

The raising procedure used for getting raised estimates of demersal elasmobranch, the procedure for the demersal species (Uhlmann et al. 2013): "Whenever a fraction of discards were sampled, a sub-sampling factor was used to expand measured observations from a sample to haul level. This sub-sampling factor is the ratio between the estimated total and sub-sampled volumes of discards.

In the next step, existing species-specific length-weight relationships were used to convert numbers-at-length also into weight-at-length. These were then standardized into discards per unit effort ('DPUE'; hereafter termed 'discard rates') rates by dividing them by the deployment duration (i.e. fishing time). To raise numbers from the haul to the trip level, over all measured hauls numbers and weights of haul-raised discarded fish are summed per length class. Then, the total duration of all hauls (including unsampled ones) is added up from sampled trips. The discarded numbers and weights are then multiplied by the ratio of total fishing divided by the sampled fishing duration to derive the total numbers and weights per trip. In the following step, the above trip-level estimates are raised to fleet level by the proportion of total over sampled fishing effort (in horsepower * days at sea)."

These effort estimators were calculated matching the stratification of the discard data that were provided in response to the ICES WGMIXFISH and STECF data calls in recent years. These are the same main gear groups which match with the sampling programme: beam-, otter trawlers, and Scottish seiners.

3.3.3 Basque Country (Spain)

The discards monitoring programme of the Basque fleet is carried out through a stratified sampling method, using the metiers as base of the sampling, (EC no.665 / 2008). Both the sampling and the subsequent raising of the discards have been carried out following the methodology agreed in "Workshop on Discard Sampling Methodology and Raising Procedures" (ICES, 2003) and in "Workshop on Discard Raising procedures" (ICES, 2007). Metier (area, gear & target) is considered as stratum and trip as sampling unit and sampled average is extrapolated by effort and by landings factors (Figure 3.2). The data are collected by observed on board and the methodology is applied both to teleost and elasmobranch species. The annual discard sampling plan covers in last years at least 5% of the total trips and hauls of the fleet.

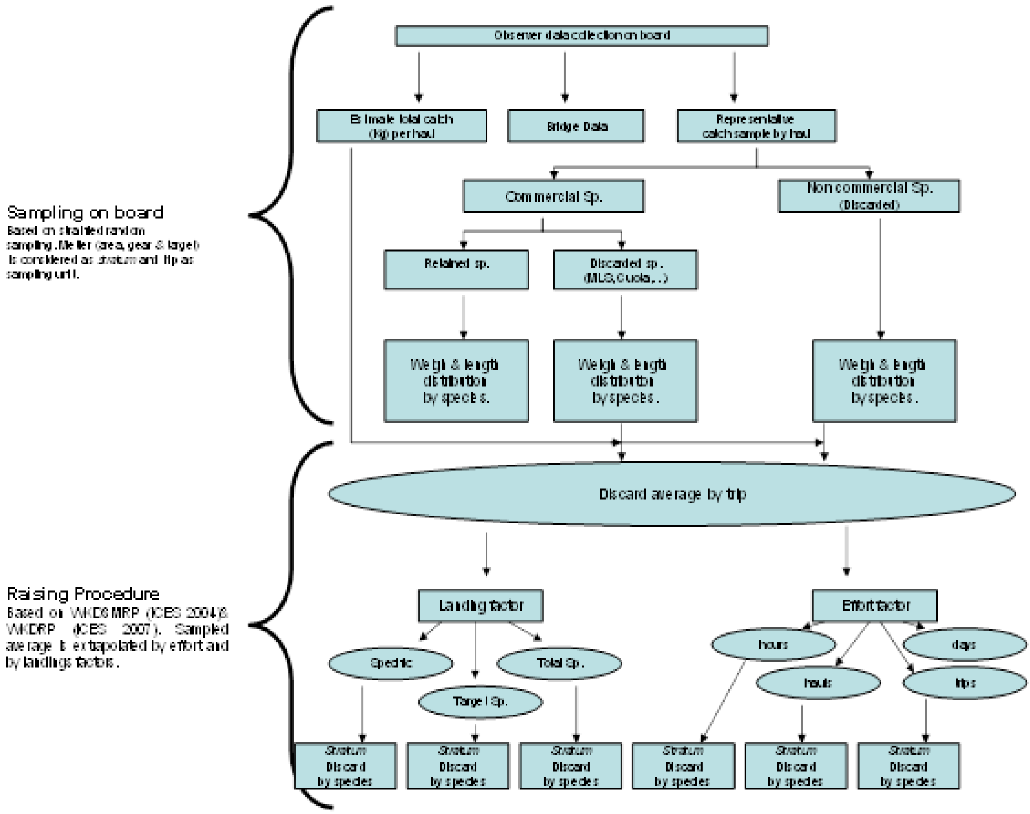


Figure 3.2. Sampling and raising methodologies used in the discards monitoring programme of the Basque fleet.

3.3.4 Portugal

Total discards estimation was carried out by ICES stock. Portuguese by-caches of elasmobranchs are derived from two main fishing fleets: trawl and Polyvalent. For the trawl fleet IPMA adopts a discard estimator which is applied a to species that occur in at least 30% of the hauls sampled in each year. Excluding *Galeus melastomus* from the OTB_CRU and *Scyliorhinus canicula* from the OTB_CRU and OTB_DEF the low frequency of occurrence of most elasmobranch species (most below 10% of occurrence in catches) Portuguese discards are not routinely estimated for them.

TRAWL – discard estimator

In the OTB_CRU and OTB_DEF *métiers* the total weight discarded (in kg) by species in each haul and trip duration (i.e. trips with the same duration of days at sea are grouped) is estimated for those occurring in more than 30% of the sampled hauls.

For each species/stock, the estimate of the total discarded weight (in kg) at the i^{th} fishing trip, the j^{th} fleet, the h^{th} haul and the s^{th} fishing day level, corresponds to the product of the ratio of discarded and retained weight of the species in the sampled catch of all *taxa* by the total weight retained in the haul of all *taxa* combined (Jardim and Fernandes, 2013):

$$\hat{d}_{ijhs} = p_{ijhs} q_{ijhs}^{-1} L_{ijhs} \text{ where } p_{ijhs} = d_{ijhs} c_{ijhs}^{-1} \text{ and } q_{ijhs} = l_{ijhs} c_{ijhs}^{-1}$$
$$var(\hat{d}_{ijhs}) = L_{ijhs}^{2} \left[p_{ijhs}(1 - p_{ijhs}) q_{ijhs}^{-2} + q_{ijhs}^{-3}(1 - q_{ijhs}) p_{ijhs}^{2} \right]$$

where:

- p is the weight ratio of the discarded species and the total of catch of all species;
- q is weight ratio of the of the weight of retained species and the total of catch of all species;
- L is the retained catch by weight (kg) of all species;
- c is the catch by weight (kg) of all species.

At the haul level the variance of the discard weight estimated is corresponds to variance of the ratio of two independent random variables (Jardim and Fernandes, 2013).

For each species/stock the estimator for the total weight discarded per unit effort (number of hours fished) at the j[th] fleet and the s[th] fishing day level is obtained by:

$$\hat{d}_{ijs} = \sum_{h=1}^{h_{ijs}} \hat{d}_{ijhs}$$
$$var(\hat{d}_{ijs}) = \sum_{h=1}^{h_{ijs}} var(\hat{d}_{ijhs})$$
$$t_{ijs} = \sum_{h=1}^{h_{ijs}} t_{ijhs}$$

$$\hat{y}_{js} = \frac{\sum_{i=1}^{n_{js}} d_{ijs}}{\sum_{i=1}^{n_{js}} t_{ijs}}$$
$$var(\hat{y}_{js}) = \left(\sum_{i=1}^{n_{js}} t_{ijs}\right)^{-2} \sum_{i=1}^{n_{js}} var(\hat{d}_{ijs})$$

where y is the discards per unit effort (in kg/h) and t is the fishing effort (in hours).

The estimated mean discarded value for each fleet is raised to the total fishing effort (T_{js}) obtained from logbook records for that fleet, and the sum of all the estimates by fleet and number of days at sea gives the overall discarded weight for trips with logbook records (Fernandes et al., 2010)):

Fleet (with logbooks) $\bar{y}_{js} = \hat{y}_{js} \times T_{js},\ var(\bar{y}_{js}) = var(\hat{y}_{js}) * T_{js}^{2}$

Overall (with logbooks) $\bar{y} = \sum_{j=1}^{J} \sum_{s=1}^{S} \bar{y}_{js},\ var(\bar{y}) = \sum_{j=1}^{J} \sum_{s=1}^{S} var(\bar{y}_{js})$

To estimate to the total discarded weight (raised to those trips without logbook records) a ratio is applied between the total number of trips performed by the fleets (N) and the total number of trips registered in logbooks (n^T):

$$\tilde{y} = \bar{y} \times \frac{N}{n^T},\ var(\tilde{y}) = var(\bar{y}) \times \left(\frac{N}{n^T}\right)^2$$

POLYVALENT – discard estimator

For the polyvalent fisheries, in particular set nets fisheries, a discard estimator is under development and it was presented at the WKHSARK3 meeting (Figueiredo et al., 2017).

The main deficiencies on the information available for the development of a discard estimation from the Portuguese polyvalent vessels are: i) the DCF on-board sampling programme has a relatively low coverage to incorporate for differences in regional and seasonal fleet activity, ii) lack of official data on the total effort (e.g. total number of trips) and landings by gear (i.e. landings are reported for all polyvalent combined not separated by fishing gear/*metier*), iii) misreporting of official landings by elasmobranch species. To note that it is common that in the same trip more than one fishing gear is used (including gillnets, trammel nets, pots and longline).

Due to these insufficiencies, a model-based approach to estimate discard weight or number by species was considered inadequate (Figueiredo et al., 2017).

For the hauls where set gillnets or trammelnets were used by the fishing vessels belonging to the POLYVALENT fleet with LOA > 12m (for which logbook data is available), a double sampling or two-phase sampling estimator was proposed. This estimator takes into consideration the probability of the species occurs in the one haul and the probability of the species be discarded if caught in the haul. The estimator proposed refers to the mean number of rejected specimens in each year and is given by:

$$\bar{\bar{Y}} = \frac{\bar{x}}{\bar{\bar{X}}}\,\bar{y}$$

where

$\bar{x} = \frac{a}{n} = p$ - sampling estimate proportion of hauls with the species;

$\bar{X} = \frac{A}{N} = P$ - proportion of hauls with the species in the "target population", in this case hauls made by the POLYVALENT fleet sing set nets with LOA > 12m in the year under analysis

$\bar{y}$ - sampling estimate mean number of discarded specimens in one haul

n - number of sampled hauls

a – number of sampled hauls with the species

N - total number of hauls in the "target population"

A- number of hauls with the species in the "target population"

Using the Taylor expansion, the square of the coefficient of variation of the estimate ($\bar{\bar{Y}}$) is given by:

$$(cv)^2 = \left(\frac{1-f}{n}\right)\left(C_{yy} + C_{xx} + 2C_{xy}\right)$$

Where f –sampling fraction *n/N*; $C_{yy} = \frac{S_y^2}{\bar{\bar{Y}}^2}$ square of the coefficient of variation of y_i (number of discarded specimens in each i-th haul); $S_y^2 = \frac{\sum_{i=1}^{N}(y_i-\bar{Y})^2}{N-1}$; $C_{xx} = \frac{S_x^2}{\bar{\bar{X}}^2}$ square of the coefficient of variation of x; $S_x^2 = \frac{\sum_{i=1}^{N}(x_i-\bar{X})^2}{N-1}$; $C_{xy} = \frac{S_{xy}}{\bar{Y}\bar{X}}$; S_{xy} covariance between X and Y.

No discard estimates for elasmobranch species caught by polyvalent vessels with LOA > 12 m using set nets from Portugal were presented at WKHSARK3. To move forward on the estimation of the mean number of rejected specimens, the size of the population, i.e. the total number of hauls is yet to be known. For that purpose, independent data sources from the onboard observer programme (e.g. logbooks) could to be used in the estimator, but are still to be compiled.

3.3.5 Iceland

As observer data is not available, alternative methods were used for raising discards for *A. radiatia* and *D. batis*. As these two species are generally landed in three months of the year (September-November), we can use landings in those months to estimate discards in other months by subtracting the landings in those other months with the average landings in Sept-Nov. The discard value is then corrected for differences in effort in terms of number of hauls. This was done for each metier each year from 2000-2016. This method most likely underestimates discards, as it does not account for size selection in the three months when the species are landed. For other species, mostly deep water sharks, we plan to use bottom trawl and gill net survey data to estimate discards in those metiers. This has been done before for the black dogfish (*C. fabricii*) in the greenland halibut bottom trawl fishery.

3.3.6 Scotland

Estimation carried out by University of Aberdeen for smoothhound.

Discard estimation of smooth-hounds (*Mustelus* spp.) was carried out using Marine Scotland Science observer programme data for the period 2009-2014. Two categories of fishing vessels and gears were considered in the analysis: i) vessels that target demersal fish, and ii) vessels that target the Norway lobster (*Nephrops norvegicus*). No attempt was made to stratify within these categories according to mesh size, although they conform to the so-called TR1 and TR2 categories, respectively. TR1 gears are defined as trawls and demersal seines with mesh sizes ≥ 100mm. TR2 gears refer to nets with mesh <100mm but ≥ 70mm.

Raised discards were estimated by fleet (D_F) using a ratio estimator, from n observed trips, according to Fernandes et al. (2011):

$$D_F = \sum L_F \frac{\sum_{t=1}^{n} D_t}{\sum_{t=1}^{n} L_t}$$

where L_F = total landings of the auxiliary variable for the fleet, obtained from the Scientific, Technical and Economic Committee for Fisheries (STECF) database; D_t = discard quantity of smooth-hounds for observed trip t; L_t = landings quantity for the observed trip t.

The auxiliary variable *L* used in the ratio estimator was the target assemblage (quantity of the species targeted by the fishery), or specifically (as there were no smooth-hound landings in the available data): Cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), whiting (*Merlangius merlangus*) and saithe (*Pollachius virens*) landings for Scottish TR1; Cod, haddock, whiting, saithe and Norway lobster landings for Scottish TR2. Results are shown in Figures 3.3-3.5.

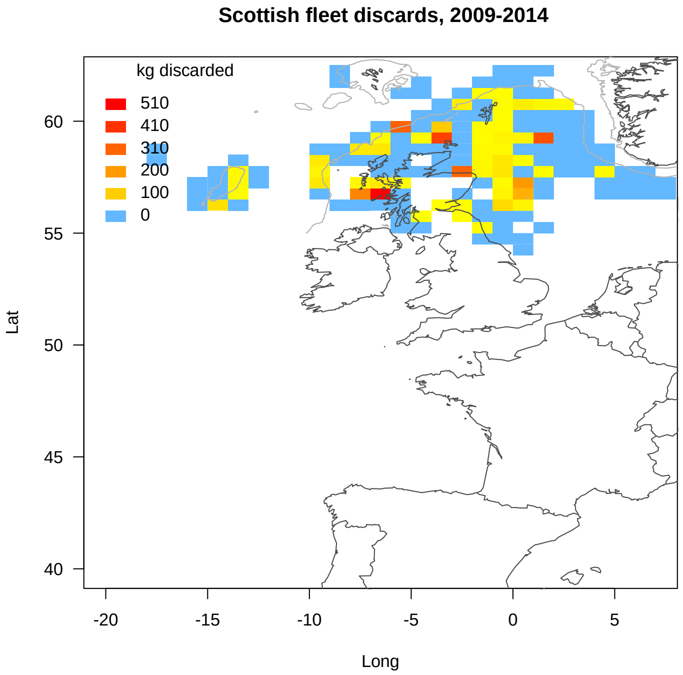


Figure 3.3: Distribution of observed *Mustelus* spp. discards in the Scottish fishing fleets, from 2009 to 2014 inclusive. Colours refer to the weight (kg) discarded in each ICES statistical rectangle according to the legend.

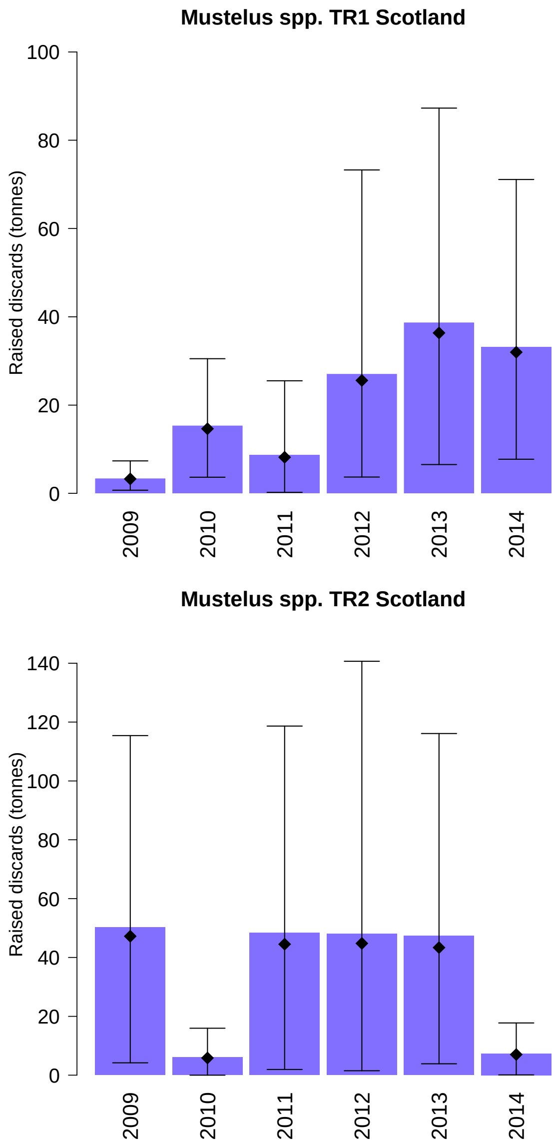


Figure 3.4: Raised discards [tonnes] of *Mustelus* spp. for Scottish TR1 fleet (left) and TR2 (right), with 95% confidence interval and median.

4 Suitability of existing programs

4.1 Introduction

To address ToR b) on the suitability of existing national programmes for the estimation of discards of elasmobranch, the workshop reviewed potential issues in national on-board observation programmes carried out easer under national fundings and EU-DCF as well as self-sampling and industry sampling programmes.

Onboard observer programs have generally been implemented for estimating discards of abundant commercially important species (e.g. hake, *Nephrops*, cod, sole, plaice). The sampling designs in most countries have therefore been defined considering the *métiers*, seasons and areas relevant for these species. Consequently, the different national sampling programmes might not be optimal for estimating precise and unbiased discards for elasmobranchs. Furthermore, the random selection of vessels within an ICES Division may result in any species with a more restricted distribution within the Division (e.g. in relation to habitat specificity) being under- or over-sampled if there are a small number of trips.

The data recorded on board can vary between species and countries. For example, some countries only count individuals, others count and measure length, etc. Some countries only record discarded elasmobranch individuals while others sample both the discarded and retained fraction of the catch. Some countries (e.g. England and Ireland) collect elasmobranch data by sex. Subsampling practices can also differ, which can affect in particular large elasmobranch species if the sampling quantity, e.g. sampled basket is too small to contain large sharks. Similarly, large sharks might be removed from the net before hauling and hence are not available on board for measurement or might not even be noticed by the observer.

A number of issues are generic for all on board observation such as refusal of access to sampling on board certain vessels or potential changes in fishing behaviour when an observer is on board.

Species identification is an issue for all species but might be more acute for rarer elasmobranchs; similarly, for data quality checking. There are suspected errors in various national datasets, based on the spatial and size distributions of records, some of which may relate to coding errors and some to misidentifications.

Knowledge on the survival of discarded individuals is also needed for informing potential exemptions from the EU landings obligation. Ideally the state of discarded elasmobranch individuals (dead or alive; the state if alive) could usefully be recorded on board, but this unfortunately not feasible in most routine observation situations, but such approaches may be feasible for a limited number of species if they are found only occasionally.

Industry self-sampling programme might differ from those carried out under the EU data collection program and probably vary more in time and space.

Below we summarize by country the characteristics and potential issues with existing sampling programmes which could impact the quality of onboard or self-sampling data for estimating elasmobranch discards.

Table 4.1. Summary of issues and characteristics of national discard sampling programmes (observer sampling and self-sampling) with respect to elasmobranch species.

Country	Metier coverage	Spatial-temporal coverage	Onboard sampling	Species identification
UK (England)	Suitable. Most metiers are sampled, but coverage can be very low. There may be reduced coverage of those metiers considered to be more selective	Seasons (quarters) and regions (ICES Divisions) are considered in the sampling design. Poor weather can affect quarterly targets. Spatial coverage is presumed adequate for those species with a broader range of habitat types (e.g. S. canicula, R. clavata), but some skates have localised areas of higher abundance within a Division, which could impact on estimates.	Data on the size compositions (by sex) of both discarded and retained elasmobranchs are collected. Depending on the metier and haul, there can be high raising factors for some hauls (but hauls with the highest raising factors generally only include subsamples of S. canicula)	Species identification training for observers, including elasmobranchs.
France	Suitable: All metiers landing elasmobranchs are sampled by the DCF sampling programme, but coverage can be very low	Seasons (quarters) and ICES Divisions are considered in the sampling design. Spatial coverage is adequate.	Suitable: Large individuals are extracted before sub-sampling occurs; both discards and landings are sampled (counted, length measured and sexed).	Species identification training for observers, including elasmobranchs. Identification problems remain for rare species, e.g. Rostroraja alba.

Country	Metier coverage	Spatial-temporal coverage	Onboard sampling	Species identification
Portugal	The main métiers catching elasmobranchs are sampled, but the coverage (ratio of trips sampled in relation to the population) may be low, especially for the polyvalent fleet (LLS_DWS and GTR/GNS_DEF). Sampling of vessels using GTR/GNS_DEF is restricted to those with LOA > 12 m. Vessel's capacity and logistic constraints may affect the execution of the plan.	Seasons and regions are considered in the sampling design. Bad weather conditions may affect the coverage by season. Insufficient sampling effort to enable robust estimates by area or by season. Hindering the understanding of differences in regional and seasonal fleet activity.	Both discards and landings sampled. Subsampling in trawl fleets may hinder the representative sample of larger individuals. Length data may not be recorded for all the sampled specimens. For the polyvalent fleet, weight data is estimated from length.	Species identification training for observers, including elasmobranchs. Identification guides were produced by IPMA, to help observers and fishermen reporting in logbooks.
Ireland	Suitable. All major metiers are covered. Inshore vessels may be under-represented.	Suitable	Potentially problematic. Large elasmobranch discard specimens may not be reliably sampled	Species identification training for observers, including elasmobranchs
Basque Country (Spain)	Suitable: Main metiers landing elasmobranchs (OTB) are sampled- Sampling cover at least the 5% of total fleet’s hauls.	Suitable: raised available Quarterly and yearly. The data presented in the WKSHARK3 are raised by year	Potentially problematic. Large elasmobranch discard specimens may not be reliably sampled	Species identification training for observers, including elasmobranchs
The Netherlands	The main metier catching demersal elasmobranchs are sampled, but the coverage is low for some metiers.	Quarters are considered in the sampling design, but raising is done annually	Potentially problematic. Large elasmobranch discard specimens may not be reliably sampled. Only discards of elasmobranchs are sampled, no concurrent landings	Species identification training for observers, including elasmobranchs

Below are some additional explanations of sampling issues by country.

4.2 UK (England)

The English programme collects data on the quantities and length distributions of fish and shellfish, both for retained and discarded samples, with data for elasmobranchs also collected by sex. Depending on the trip (vessel, gear, catch volume and composition), there can be a high raising factor (RF) in some hauls. Most hauls sampled have a RF of 1, although a very small proportion of hauls have a RF >30. The hauls with high RFs often only include a restricted number of the more frequent elasmobranchs, such as *S. canicula.* Typically, larger and more conspicuous species are recorded for the entire catch (RF = 1), but more numerous species (e.g. *S. canicula* and some skates) included in sub-samples and raised accordingly.

4.3 Ireland

Due to the nature of the one box sampling of discards, elasmobranchs may not always be representatively sampled. This is especially so for larger specimens that may occur as a one off or are not abundant in the catch overall. Landings are sampled more representatively as they are targeted by the sampler and then sampled according to their abundance and length frequency distribution (Moore & Gerritsen 2017WD).

4.4 The Netherlands

In the Netherlands, there is a self-sampling program in place using a 'reference fleet' within the demersal fisheries. This reference fleet consists of vessel owners willing to participate in the self-sampling programme and where the fisher's retained fractions of their discards during some trips. These are bagged, sealed and brought back to shore. There, the species and length compositions are determined. Because the species are bagged there may be a size bias in the sample, with smaller species and specimens being over observed within trips.

Throughout the year, observers accompany approximately 10 trips are independently sampled using observers, There, the potential size bias is probably lower.

Within the discards self-sampling program there is no length information by species for the landings of the same trips.

4.5 Portugal

Portuguese information on elasmobranch discards have been collected under the Data Collection Framework (EU DCF/NP) through an on-board sampling programme, carried out by Instituto Português do Mar e da Atmosfera (IPMA) (Serra-Pereira et al. 2017 WD). Two main fishing segments have been sampled: bottom otter trawl and polyvalent. Collection of bottom otter trawl discards data covers two *métiers* i) bottom otter trawl crustacean fishery (OTB__>=55_0_0, herein OTB_CRU) and; ii) bottom otter trawl demersal fish fishery (OTB__>=65_0_0, herein OTB_DEF). The information routinely sampled from the polyvalent segment covers two fisheries: i) deep-water longlines targeting black scabbardfish at depths deeper than 1000 m deep (*métier* LLS_DWS_0_0_0, herein LLS_DWS); and ii) set net fisheries which includes the trammel or gillnets as fishing gears (include the *métiers* GNS_DEF_60-79_0_0, GNS_DEF_80-99_0_0, GNS_DEF_>=100_0_0, GTR_DEF_80- 99_0_0 and GTR_DEF_>=100_0_0, all considered to be part of a single stratum, GNS/GTR_DEF) that operate at depths shallower than

150 m and target a multi-species complex, by vessels with length overall larger than 12 m.

The collection of on-board data from OTB_DEF and OTB_CRU started in 2003, whereas from LLS_DWS started in 2005 and from GNS/GTR_DEF in 2011. The sampling protocol for OTB *métiers* include the collection of numbers and weights by species, while that for polyvalent fleet only accounts for numbers. Length data (by sex) is not always collected by specimen. In the trawl fisheries, subsamples of two 15 (OTB_CRU) or 20 kg (OTB_DEF) boxes may affect the representative sample of larger specimens.

Low execution rate of the sampling plan of polyvalent trips is related to: i) vessels not having space on-board to accommodate the observers; ii) inability to guarantee their safety under bad weather conditions; iii) logistic constraints in accessing ports of departure (Serra-Pereira et al. 2017 WD).

4.6 Basque Country (Spain)

Elasmobranch and teleost are sampled with the same methodology, and there is not a specific sampling plan for elasmobranchs. The most important fleet catching elasmobranchs is the trawler fleet (metier OTB_DEF_>=70* in subdivision 8b). This métier targets mainly demersal teleost several rays and dogfish species. Sampling is done by observers and covers at least the 5% of the total trips and hauls every year. Sampling and raising methodologies are considered robust for the most abundant species but for the lesser common ones and large elasmobranchs the sampling method and raising tend to over-estimate discards.

4.7 France: industry-sampling for undulate ray in the English Channel and Bay of Biscay

An industry-sampling program to monitorundulate ray by-catch is on-going in the Bay of Biscay (8ab) and English Channel (7de). All fishing gears are sampled.. Fishing authorisation to land this species are delivered by the French fisheries Ministry (DPMA) to vessels willing to participate. Participating vessels report the discarded and landed weight haul-by-haul for all their fishing opeartions.

A potential issue of this program is the discard weight estimation by the fishermen which may be biased. It would be necessary to set up a validation through observer programs on an independent sample of these vessels.

In in 2016 the sampling covered 9 months and no data onthe length composition of the landings and discards were collected. Contrarily, length composition data were collected in 2015, where the sampling was carried out for 3.5 months..

In 2017, theprotocol for this industry-sampling programme should remain the same with the addition of the data on the discarded weight for authorized size (> 78 cm) and prohibited size (< 78 cm) by haul. This self-sampling program is expected to be continued for several years.

5 Discard retention patterns

5.1 Introduction

The discard-retention patterns of fish are a function of the capture-gear (i.e. catchability and selectivity), regulations (e.g. size restrictions, quota availability), marketability (e.g. species, size and quality of fish, market price) and individual fisher behaviour (e.g. some vessels may retain fish for bait in pot fisheries; some vessels may only land lower value species if they are in a sufficient quantity). Consequently, there are a range of different discard-retention patterns between various species, across fleets and over time (Silva *et al.*, 2012, 2013).

For the present work, distinct case studies were investigated, addressing some of the stocks to be examined by WGEF in 2017.

The rationale for this work was to:

i) To identify which data sets may provide suitable data for further length-based analyses

ii) To examine existing data to determine where the direct or indirect effects of management measures may have led to changes in discard-retention patterns

iii) To identify where there are relatively higher levels of discarding (e.g. in relation to discard survival)

Not all metiers/fleets will have observer coverage at a level that will be able to detect changes in discard retention patterns. Where observer coverage is high, changes in discarding pattern for less commonly-encountered species may also be undetectable. The suitability of current discard observer programmes to quantify rare elasmobranch encounters is discussed in Chapter 6.

Time constraints prevented detailed analyses of these data, with information from exploratory studies provided below. There are, however, several reasons why fish may be discarded, which should also be considered when interpreting discards data.

i) Smaller individuals are not generally of marketable size or value (or may be subject to a minimum landing size in some inshore areas or for some voluntary measures introduced by a specific fishery).

ii) Regulatory discards: Some fish may be discarded because of insufficient quota, limited trip limits of bycatch quotas (e.g. North Sea skates and rays "*shall not comprise more than 25% by live weight of the catch retained on board per fishing trip*" for those vessels over 15 m LOA), or prohibited status.

iii) State of the fish. For example, trawl-caught skates can be damaged in the cod-end if there are boulders or a heavy bycatch of hard/abrasive invertebrates; skates caught in those gillnet fisheries with a comparatively long soak time can be damaged by isopods and other scavengers.

iv) The presence of observers onboard might influence the discarding practices of fishers.

Case studies of discard estimations are provided in the next section. These were selected based on geographic location, number of fisheries and stock distribution.

5.2 Tope *Galeorhinus galeus* in the Northeast Atlantic and Mediterranean

National data were examined for UK (England), Ireland, France and Spain (Basque country) (Figures 5.1-5.3). Portugal was not included in the analysis, as there were no records of tope from the observer programme in Division 9.a, although it is known that it can be occasionally caught by polyvalent vessels.

The collation of these data enabled the discard-retention patterns to be examined for two main gear categories: otter trawl and gillnet. Tope is a larger-bodied and more pelagic shark, and so there were only limited data on their capture in beam trawl fisheries.

In relation to management measures, current EU regulations prohibit the landing of tope when caught by longline in Union waters of ICES Division 2.a and subarea 4 and in Union and international waters of ICES subareas 1, 5-8, 12 and 14. National UK management measures limit fisheries to 45 kg live weight per day.

5.2.1 Preliminary findings

- There are insufficient data to interpret any trends in discard/retention patterns in these fisheries. Tope is not caught in large numbers, and it is possible that data for smaller tope and smooth-hounds may be confounded.
- There were no clear length-based differences in retention in UK data, which may reflect national measures in place.
- Current observer programmes have only limited data. For example the UK (English) observer programme usually has <100 tope measured (aggregated data after it has been raised to haul) each year, which may limit the utility of these data for Length-Based Indicators.

5.3 Smooth-hounds *Mustelus* spp. in the Northeast Atlantic

National data were examined for UK (England) and France (Figures 5.4-5.7). Portugal was not included in the analysis, because only one specimen of *Mustelus mustelus* (48 cm TL) was recorded from the observer programme on-board a *Nephrops* bottom trawler in Division 9.a, although it is known that it can occasionally be seen in landing auctions.

The collation of these data enabled the discard-retention patterns to be examined for four main gear categories: otter trawl, beam trawl, gillnet and, to a lesser extent, longline.

There are no specific management measures relating to smooth-hounds, although the restrictions on landing spurdog is thought to have been one of the factors leading to increased retention of smooth-hounds in some fisheries. For this reason, data for UK (England) were examined in 5-year periods (2002–2006; 2007–2011; 2012–2016).

Whilst larger smooth-hounds may be landed for human consumption in some fisheries, other fisheries may land all sizes for bait in pot fisheries.

5.3.1 Preliminary findings

- Beam trawls generally take a greater proportion of smaller specimens (ca. <70 cm), whilst a broader length range are taken by otter trawl, and gill nets generally take larger specimens (ca. >70 cm).

- There is the indication that there is increased retention of smooth-hounds in UK fisheries (otter trawl and gillnet), although further studies are needed to better quantify this.
- Otter trawls tend to sample the broadest length range. The utility of the overall length composition (discard and retained) from these fleets for the development of LBI should be investigated by WGEF.

5.4 Thornback ray *Raja clavata* in Divisions 4.b.c and 7.d

National data were examined for UK (England), France, the Netherlands and Spain (Basque Country)(Figures 5.8-5.12). The collation of these data enabled the discard-retention patterns to be examined for four main gear categories: otter trawl, beam trawl, longline and gillnet (the latter also considered by mesh size).

Thornback ray is managed under the generic TAC for skates and rays in the North Sea (Subarea 4), and a separate TAC area in Division 7.d. Larger (>15 m) vessels in Subarea 4 are also subject to a bycatch limit, under which skates should "*not comprise more than 25% by live weight of the catch retained on board per fishing trip*"). Some sections of the fleet are subject to a minimum landings size (e.g. in some inshore areas of England). Quota has thought to have been restrictive for some fisheries in recent years, and so data were examined over time.

5.4.1 Preliminary findings

All gears show similar patterns of retention and discarding, with the exception of longlines. These are much more selective for larger fish, and so there are few small fish discarded.

French data were available for most common métiers from 2011–2015. Only OTB_DEF are presented here (Figure 5.10). These show a general increase in the proportion of discards of smaller fish since 2011, with a particularly noticeable increase in 2015 compared to previous years. Further data are required to determine whether the 2015 figures are part of an increasing trend, or a particularly large year-effect.

5.5 Blonde ray *Raja brachyura* in Divisions 4.c and 7.d

National data were examined for UK (England), France and the Netherlands (Figures 5.13-5.15). The collation of these data enabled the discard-retention patterns to be examined for three main gear categories: otter trawl, beam trawl and gillnet (the latter also considered by mesh size where possible).

Blonde ray is also managed under the generic TAC for skates and rays in the North Sea (Subarea 4), and a separate TAC area in Division 7.d. Larger (>15 m) vessels in Subarea 4 are subject to a bycatch limit (see thornback ray above) and some sections of the fleet are subject to a minimum landings size. Whilst the general skate quota has thought to have been restrictive for some fisheries in the stock area in recent years, blonde ray is usually a higher value species than thornback ray.

5.5.1 Preliminary findings

Gill-nets show just small numbers of discarded *Raja brachyura* within all countries' data. Both UK and French data show high proportions of discarded small fish from otter trawls.

5.6 Cuckoo ray *Leucoraja naevus*

Cuckoo ray is currently examined for a nominal North Sea stock and a stock in Subareas 6, 7 and 8.a.b.d. National data were examined for France, Ireland, Spain (Basque country), the Netherlands and UK (England) (Figures 5.16-5.21). Portugal was not included in the analysis, since there is limited length data for cuckoo ray from the observer programme in Division 9.a. From bottom otter trawl, five specimens were sampled (discarded 27–32 cm; retained 51–58 cm), while for set nets 10 specimens were sampled (discarded 48–55 cm; retained 49–61 cm).

The collation of these data enabled the discard-retention patterns to be examined for (a) three main gear types (otter trawl, beam trawl and gillnet) used by the UK fleet in the Celtic Seas ecoregion, and (b) the various national otter trawl fisheries operating in the North Sea (UK data), north-west Scotland (Irish data), Celtic and Irish Sea (Divisions 7.a-c, e-k; Ireland, France, UK) and Bay of Biscay (Divisions 8.a.b.d; France and Spain (Basque Country).

Cuckoo ray is managed under the generic TAC for skates and rays in the Celtic Seas ecoregion and a separate TAC for the Bay of Biscay and Iberian waters. The more offshore distribution of this species means that it is less likely to be taken in fisheries subject to a minimum landing size.

5.6.1 Preliminary findings

Few data are available from the Dutch fleets, with limited catch data available. This is to be expected based on the main fishing locations of the Dutch fleets. Similarly, the numbers of fish sampled by the French fleet in the North Sea are too small to determine trends.

Fishers in the Celtic Sea and Irish Sea report differing discard rates between Irish and French vessels. This is based on differing market requirements. This is corroborated by the figures below (Figures 5.16 and 5.21). Irish otter trawls operating in 7.a.e-k discard most of their catches of *L. naevus*, whereas they are retained by French vessels operating in the same area. UK vessels operating in the same area show a discard pattern midway between these two extremes, with some discarded and some retained. Discards/retentions by the Basque Fleet in 8 show that most fish below a certain size are discarded, with larger specimens retained. Irish otter trawl sampling in ICES sub-area 6 shows two distinct cohorts in the data that are not visible in other gears, or from data for other countries.

5.7 Lesser-spotted dogfish *Scyliorhinus canicula*

There are likely to be a succession of stocks or metapopulations of this species, with ICES providing advice on the species by ecoregion.

5.7.1 *S. canicula* in the North Sea and eastern Channel

The following data were examined:

- UK (Eng) data for 4.b.c and 7.d by otter trawl (including Nephrops trawl), beam trawl, longline and gillnet (Figure 5.22).
- French data for Subarea 4 and Division 7.d by otter trawl (Figure 5.23)

5.7.2 *S. canicula* in the Celtic Seas

The following data were examined:

- UK (Eng) data for 6, 7a-c, 7.e-k by otter trawl (including *Nephrops* trawl), beam trawl, longline and gillnet (Figure 5.24).
- Irish data for 6, 7a-c, 7.e-k by otter trawl and beam trawl (Figure 5.25)
- French data for 6, 7a-c, 7.e-k by otter trawl (Figure 5.26)

5.7.3 *S. canicula* in the Bay of Biscay

The following data were examined:

- French data for 8.a.b.d by otter trawl (Figure 5.27)
- Spanish (Basque) data for 8.a.b.d by otter trawl (Figure 5.28)

5.7.4 *S. canicula* in the Iberian waters

The following data was examined:

- Portuguese data for 9.a by otter trawl (both demersal fish and *Nephrops* trawl) and set nets (Figure 5.29).

5.7.5 Preliminary findings

Lesser-spotted dogfish is probably the most caught elasmobranch in European waters. However, it is rarely a target species. This is shown in the discard-retention patterns of the examined fleets, where in most fleets and nations, the vast majority of specimen are discarded rather than retained, regardless of size. However, the UK otter-trawl fishery shows a higher retention pattern than other gears or similar gears from other countries.

5.8 *Amblyraja radiata* in the North Sea

A. radiata are currently on the prohibited species list of the European Commission Fishing regulations. They have always been primarily a bycatch fishery, with the majority discarded (Silva *et al.*, 2012). This is borne out in the data examined, which were from the Dutch observer scheme (Figure 5.30)

5.9 Overall conclusions

While observer data are available from all countries, not all métiers are sampled to a level that can allow patterns in discard/retention ratios to be observed. Similarly, few métiers have been intensively sampled enough to allow changes in pattern to be determined. Otter trawl-based métiers have the most number of samples for almost all examined species. These are most likely to be of use in stock assessments. Length-based indicators are probably only going to be useable for this gear-type for the majority of demersal elasmobranch stocks. Whilst some nations have large samples sizes for various gillnet métiers, the length-distributions are influenced greatly by mesh size, which would need to be considered in future evaluations of length-based indicators.

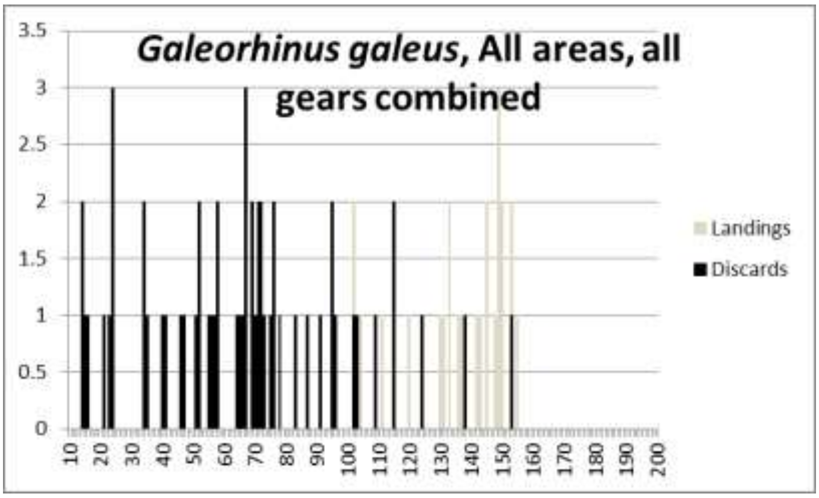


Figure 5.1. ***Galeorhinus galaeus*****. Discard/landing records from Irish observers. There are insufficient records to present observations by gear type.**

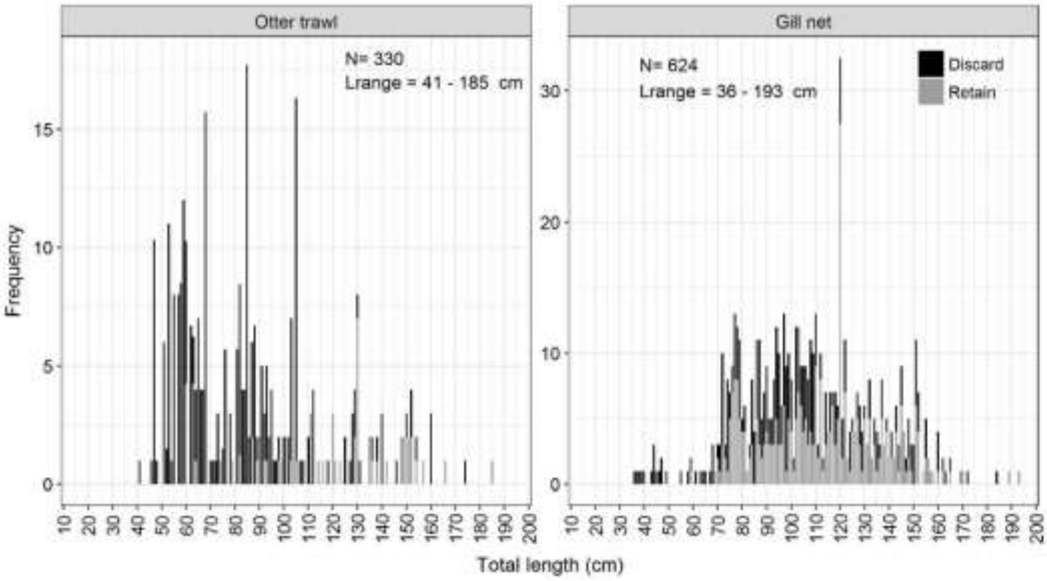


Figure 5.2: Length-based discard-retention pattern of tope *G. galeus* for otter trawl (left) and gill net (right), as recorded during the UK (English) observer programme (data combined for the years 2002-2016).

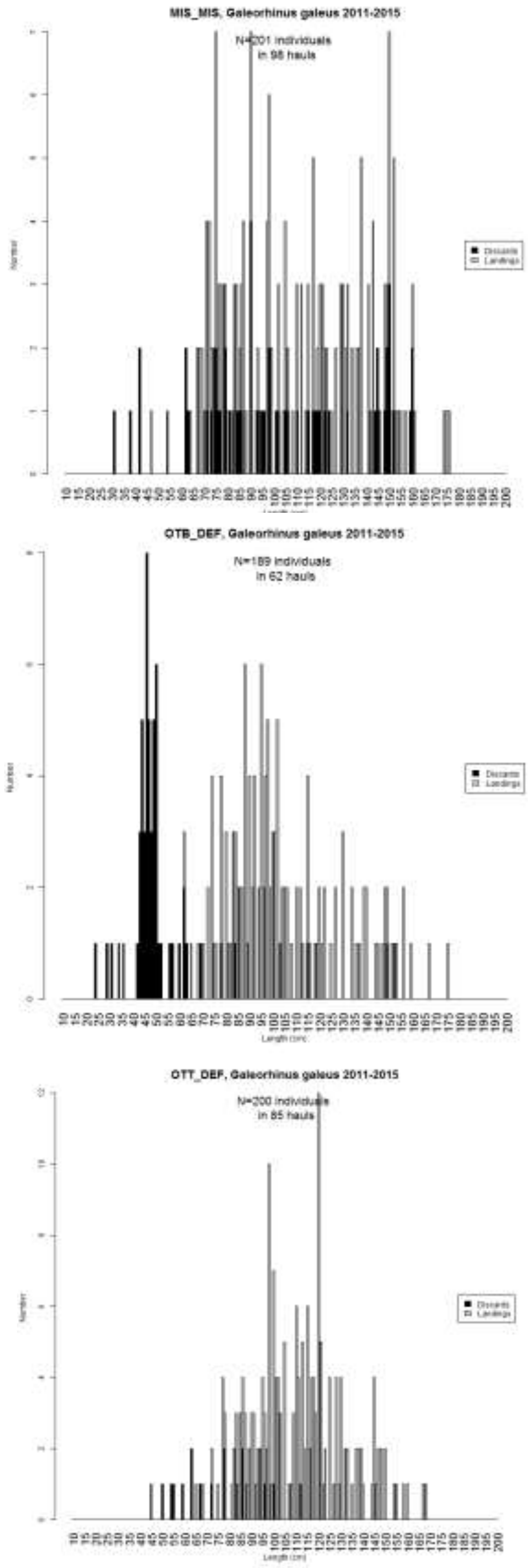


Figure 5.3. Length-based discard-retention pattern of tope, *G. galeus*, by metier, as recorded during the French observer programme (data combined for the years 2011-2016).

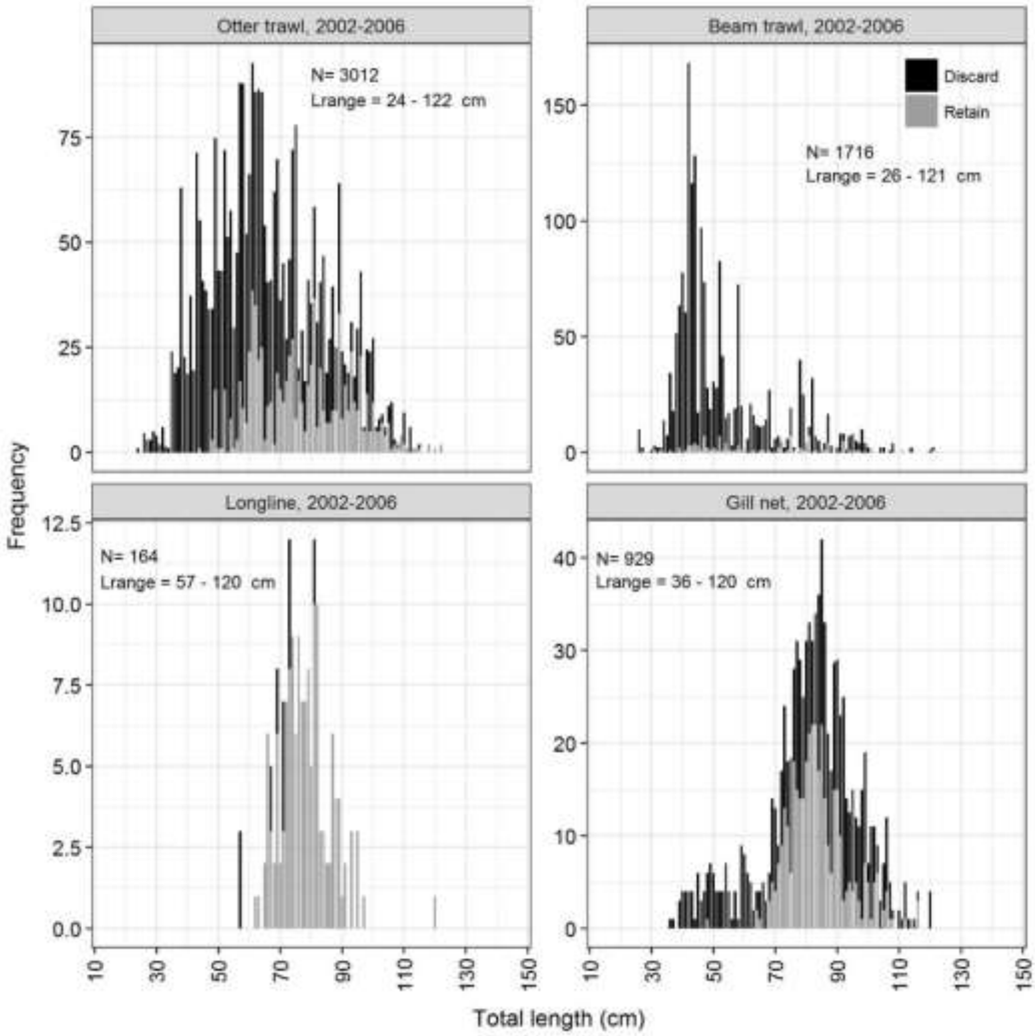


Figure 5.4: Length-based discard-retention pattern of smooth-hounds *Mustelus spp*. for otter trawl (top left), beam trawl (top right), longline (bottom left) and gill net (bottom right) as recorded during the UK (English) observer programme in the years 2002-2006.

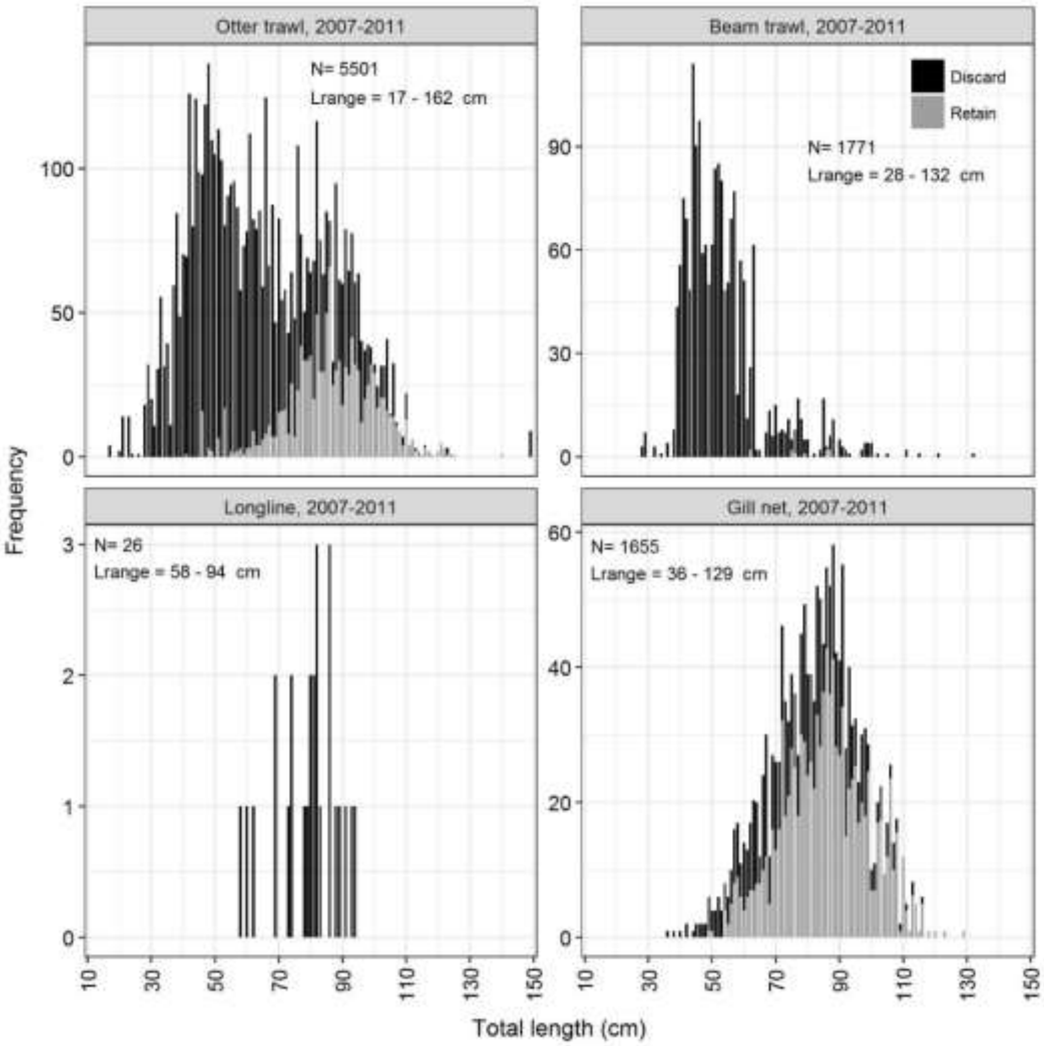


Figure 5.5: Length-based discard-retention pattern of smooth-hounds *Mustelus spp.* for otter trawl (top left), beam trawl (top right), longline (bottom left) and gill net (bottom right) as recorded during the UK (English) observer programme in the years 2007-2011.

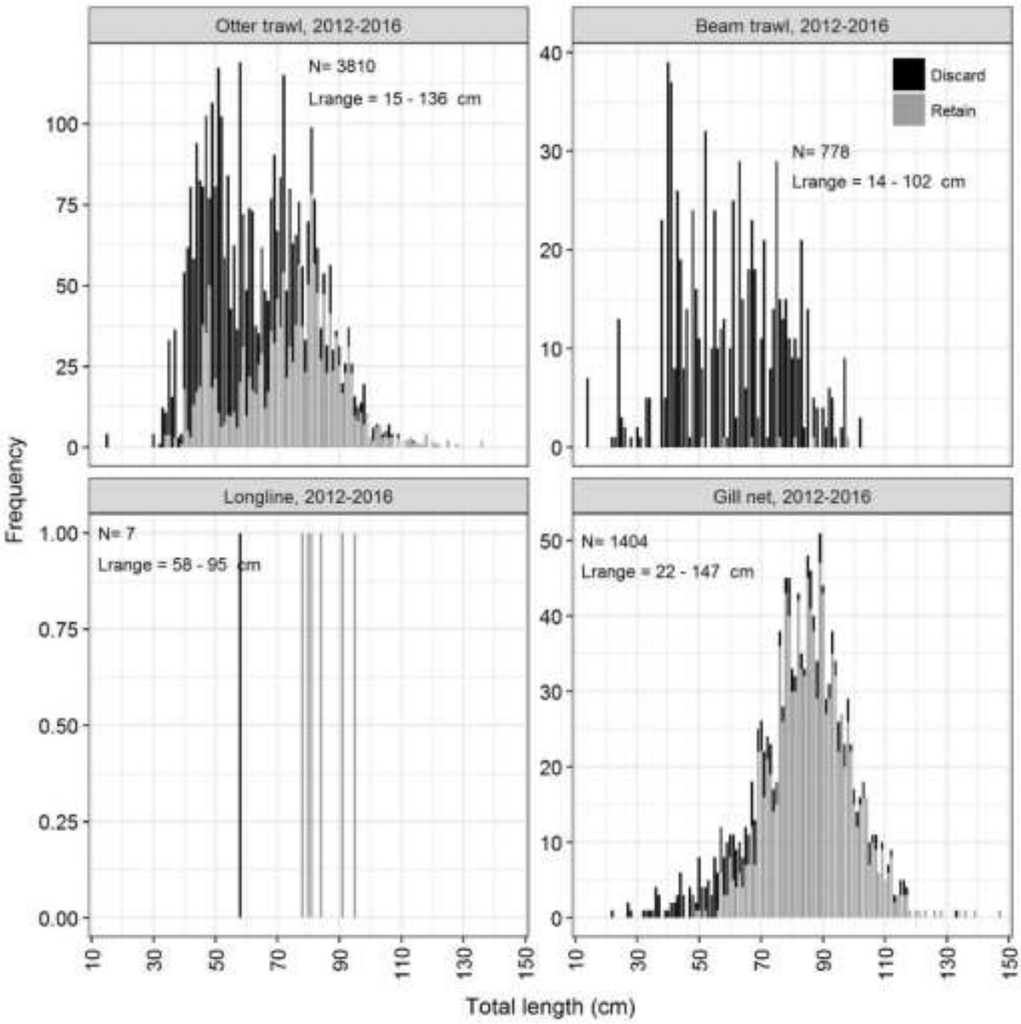


Figure 5.6: Length-based discard-retention pattern of smooth-hounds *Mustelus spp.* for otter trawl (top left), beam trawl (top right), longline (bottom left) and gill net (bottom right) as recorded during the UK (English) observer programme in the years 2012-2016.

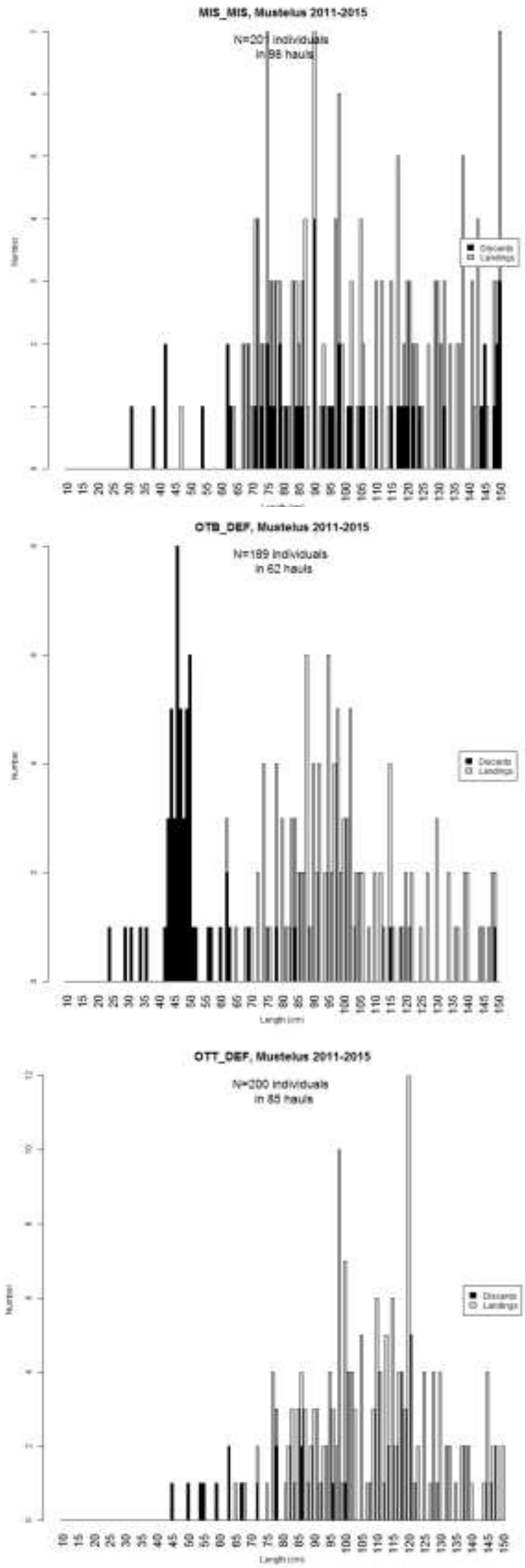


Figure 5.7. Length-based discard-retention pattern of Smoothhhounds, *Mustelus spp*. by metier as recorded during the French observer programme (data combined for the years 2011-2016).

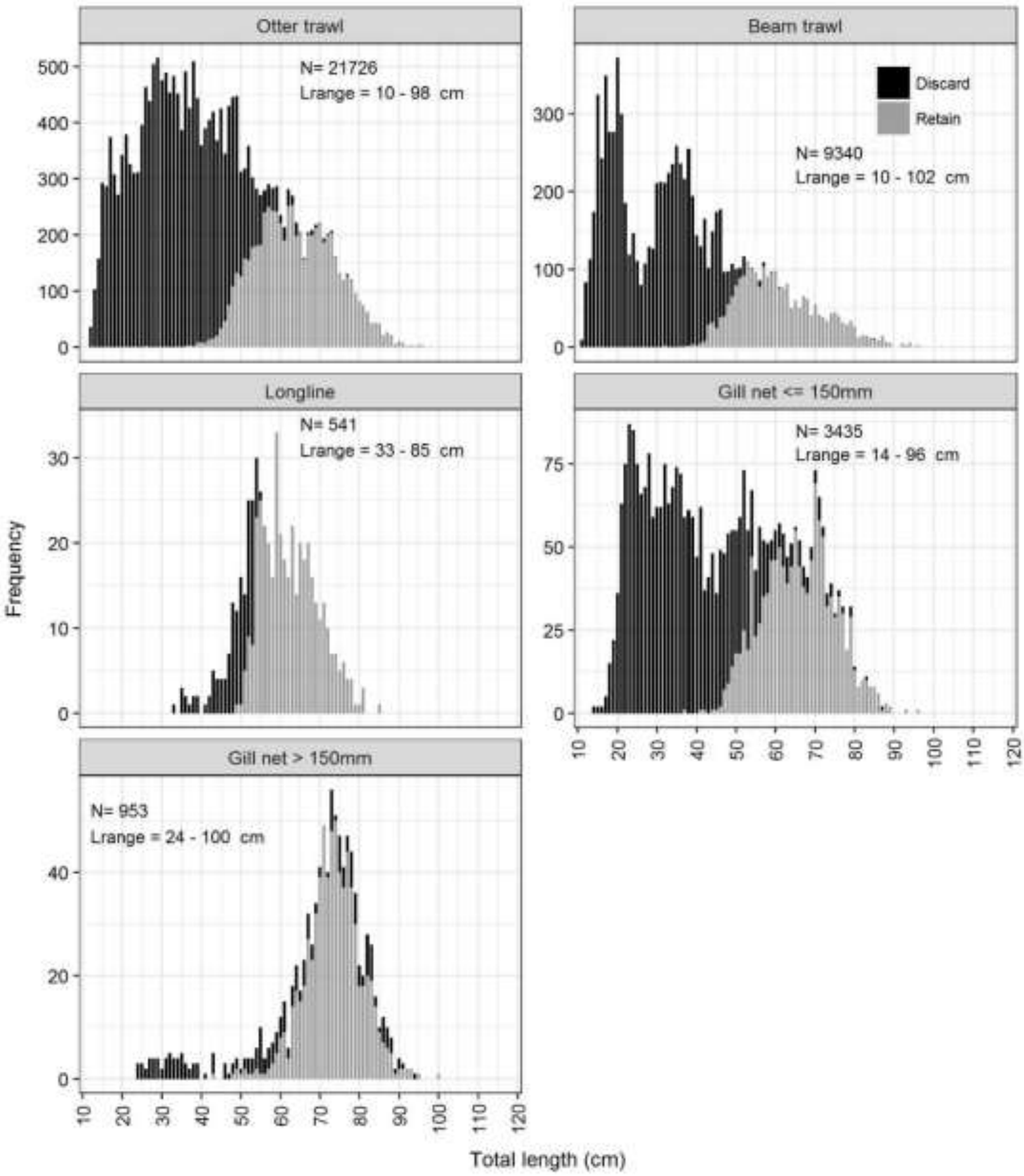
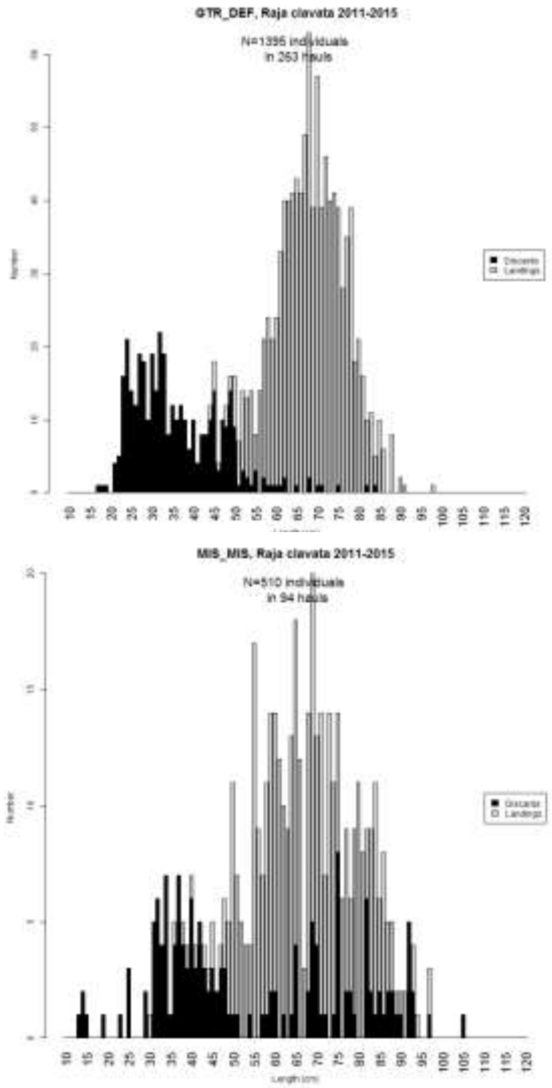


Figure 5.8: Length-based discard-retention pattern of thornback ray *Raja clavata* (ICES Divisions 4.b.c and 7.d) for otter trawl, beam trawl, longline, gill net (≤150 mm mesh size) and gillnet (>150 mesh size) as recorded during the UK (English) observer programme (2002-2016).


GTR_DEF, Raja clavata 2011-2015
N=1395 individuals
in 263 hauls
MIS_MIS, Raja clavata 2011-2015
N=510 individuals
in 94 hauls

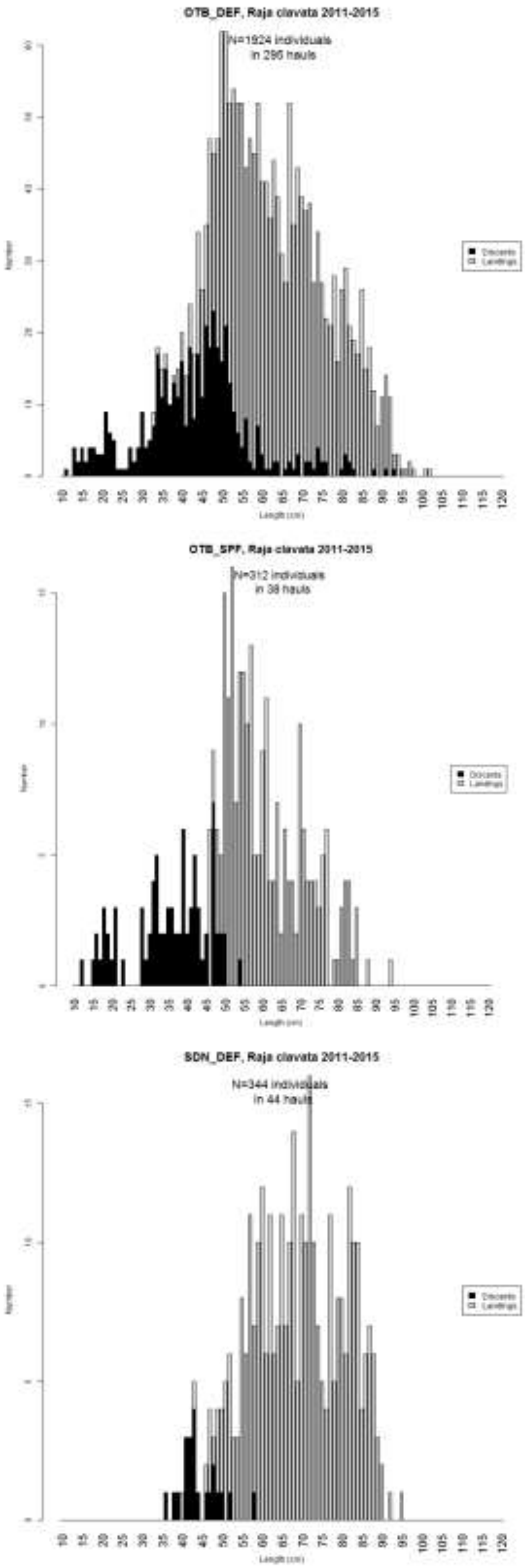
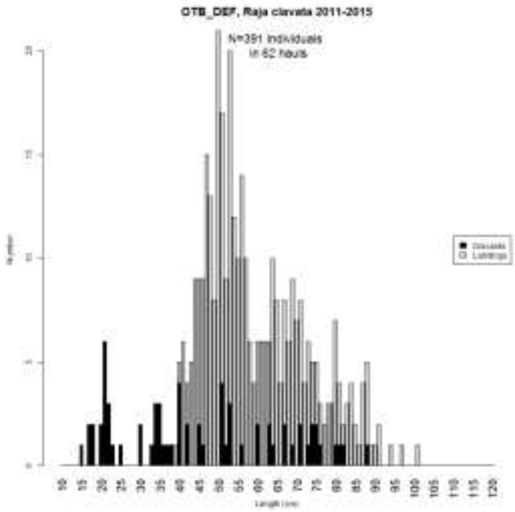
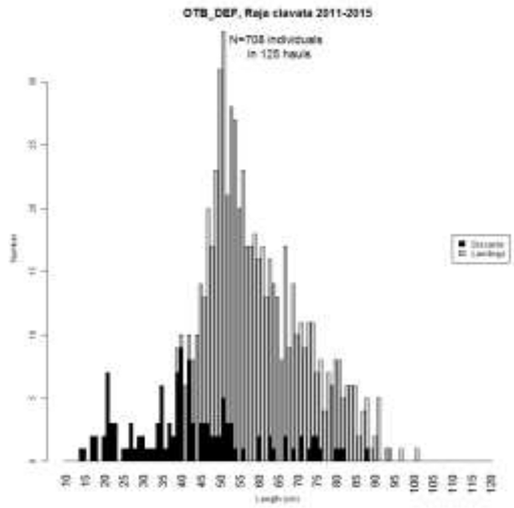


Figure 5.9. Length-based discard-retention pattern of thornback ray, *Raja clavata* by metier, ICES Divisions 4.b.c and 7.d, as recorded during the French observer programme (data combined for the years 2011-2016).


OTB_DEF, Raja clavata 2011-2015
N=391 individuals
in 62 hauls


OTB_DEF, Raja clavata 2011-2015
N=708 individuals
in 128 hauls

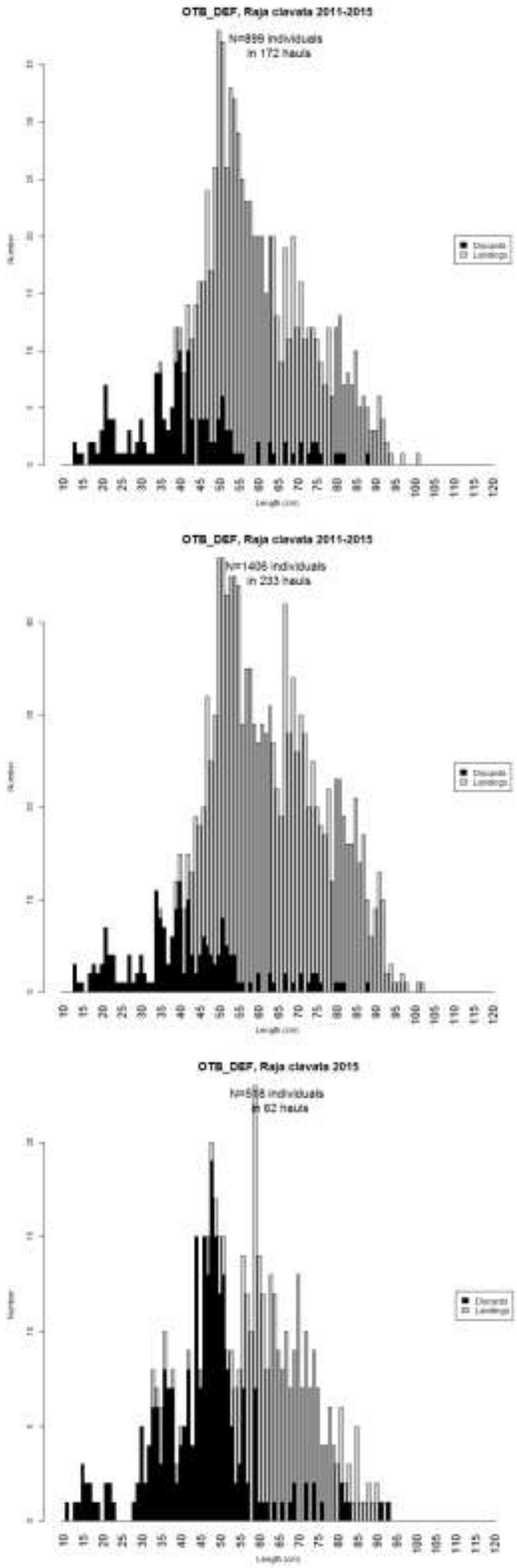


Figure 5.10. France OTB-DEF discards and retentions of *Raja clavata*, 2011-2015.

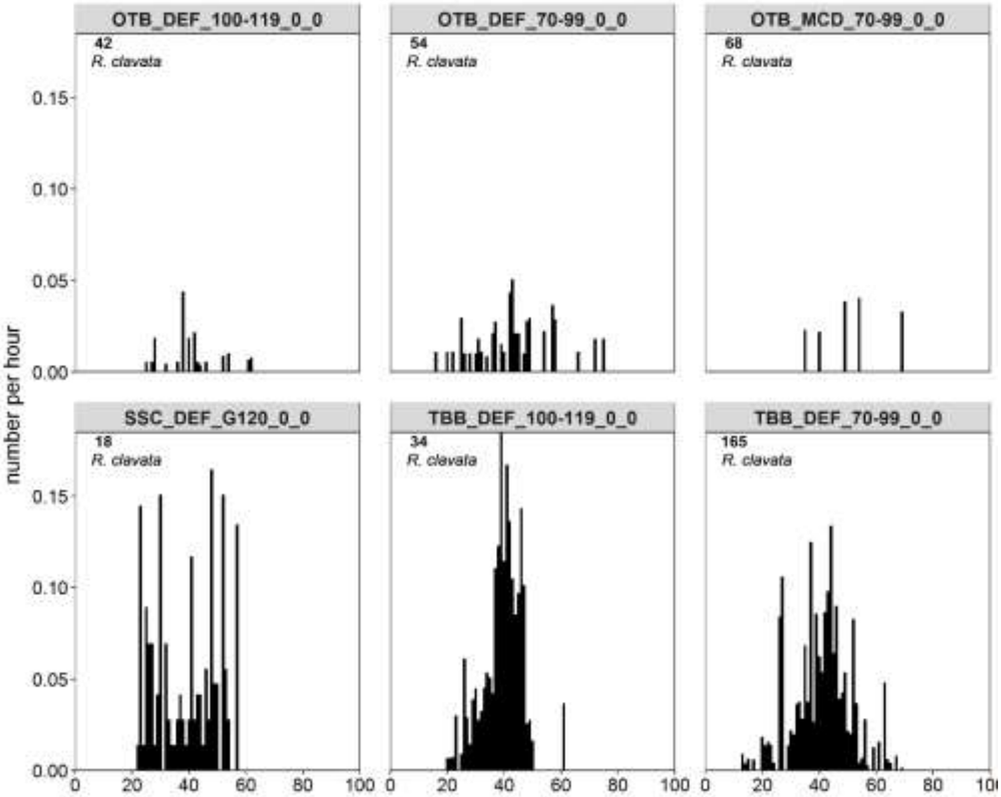


Figure 5.11: Panels show the discards per centimetre classes for *Raja clavata*. Data are based on self-sampling of the Dutch fishing fleet in area 4.c and 4.b. The numbers in the left corner of each panel represent the number of trips sampled in that metier. Metiers for which less than 15 trips were sampled were excluded from the analysis.

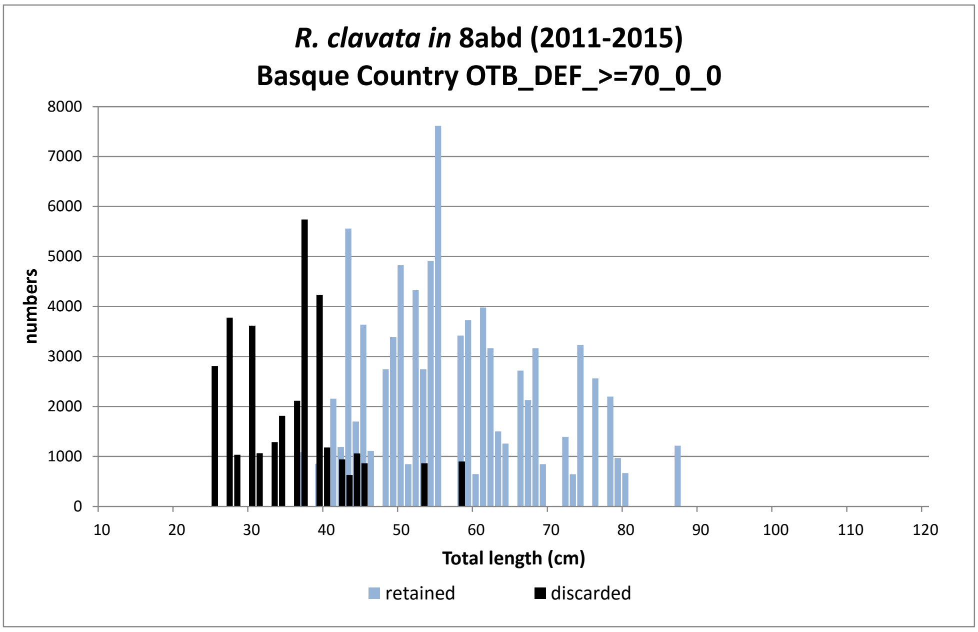


Figure 5.12: Length frequency distribution of thornback ray *Raja clavata* discarded and retained fractions sampled onboard Basque Country's OTB (Divisions 8abd) in the period 2011-2015. Numbers raised to the total trips.

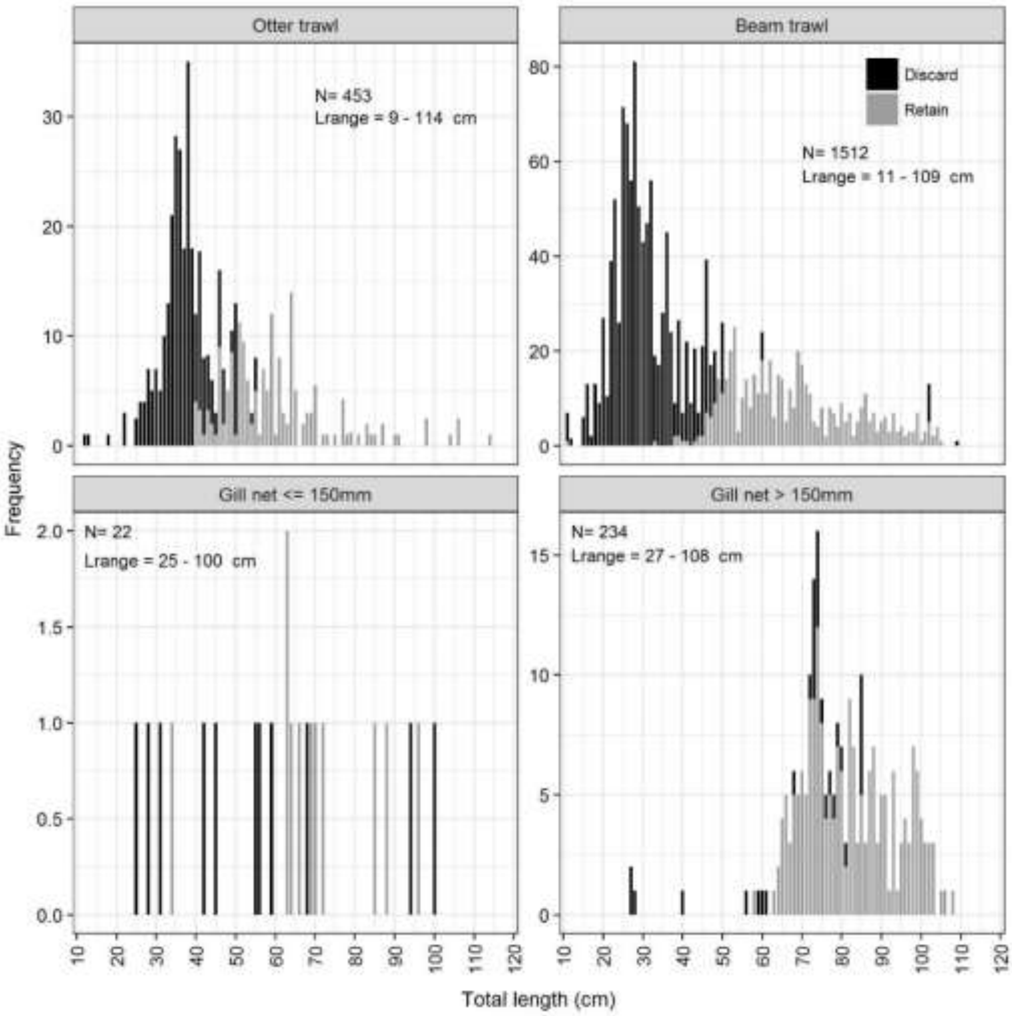


Figure 5.13: Length-based discard-retention pattern of blonde ray *Raja brachyura* (ICES Divisions 4.c and 7.d) for otter trawl, beam trawl, gill net (≤150 mm mesh size) and gillnet (>150 mesh size) as recorded during the UK (English) observer programme (2002-2016).

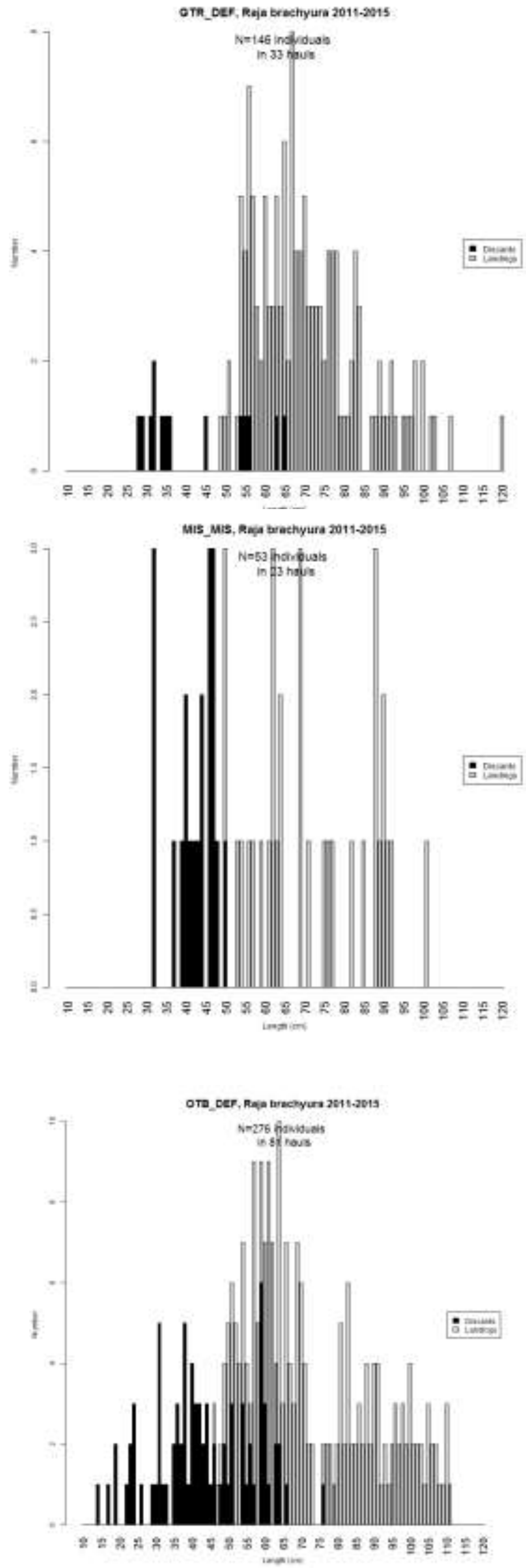


Figure 5.14: Length-based discard-retention pattern of blonde ray, *Raja brachyura* by metier, ICES Divisions 4.c and 7.d, as recorded during the French observer programme (data combined for the years 2011-2016).

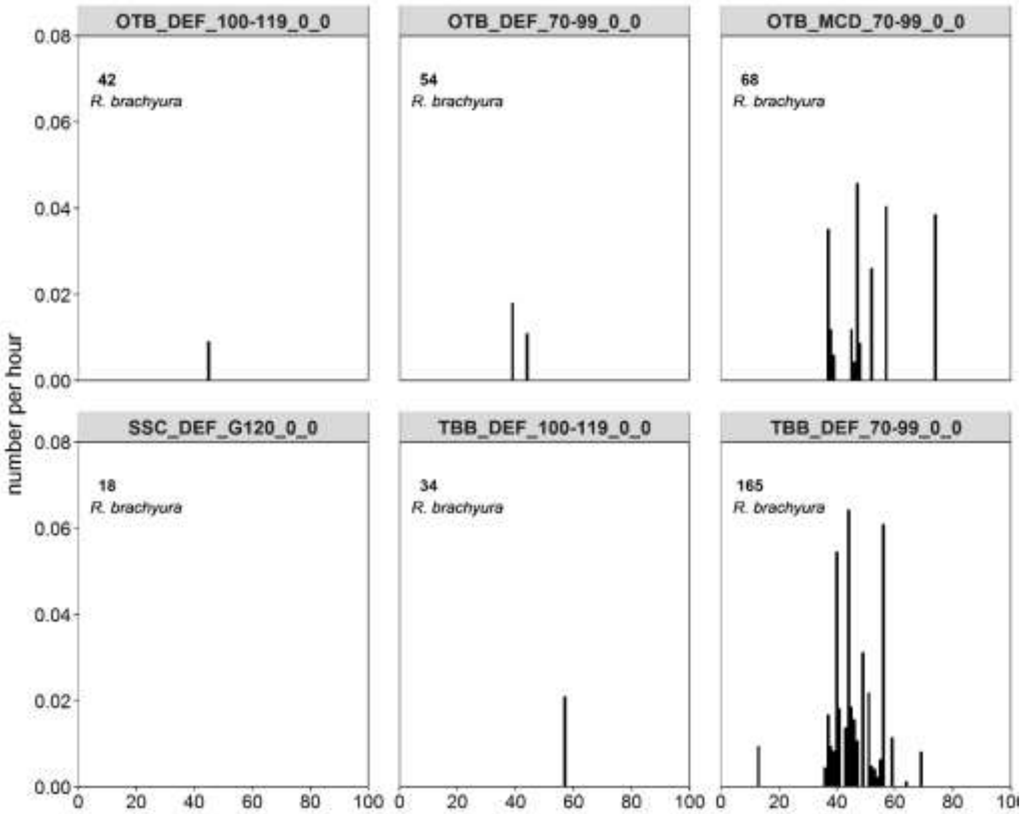


Figure 5.15: Panels show the discards per centimetre classes for *Raja brachyura*. Data are based on self-sampling of the Dutch fishing fleet in area 4.c and 4.b. The numbers in the left corner of each panel represent the number of trips sampled in that metier. Metiers for which less than 15 trips were sampled were excluded from the analysis.

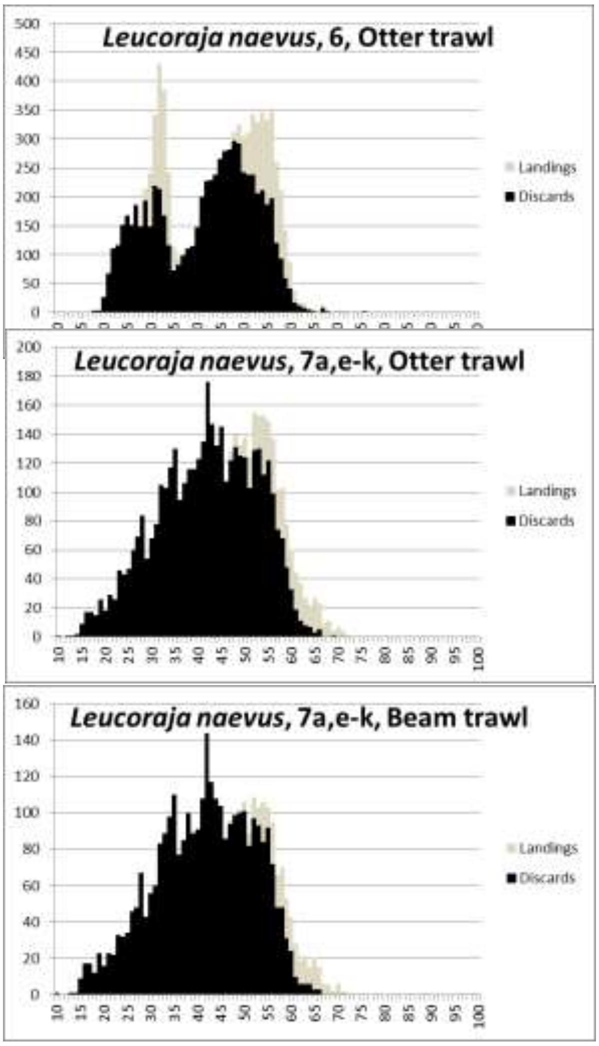


Figure 5.16 ***Leucoraja naevus*****. Discard/landing records from Irish observers.**

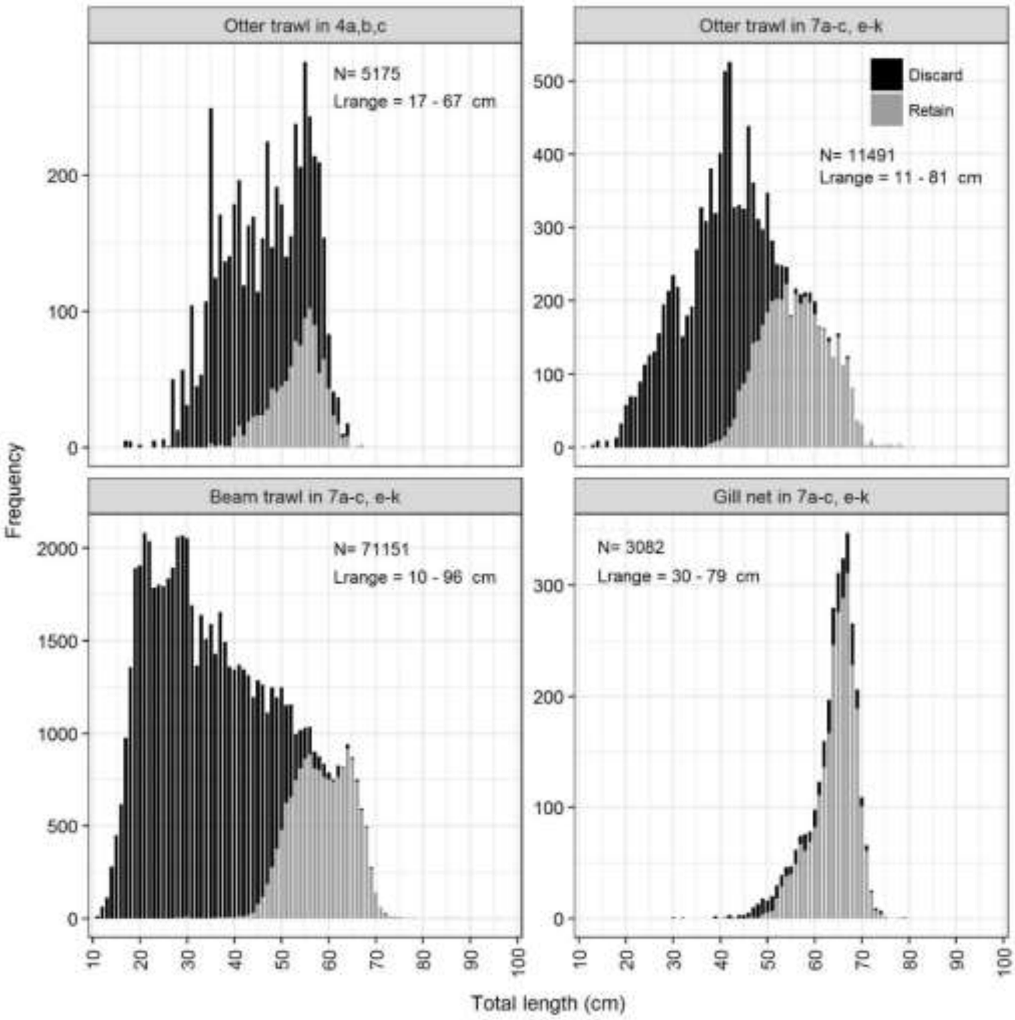


Figure 5.17: Length-based discard-retention pattern of cuckoo ray Leucoraja naevus in ICES Subarea 4 (otter trawl only) and Divisions 7.a-c and e-k (otter trawl, beam trawl and gillnet) as recorded during the UK (English) observer programme (2002-2016).

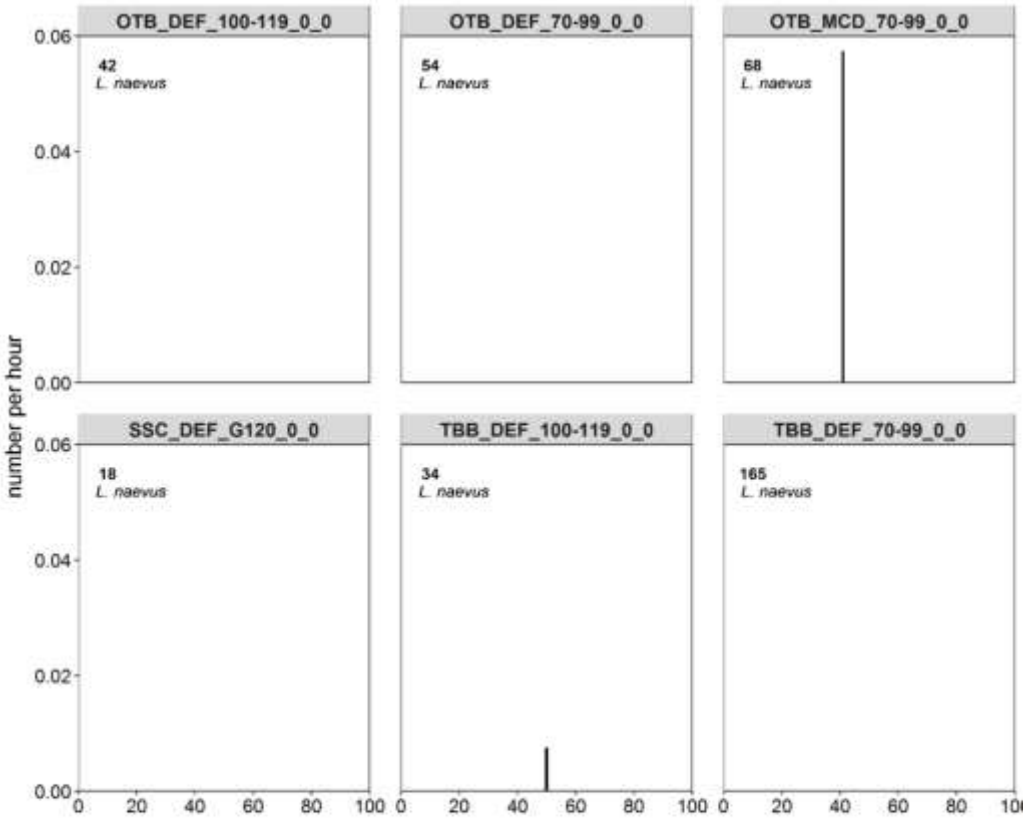


Figure 5.18: Panels show the discards per centimetre classes for *Leucoraja naevus*. Data are based on self-sampling of the Dutch fishing fleet in area 4.c and 4.b. The numbers in the left corner of each panel represent the number of trips sampled in that metier. Metiers for which less than 15 trips were sampled were excluded from the analysis.

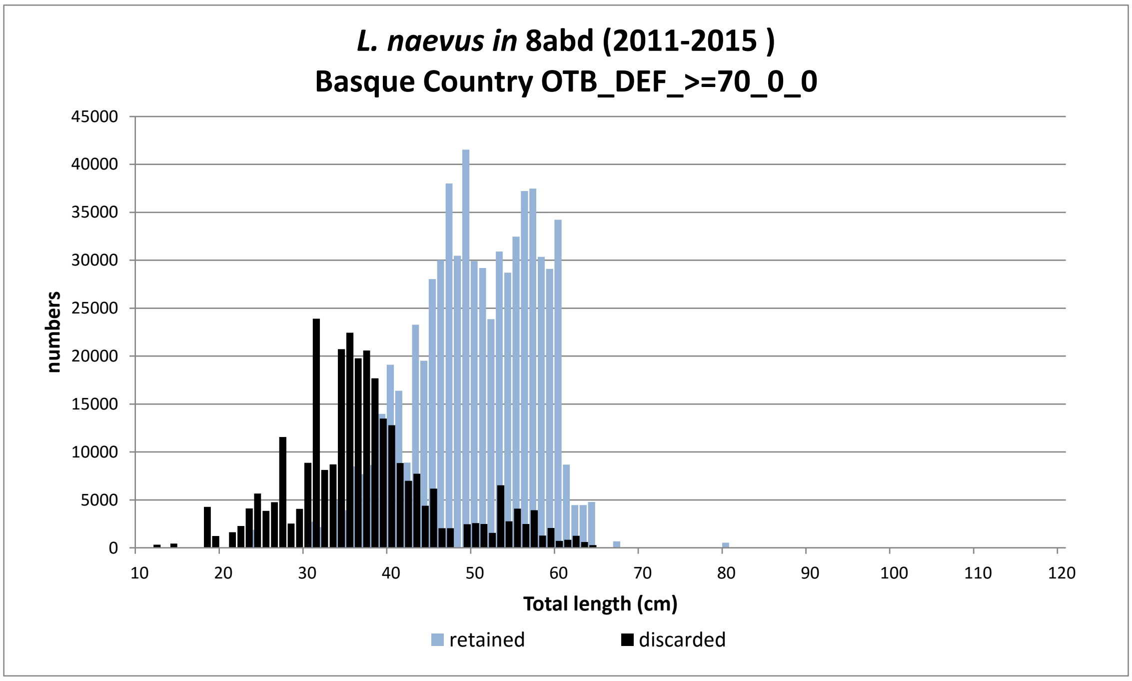


Figure 5.19: Length frequency distribution of cuckoo ray *Leucoraja naevus* discarded and retained fractions sampled onboard Basque Country's OTB (Divisions 8abd) in the period 2011-2015. Numbers raised to the total trips.

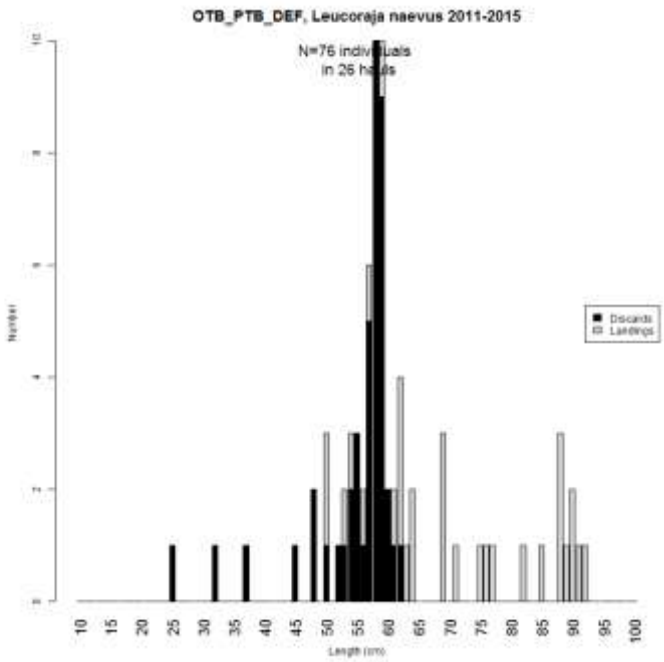


Figure 5.20: Length-based discard-retention pattern of cuckoo ray, *Leucoraja naevus* by metier, ICES Sub-areas 3 and 4, as recorded during the French observer programme (data combined for the years 2011-2016).

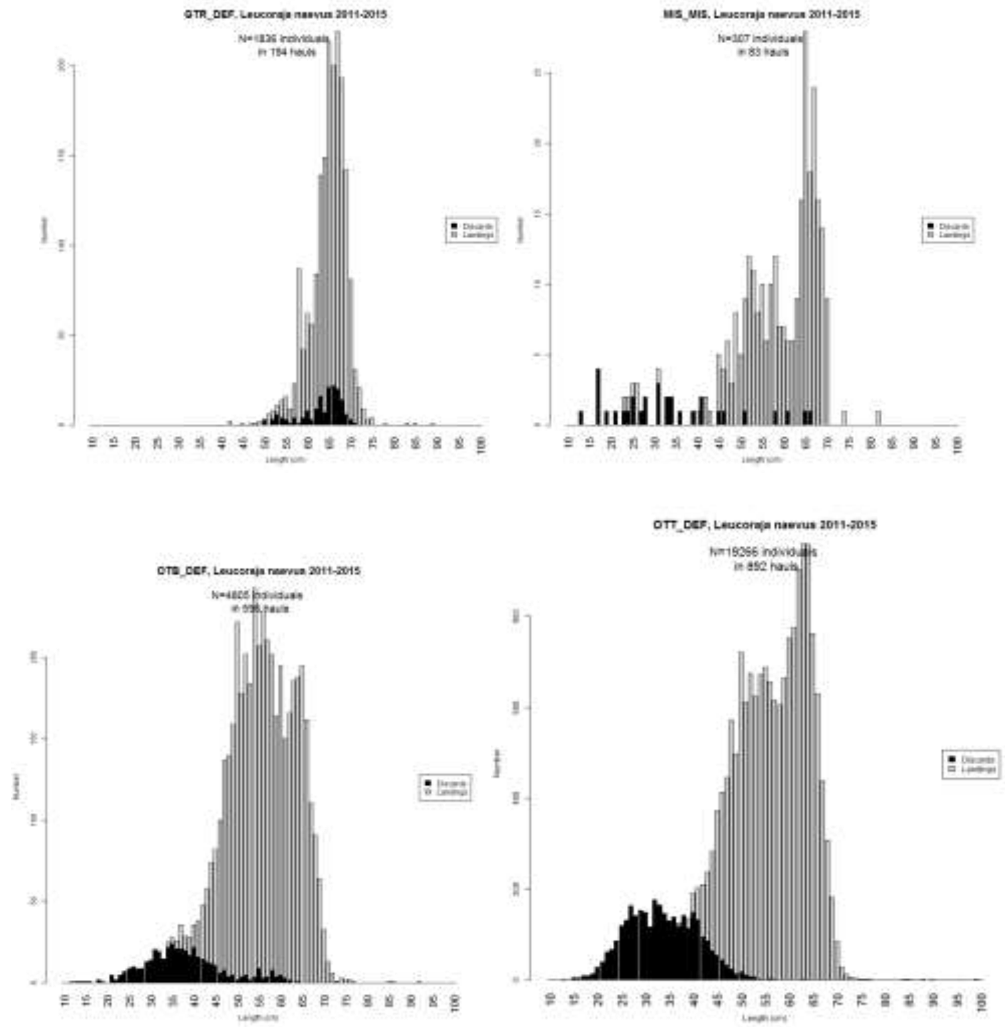


Figure 5.21. Length-based discard-retention pattern of cuckoo ray, *Leucoraja naevus* by metier, ICES Sub-areas 6 and 7, as recorded during the French observer programme (data combined for the years 2011-2016).

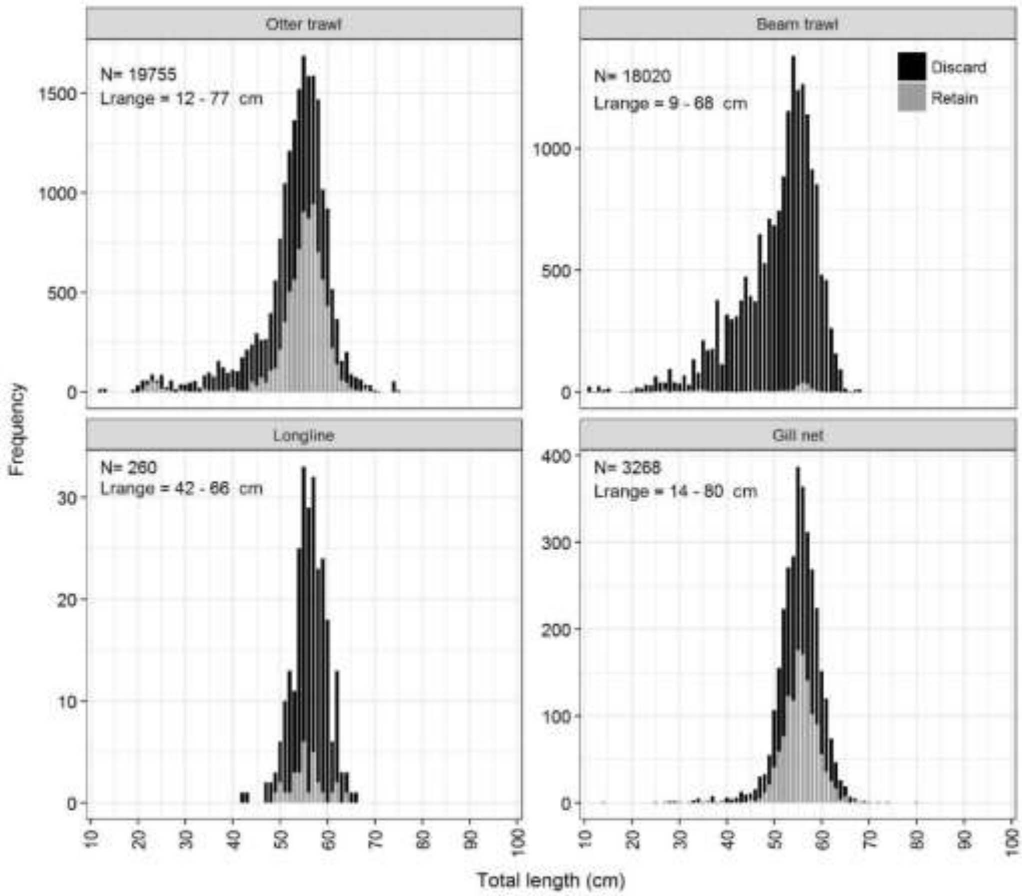
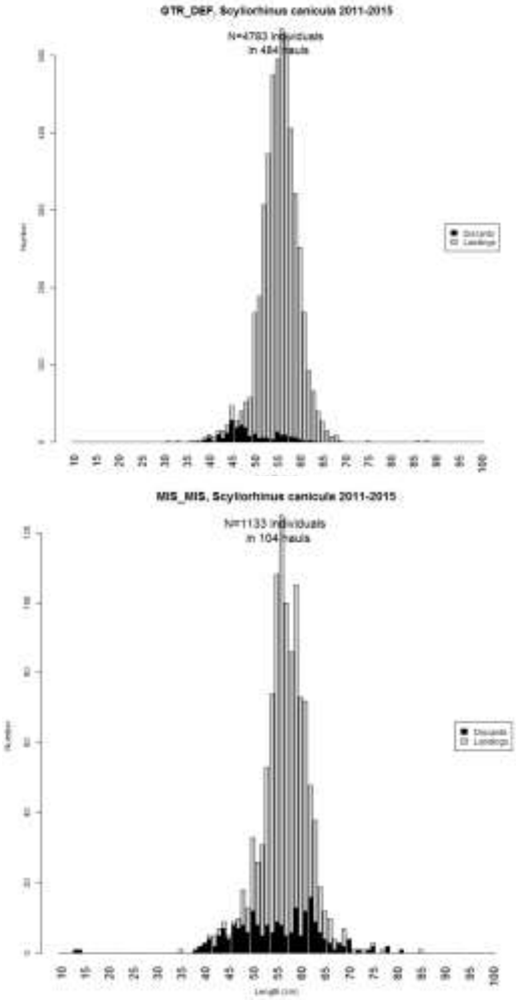
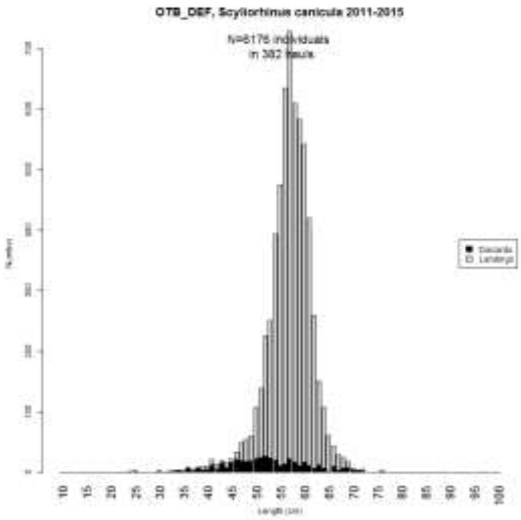
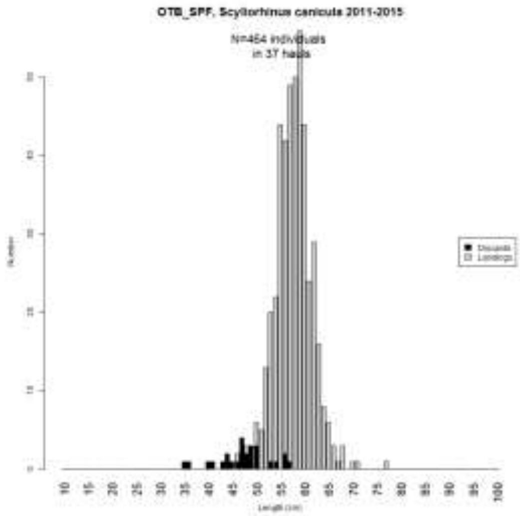


Figure 5.22: Length-based discard-retention pattern of lesser-spotted dogfish *Scyliorhinus canicula* in the North Sea ecoregion (Subarea 4 and Division 7.d) in otter trawl, beam trawl, longline and gillnet as recorded during the UK (English) observer programme (2002-2016).


GTR_DEF, Scyliorhinus canicula 2011-2015
N=4783 individuals
in 484 hauls
Discards
Landings
10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
MIS_MIS, Scyliorhinus canicula 2011-2015
N=1133 individuals
in 104 hauls
Discards
Landings
10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100


OTB_DEF, Scyliorhinus canicula 2011-2015
N=6176 individuals
in 382 hauls
Discards
Landings
10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100


OTB_SPF, Scyliorhinus canicula 2011-2015
N=464 individuals
in 37 hauls
Discards
Landings
10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100

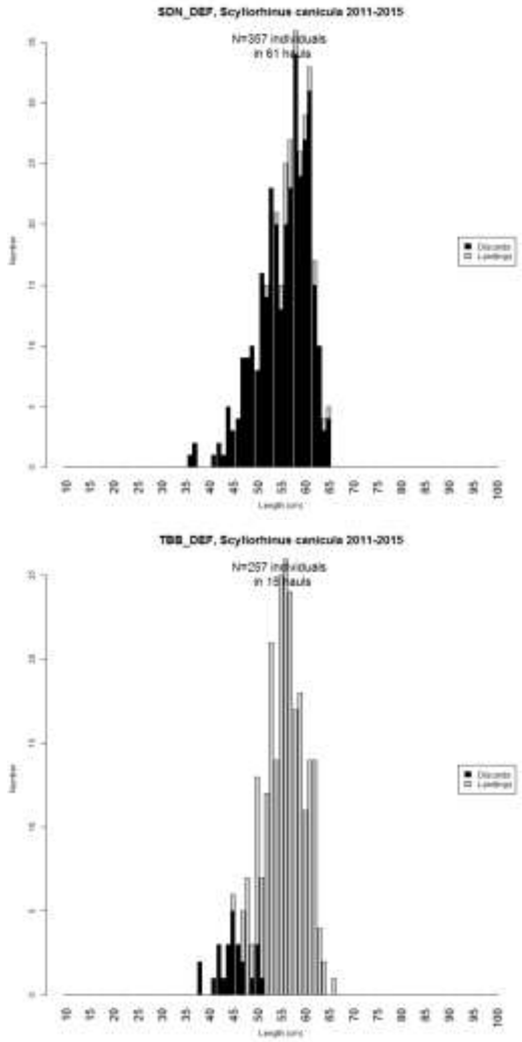


Figure 5.23: Length-based discard-retention pattern of lesser-spotted dogfish, *Scyliorhinus canicula* by metier, (Subareas 3& 4 and Division 7.d), as recorded during the French observer programme (data combined for the years 2011-2016).

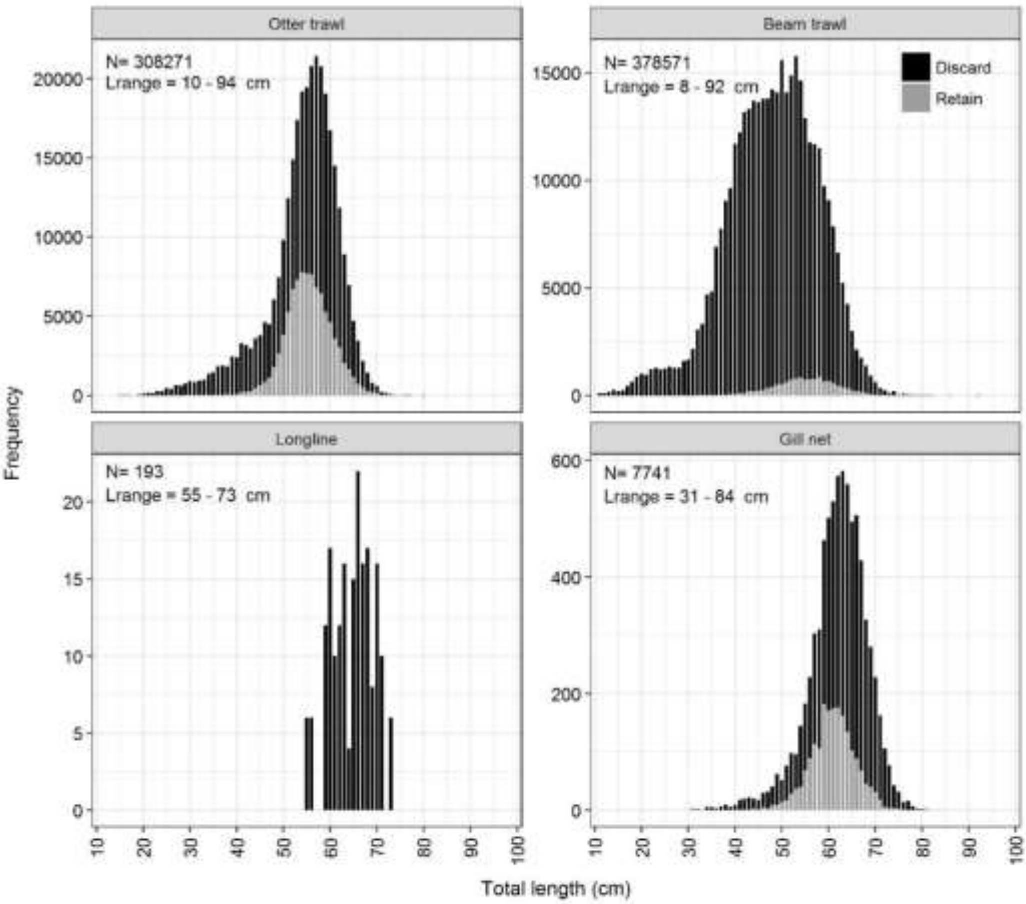


Figure 5.24: Length-based discard-retention pattern of lesser-spotted dogfish Scyliorhinus canicula in the Celtic Seas ecoregion (Subarea 6 and Divisions 7.a-c and 7.e-k) in otter trawl, beam trawl, longline and gillnet as recorded during the UK (English) observer programme (2002-2016).

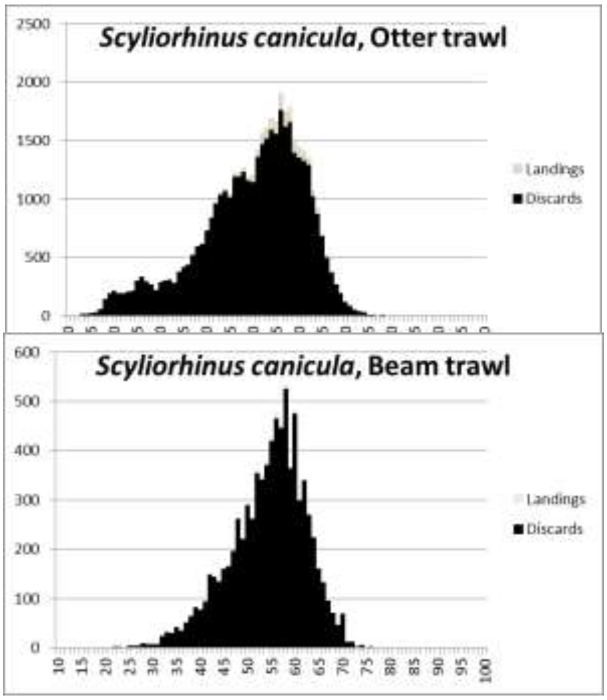
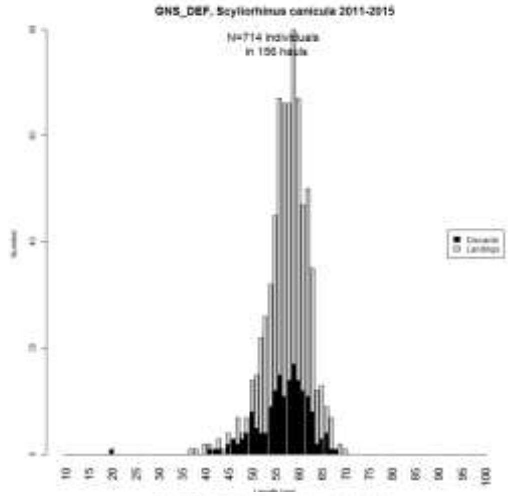
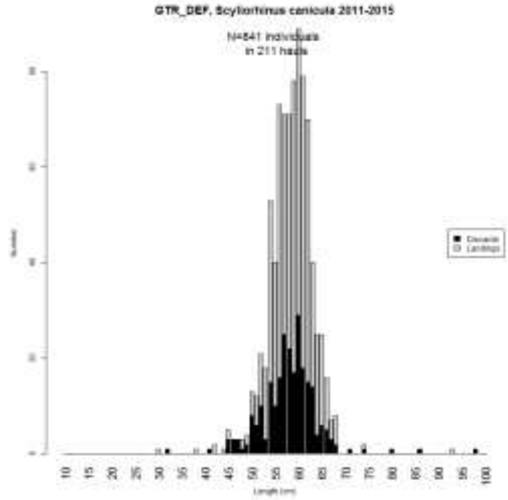
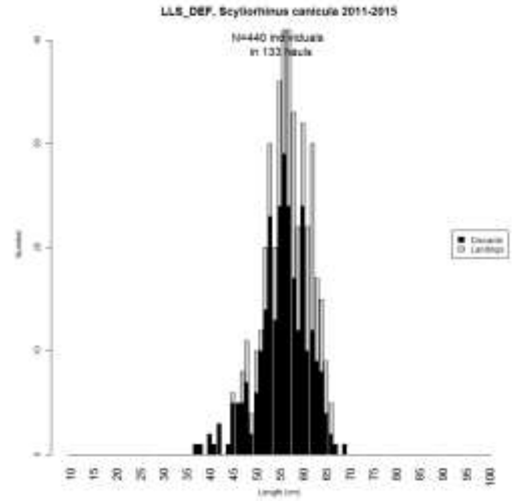
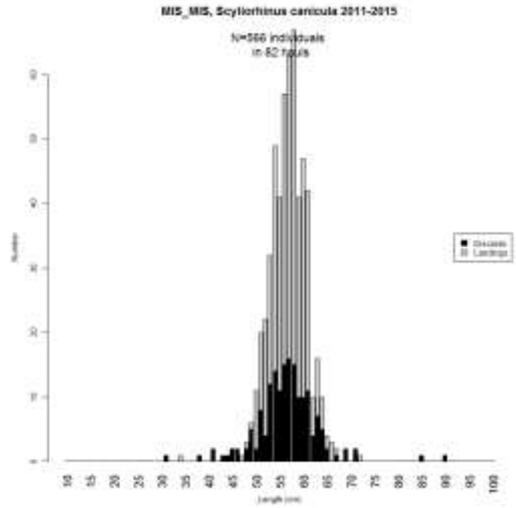


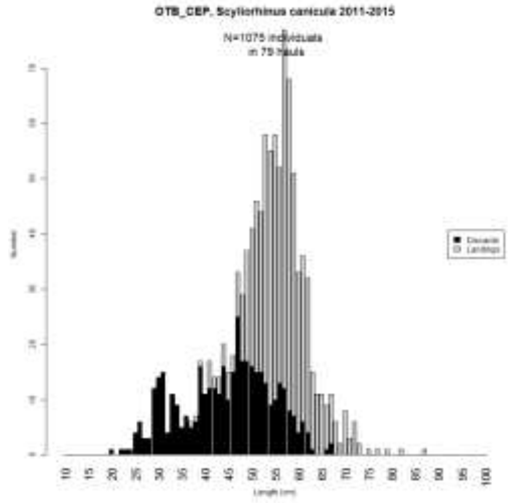
Figure 5.25 ***Scyliorhinus canicula*****. Discard/landings records from Irish observers.**

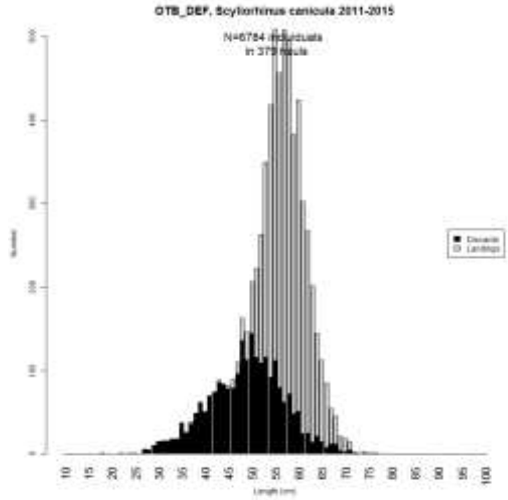

GNS_DEF, Scyliorhinus canicula 2011-2015
N=714 individuals
10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100


GTR_DEF, Scyliorhinus canicula 2011-2015
N=841 individuals
in 211 hauls
10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
Length (cm)


LLS_DEF, Scyliorhinus canicula 2011-2015
N=440 individuals
in 133 hauls
Discards
Landings
Length (cm)


MIS_MIS, Scyliorhinus canicula 2011-2015
N=566 individuals
in 82 hauls
Discards
Landings
Length (cm)


OTB_CEP, Scyliorhinus canicula 2011-2015
N=1075 individuals
in 79 hauls


OTB_DEF, Scyliorhinus canicula 2011-2015
N=6784 individuals
in 379 hauls

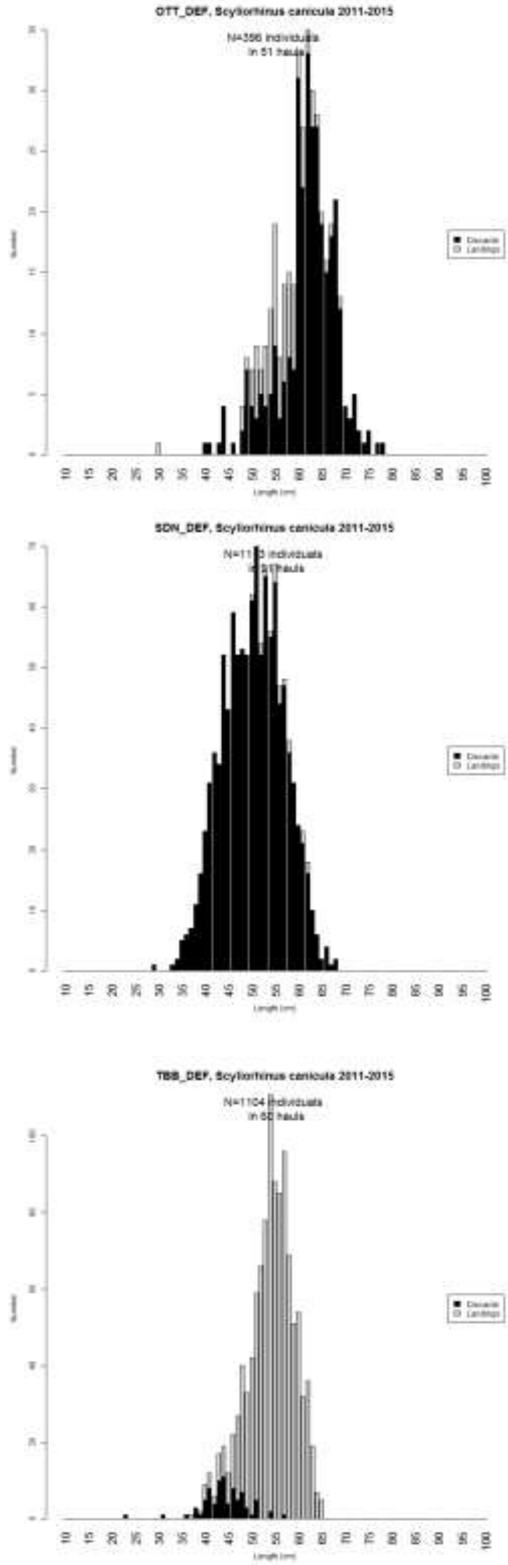
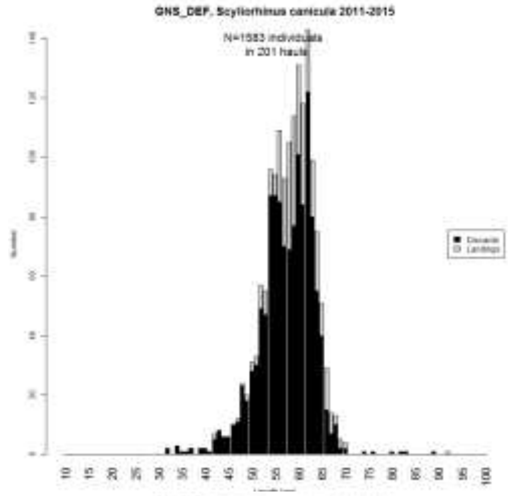
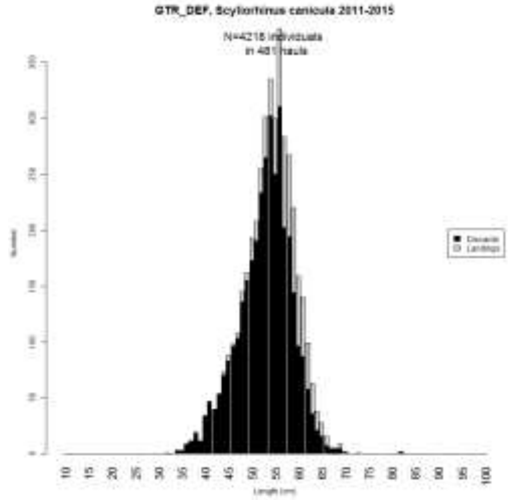
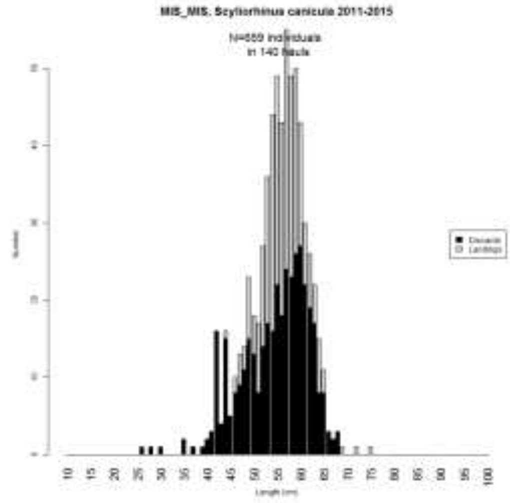
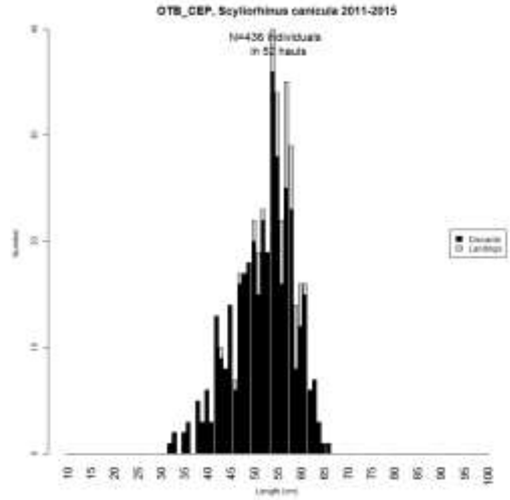


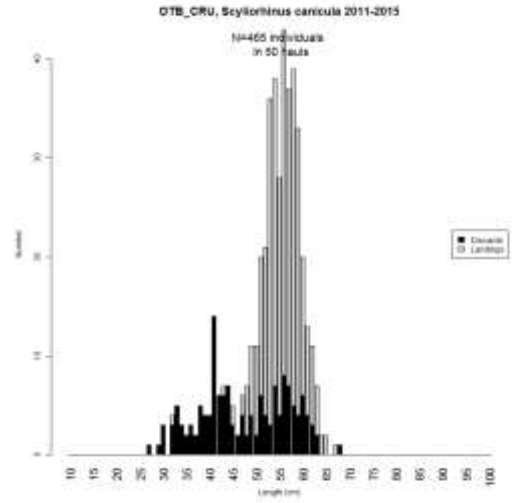
Figure 5.26 (a-i). Length-based discard-retention pattern of lesser-spotted dogfish, *Scyliorhinus canicula* by metier, (Divisions 7.a.b.c.e.k.), as recorded during the French observer programme (data combined for the years 2011-2016).

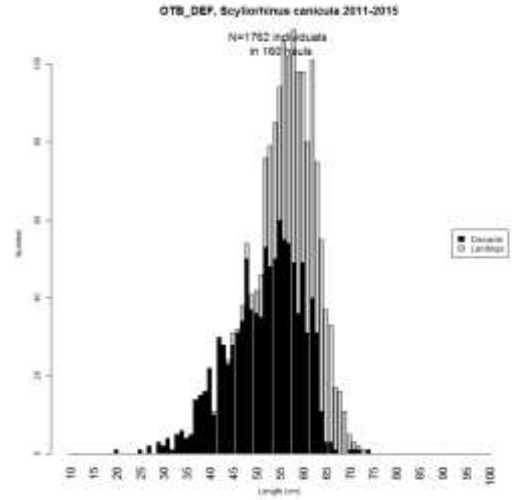

GNS_DEF, Scyliorhinus canicula 2011-2015
N=1583 individuals
in 201 hauls
Discards
Landings


GTR_DEF, Scyliorhinus canicula 2011-2015
N=4216 individuals
Discards
Landings
Length (cm)


MIS_MIS. Scyliorhinus canicula 2011-2015
N=659 individuals
in 140 hauls
Discards
Landings
10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
Length (cm)


OTB_CEP. Scyliorhinus canicula 2011-2015
N=436 individuals
in 52 hauls
Discards
Landings
10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
Length (cm)


OTB_CRU, Scyliorhinus canicula 2011-2015
N=465 individuals
in 50 hauls
Discards
Landings
Length (cm)


OTB_DEF, Scyliorhinus canicula 2011-2015
Discards
Landings
Length (cm)

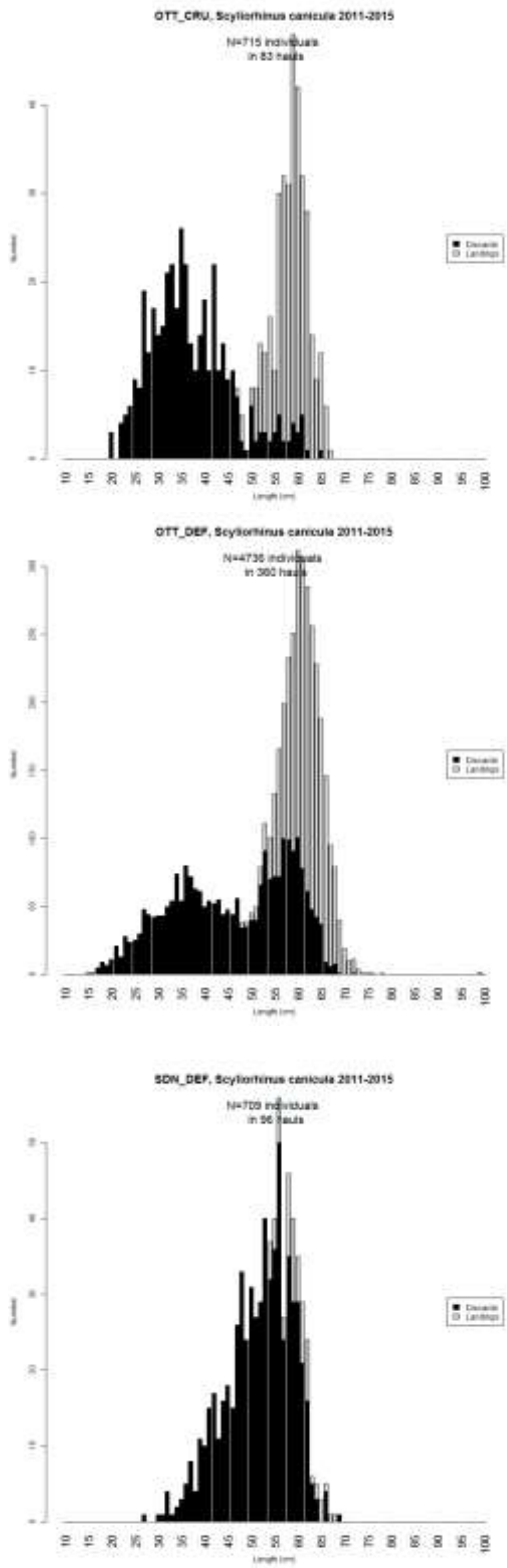


Figure 5.27 (a-i). Length-based discard-retention pattern of lesser-spotted dogfish, *Scyliorhinus canicula* by metier, (Divisions 8.a.b.c.), as recorded during the French observer programme (data combined for the years 2011-2016).

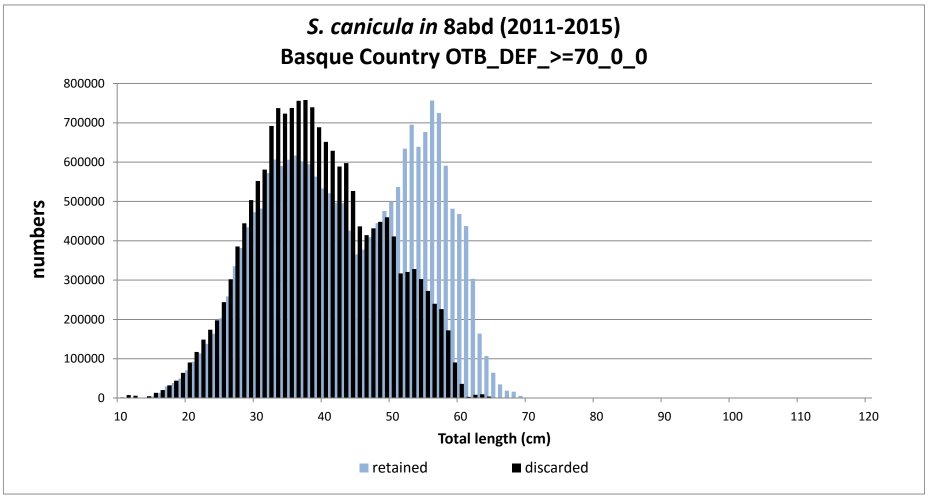


Figure 5.28: Length frequency distribution of lesser-spotted dogfish *Scyliorhinus canicula* discarded and retained fractions sampled on-board Basque Country's OTB (Divisions 8abd) in the period 2011-2015. Numbers raised to the total trips.

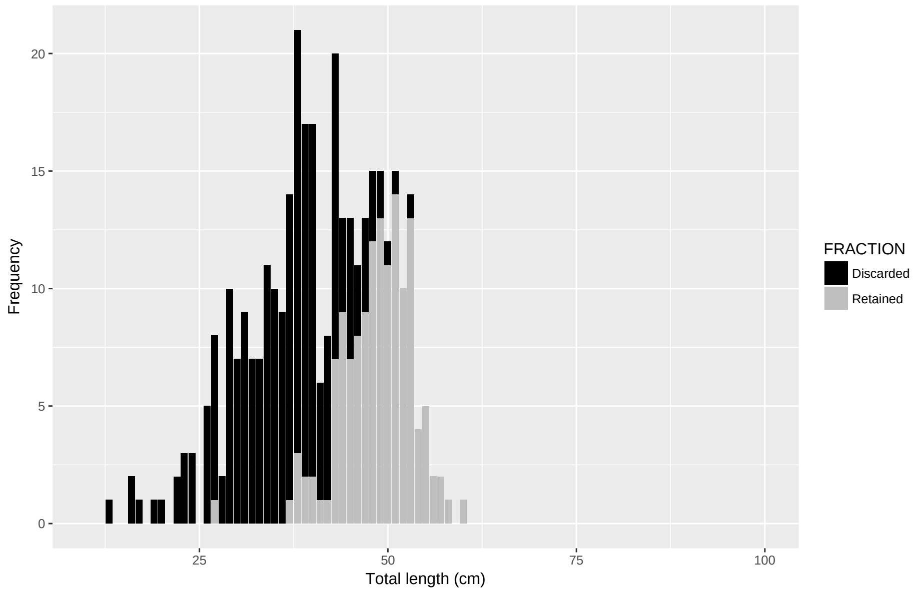


Figure 5.29a: Length frequency distribution of lesser-spotted dogfish *Scyliorhinus canicula* discarded and retained fractions sampled onboard Portuguese vessels (Division 9.a) using otter bottom trawl for demersal fish (2011-2014). Data not raised to the total landings. n=348 sampled individuals.

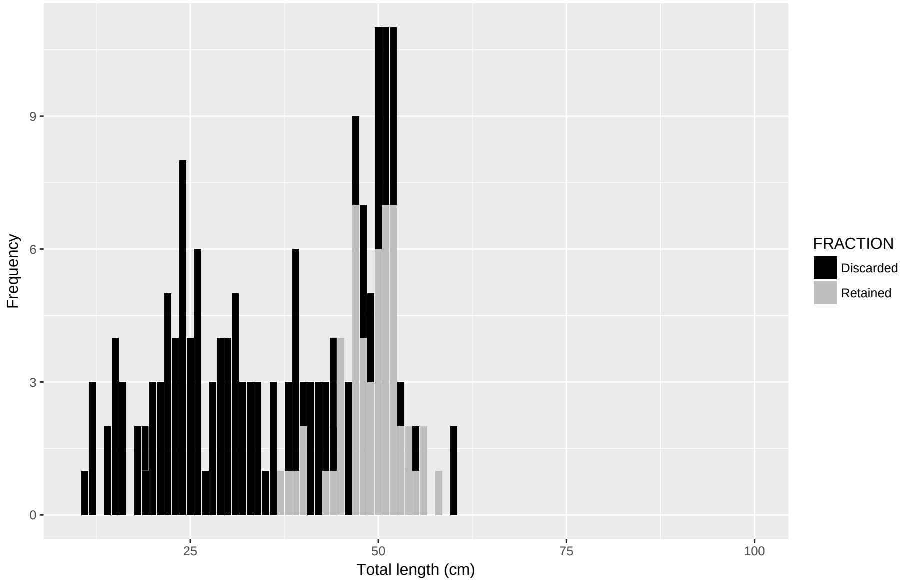


Figure 5.29b: Length frequency distribution of lesser-spotted dogfish *Scyliorhinus canicula* discarded and retained fractions sampled onboard Portuguese vessels (Division 9.a) using otter bottom trawl for Nephrops (2011-2014). Data not raised to the total landings. n=182 sampled individuals.

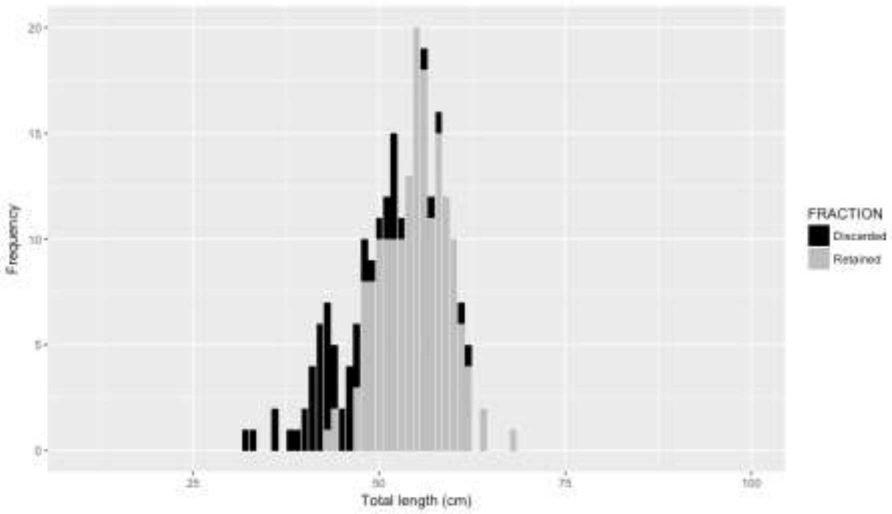


Figure 5.29c: Length frequency distribution of lesser-spotted dogfish *Scyliorhinus canicula* discarded and retained fractions sampled onboard Portuguese vessels (Division 9.a) using set nets (2011-2014). Data not raised to the total landings. n=227 sampled individuals.

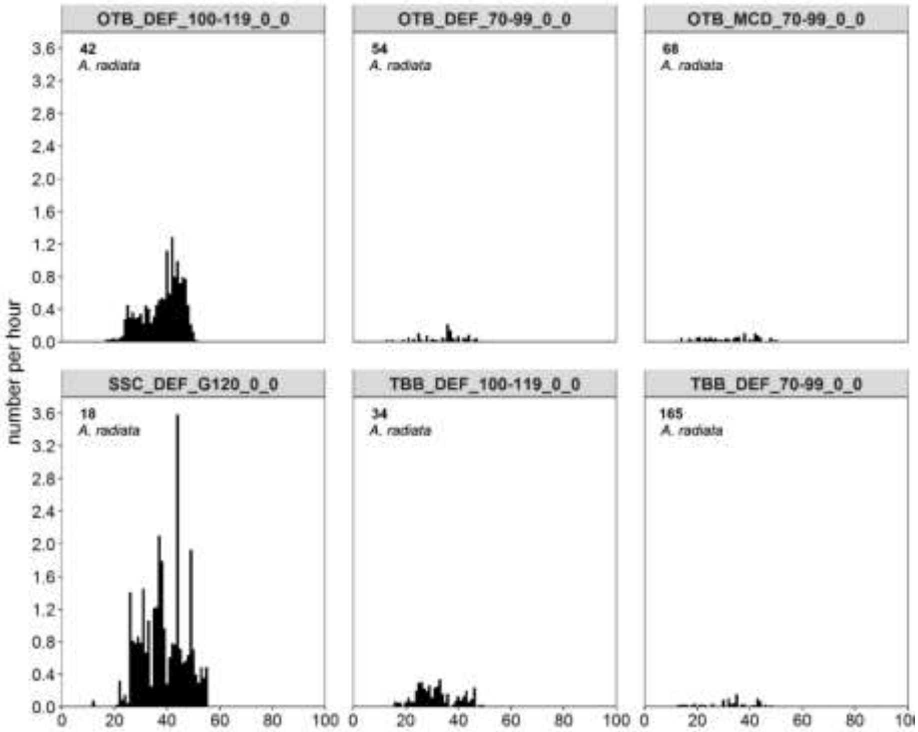


Figure 5.30: Panels show the discards per centimetre classes for *Amblyraja radiata*. Data are based on self-sampling of the Dutch fishing fleet in area 4.c and 4.b. The numbers in the left corner of each panel represent the number of trips sampled in that metier. Metiers for which less than 15 trips were sampled were excluded from the analysis.

6 Suitability of existing national programmes to inform on the by-catch of rare elasmobranch species

6.1 Introduction

This section is related to ToR (d), to *"Examine the suitability of existing national programmes to inform on the bycatch of rare elasmobranch species (e.g. basking shark and angel shark), and identify which areas, seasons and gears for which more informative data on discarding of rare species could be collected"*.

It should be recognised that 'rarity' may take several forms, as summarised in ICES (2003), as some species can be naturally rare, some species may appear 'rare' due to unsuitable census methods, and some species may be viewed as 'rare' if they have declined.

A distinction has been made between species which are 'rare' in an ecological sense and/or those which are uncommon in the national programmes. Deep-water species are not included in this section, as they are not sampled routinely under existing programmes, and deep-water fisheries have largely ended in many countries.

For the purposes of the present report, eight case study species were considered (Table 6.1), which are all species for which ICES provides (or has provided) advice for.

Table 6.1 Species included in the analysis of rare elasmobranch species

Rare (or locally rare) demersal species	Pelagic species that are uncommon in national observer programmes
Angel shark (Squatina squatina)	Basking shark (Cetorhinus maximus)
White skate (Rostroraja alba)	Porbeagle (Lamna nasus)
Common guitarfish (Rhinobatos rhinobatos)	Common thresher shark (Alopias vulpinus)
Undulate ray (Raja undulata) locally in 7.b.j	
Starry smooth-hound (Mustelus asterias) in 9.a	

6.2 General information on national programmes

Onboard observer programmes for English and Welsh fleets are monitored by CEFAS (under EU MAP) and the Sea Mammal Research Unit (SMRU). The latter programme is conducted primarily to monitor the bycatch of marine mammals and so focuses primarily on pelagic and gillnet fisheries.

In Norway it is compulsory to register bycatch of porbeagle and basking shark in the electronic logbooks.

The Marine Institute in Ireland carries out on-board fish sampling under the EU-MAP (Formerly DCF) programme. The Irish Whale and Dolphin Group (IWDG) records sightings of basking shark (and other large pelagic sharks) as part of their dedicated marine mammal ship survey programme as well as casual sightings.

The integration of data from dedicated and opportunistic surveys conducted in France could provide a valuable perspective to better understand spatial and seasonal distribution of various species, including pelagic sharks, such as basking shark. Observatoire Pelagis (UMS 3462 University of La Rochelle/CNRS; http://www.observatoire-pelagis.cnrs.fr/) records sightings of basking shark as part of their dedicated onboard and aerial national marine mammals and seabirds observation programmes, as well as casual sightings, in French waters. Since 1997, the French NGO, APECS (Association Pour l'Etude et la Conservation des Sélaciens, Brest, http://www.asso-apecs.org/) has led a national basking shark sightings recording scheme (citizen science programme). Data include date, hour and position of the sighting, the number of individuals, visual estimates of total lengths, behaviour, together with observer ID and the availability of pictures. This programme provides a picture of the spatial and temporal distribution of surface sightings of this species in French waters.

6.3 Species overviews

For each of the selected species (except *Raja undulata* in 7.b.j and *Mustelus asterias* in 9.a) there is an overview of the:

1) Suitability of national programmes
2) Which areas, seasons and gears are recommended for more information

These can be seen in Tables 6.2 (rare demersal species) and 6.3. (uncommon in national programmes). Information on the undulate rays and starry smooth-hound is included in the text.

Starry smooth-hound *M. asterias* can be considered to be rarely caught in Division 9.a. No records were available in the Portuguese observer database are available And tlandings observation programme undertaken by IPMA shows that smooth-hounds (*Mustelus* spp.) caught mainly by the polyvalent fleet operating in Division 9.a. correspond to *M. mustelus.* Further studies to better identify the latitudinal ranges of both these species are required.

6.4 Legislative issues

All species are covered by international legislation and the legality of data collection is unclear for these species. For species such as angel shark, white skate and basking shark, it is prohibited for EU vessels to fish for, retain on board, trans-ship or land the species (Council Regulation (EU) 2017/127 of 20 January 2017). Clarity is required to know if observers are allowed to record the length and sex of individuals on board prior to them being discarded, or even if scientific observers can retain specimens of dead bycatch for scientific purposes. It is recommended to ask for guidance from the European Commission on this issue.

6.5 Observer data

All the information available is based on observer data and the data registration format may not allow the recording of non-standard information such as how:

- to report species tangled in the ropes and not taken in a net, or cut out of the net prior to taking the catch on board, as sometimes occurs for basking shark for example;
- to record bycatch < 50 kg for those vessels with logbook requirements – which could include a number of individuals of skates or sharks;
- to record escaped or released individuals.

It is recommended to do more targeted sampling for these species in the data collection and to agree on a registration protocol. This could be captured in a recommendation to WGCATCH.

The Advisory Councils can have a role in encouraging members to self-sample/provide additional data e.g. releases of basking sharks from gear, to relevant national programmes.

6.6 Sampling activities

A number of proposals for new or improved sampling activities were discussed by the group:

- The reporting of 'rare' species by fishers during self-sampling may be compromised if fishers perceive that the occurrence of 'rare' species could have implications for access to fishing grounds where such species may occur or lead to other responses from management. It should be clear to both fishers and managers that commitment to a self-sampling programme should be to allow data collection for which appropriate analyses and interpretation of the data should be undertaken. Moreover, the incidental catches of rare species could potentially be seen as something positive, as it might reflect increases in abundance or distribution.
- It is suggested that WGEF consider a recommendation to WGCATCH for procedures in sampling programmes: e.g. species, sex, length, weight, fate (retained, discarded dead, discarded alive), which may require an additional field in observer data. There is a possibility that this has been addressed already as "*WGCATCH now formally recognizes the need to address sampling protocol deficiencies for rare event species in the DCF by incorporating an explicit ToR to address this issue at their annual meetings and have expanded their membership to include WGBYC*" (ICES, 2016c).
- How to report those species that can attain a large size, but occur in small numbers? Would it be more appropriate to have data on individual numbers rather than weight? Should there be an ICES 'sightings' database for such species??
- The random nature of trip selection may not be suitable for some rare species if they have restricted distribution and/or high habitat specificity. Dedicated research programmes may be needed to address this.
- France, the UK, Scotland, Ireland and Norway have databases for basking shark sightings but these use different systems. A concerted action to harmonise these data could usefully be undertaken
    - Strandings and sightings of basking sharks could be used to better assess the stock status
    - Data are not always available, and improved access should be facilitated
    - There may be incidental captures of basking sharks in some métiers not necessarily sampled for elasmobranchs (e.g. the ropes of pot and trap fisheries and other static gears); this is still bycatch but may not be reported/collated.
    - Data from cetacean observer programmes might have information on basking sharks.

6.7 Data Collection : EU Multi-annual Programme for collection, management and use of data (EU MAP)

The ICES Working Group on Bycatch of Protected Species (WGBYC) has identified weaknesses in the Data Collection Framework (DCF) to adequately capture bycatch incidences of rare event species, such as cetaceans (ICES, 2016c). Although WGBYC primarily looks at cetaceans, collaboration to identify if the same applies to the encounter of large elasmobranchs is recommended. It is recommended that this report be sent for for the attention of WGBYC.

The current specification of the DCF requires recreational catch estimates for some individual species (cod, salmon, sea bass, eels, bluefin tuna and more recently “sharks” (all sharks and skates/rays listed by region in Commission Decision 2010/93/EU)). This is potentially a new source of information for elasmobranch (by)catch.

An overview of the DCF landings data of the selected species is available on the WKSHARKS SharePoint.

Table 6.2. Overview of rare demersal species.

Country	Angel shark (*Squatina squatina*)	White skate (*Rostroraja alba*)	Common guitarfish (*Rhinobatos rhinobatos*)
France	Overall, observer data since 2003 include three records in Divisions 7.e–g. The option that these correspond to misidentification cannot be excluded although one record was confimed by a photo in 7.g. In contrast, 10 individuals were recorded in the Mediterranean, all in GSA 8 (Corsica), an area where fishing intensity is considered to have been always moderated. In both the Atlantic and Mediterranean, catches occurred in trawl and trammelnets, but there was not enough records to consider the distribution by seasons.	Overall, 16 records since 2003 in 2.a, 4.a–b, 5.b and 6.a, which are areas outside the expected biogeographical range of the species. Some of the individuals were of small size, and the potential for misidentification with juvenile Dipturus or Leucoraja fullonicacannot be excluded. All records were in trawls for demersal or deep-water fish and occured throughout the years. Thirty four records occurred in the Mediterranean (GSA8)	Not recorded in the database. French Atlantic waters outside the geographical range of the species.
Ireland	No records in observer database. Only ocassionally encountered by fishing vessels, mainly in 7.a. Dedicated observer trips would be required to monitor this species.	No records. Mainly found inshore, outside the range of most vessels sampled under DCF.	Species does not occur in Irish waters
Norway	No records by self-sampling reference fleets. Very rare in area. Several years since the last observation.	Species does not occur in Norwegian waters	Species does not occur in Norwegian waters
Iceland	Species does not occur in Icelandic waters	Species does not occur in Icelandic waters	Species does not occur in Icelandic waters
Basque Country (Spain)	This species could be caught by gillnetters in coastal waters and/or trawlers in subarea 8, but there are no records in observer database .	This species could be caught by gillnetters in coastal waters and/or trawlers in subarea 8 but there are no records in observer database	The Cantabrian Sea is at the very northern biogeographic limits of this species (McEachran & Capapé, 1984). Largely outside the normal stock range

Country	Angel shark (Squatina squatina)	White skate (Rostroraja alba)	Common guitarfish (Rhinobatos rhinobatos)
Portugal	Only encountered rarely in the area. No records in the observer database.	No records in the observer database. The species may be occasionally encountered by fishing vessels, mainly operating with set nets in coastal waters.	Iberian waters are at the northern biogeographic limits of this species (McEachran & Capapé, 1984), and Portuguese waters are largely outside the normal stock range.
United Kingdom (England)	There are no records of angel shark in current CEFAS data (2002–2016), although the SMRU programme reported three specimens in Welsh waters over the period 2011–2014. There have been various reports of angel shark in the inshore waters of the western English Channel, Bristol Channel and Welsh waters, indicating this species still occurs in the area. Increased observer coverage on otter trawlers and gillnetters in these areas might provide further data.	There are limited, nominal data for white skate in the CEFAS observer data (2002–2016) that relate to three individuals (66–83 cm) caught in 2010 from Division 4.a. Given that these records are from outside the known distribution area for white skate, they are likley to be misidentifications, possibly with Leucoraja fullonica. There has been one verified report of a white skate that was discarded (alive) in the English Channel. This species is potentially overlooked in some areas, and so improved training in species identification for this species could usefully be considered.	Species does not occur in UK waters

Table 6.3 Overview of species uncommon in national programmes.

Country	Basking shark (Cetorhinus maximus)	Porbeagle (Lamna nasus)	Common thresher shark (Alopias vulpinus)
France Suitability Identify areas, seasons, gears	Overall, 13 records in observer data since 2003 in Divisions 2.a, 6.a, 7.g, 7.j, 8.a and 8.b. Length distribution is in aggreement with the species size. The small number of records does not allow the seasonal distribution to be considered.	Overall 56 records since 2003 mostly in subareas 7 and 8, mostly in set gillnets and trammelnets and pelagic trawls for large fish. There may be some seasonal pattern in the catch with 10/14 catch in 7.d–e, while there were no records in Divisions 7g–k and Subarea 8 during the first quarter. In contrast more records occurred in the third quarter in Divisions 7g–k and Subarea 8. The number of records was however small.	Overall 112 records since 2003 mainly in fisheries for pelagic fish with trawls and longlines. Mostly in Subarea 8. Records were six times less frequent during quarter one than in the rest of the year.
Ireland Suitability	Unsuitable. No mechanism for reporting catch of slipped/escaped individuals.	Unsuitable for sampling larger specimens. No mechanism for reporting catch of slipped/escaped individuals.	Only rarely encountered in area
Identify areas, seasons, gears	Species comes inshore in summer and is more likely to be encountered during these months in several gear types.		
Norway Suitability	One record by self-sampling reference fleet (2015 data). The whole time series should be checked (2001–2016).	Nine records by self-sampling reference fleet (2015 data, 2415 hauls total). The whole time series should be checked (2001–2016).	Very rare in area. Several years since last observation.
Identify areas, seasons, gears		Seven of these records were by gillnetters at the coast of mid-Norway (2.a) in May-June (208 hauls total)	

Country	Basking shark (*Cetorhinus maximus*)	Porbeagle (*Lamna nasus*)	Common thresher shark (*Alopias vulpinus*)
Iceland Suitability	Unsuitable, observers are not required to report basking sharks at the moment. Records come from landings, self-reporting by the pelagic fleet and survey records	Unsuitable, observers are generally not required to report porbeagle at the moment, with the exception of observers on Japanese tuna boats. Records mainly come from those tuna boat observers and from landings and survey records.	Very rarely encountered in area
Identify areas, seasons, gears	Species comes inshore in summer and has been encountered in shrimp trawl and bottom trawl during these months	Tuna long line dominates records, followed by shrimp trawl. Most records come from fall and spring.	
Basque Country (Spain) Suitability Identify areas, seasons, gears	No historical records in observer database. In exceptional occassions two juveniles were observerd entangled in lines and gillnets	No records in observer database since 2014. Occasionally could be encountered by pelagic long liners targeting blue sharks in subarea 8	No records in observer database since 2013. Occasionally could be encountered by pelagic long liners targeting blue sharks in subarea 8.
Portugal Suitability Identify areas, seasons, gears	Only rarely encountered in the area. No records in observer database	Only rarely encountered in the area. No records in observer database.	No records in observer database. Occasionally could be encountered by pelagic long liners targeting blue sharks

Country	Basking shark (*Cetorhinus maximus*)	Porbeagle (*Lamna nasus*)	Common thresher shark (*Alopias vulpinus*)
United Kingdom (England) Suitability	There are only two records of basking shark in current CEFAS data (2002–2016). Both were caught in gillnets and discarded. The first specimen was 382 cm and was caught in 7.e in Oct 2002, the second a 378 cm specimen caught in Feb 2012 in 7.f.	There are several records of porbeagle in current CEFAS data (2002–2016), ranging from 2–23 measured individuals a year. Most of these specimens (90%) have been recorded as a bycatch in gillnets, with the remaining individuals from midwater and bottom trawl. Two thirds of all records were from July to October inclusive, indicating a degree of seasonality, which would correspond to known latitudinal movements (Biais et al., 2017). A summary of earlier data were presented by Bendall et al. (2013).	There is only one record of common thresher in current CEFAS data (2002–2016). One 210 cm individual was discarded after being caught by gillnet (Div. 7.e; Oct 2012).
Identify areas, seasons, gears	Basking sharks are more likely to be caught in larger (high-headline and midwater) trawls, gillnets, and may also be entangled in ropes associated with various static gears (e.g. pots).	Porbeagle is an occasional bycatch species in trawl fisheries, but may be a more frequent seasonal bycatch in gillnet fisheries. Further analyses of these data are required.	Common thresher is caught occasionally in gillnet fisheries, with several reports from the southern North Sea and English Channel (e.g. Ellis, 2004).

7 Review of existing data on the at-vessel mortality and post-release mortality of elasmobranch species by gear type and identify important data gaps

7.1 Introduction

The survival of elasmobranch bycatch broadly encompasses *at-vessel mortality* (AVM, also referred to as capture mortality or immediate mortality), which refers to the proportion of fish that are dead when the catch is brought onto the vessel for handling, and *post-release mortality* (PRM), relating to those fish that are discarded alive but die due to injuries sustained during capture and handling, or through the discarded fish being predated on by scavengers or opportunistic predators.

There are, however, other sources of *cryptic mortality*, such as those individuals that may be killed (directly or indirectly) by the interaction with the fishing gear but are not brought onto the deck, and these usually remain unquantified.

Ellis *et al.* (2017) reviewed published studies on the various facets of discard survival of elasmobranch fish, although there have also been several recent papers published since this review was written (Barnes *et al.*, 2016; Bell & Lyle, 2016; Dapp *et al.*, 2016; Escalle *et al.*, 2016; Whitney *et al.*, 2016; Barkley *et al.*, 2017; Dapp *et al.*, 2017; Rogers *et al.*, 2017).

The ICES Workshop on Methods for Estimating Discard Survival (WKMEDS) have reviewed approaches and developed guidelines for estimating discard survival, and have also reviewed existing studies for case study taxa. The work of WKMEDS has focused largely on a limited range of commercial species for which there is suspected to be some capacity for them to be candidates for "high survival" exemptions under the landing obligation, including Norway Lobster *Nephrops norvegicus*, plaice *Pleuronectes platessa*, sole *Solea solea* and, in terms of elasmobranchs, skates and rays (ICES, 2016d, 2016e).

Whilst there is a clear rationale to understand the discard survival for those stocks that may be subject to the landing obligation, there is still a need for a comparable knowledge for other stocks and species. For example, whilst prohibited species are exempt from the landing obligation, there is still a need to understand the discard survival of such species. If a depleted species has a high discard mortality, then prohibited listings alone may not provide sufficient protection from fishing mortality.

7.2 Approaches

There are multiple approaches to understanding the different elements of 'discard survival' (see Ellis *et al.*, 2017), with some of the more frequent approaches described below.

In relation to AVM, the most frequent data used are the numbers dead or alive as recorded by sea-going observers, and such data can be collected over a wide range of métiers and fleets. When data are collected by large numbers of observers, such data are often recorded as a simple binary choice (dead or alive). When more dedicated studies are undertaken with a more restricted number of observers, then additional information on 'vitality' or 'health state' may be collected, such as through the scoring of three (e.g. lively, sluggish, dead) or more categories. In recent years, there have also been efforts to better define the criteria assessed visually when assigning vitality scores (e.g. degree of body movements, movements of the gills/spiracle etc.), and some studies have also scored 'vitality' and 'damage' separately.

Conventional, mark-recapture tagging have also been applied in some instances. Whilst such studies can demonstrate that fish can survive the capture/discarding process (depending on the return rates), it does not quantify the survival, especially as there are many factors that influence return and reporting rates of recaptures. Nevertheless, such approaches are (i) generally low cost, (ii) able to be undertaken across vessels, fleets and seasons, (iii) able to provide supporting information to other studies, and (iv) potentially useful if different fisheries/species are to be compared on a relative scale.

Electronic tagging (including acoustic tags, data storage tags, satellite tags etc.) provide more detailed information on the post-release behaviour and survival. These approaches are the best approach for larger and/or more pelagic species, for which short-term survival experiments in tanks (or sea cages) are less appropriate. The main disadvantage of these approaches are the costs of tags, which generally result in low sample size. This is particularly so if there needs to be appropriate coverage of different vessels/gears in the fleet, seasons, size of fish, fishing ground (e.g. depth of capture), size, sex and other factors.

Survival tanks are used widely to assesses the short-term survival (often over a period of several days), although appropriate experimental design and use of controls are required to mitigate for the potential effects of captive stress. Survival tank work is often conducted over a few trips/vessels, and so there is the issue of the representativeness of the data in relation to the wider fleet/seasonal coverage that may not be studied, and also whether the samples used are replicates or pseudo-replicates.

7.3 Summary of available studies and data gaps

WKSHARKS3 noted the following additional data gaps with regards elasmobranch fishes (see also Tables 7.1-7.12).

7.3.1 Spurdog *Squalus acanthias*

Spurdog was added to the prohibited list in EU fishing opportunities in 2017 (albeit with potential derogations for landing bycatch in avoidance programmes). Whilst the 'prohibited status' implies that the species will not be included in the landing obligation, there is still a need to understand the degree to which this locally/seasonally common small shark may survive capture and discarding.

Spurdog is taken in a variety of gears, including lines, nets and trawl. Survivorship is likely to be vary with a variety of factors, including gear type and soak time (Ellis *et al.*, 2017 and references therein). Trawlers can have occasional capture events involving large numbers of spurdog, and under such circumstances the mortality would be expected to increase, due to the weight of the catch and that spurdog spines can inflict damage.

Most of the relevant data available for this species are from outside the ICES area (Table 7.1). Improved studies on the discard survival (AVM and PRM) are needed for a range of gears, notably gillnet and trawl fisheries.

7.3.2 Catsharks (Scyliorhinidae)

There have been three published studies on *Scyliorhinus canicula* (Table 7.2), indicating survival of *ca.* 78-98% in otter and beam trawl fisheries. Whilst there have been no published studies for gillnet fisheries, this species is considered a robust species with buccal-pump ventilation that may be expected to survive capture in gillnets with short to moderate soak times, as has been observed in scyliorhinids from elsewhere in the world. It is unclear as to when increasing soak time would result in exacerbated mortality.

Whilst there are no published data for *Scyliorhinus stellaris,* the larger size and shallow water habitat of this species would suggest that survival could be similar to that observed in *S. canicula* and shallow-water scyliorhinids elsewhere.

There is limited information on catsharks in deeper waters (e.g. *Galeus melastomus;* Table 7.3), and further studies on this species could usefully be undertaken, as there are likely to be increasing effects from barotrauma.

7.3.3 Hound sharks (Triakidae)

There are limited data on the discard survival of European smooth-hound sharks (Table 7.4). Anecdotal observations indicate that the smallest size categories of smooth-hounds are often dead after being caught in beam trawl (J. Ellis, pers. obs.), but this is unquantified. Larger smooth-hounds are caught more frequently in otter trawl and gill net fisheries, and the survival is unquantified. Further studies are required to inform on both the AVM and PRM of this species.

There are few studies on tope (Table 7.5), mostly from outside the ICES area, and improved knowledge of the AVM and PRM of this species is required.

7.3.4 Porbeagle *Lamna nasus* and common thresher *Alopias vulpinus*

There are a wide range of published studies on the AVM and PRM of a variety of pelagic sharks when taken in longline and, to a lesser extent, purse seine fisheries (Ellis *et al.*, 2017; Poisson *et al.*, 2017). There are a range of studies from elsewhere in the world examining the survival of blue shark and shortfin mako in high seas fisheries, and these are not addressed further here.

Within the ICES area, there can be occasional bycatch of porbeagle and common thresher in various fisheries in the continental shelf waters of the ICES area. For example, there can be seasonal captures of porbeagle (Table 7.6) and common thresher (Table 7.7) in demersal gillnet fisheries, and occasional captures in trawls (high headline bottom trawls and midwater/pelagic trawls. In general, pelagic sharks are obligate ram ventilators and so are survival can be reduced in entangling gears.

Improved data collation on the AVM of pelagic sharks is required. Given the, often, sporadic nature of this bycatch, there should be consideration of how existing data collection programmes (e.g. observer programmes) could collect such data opportunistically.

7.3.5 Deep-water sharks

Deep-water sharks are managed under a TAC in some areas (with this TAC = 0 in some management areas), or are listed as prohibited species in other areas.

Whilst scientific studies have been able to tag and release some species of deep-water shark (Rodríguez-Cabello *et al.*, 2016), the survival of most species under normal fishing operations (e.g. if caught in trawl, or where gears are hauled at a faster rate) is expected to be low, but there is a paucity of quantified data for the various fisheries that may operate over the overall depth range of these species (Table 7.8)

7.3.6 Skates and rays (Rajidae and Arhynchobatidae)

There have been several published studies from fisheries in the ICES area and elsewhere (Table 7.9), and there are also a range of on-going national (UK, Dutch and Belgian) studies examining survival of skates and rays in various fisheries. Improved data on these species are required, and WKMEDS has on-going terms of reference to examine the discard survival of this group.

There are AVM data for various inshore métiers, but more data are required for larger vessels operating offshore. There have been several studies using survival tanks to examine short-term survival, but sample sizes are often limited, and improved coverage of different fisheries could usefully be undertaken to better understand PRM.

7.3.7 Other species

Data on the discard survival for several other stocks and species of interest, including angel shark (Table 7.10), basking shark (Table 7.11) and Greenland shark (Table 7.12) are also lacking. As noted above, for species with sporadic bycatch, where dedicated programmes are unrealistic, there should be consideration of how existing data collection programmes (e.g. observer programmes) could collect such data opportunistically.

7.4 Future data needs

- There are on-going national studies to examine the discard survival of various commercial skate species in some fisheries. Once these studies have been completed, there will need to be consideration of which other skate species and/or fisheries should also be examined.
- There is only limited information on the AVM and PRM of both spurdog and starry smooth-hound, and both species are sufficiently abundant to consider dedicated studies examining the survival from otter trawl and gillnet fisheries. If such studies were to be conducted, then the opportunistic collection of comparable data for tope could usefully be included.
- There are some data on survival of lesser-spotted dogfish, and this species is generally considered to be quite hardy. Studies to collate information on the AVM in other fisheries (e.g. gillnet) could usefully be undertaken.
- There are no data on either the AVM or PRM of black-mouth dogfish, which is found in deeper water than *Scyliorhinus* spp. Initially, studies to collate information on the AVM in various fisheries could usefully be undertaken.
- Porbeagle, common thresher, basking shark and angel shark are all occasionally a bycatch in various otter trawl and gillnet fisheries. There should be consideration of whether existing observer programmes could collect information on whether discards are discarded alive or dead.

Table 7.1: Summary of relevant studies on capture mortality and discard survival of spurdog Squalus acanthias

Gear	Comments	Relevant published studies for informing on discard survival:		
		ICES AREA	OTHER REGIONS	RELATED SPECIES
Longline	Formerly targeted in longline fisheries and currently a bycatch in mixed demersal longline fisheries. Survival likely to be influenced by soak time, location of hooking and method of unhooking (e.g. by hand or bait stripper).	No data	Mandelman & Farrington (2007b)	-
Bottom otter trawl and midwater trawl fisheries	Variable bycatch in trawl fisheries, more so in demersal otter trawl fisheries. Survival likely to be influenced by haul duration, catch volume (large catch events of spurdog are more likely to crush individuals) and whether the spurdog are enmeshed	No data	Mandelman & Farrington (2007a, b) Rulifson (2007)	–
Gillnet	Formerly targeted locally in some gillnet fisheries, currently a bycatch in mixed demersal gillnet fisheries. Survival likely to be influenced by soak time, presence of scavengers, and method of handling when nets are retrieved.	Bendall et al. (2012)	Rulifson (2007) Braccini et al. (2012) Lyle et al. (2014)	–
Rod and line (recreational)	May be caught in some recreational fisheries. Survival likely to be influenced by location of hooking and handling	No data	No data	

Table 7.2: Summary of relevant studies on capture mortality and discard survival of lesser-spotted and greater-spotted dogfish (*Scyliorhinus* spp.)

		Relevant published studies for informing on discard survival:		
Gear	Comments	ICES AREA	OTHER REGIONS	RELATED SPECIES
Longline	Bycatch species in mixed demersal longline fisheries in coastal waters. Survival likely to be affected by soak time, location of hooking and method of unhooking (e.g. by hand or bait stripper).	No data	No data	–
Bottom otter trawl	Frequent bycatch in demersal otter trawl fisheries. Survival likely to be influenced by haul duration, volume and composition of catch, and whether they are enmeshed in trawl netting.	Rodríguez-Cabello et al. (2005)	–	–
Beam trawl and dredge	Frequent bycatch in demersal otter trawl fisheries. Survival likely to be influenced by haul duration, volume and composition of catch.	Kaiser & Spencer (1995) Revill et al. (2005)	–	–
Gillnet	Frequent bycatch species in mixed demersal gillnet fisheries. Survival likely to be influenced by soak time, and method of handling when nets are retrieved. As a species with buccal-pump ventilation, scyliorhinids may be able to withstand enmeshing for longer periods than other shark taxa.	No data	No data	Walker et al. (2005) Braccini et al. (2012) Lyle et al. (2014)
Rod and line (recreational)	Frequently caught in recreational fisheries, including catch-and-release Survival may be influenced by location of hooking and handling.	No data	No data	–

Table 7.3: Summary of relevant studies on capture mortality and discard survival of black-mouth dogfish *Galeus melastomus*

		Relevant published studies for informing on discard survival:		
Gear	Comments	ICES area	Other regions	Related species
Longline	Bycatch species in demersal longline fisheries in deeper waters. Survival likely to be influenced by soak time, location of hooking and method of unhooking (e.g. by hand or bait stripper). Potential effects from being raised from depth.	No data	–	Brooks et al. (2015)
Bottom otter trawl	Frequent bycatch in offshore demersal otter trawl fisheries. Survival likely to be influenced by haul duration, volume and composition of catch, and whether they are enmeshed in trawl netting. Potential effects from being raised from depth.	No data	No data	
Gillnet	Bycatch species in offshore demersal gillnet fisheries. Survival likely to be influenced by soak time, and method of handling when nets are retrieved. Potential effects from being raised from depth.	No data	No data	–

Table 7.4: Summary of relevant studies on capture mortality and discard survival of starry smooth-hound *Mustelus asterias*

		Relevant published studies for informing on discard survival:		
Gear	Comments	ICES area	Other regions	Related species
Longline	Bycatch species in mixed demersal longline fisheries in coastal waters. Survival likely to be influenced by soak time, location of hooking and method of unhooking (e.g. by hand or bait stripper).	No data	No data	Frick et al. (2010) Scott-Denton et al. (2011) Brooks et al. (2015) Butcher et al. (2015)
Bottom otter trawl	Variable bycatch in demersal otter trawl fisheries. Survival likely to be influenced by haul duration, catch volume and whether they are enmeshed in trawl netting.	No data	No data	Fennessy (1994)
Beam trawl	Variable bycatch of small individuals in beam trawl fisheries. Survival likely to be influenced by haul duration, and the volume and nature of catch. Anecdotal observations would indicate that the smallest individuals are unlikely to survive	No data	No data	No data
Gillnet	An important bycatch species in mixed demersal gillnet fisheries. Survival likely to be influenced by soak time, and method of handling when nets are retrieved.	No data	No data	Walker et al. (2005) Frick et al. (2010) Braccini et al. (2012) Lyle et al. (2014)
Rod and line (recreational)	Caught in recreational fisheries, including catch-and-release. Survival likely to be influenced by degree of hooking and handling	No data	No data	No data

Table 7.5: Summary of relevant studies on capture mortality and discard survival of tope *Galeorhinus galeus*

Gear	Comments	Relevant published studies for informing on discard survival	
		ICES AREA	OTHER REGIONS
Longline	Occasional bycatch species in mixed demersal and pelagic longline fisheries, and should be released from such gears in some EU waters Survival likely to be influenced by soak time, location of hooking, and method of unhooking (e.g. by hand or bait stripper).	No data	Megalofonou et al. (2005) Coelho et al. (2012) Rogers et al. (2017)
Trawl (bottom and midwater)	Variable bycatch in demersal otter trawl fisheries. Survival likely to be influenced by haul duration, catch volume and whether they are enmeshed in trawl netting.	No data	No data
Gillnet	Seasonal bycatch species in mixed demersal gillnet fisheries. Survival likely to be influenced by soak time, how it is entangled, and method of handling/dientangling when nets are retrieved.	No data	Walker et al. (2005) Braccini et al. (2012)
Rod and line (recreational)	Important target species in some recreational fisheries, including catch-and-release. Survival likely to be influenced by a range of factoirs: degree of hooking, fight time, handling and whether it is brought onboard or unhooked whilst in the water.	No data. Published tagging studies (e.g. Holden & Horrod, 1979) demonstrate that angler-caught fish can survive, but the level of any mortality is unknown.	No data

Table 7.6: Summary of relevant studies on capture mortality and discard survival of porbeagle *Lamna nasus*

Gear	Comments	Relevant published studies for informing on discard survival		
		ICES AREA	OTHER REGIONS	RELATED SPECIES
Longline	Formerly targeted in longline fisheries. Bycatch species in pelagic longline fisheries. Survival likely to be influenced by soak time, location of hooking and method of boarding/unhooking	No data	Francis et al. (2001) Coelho et al. (2012) Epperly et al. (2012) Gallagher et al. (2014) Campana et al. (2016)	-
Trawl (bottom and midwater)	Very oocasional bycatch in demersal otter trawl fisheries. Bycatch in midwater trawl fisheries. Survival likely to be influenced by haul duration, nature of catch (composition and quantity) and catch handling	No data	No data	-
Gillnet	Seasonal bycatch species in mixed demersal gillnet fisheries. Survival likely to be influenced by soak time, how it is entangled, and method of handling/dientangling when nets are retrieved.	Bendall et al. (2012)	No data	Reid & Krogh (1992)
Rod and line (recreational)	Caught in recreational fisheries, including catch-and-release. Survival likely to be influenced by a range of factoirs: degree of hooking, fight time, handling and whether it is brought onboard or unhooked whilst in the water.	No data	No data	French et al. (2015)

Table 7.7: Summary of relevant studies on capture mortality and discard survival of common thresher shark *Alopias vulpinus* (see also Poisson *et al.*, 2017 for other on other species of thresher shark)

		Relevant published studies for informing on discard survival		
Gear	Comments	ICES AREA	OTHER REGIONS	RELATED SPECIES
Longline	Bycatch species in pelagic longline fisheries. Survival likely to be influenced by soak time, location of hooking and method of boarding/unhooking	No data	Bromhead et al. (2012) Gilman et al. (2015)	Coelho et al. (2012)
Gillnet	Seasonal bycatch species in some mixed demersal gillnet fisheries. Survival likely to be influenced by soak time, how it is entangled, and method of handling/dientangling when nets are retrieved.	No data	Walker et al. (2005) Braccini et al. (2012)	Reid & Krogh (1992)
Trawl (bottom and midwater)	Very oocasional bycatch in demersal otter trawl and midwater trawl fisheries. Survival likely to be influenced by haul duration, nature of catch (composition and quantity) and catch handling	No data	No data	No data
Rod and line (recreational)	Caught in recreational fisheries, including catch-and-release. Survival likely to be influenced by a range of factors: degree of hooking, fight time, handling and whether it is brought onboard or unhooked whilst in the water.	No data	Heberer et al. (2010) Sepulveda et al. (2015)	-

Table 7.8: Summary of relevant studies on capture mortality and discard survival of 'deep-water sharks'

Gear	Comments	Relevant published studies for informing on discard survival	
		ICES AREA	OTHER REGIONS
Longline	Formerly targeted in longline fisheries and currently a bycatch in other longline fisheries that may overlap with the spatial and bathymetric range of deep-water sharks. Survival likely to be influenced by soak time, location of hooking, and the speed at which the lines are hauled (effects of barotrauma).	No data under normal ommercial fishing practices. Scientific investigations indicate that some species have the capacity to survive. (Rodríguez-Cabello & Sánchez, 2014)	No data under normal commercial fishing practices. Scientific investigations indicate that some species have the capacity to survive (Brooks et al., 2015)
Bottom otter trawl	Variable bycatch in deep-water trawl fisheries. Survival likely to be influenced by haul duration, catch volume/composition, whether the sharks are enmeshed and the speed at which the net is hauled to the surface (effects of barotrauma).	No data	No data
Gillnet	Formerly targeted locally in some gillnet fisheries. Limited overlap between the spatial/bathymetric range of deep-water sharks with gillnet fisheries on shelf edge. Survival likely to be influenced by soak time, presence of scavengers, the speed at which the lines are hauled (effects of barotrauma), and method of handling when nets are retrieved.	No data	No data

Table 7.9: Summary of relevant studies on capture mortality and discard survival of skates (Rajidae and Arhynchobatidae)

Gear	Comments	Relevant published studies for informing on discard survival: ICES area	Relevant published studies for informing on discard survival: Other regions
Longline	Target or bycatch species in a range of demersal longline fisheries, typically those undertaken by artisanal fleets in inshore areas. Survival likely to be influenced by soak time, location of hooking and method of unhooking (e.g. by hand or bait stripper).	Ellis et al. (2008)	Benoît et al. (2010a) Endicott & Agnew (2004) Scott-Denton et al. (2011)
Bottom otter trawl	Important bycatch species (sometimes targeted) in bottom otter trawl fisheries over much of the continental shelf. Survival likely to be influenced by haul duration, and catch volume/composition.	Ellis et al. (2008) Enever et al. (2009, 2010)	Laptikhovsky (2004) Benoît et al. (2010a, 2012) Cicia et al. (2012) Mandelman et al. (2012) Saygu & Deval (2014)
Beam trawl and dredge	Bycatch species in beam trawl and dredge fisheries, with proportionally more smaller (juvenile) specimens caught. Survival likely to be influenced by haul duration, the volume and nature of catch, and size of the fish.	Kaiser & Spencer (1995) Depestele et al. (2014)	Benoît et al. (2010b) Rudders et al. (2015)
Gillnet	Target or bycatch species in a range of demersal gillnet and tanglenet fisheries. Survival likely to be influenced by soak time (including potential exposure to scavangers), and method of handling when nets are retrieved.	Ellis et al. (2008) Bendall et al. (2012)	Lyle et al. (2014)
Rod and line (recreational)	Coastal species caught in recreational fisheries. Specimens may be released or retained for consumption, depending on species, size and fisher. Survival likely to be influenced by degree of hooking and handling.	No data	No data

Table 7.10: Summary of relevant studies on capture mortality and discard survival of angel shark *Squatina squatina*

Gear	Comments	Relevant published studies for informing on discard survival		
		ICES AREA	OTHER REGIONS	RELATED SPECIES
Bottom otter trawl	Occasional bycatch in bottom trawl fisheries. Survival likely to be influenced by haul duration, and catch volume/composition.	No data	No data	Fennessy (1994)
Beam trawl	Smaller individuals are a potential bycatch in beam trawl fisheries. Survival likely to be influenced by haul duration, and catch volume/composition.	No data	No data	No data
Gillnet	Occasional bycatch in a range of demersal gillnet and tanglenet fisheries. Survival likely to be influenced by soak time and method of handling when nets are retrieved.	No data	No data	Reid & Krogh (1992) Walker et al. (2005) Braccini et al. (2012)

Table 7.11 Summary of relevant studies on capture mortality and discard survival of basking shark *Cetorhinus maximus*

Gear	Comments	Relevant published studies for informing on discard survival	
		ICES AREA	OTHER REGIONS
Trawl (bottom and midwater)	Occasional bycatch in trawl fisheries. Survival likely to be influenced by haul duration, and also how the specimen is handled when being released.	No data	No data
Gillnet	Occasional bycatch in gillnet fisheries. Survival likely to be influenced by soak time and how the specimen is handled when nets are retrieved.	No data, but some anecdotal observations (e.g. Valeiras et al., 2001)	No data
Static gear (rope entanglement)	Occasional entanglement in various fisheries that have ropes connecting bottom gear to surface buoys (e.g pot and gillnet fisheries). Survival presumably relating to the time spent entangled before release.	No data	No data

Table 7.12 Summary of relevant studies on capture mortality and discard survival of Greenland shark *Somniosus microcephalus*

		Relevant published studies for informing on discard survival		
Gear	Comments	ICES area	Other regions	Related species
Trawl (bottom and midwater)	Occasional bycatch in trawl fisheries. Survival likely to be influenced by haul duration, and also how the specimen is handled if it is being released.	No data	No data	No data
Gillnet	Occasional bycatch in gillnet fisheries. Survival likely to be influenced by soak time and how the specimen is handled when nets are retrieved.	No data	No data	No data
Longline	Targeted in some localised longline fisheries and occasional bycatch in other longline fisheries that overlap with the spatial and bathymetric range of this species. Larger specimens may break the traces and not be brought to the surface. Survival of other specimens likely to be influenced by soak time, hooking location, and (if caught at depth) the speed at which the lines are hauled (i.e. effects of barotrauma).	Barkley et al. (2016)	No data	No data

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