IBTSWG REPORT 2017

ICES STEERING GROUP ON INTEGRATED ECOSYSTEM OBSERVATION AND MONITORING

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Interim Report of the International Bottom Trawl Survey Working Group

27-31 March 2017

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

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IBTS

INTERNATIONAL-BOTTOM-TRAWL-SURVEY

Executive Summary

The report presents summaries of the national contributions in 2016–2017 and planning for 2017–2018 for the surveys coordinated by the International Bottom Trawl Survey Working Group (IBTSWG). In the North Sea, the surveys are performed in quarters 1 and 3; in the Northeast Atlantic the surveys are conducted in quarters 1, 3, and 4 with a suite of 14 national surveys covering shelf areas from north off Scotland to the Gulf of Cádiz.

North Sea Q1, 2017: Seven countries using six different vessels participated and performed 377 valid GOV hauls and 655 valid MIK hauls in the period between 18 January and 24 February. All rectangles were covered by at least 1 GOV haul and only one rectangle was not covered by any MIK haul. Denmark and Sweden both used "DANA" and Norway used "Cefas Endeavour" because "GO SARS" was not available during the time of the survey. All countries used their own survey gear. The almost complete coverage of the area including three additional rectangles (52E9, 52F0, 52F1) in the north was mainly because of the very good weather conditions but also due to the change in the allocation of rectangles to the different countries which reduced steaming time. The Netherlands were not able to execute MIK hauls during a significant part of its survey but most of these stations were covered by other countries. Despite some minor adaptions, no further changes of the survey are planned for 2018. [The allocation of the area had significantly changed for the 2017 Q1. The allocation combined with very favourable weather conditions resulted in almost complete coverage, which was actually the first time in a couple of years despite the reduction in effort. However, as this was largely due to the very good weather conditions it was impossible to evaluate the allocation and to discuss whether further changes are required]

North Sea Q3, 2016: Six countries using five different vessels participated and performed 382 valid GOV hauls in period from 15 July to 7 September. Denmark and Sweden used both "DANA" but with their own survey gear. The total number of hauls was the highest ever in the time-series. This was partly because of good weather conditions but also because, as in 2015, a mixture of 15 and 30 min tows was used. Denmark, Germany, Norway, and Scotland participated in this exercise performing between 17% and 43% more hauls than mandatory. No major change in the rectangle allocation scheme between countries is planned but is yet not finally decided whether the use of 15 min tows continues in 2017 survey. [All participants are encouraged to record time to settle and time to haul, in addition to the normal parameters. If time permits, catch information for 0-minute tows (i.e. tows that are hauled as soon as the net settles on the bottom) are desired. Details for recording the additional haul information can be found in section 11.1.6.

Northeast Atlantic 2016: Seven vessels from five countries performed 13 surveys along the Northeastern Atlantic IBTS area. A total of 1066, out of the 1057 hauls planned, were accomplished within 297 days at sea distributed between the first, third and fourth quarters. Tow duration was reduced for UK-NIGFS and Porcupine survey, as proposed in IBTS2016. In both cases catches were reduced and work on board was easier to accomplish while no immediate effect on representability of the samples, while possible effects on length distributions and or taxonomical diversity will be explored. The Irish Anglerfish and Megrim Survey (IE-IAMS) has been included in this report as agreed in last year's meeting.

The IBTSWG has produced three manuals, the manual for the North Sea IBTS and the Northeast Atlantic IBTS as well as the manual for the MIK sampling during the North Sea IBTS, which are currently being revised. All of these manuals will be submitted to ICES in their newest version until the end of 2017.

Staff exchange has been a routinely performed in IBTS surveys with great success and advantage to the surveys standardization. The group strongly recommends that this practice continues and involves more countries.

IBTSWG is willing to support the establishment of a WG on Marine Litter. This would facilitate improvements on collection and recording protocols, data checking procedures for the database and creation of a field guide.

IBTSWG is planning to organize a flume tank workshop together with WGFTFB to identify a possible new standard survey gear for the NS-IBTS.

1 Administrative details

Working Group name

International Bottom Trawl Survey Working Group (IBTSWG)

Year of Appointment within the current cycle

2015

Reporting year within the current cycle (1, 2 or 3)

2

Chair(s)

Kai Wieland, Denmark

Corina Chaves, Portugal

Meeting venue

ICES Headquarters, Copenhagen, Denmark

Meeting dates

27–31 March 2017

2 Terms of Reference a) – i)

ToR	Description	Background	Science plan topics addressed	Duration	Expected deliverables
a	Coordination and reporting of North Sea and northeastern Atlantic surveys, including appropriate field sampling in accordance to the EU Data Collection Framework	Intersessional planning of Q1- and Q3-surveys; communication of coordinator with cruise leaders; combing the results of individual nations into an overall survey summary.	30	Recurrent annual update	1) Survey summary including collected data and description of alterations to the plan, to relevant assessment-WGs (WGHMM, WGCSE, WGNEW, WGNSSK, HAWG, WGDEEP, WGEF, WGEEL, WGCEPH, WGHANSA) and SCICOM. 2) Indices for the relevant species to assessment WGs (see above) 3) Planning of the upcoming surveys for the survey coordinators and cruise leaders.
b	Review IBTS SISP manuals and consider additional updates and improvements in survey design and standardization	Intersessional activity, ongoing in order to improve survey quality	31	Permanently ongoing	Updated version of survey manual, whenever substantial changes are made (intersessionally)
c	Address DATRAS-related topics	Issues with data handling,	30	Multi-annual activity,	Prioritized list of issues and suggestion for

	in cooperation with DUAP: data quality checks and the progress in re-uploading corrected datasets, quality checks of indices calculated, and prioritizing further developments in DATRAS.	data requests or challenges with re-uploading of historical or corrected data to DATRAS have been identified and solutions are being developed		supported by WKDATR workshop in January of 2013 to solve issues with highest priorities;	solutions and for quality checking routines, as well as definition of possible new DATRAS products, submitted to DATRAS group at ICES (Compare Action List in 2013 report). Once data quality control routines are estabished, annual check of recent survey data.
d	Produce a swept-area-based index (instead of haul time-based index) to be explored in collaboration with the WGISDAA	Swept-area is suggested as an alternative to haul time, because it would remove possible bias resulting from different riggings or gear specifications. In order to evaluate the effect changing to new indices, IBTSWG intends to liase with relevant stock coordinators or assessment groups at ICES.	28	1 year	Manuscript for paper or CRR, analysing the potential advantages of moving to swept-area-based standardization. To be presented to assessment groups for evaluation by 2016 (postponed to 2018).
e	Analyse and report on the effect of variable sweep length, groundgears and GOV riggings	Some aspects of the gear applied in the surveys are not required to be standardized. The effect of	28	2 years	Working document(s) by 2016, Manuscript or CRR by 2017

	between the participating countries	these variations are to be evaluated. Partly, different standards for sweep lengths have been applied in Q1 vs. Q3 surveys, and different groundgears and riggings are applied. (For this ToR, the IBTS WG seeks support from gear technology experts and welcomes their contribution, in particular for advice on a potential change of the survey gear.)		
f	Evaluate the present scheme of collection of age and other biological data	Analysis of spatial distribution of sampling of age and other biological data, options to increase efficiency and minimum required sample sizes	2 years	Working document(s) by 2016, Manuscript by 2017
g	Evaluate the current survey design and explore modifications or alternative survey designs, identifying any potential benefits and drawbacks with respect to spatial	Specific issues to be addressed include: Effect of tow duration; Suitability of species-specific index areas; Stratification and optimal spatial distribution	3 years	Paper on tow duration experiment in NS-IBTS 3Q 2015 by 2016, Manuscript for paper or CRR by 2018.

	distribution and frequency of sampling.	of effort.			
h	Data overviews	ICES is building an overview of the different data products and how the information flows from survey to advice, and input is needed from the survey groups in this process.	25, 27	Sept 2016	Quality assure the data product overviews
i	Give input to WKSUREP on data reporting guidelines.	The information flow between data users and the data providers needs to be strengthened	31	Sept 2016	Comment on WKSUREP draft data reporting guidelines.

3 Summary of Work Plan

Year 1 (2016)	Evaluate the effect of changing to swept-area-based indices for additional examples/stocks, particularly linked to WGISDAA and benchmark process (ToR d). Evaluate the results of the tow duration experiment from the NS-IBTS 3Q 2015 survey.
Year 2 (2017)	Continue analyses of different GOV configurations (ToR e).
Year 3 (2018)	Complete the evaluation of the current survey design and explore modifications or alternative survey designs (ToR g), Update survey manuals if necessary (ToRs e, f, and g)
Recurrent annual activity	Updates for ToRs a, b, and c.

4 List of Outcomes and Achievements of the WG in this delivery period

Description of survey products: Survey summaries of IBTS coordinated surveys for Q3/Q4 2016 and Q1 2017;

Updates of survey manual for the International Bottom Trawl Surveys in the North Sea and in the Northeast Atlantic areas as well as for the MIK sampling in the Q1 NS-IBTS. The manuals will be submitted to review by SGESST by July 2017.

Tow duration experiment have been conducted in Q3 2016 NS-IBTS and analysed together with the data from Q3 2015 NS-IBTS;

Input data and algorithms for NS-IBTS swept-area estimates have been checked for almost all countries;

First results from analyses on survey stratification based on fish communities and other ecological information have been presented for the NS-IBTS and the Western English Channel NeAtl-IBTS

5 Coordination of North Sea and Northeast Atlantic surveys (ToR a)

5.1 North Sea Q1

(Coordinator: Ralf van Hal)

5.1.1 General overview

The North Sea IBTS Q1 survey aims to collect data on the distribution, relative abundance and biological information on a range of fish species in ICES Areas 3a, 4, and 7d. During daytime a bottom trawl, the GOV (Grand Ouverture Verticale), with groundgear A or B, was used. A CTD was deployed at most trawl stations to collect temperature and salinity profiles. During night-time herring larvae were sampled with a MIK-net (Methot Isaac Kitt). Age data were collected for the target species cod, haddock, whiting, saithe, Norway pout, herring, mackerel, and sprat, and a number of additional species.

The full quarter 1, 2017 fleet consisted of six vessels: “Dana” (Sweden and Denmark), “Cefas Endeavour” (Norway), “Scotia” (Scotland), “Thalassa” (France), “Tridens II” (Netherlands) and “Walther Herwig III” (Germany). The survey covered the period 18 January to 24 February 2017 (Table 5.1.1.1).

This year the allocation of the rectangles was changed in line with the proposal in the IBTSWG report of 2016 (ICES, 2016). The change took place because the French had less effort to allocate to the IBTS.

A total of 385 GOV hauls (8 of which were invalid) (Table 5.1.1.2) and 655 MIK hauls (Table 5.1.1.3) were deployed. This means that all rectangles were covered by at least 1 GOV haul (Figure 5.1.1.1) and only one rectangle was not sampled by using the MIK whereas all others were covered by at least 1 MIK haul. The result was mainly because of very good weather conditions but the changed allocation of rectangles reducing steaming time is also likely to have contributed.

Biological data are collected from a number of species, for most of these species length, weight, gender and maturity and age material were collected (Table 5.1.1.4). An impression of the catches is given in Figure 5.1.1.2, by presenting the total fish catch in kilogrammes. Gear geometry plots are given in Figures 5.1.1.3a to 5.1.1.3d (lines represent theoretical values for the GOV from flume tank experiments, ICES 2015)

A specific comment is to be made on the Norwegian participation in 2017: Regularly Norway uses the vessel GO SARS, however this was in dock at the time of the survey. Therefore, the Cefas Endeavour was used (with the Norwegian gear and doors).

Table 5.1.1.1. Overview of the surveys performed during the North Sea IBTS Q1 survey in 2017.

		January																					February																						
country	Vessel	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Sweden	Dana																																												
France	Thalassa II																																												
Norway	CEFAS Endeavour																																												
Germany	Walther Herwig III																																												
Scotland	Scotia III																																												
Denmark	Dana																																												
Netherlands	Tridens 2																																												

Table 5.1.1.2. Overview of the GOV stations fish in the North Sea IBTS Q1 survey in 2017.

ICES Divisions	Country	Gear	Tows planned	Valid	Invalid	% stations fished
3a	SWE	GOV-A	44	45		102%
3a	DEN	GOV-A	0	1		
4	GFR	GOV-A	75	73		97%
	SWE	GOV-A	2	2		100%
	NOR	GOV-A	42	40	4	95%
	FRA	GOV-A	43	47		109%
	DEN	GOV-A	40	42		105%
	NED	GOV-A	54	55		102%
	SCO	GOV-A	12	12		100%
	SCO	GOV-B	47	46	3	98%
7d	FRA	GOV-A	10	14	1	140%

Table 5.1.1.3. Overview of the MIK stations fish in the North Sea IBTS Q1 survey in 2017.

ICES Divisions	Country	Gear	Tows planned	Valid	Invalid	% stations fished
3a	SWE	MIK	62	62		100%
4	GFR	MIK	150	146		97%
	SWE	MIK	4	4		100%
	NOR	MIK	84	78		93%
	FRA	MIK	86	86		100%
	DEN	MIK	80	87	1	109%
	NED	MIK	108	79	2	73%
	SCO	MIK	116	97		84%
7d	FRA	MIK	20	16	1	80%

Table 5.1.1.4. Overview of individual length, weight and/or maturity and/or age samples collected during the North Sea IBTS Q1 survey in 2017 (as submitted to DATRAS prior to the meeting, final numbers may differ).

Species	DEN	FRA	GFR	NED	NOR	SCO	SWE	Total
Clupea harengus	490	422	1068	457	749	448	1779	5413
Merlangius merlangus	652	795	968	515	707	882	832	5351
Melanogrammus aeglefinus	101	21	1211	169	786	1077	226	3591
Gadus morhua	110	44	444	194	248	690	708	2438
Pleuronectes platessa	568	517	390	342	0	0	498	2315
Sprattus sprattus	412	234	234	400	0	113	754	2147
Trisopterus esmarkii	77	0	331	113	343	386	250	1500
Pollachius virens	19	0	196	4	522	389	79	1209
Eutrigla gurnardus	150	0	495	0	0	0	0	645
Microstomus kitt	108	57	200	0	0	0	0	365
Scomber scombrus	43	0	0	33	196	83	0	355
Scyliorhinus canicula	0	0	125	0	32	0	0	157
Merluccius merluccius	14	0	80	0	0	0	53	147
Amblyraja radiata	0	0	85	0	51	0	0	136
Limanda limanda	124	0	0	0	0	0	0	124
Squalus acanthias	0	0	114	0	0	0	0	114
Solea solea	1	76	0	0	0	0	36	113
Trisopterus luscus	0	92	0	0	0	0	0	92
Glyptocephalus cynoglossus	8	0	0	0	0	0	63	71
Mullus surmuletus	0	65	0	0	0	0	0	65
Lithodes maja	0	0	39	0	19	0	0	58
Lophius piscatorius	3	0	34	0	0	0	0	37
Mustelus asterias	0	0	33	0	2	0	0	35
Leucoraja naevus	0	0	24	0	10	0	0	34
Chelidonichthys cuculus	0	23	0	0	0	0	0	23
Dicentrarchus labrax	0	20	0	0	0	0	0	20
Scophthalmus maximus	3	0	0	9	0	0	0	12
Nephrops norvegicus	0	0	5	0	2	0	0	7
Scophthalmus rhombus	2	1	0	3	0	0	0	6
Raja montagui	0	0	6	0	0	0	0	6
Galeus melastomus	0	0	0	0	4	0	0	4
Cancer pagurus	0	0	3	0	0	0	0	3
Leucoraja fullonics	0	0	2	0	0	0	0	2
Lophius budegassa	0	0	1	0	0	0	0	1
Micromesistuis poutassou	0	0	1	0	0	0	0	1

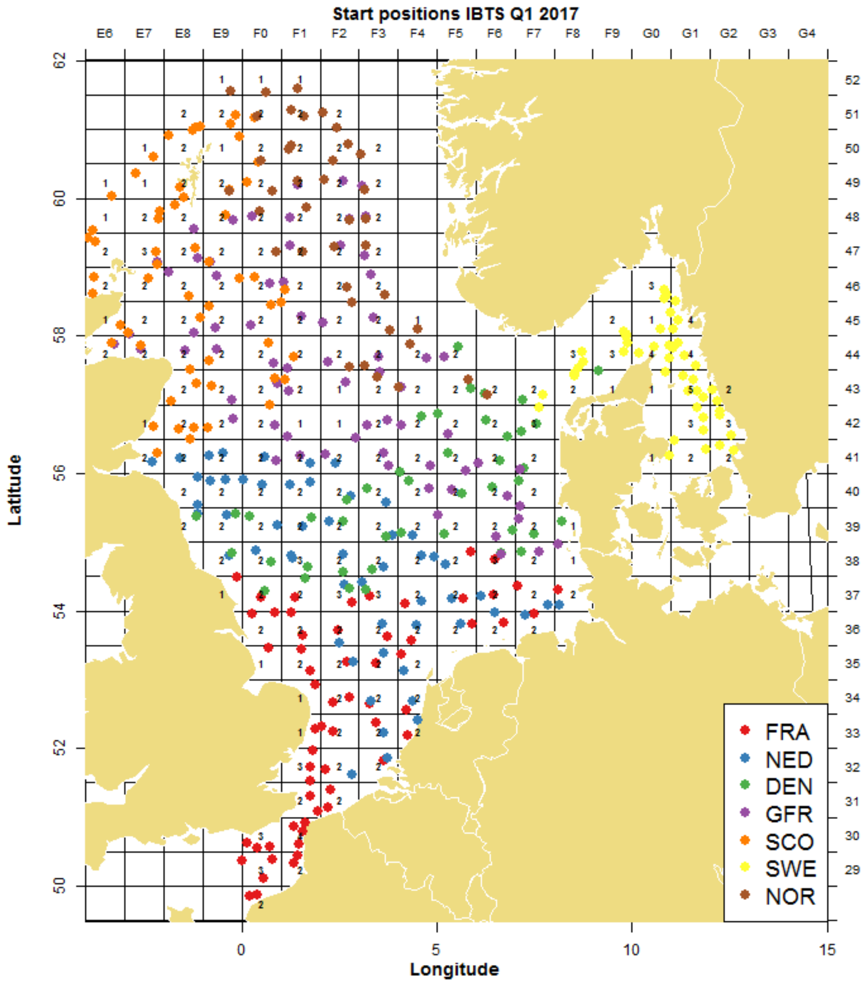


Figure 5.1.1.1 Number of hauls per ICES rectangle with GOV during the North Sea IBTS Q1 2017 and the start positions of the trawls by country.

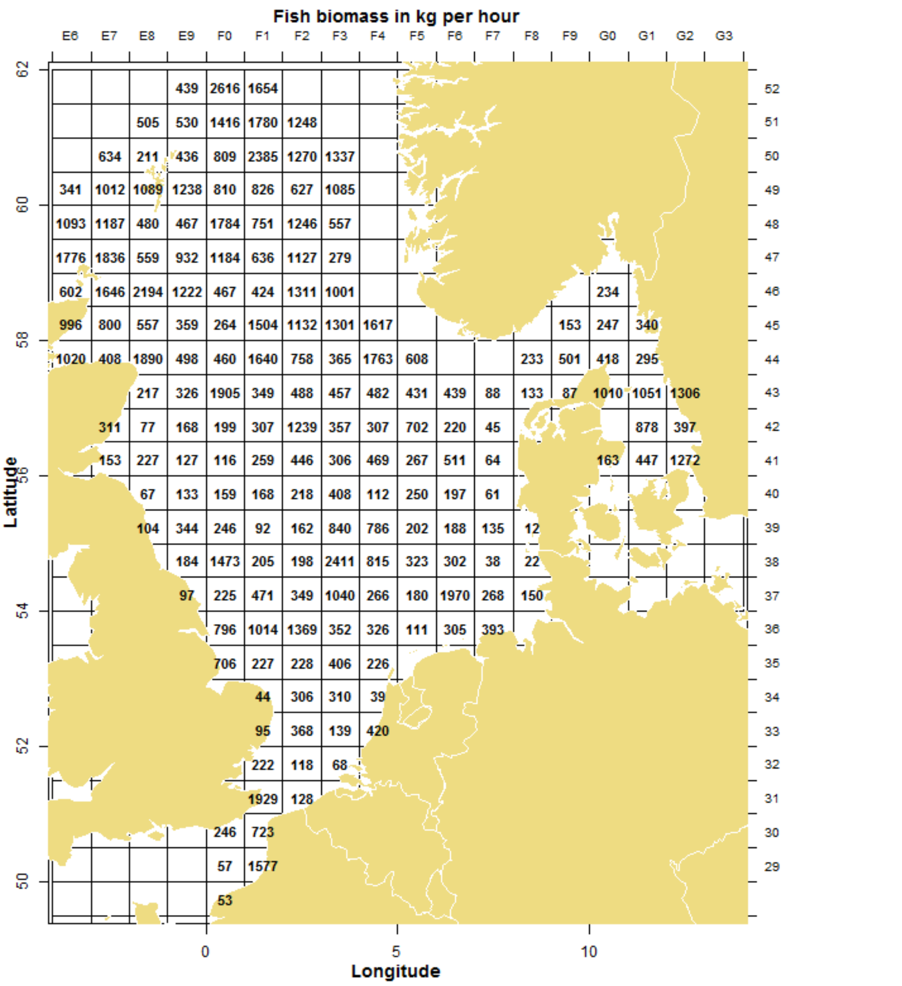


Figure 5.1.1.2 Distribution of fish biomass in IBTS hauls by rectangle in the North Sea, Q1 2017 (values standardized to kg per hour haul duration; mean per rectangle).

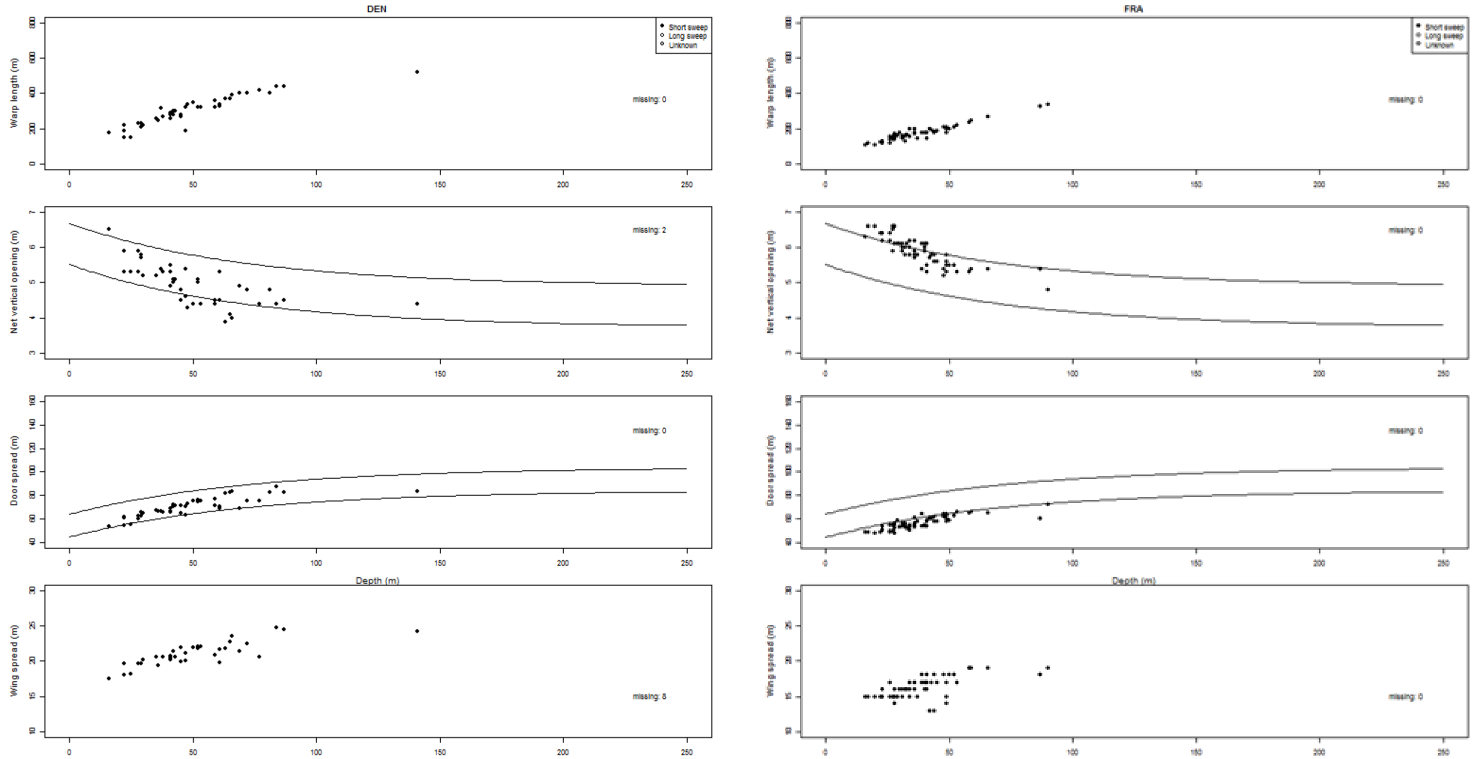


Figure 5.1.1.3a Danish and French warp length and gear geometry

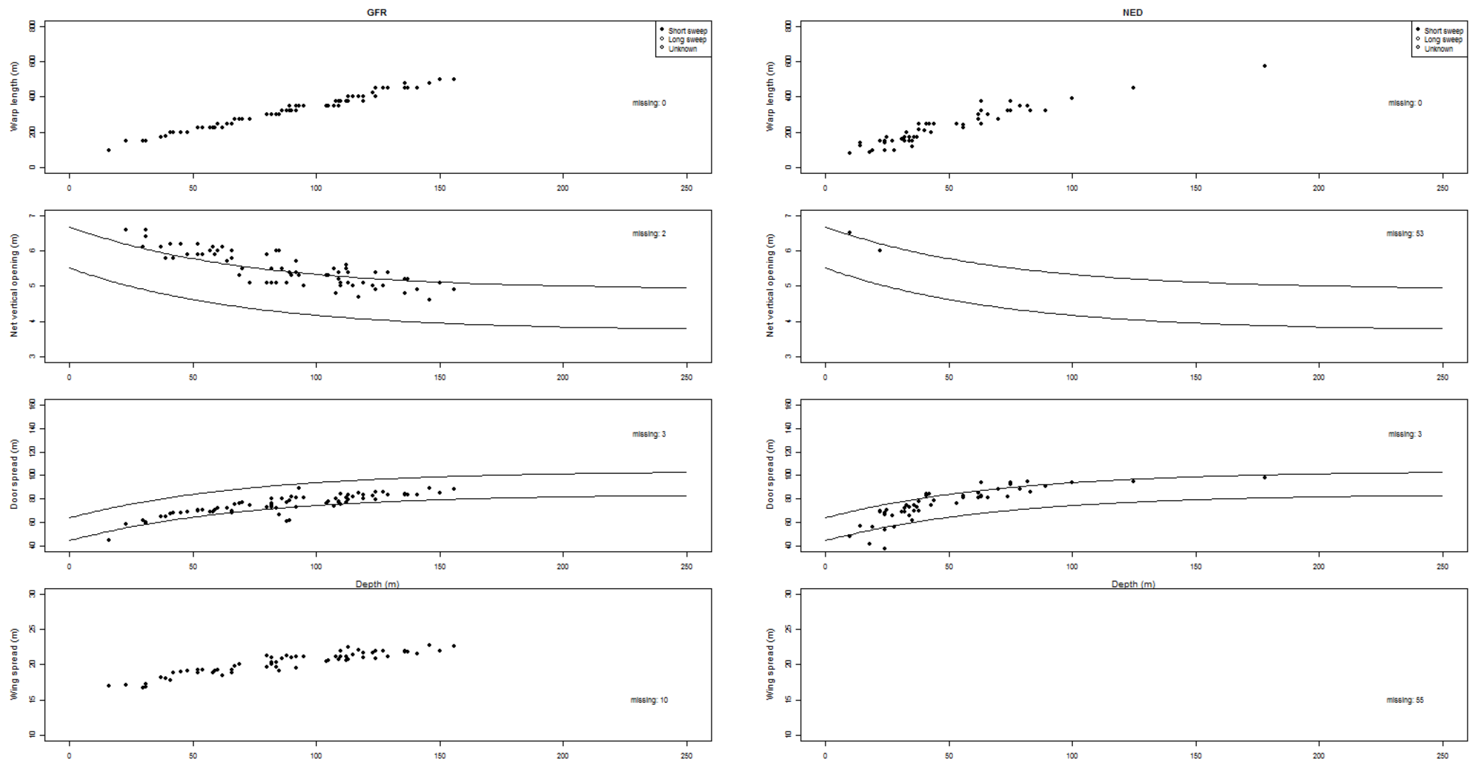


Figure 5.1.1.3b German and Dutch warp length and gear geometry . No Dutch wing sensors and due to a new Simrad system vertical net opening was observed on board but not recorded

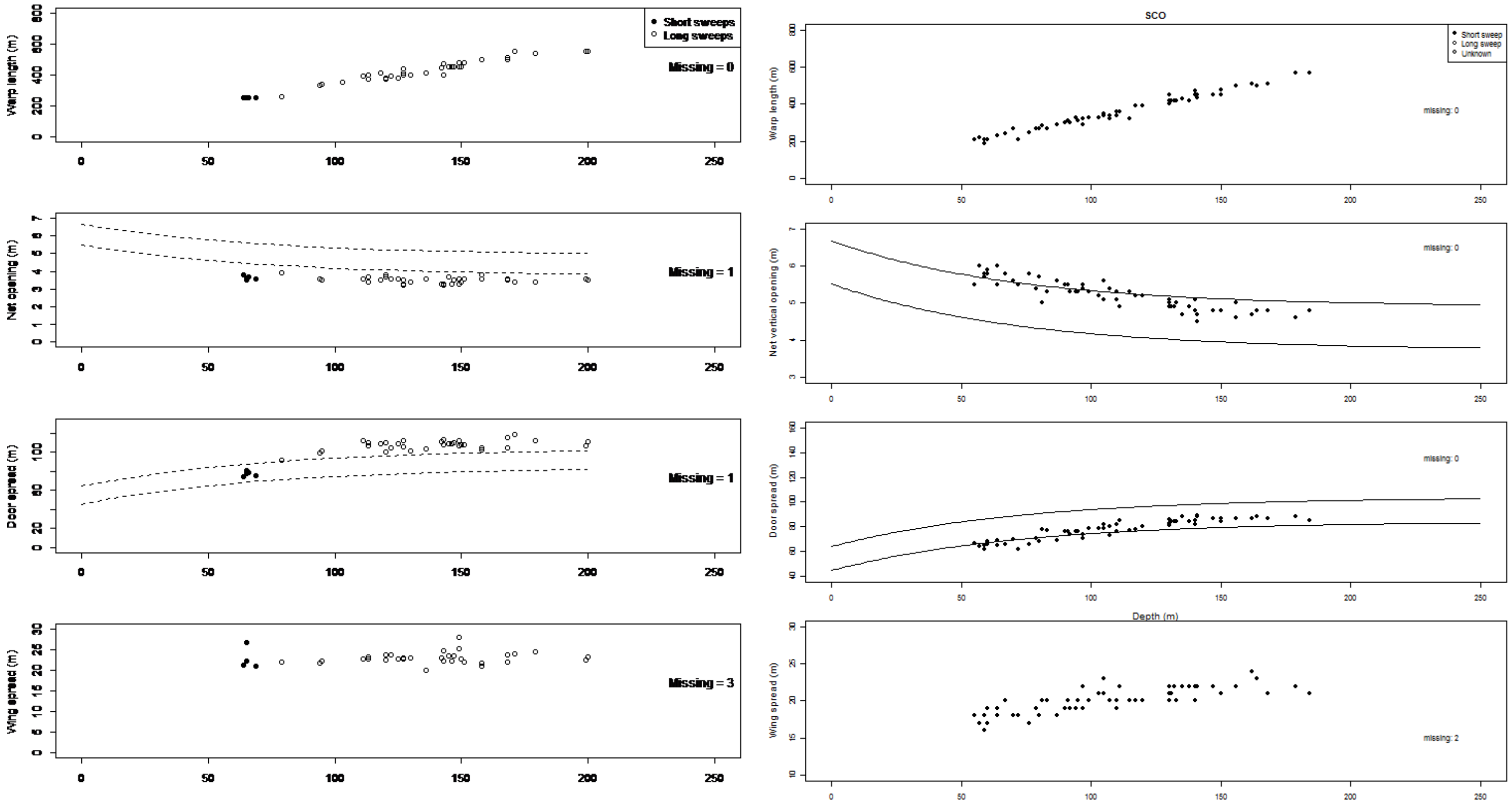


Figure 5.1.1.3c Norwegian and Scottish warp length and gear geometry.

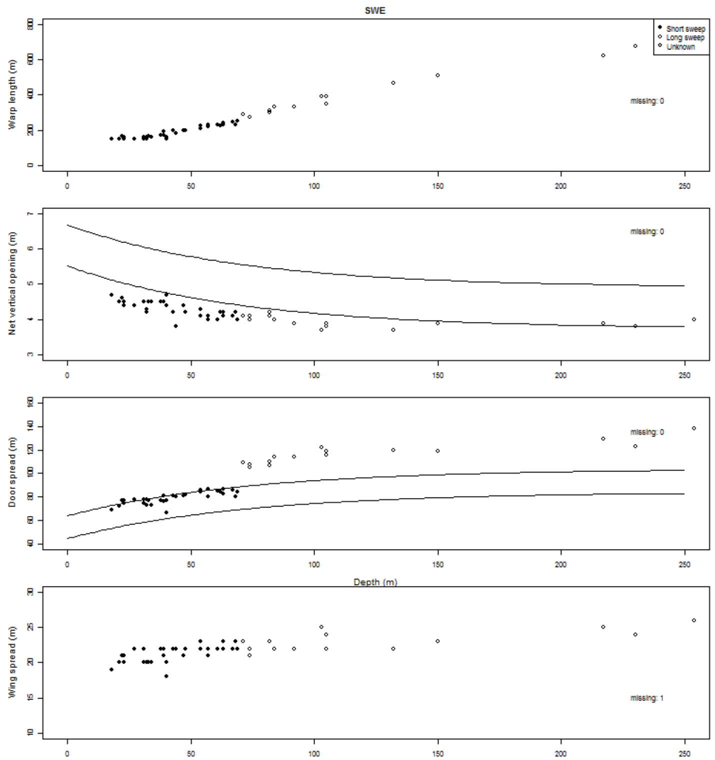


Figure 5.1.1.3d Swedish warp length and gear geometry.

5.1.2 Issues and problems encountered

The Dutch lost all their MIK nets in the first half of the two week trip. This made it impossible to execute MIK tows in the most northwestern rectangles covered by the Dutch. Where possible, a portion of these rectangles was covered by some of the other countries. The Dutch were able to use the French MIK net for their next week, and many thanks the French for that. The Dutch were able to repair one of their own nets to be used during their last week.

A large oil and gas development area stretches across ICES rectangles 42F1 and 42F2 in the British EEZ where any activity is prohibited. In 42F1 the fishable area is reduced to a small corridor of 5–7 nmi width along its southern and western boundaries while in 42F2 between a third and a half of the rectangle is covered by that restriction (Figure 5.1.2.1). Opportunities to carry out scientific work are therefore considerably reduced in those 2 rectangles.

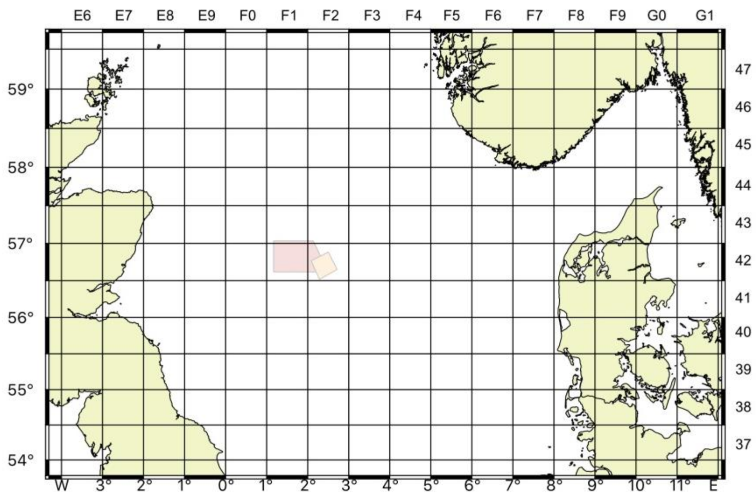


Figure 5.1.2.1: Position of the oil and gas development area in the British EEZ.

5.1.3 Additional activities

Next to the GOV and MIK tows all countries have collected additional data. All countries collected seafloor litter from the GOV tows and collected CTD (temperature and salinity) at all GOV stations when possible. A complete list of additional activities is given in Table 5.1.3.1.

Table 5.1.3.1 Overview of additional activities in the North Sea IBTS Q1 survey in 2017.

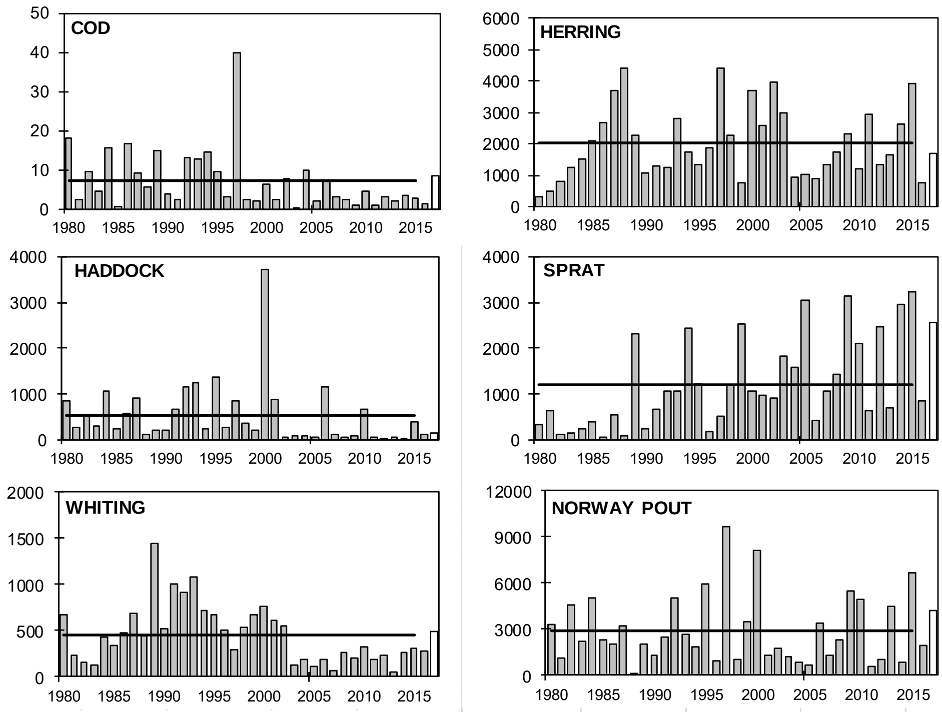
Activity (x) not all hauls	GFR	NOR	SCO	DEN	NED	SWE	FRA
CTD (temperature+salinity)	x	x	x	x	x	x	x
Seafloor Litter	x	x	x	x	x	x	x
Water sampler (Nutrients)			x	x		(x)	x
Egg samples (Small fine-meshed ringnet, CUFES)	x	x	x	x	x		x
By-caught benthic animals		x			x		x
Observers for mammals and/or birds							x
Additional biological data on fish		x	(x)	(x)		x	
Benthic samples (boxcore, video, dredge)							
Zoo and phytoplankton		x					x
Jellyfish		x					x
Hydrological transect		x					
Beam trawl (juvenile fish - age 0)		x					

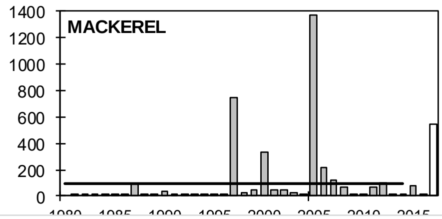
5.1.4 GOV

The preliminary indices for the recruits of seven commercial species based on the 2017 quarter 1 survey are shown in Figure 5.1.4.1. According to these preliminary results, cod and whiting are around the long-term mean values. Sprat, mackerel, and Norway pout are above the long-term mean and herring and haddock below the long-term mean values.

International Bottom Trawl Survey: 1-group indices as average N/hour fishing 4/18/2017

1980-2015 Final indices, 2016 preliminary values based on: 376 hauls





	final	preliminary	MEAN
	2016	2017	av 80-16
cod	1.4	**8.6**	7
haddock	104.4	**158**	521
whiting	281.3	**485**	451
Norway pout	1928.6	**4171**	2897
herring	779.4	**1678**	2010
sprat	854.6	**2567**	1199
mackerel	0.9	**549**	95

Figure 5.1.4.1. Time-series of indices for 1-group (1-ring) herring, sprat, haddock, cod, whiting, Norway pout, and mackerel caught during the quarter 1 IBTS survey in the North Sea, Skagerrak and Kattegat. Indices for the last year are preliminary, and based on a length split of the catches. Horizontal line is the mean 1980–2016.

Distribution maps of the 1-group of NS-IBTS target species with the limits of the species-specific stock assessment or index areas are given in Figures 5.1.4.2a to 5.1.4.2e.

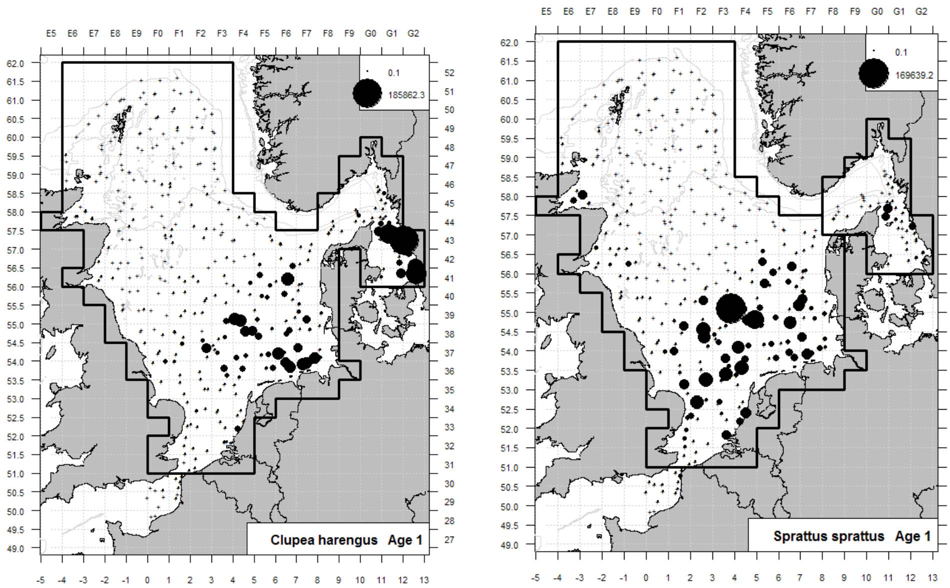


Figure 5.1.4.2a Distribution of herring and sprat age 1 in the quarter 1 IBTS 2017 (thick line: stock assessment areas).

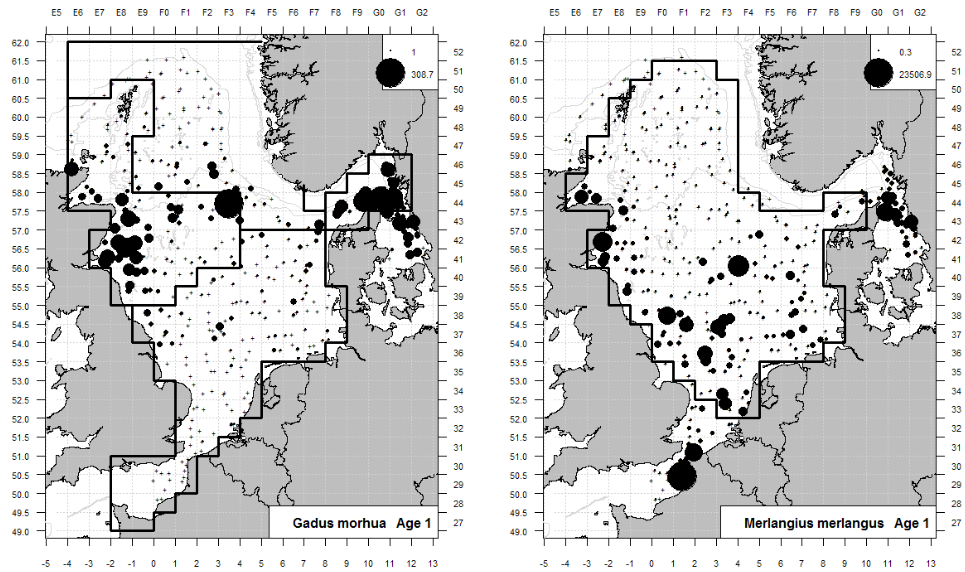


Figure 5.1.4.2b Distribution of cod and whiting age 1 in the quarter 1 IBTS 2017 (thick line: stock assessment areas).

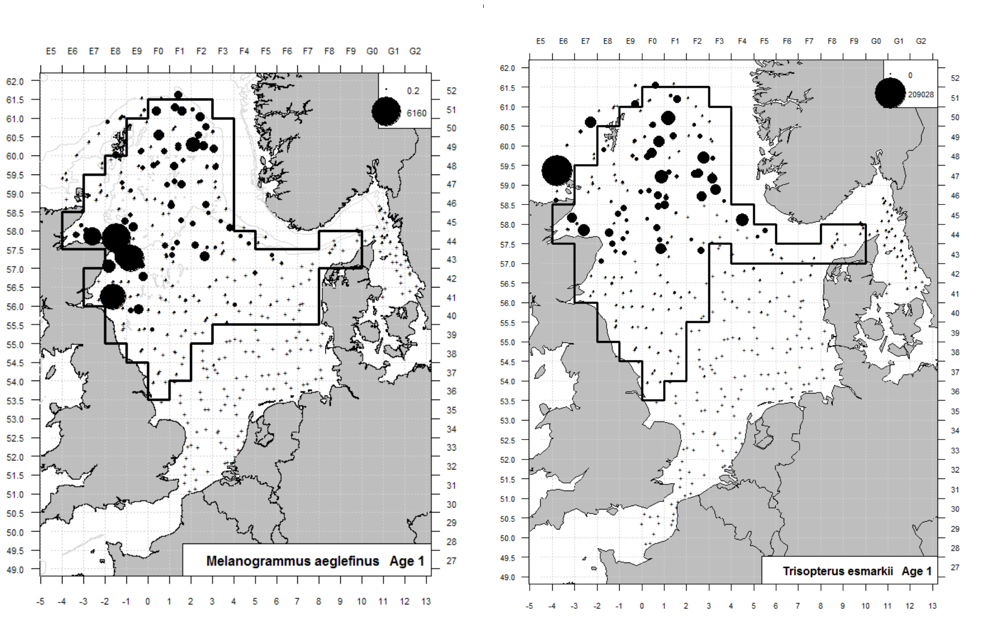


Figure 5.1.4.2c Distribution of haddock and Norway pout age 1 in the quarter 1 IBTS 2017 (thick line: index areas).

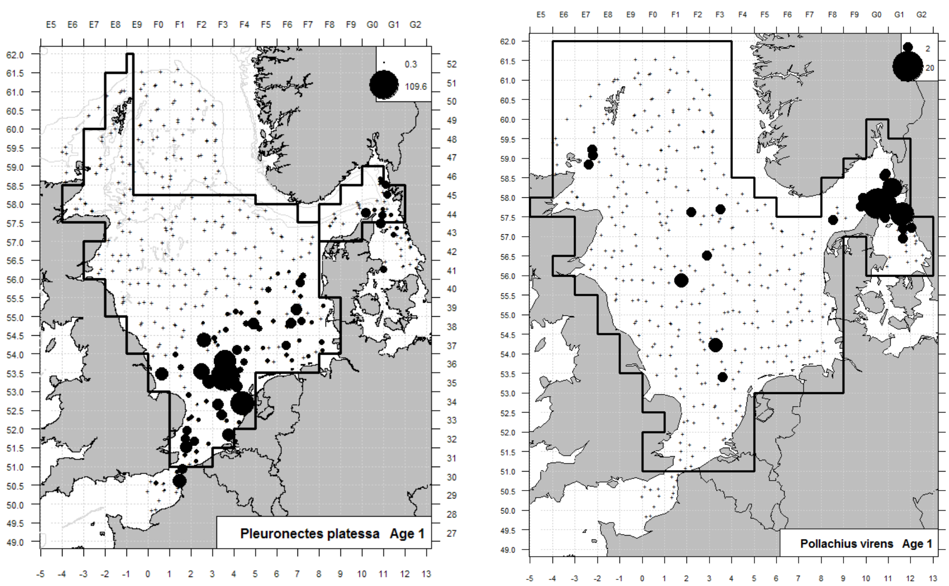


Figure 5.1.4.2d Distribution of plaice and saithe age 1 in the quarter 1 IBTS 2017 (thick line: stock assessment areas).

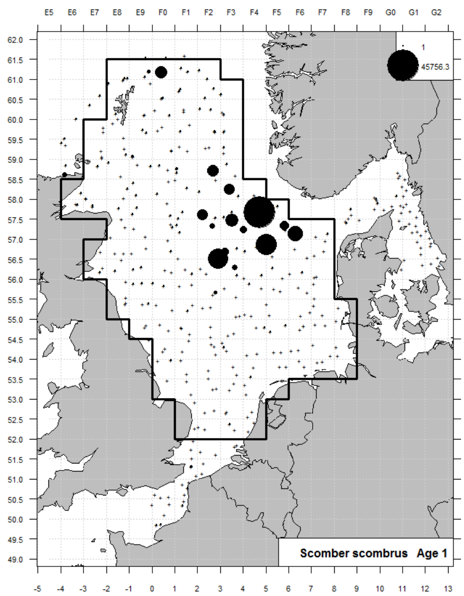


Figure 5.1.4.2e Distribution of mackerel age 1 in the quarter 1 IBTS 2017 (thick line: index area).

5.1.5 MIK

For the ICES Herring Assessment Working Group (HAWG), the IBTS survey provides recruitment indices and abundance estimates of adults of herring and sprat for the North Sea area South of 62°N. Sampling at night with fine-meshed nets (MIK; Midwater Ringnet) was implemented from 1977 onwards, and the catch of herring larvae has been used for the estimation of 0-ringer abundance in the survey area. The 0-ringer abundance (IBTS-0 index) in the survey area is used as a recruitment index for the North Sea herring stock. Index values are calculated as described in the HAWG report of 1996 (ICES, 1996/ACFM:10).

This year, 655 depth-integrated hauls were completed with the MIK-net. The coverage of the survey area was very good with at least 2 hauls in most of ICES rectangles in the North Sea as well as in the Kattegat and Skagerrak. Few rectangles were only sampled once, and there was only one rectangle (41E9) that could not be sampled at all. Index values are calculated as described in detail in the Stock Annex. This year, there were 32 hauls from the area south of 54°N with mean larval length <20 mm which had to be excluded from the index calculation as specified in the calculation procedure. The index is, thus, calculated from the results of 623 hauls, and 2 rectangles, 31F2 and 32F2, in the Southern Bight are not accounted for in the index calculation. These small larvae in the southern area are thought to be larvae of the Downs component of North Sea herring. The exclusion of these stations from the index should ensure that the Downs component is not accounted for in the IBTS0 index.

Larvae measured between 7 and 39 mm standard length (SL). Again and as in most years, the smallest larvae <10 mm were the most numerous and were caught in the 10's of thousands, while larger larvae >18 mm SL were much rarer (Figure 5.1.5.1). The smallest larvae were chiefly caught in 7d and in the Southern Bight. The large larvae appeared chiefly and in low quantities in the western central and in the southern North Sea. The potential herring larvae nursery area of the German Bight and west of Denmark remained virtually devoid of large herring larvae. Also in the Kattegat and Skagerrak area, herring larvae remained relatively rare.

The 0-ringer abundance according to the standard estimation method

The time-series of IBTS 0-ringer estimates according to the standard index calculation algorithms is shown in Figure 5.1.5.1. The new index value of 0-ringer abundance of the 2016 year class is estimated at 22.8. This index is less than last year's estimate for the 2015 year class. It is 22.1% of the long-term mean, and is the second lowest after the 2014 year class since 1992.

The 0-ringer abundance according to the newly proposed estimation method

Following the recommendations/suggestions of WGISDAA and WKHERLARS a new exclusion rule to reliably remove the Downs herring larvae from the index calculation was introduced. The rules can be summarized as follows:

The herring larvae data of every station are used

The exclusion rule is applied only in area that is potentially affected by drift of Downs larvae, i.e. south of 54°N and west of 6°E and south of 57°N and east of 6°E

In that area defined above, only larvae >18 mm SL are included in the index calculation.

Those rules are applied each year to produce a preliminary index. A final index will be produced later the same year utilizing drift models in order to apply necessary modifications to boundaries and critical length stated in rules 2. and 3.

The newly proposed rule (without step 4.) was applied to the MIK herring larvae data time-series from 1992 onwards, where because of data quality issues all French data prior to 2008 were excluded. The results of the calculation can be viewed in Figure 5.1.5.1. For most of the time-series the new algorithm produces comparable index values. However, for some years the results differ substantially from each other. For those year classes, where it was apparent that increased drift of small Downs larvae influenced the index (2013 and 2015), the index decreased (from 164.8 to 113.8, and from 99.8 to 81.2, respectively). This year's index was slightly increased by application of the new algorithm (27.8 instead of 22.8).

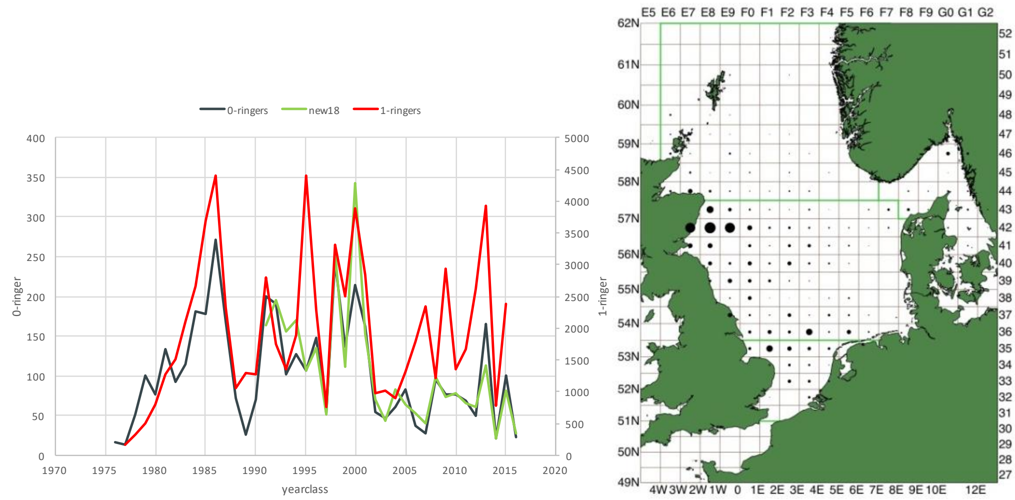


Figure 5.1.5.1 Distribution of MIK caught herring larvae during the IBTS Q1 2017 (right) and the time-series of 0- and 1-ringer abundance by year class since 1976 (left) The green line represents the 0-ringer index according to the new algorithm.

5.1.6 Planning and Participation in 2018

All seven participants in the Q1 survey will participate in 2018 and most likely with their own vessel, except for Sweden who will use the Danish vessel 'Dana' again.

The allocation of the area had significantly changed for the 2017 Q1. The allocation combined with very good weather conditions resulted in a nearly complete coverage, which was actually the first time in a couple of years despite the reduction in effort. However, as this was largely due to the very good weather conditions it was impossible to actually evaluate the allocation and to discuss if further changes are required.

The Swedish participation in the North Sea, going out of the Skagerrak/Kattegat, was a positive experience that they were happy to continue with. In an effort to increase the overlap between Sweden and other participants it was even suggested to increase the number of hauls allocated to Sweden in the North Sea. This resulted in one extra haul which was swapped with Denmark and they will do a haul in the Skagerrak thus increasing the haul overlap. Some additional small changes were proposed as shown in the by country maps shown below. These changes have been implemented to reduce the number of rectangles completed by a single country, and to bring Germany closer to their own waters which will reduce the transit time at either end of the survey.

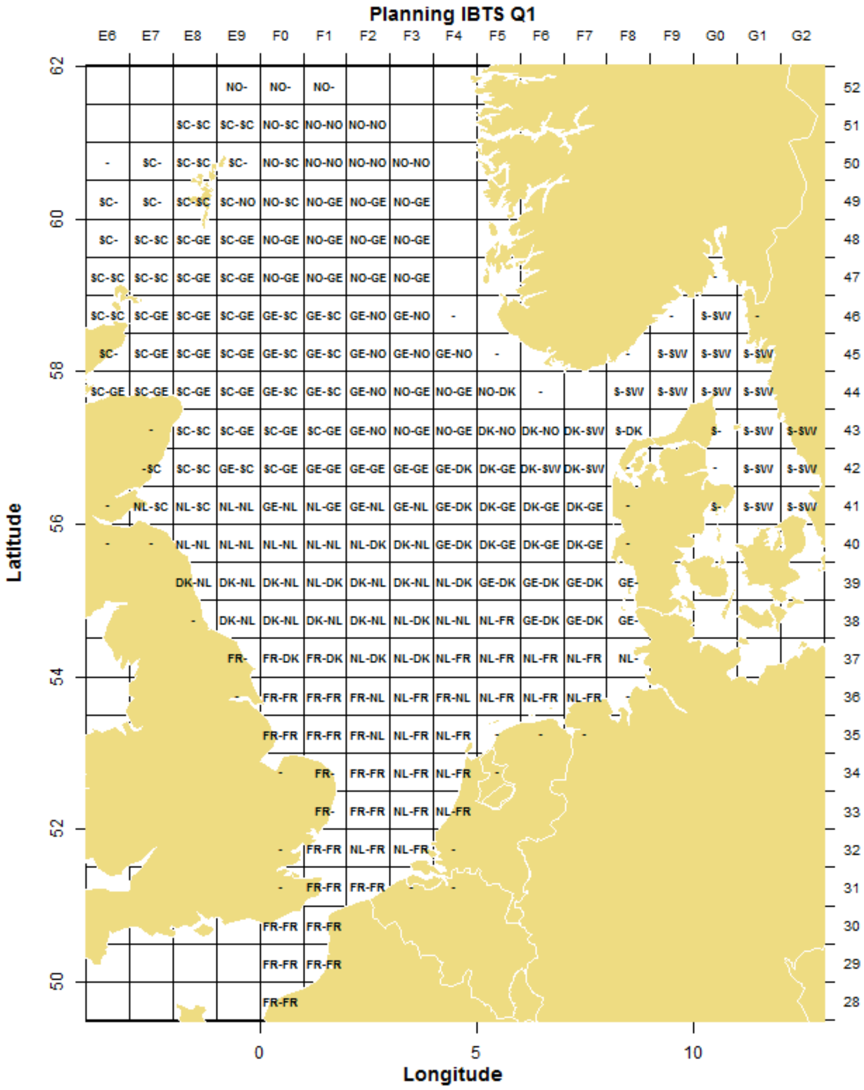


Figure 5.1.6.1 Allocation map for Q1 2018

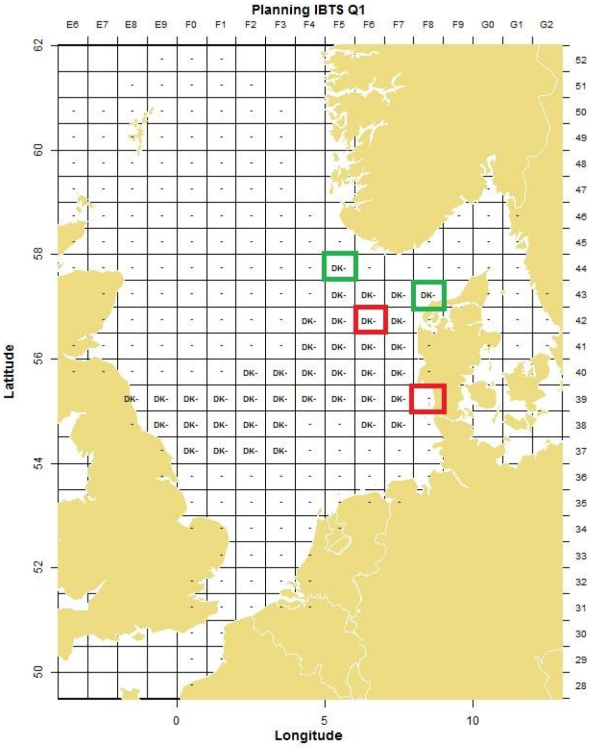


Figure 5.1.6.2a Allocation map for Denmark in 2018, green squares are extra hauls, the red squares indicate a reduction in hauls.

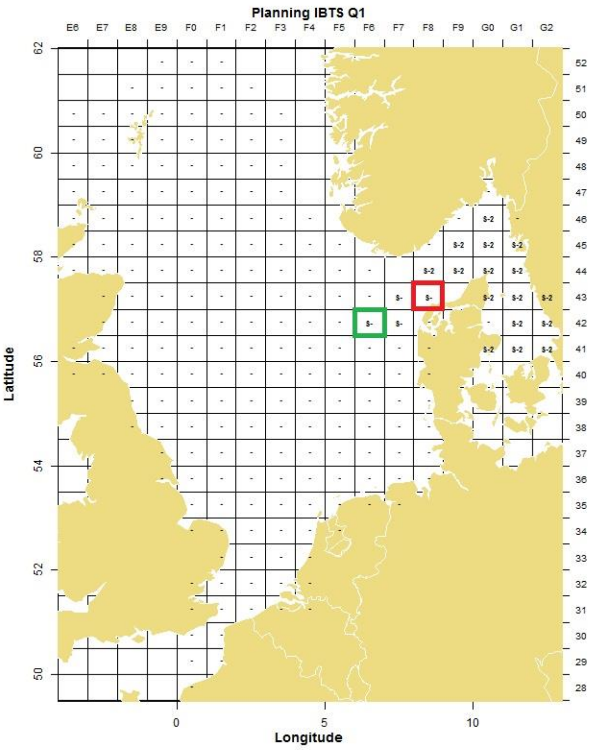


Figure 5.1.6.2b Allocation map for Sweden in 2018, green squares are extra hauls, the red squares indicate a reduction in hauls.

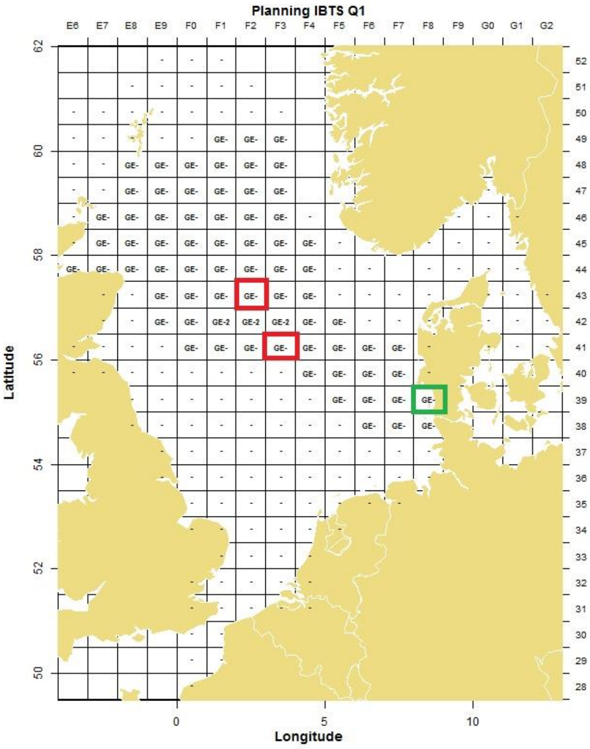


Figure 5.1.6.2.c Allocation map for Germany in 2018, green squares are extra hauls, the red squares indicate a reduction in hauls.

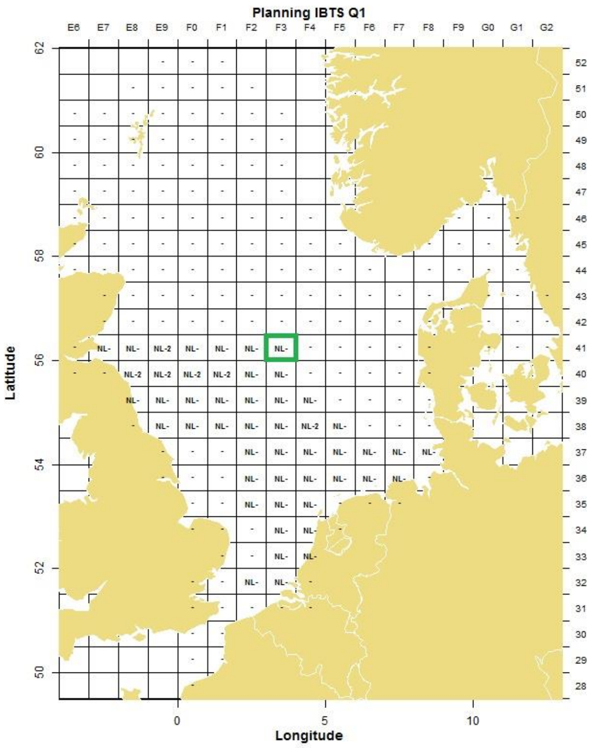


Figure 5.1.6.2.d Allocation map for the Netherlands in 2018, green squares are extra hauls, the red squares indicate a reduction in hauls.

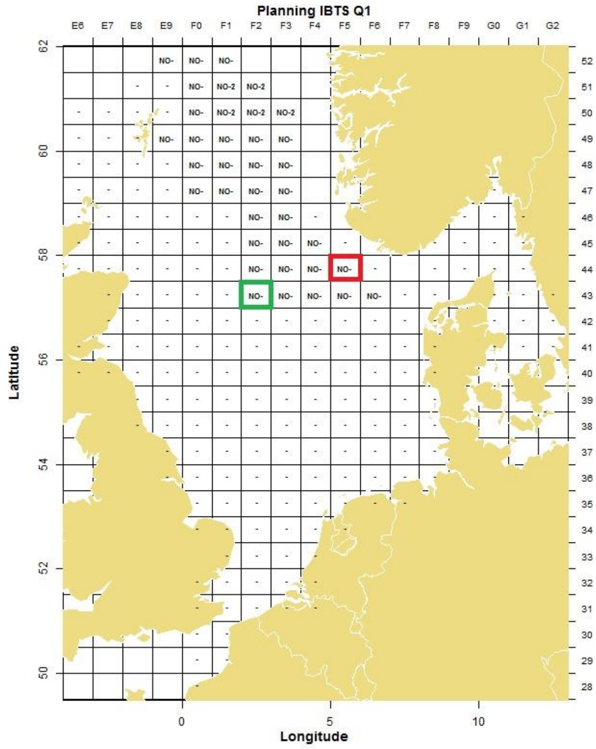


Figure 5.1.6.2e Allocation map for Norway in 2018, green squares are extra hauls, the red squares indicate a reduction in hauls.

5.1.7 Staff Exchange

During the IBTS 2017 Q1, a staff exchange occurred between France and Netherlands in order to identify potential differences in material and methods used during the survey. This experience was particularly useful since the direct interaction between colleagues during 10 days permitted to easily identify the majority of technical differences and to allow detailed discussions to take place on each of them. Subsequently, both nations were able to identify which improvements could be implemented that would reduce the spent time on processing the catch of an entire hauls without any loss of data quality. According to this personal experience, it does not seem that the small methodological divergences between the two nations may lead to significant differences in the final datasets. This experience also permitted to better know each other's in the IBTS working group and will clearly facilitate the long-term coordination in the group. We clearly have to repeat this experience every year, as much as possible.

Staff exchange are actively encouraged between the different participant countries. There is a growing awareness within the ICES internationally coordinated monitoring programs of the usefulness in exchanging sea-going technical and scientific personnel. Participating in other countries surveys provides an ideal opportunity to observe and study trawling and biological sampling procedures on-board different vessels, and may lead to new insights that may improve one's own procedures and protocols.

References

ICES 1996. Report of the Herring Assessment Working Group for the Area South of 62°N. ICES CM 1996/ACFM:10.

ICES 2009. Report of the International Bottom Trawl Survey Working Group (IBTSWG). ICES CM 2009/RMC:04

ICES 2015. Manual for the International Bottom Trawl Survey. Series of ICES Survey Protocols SISP 10 – IBTS IX. 86 pp.

ICES 2016. Report of the International Bottom Trawl Survey Working Group (IBTSWG). ICES CM 2016/SSGIEOM:24. 292 pp.

5.2 North Sea Q3

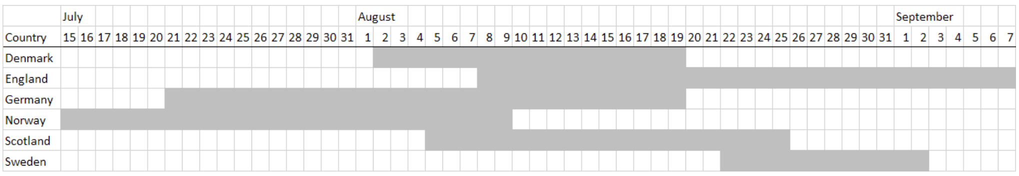
(Coordinator: Jennifer Devine)

5.2.1 General overview

The North Sea IBTS Q3 survey aims to collect data on the distribution, relative abundance and biological information on a range of fish species in ICES Division 3a and Subarea 4. The bottom trawl, GOV (Grand Ouverture Verticale) with standard groundgear A for normal bottom conditions or groundgear B for rough ground, is used during the hours of daylight. A CTD was deployed at most trawl stations to collect temperature and salinity profiles. Age data were collected for cod, haddock, whiting, saithe, Norway pout, herring, mackerel, and sprat, and a number of additional species.

Six nations (using five vessels) participated in the quarter 3 survey in 2016: Dana (Denmark and Sweden), Walther Herwig III (Germany), Johan Hjort (Norway), Cefas Endeavour (England) and Scotia (Scotland). The overall survey period extended from 15 July to 7 September (Table 5.2.1.1).

Table 5.2.1.1 Overview of the surveys performed during the North Sea IBTS Q3 survey in 2016.



In total, 382 valid GOV hauls were made in the planned rectangles (Table 5.2.1.2). As in 2015, IBTSWG 2016 decided that for North Sea rectangles in which two hauls were allocated, tow duration of one of the two hauls was reduced to 15 min, while 30-min tow duration was maintained for the other. Denmark, Germany, Norway, and Scotland participated in this, while England and Sweden remained unchanged. The introduction of 15-min tows allowed for the extension of the survey area and resulted in a much more balanced coverage of the North Sea than in previous years (Figure 5.2.1.1). While some rectangles did not achieve coverage of two hauls, the number of rectangles with only one haul was less than in any other year since 2010 (section 11.1). Of those with only one haul, most are rectangles that have a small amount of area at depths <200 m, which is the maximum survey depth limit according to the manual, are largely covered by land or other obstructions, or are not fishable with the GOV (Figure 5.2.1.1).

Table 5.2.1.2. Overview of the GOV stations fished in the North Sea IBTS Q3 survey in 2016 (*: relative to the number of tows proposed in the manual; number of tows as submitted to DATRAS prior to the meeting).

ICES Division	Country	Gear used	Number of tows proposed (Manual)	Number of proposed valid tows	Number of additional valid tows	Proportion of achieved valid tows (%) *	Proportion of valid 15 min tows (%)
3a	SWE	GOV-A	45	45	0	100	0
	DEN	GOV-A	-	-	6	125	0
4a,b,c			47	47	6		54
	ENG	GOV-A	76	76	2	103	3
	GER	GOV-A	29	32	2	117	67
4a,b	NOR	GOV-A	47	50	17	143	76
4a	SCO	GOV-B	44	44	6	118	66
4b		GOV-A	40	40	9		

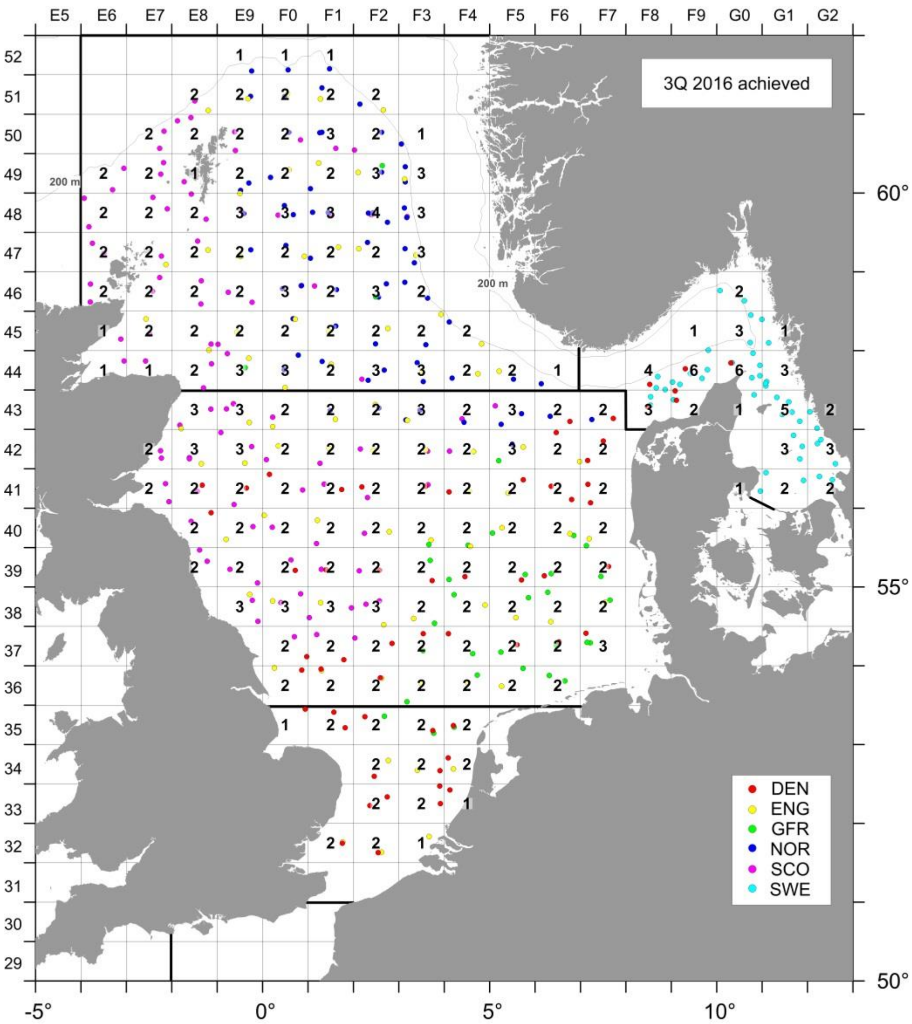


Figure 5.2.1.1. Number and start position of hauls per ICES statistical rectangle as taken with the GOV during the North Sea IBTS Q3 2016. Thick lines indicate borders of ICES divisions in the North Sea (4a, 4b, and 4c), the Skagerrak/Kattegat (3a), and the English Channel (7d).

Biological data (weight, gender, maturation stage, and age material) were collected for many species (Table 5.2.1.3); maturation stage can be difficult to determine outside the spawning period and was therefore not recorded as routinely as in quarter 1. For some species, otoliths have yet not been read and thus age information must be submitted to DATRAS at a later time.

Table 5.2.1.3. Overview of additional biological data collected in addition to the regular measurements specified in the manual during the North Sea IBTS Q3 survey in 2016.

Species	DEN	ENG	GER	NOR	SCO	SWE	Total
Amblyraja radiata		149	3	55	53		260
Chelidonichthys cuculus		7					7
*Dipturus batis**		1					1
*Dipturus intermedia**					6		6
Enchelyopus cimbrius		31					31
Galeorhinus galeus		2	3				5
Galeus melastomus		6		3			9
Hippoglossus hippoglossus		12					12
Leucoraja circularis				1			1
Leucoraja fullonica		1					1
Leucoraja naevus		17		4	35		56
Limanda limanda		271					271
Lophius piscatorius		63					63
Merluccius merluccius		407	17	9	144		577
Microstomus kitt		259	102				361
Molva molva		45					45
Mullus surmuletus		42			17		17
Mustelus asterias		38			1		39
Raja brachyura					2		2
Raja clavata		60		1	2		63
Raja montagui		13			58		71
Scophthalmus maximus		12			1		13
Scophthalmus rhombus		5	4		3		12
Scyliorhinus canicula		81	3	11			86
Squalus acanthias		11	1		34		46
Zeus faber		5			3		8

*** *Dipturus batis* and *D. intermedia* are currently under nomenclature review.**

5.2.2 Issues and problems

There were no major issues and problems.

5.2.3 Ecosystem considerations

Norway reported several large catches of saithe. These data were removed from index estimations at the request of WGNSSK.

5.2.4 Additional activities

All countries are required to collect sea floor litter from the GOV tows and CTD data (temperature and salinity, oxygen for some countries) at all GOV stations when possible. A list of other additional activities is given in table 5.2.4.1.

Table 5.2.4.1. Overview of additional activities in the North Sea IBTS Q3 survey in 2016. Water samples for CTD calibration not explicitly listed, x: routinely, (x): *ad hoc* studies.

Activity	DEN	ENG	GER	NOR	SCO	SWE
CTD	x		x	x	x	x
Seafloor Litter	x	x	x	x	x	x
Water sampler (Nutrients)					x	(x)
Collection of fish tissue (genetics)					(x)	x
Jellyfish from GOV catches		x		x		
Epibenthos (beam trawl)			x	x		
Sediment (VanVeen grab)			x			
Seabirds, Marine mammals		x				
Hydrological transect				x		
Acoustics (Ichthyofauna)		x		x		x

5.2.5 Gear geometry

The current manual does not specify a specific warp length to depth ratio as this may not fit to the different vessels. It has, however, been emphasized that each country carefully measure net geometry, i.e. door spread and headline height over bottom (vertical opening) and, if possible, also wing spread. Missing observations of these parameters are listed below in Table 5.2.5.1.

Table 5.2.5.1. Number of valid tows with missing gear parameters (No sensors for wing spread were available for Denmark and Norway).

Parameter	DEN	ENG	GFR	NOR	SCO	SWE
Door spread	0	0	5	0	0	0
Net opening	0	3	0	0	0	0
Wing spread	59	20	0	48	0	1

No country had serious problems in achieving the theoretical values for door spread (Figures 5.2.5.1 a-c). Most countries were within or near the theoretical values for net opening for almost all tows they made. Norway and Sweden had net opening that was consistently low, but the gear operated within the normal range for these countries (see manual, version IX).

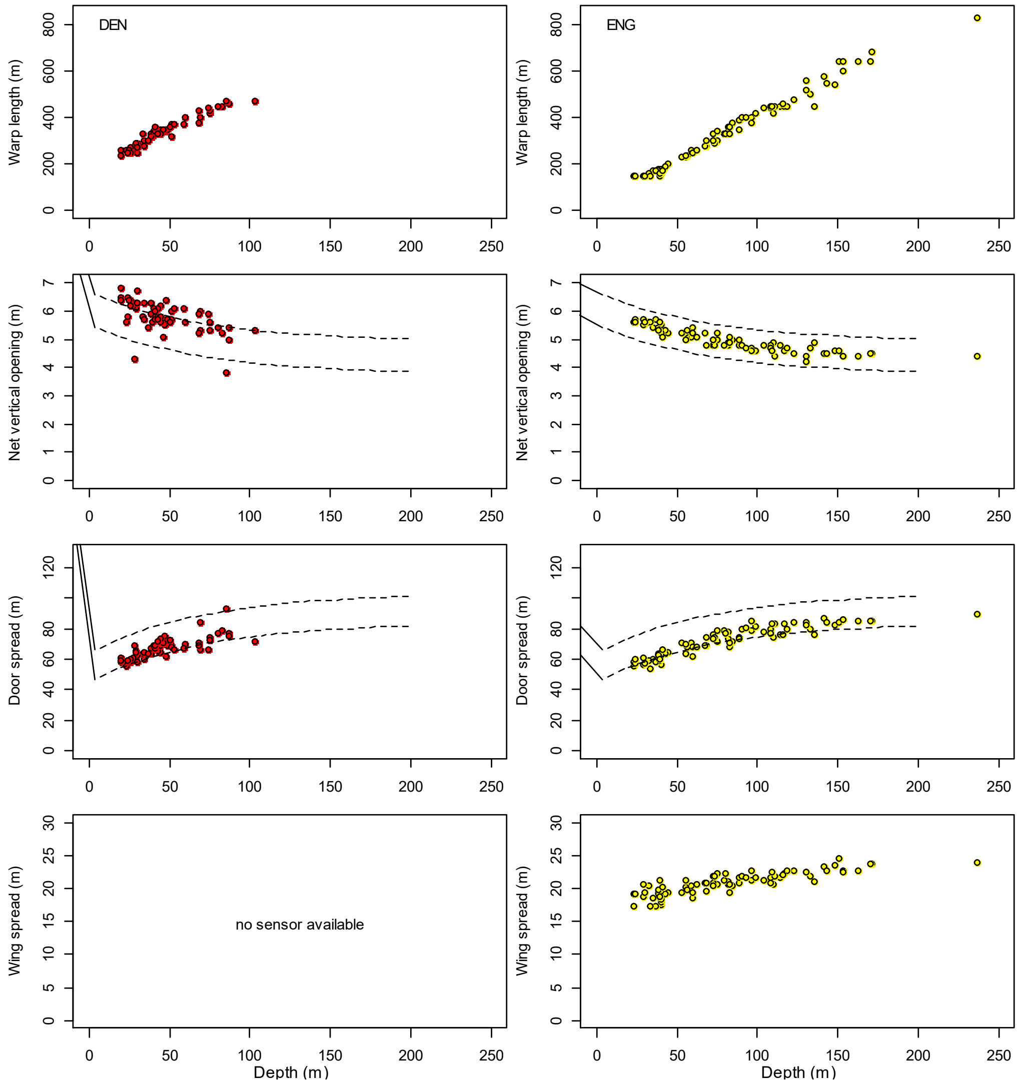


Figure 5.2.5.1a. Warp length and net geometry related to depth by country for the North Sea IBTS Q3 2016, Denmark and England. Dashed lines: theoretical lower and upper limits for the standard GOV 36/47 based on flume tank experiments, see manual.

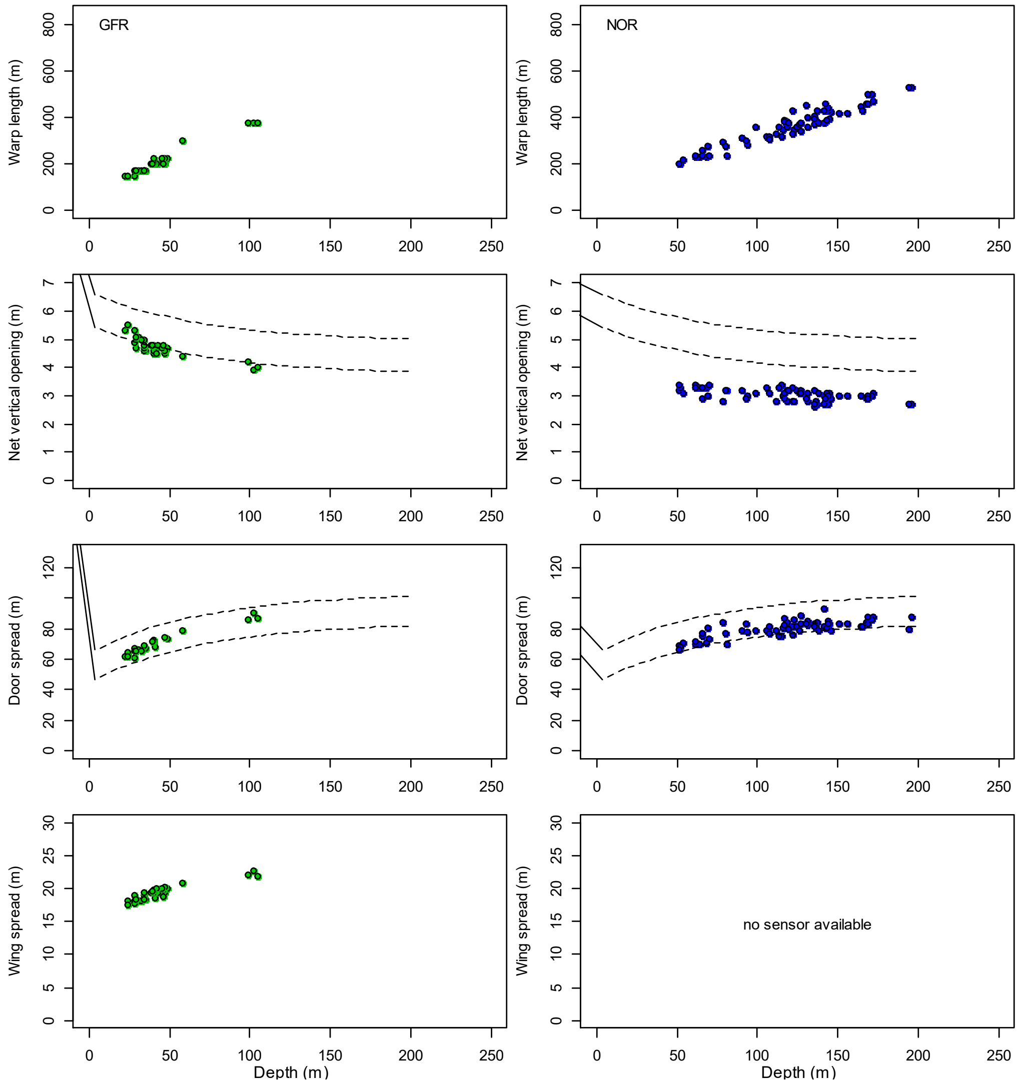


Figure 5.2.5.1b. Warp length and net geometry related to depth by country for the North Sea IBTS Q3 2016, Germany and Norway. Dashed lines: theoretical lower and upper limits for the standard GOV 36/47 based on flume tank experiments, see manual.

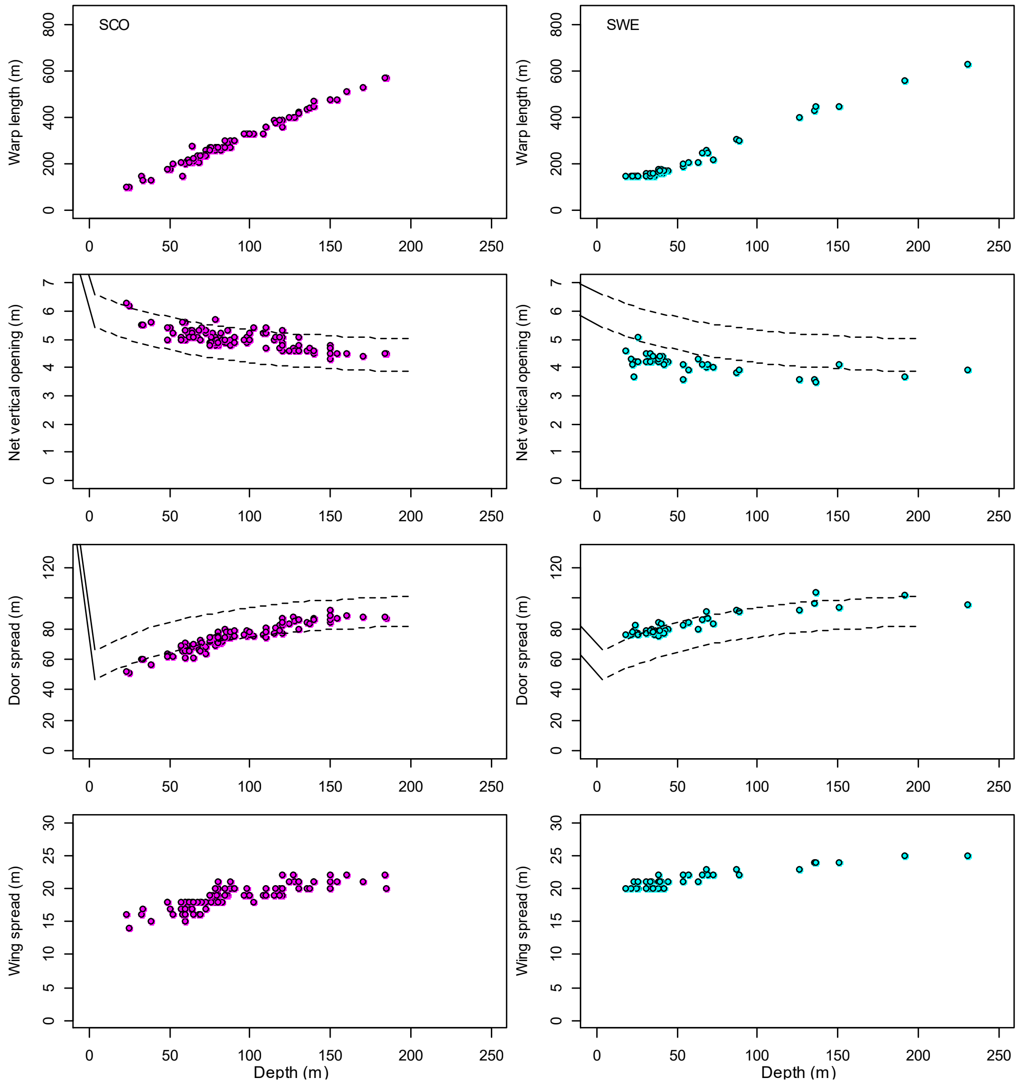


Figure 5.2.5.1c. Warp length and net geometry related to depth by country for the North Sea IBTS Q3 2016, Scotland and Sweden. Dashed lines: theoretical lower and upper limits for the standard GOV 36/47 based on flume tank experiments, see manual.

5.2.6 GOV standard indices and distribution of target species

Distribution plots for the recruits of the NS-IBTS standard species based on the 2016 quarter 3 survey are shown in Figure 5.2.6.1 (a-i). For some target species, high densities were found outside the actual index areas; cod and plaice index areas were revised during recent benchmarks and are currently not those used for the DATRAS-generated indices. For other species, this may warrant a revision of the species-specific areas on which the standard indices calculated in DATRAS are based. For many species, the DATRAS download of cpue by age and haul does not include data for rectangles 45F5 and 44F6, which are outside the current roundfish area boundaries, although valid tows have been made there.

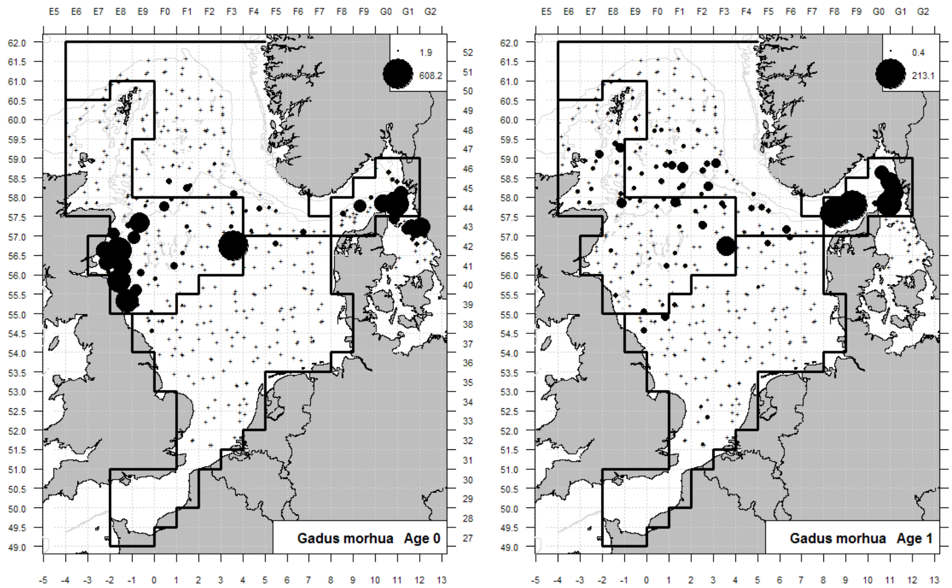


Figure 5.2.6.1a. Distribution of cod in the quarter 3 IBTS 2016 (thick line: cod stock assessment areas).

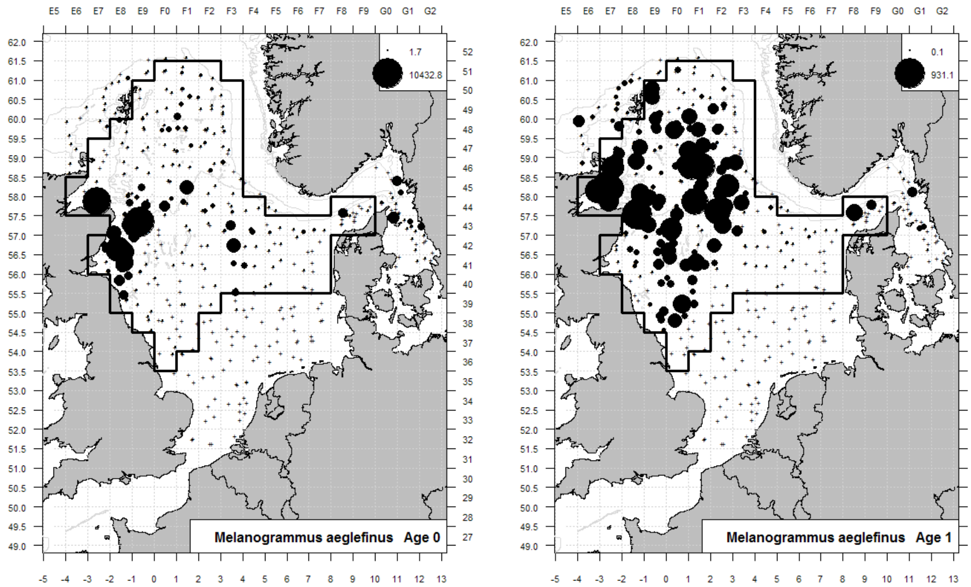


Figure 5.2.6.1b. Distribution of haddock in the quarter 3 IBTS 2016 (thick line: haddock index area).

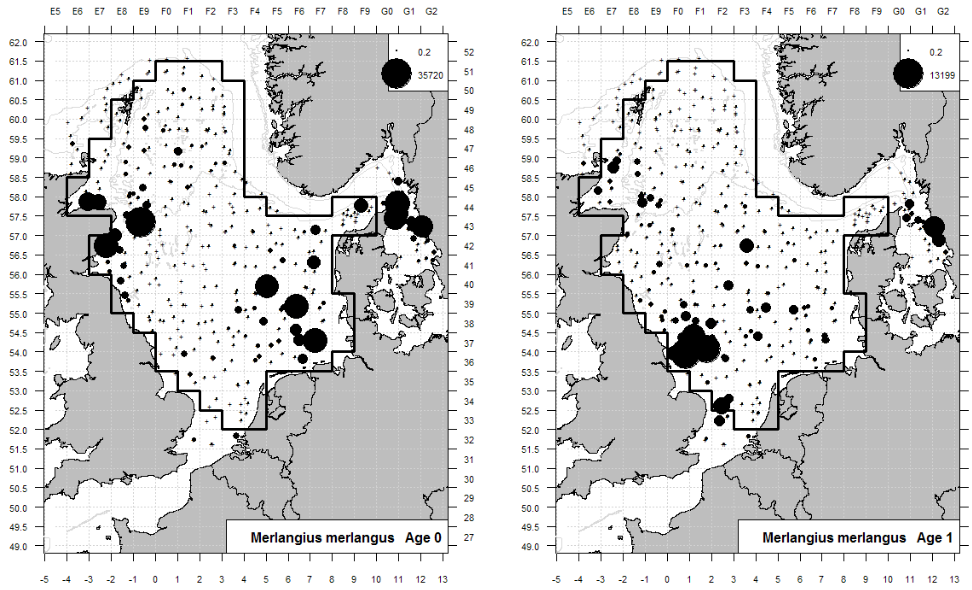


Figure 5.2.6.1c. Distribution of whiting in the quarter 3 IBTS 2016 (thick line: whiting index area).

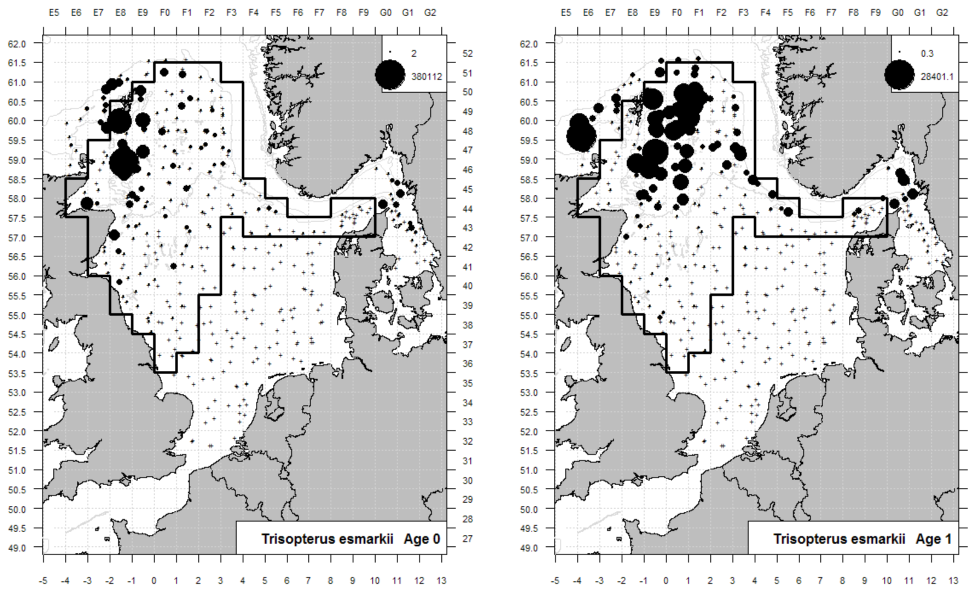


Figure 5.2.6.1d. Distribution of Norway pout in the quarter 3 IBTS 2016 (thick line: Norway pout index area).

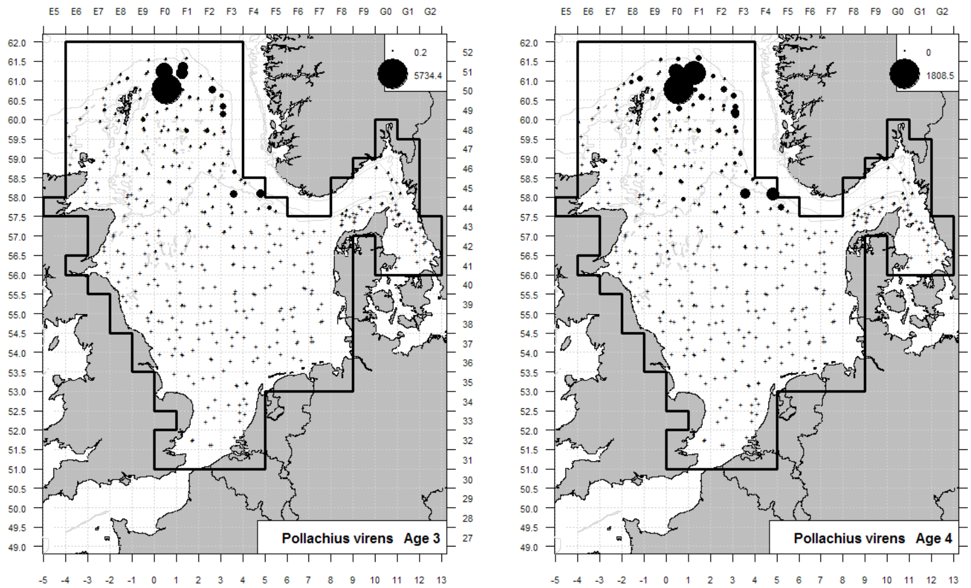


Figure 5.2.6.1e. Distribution of saithe in the quarter 3 IBTS 2016 (thick line: saithe index area).

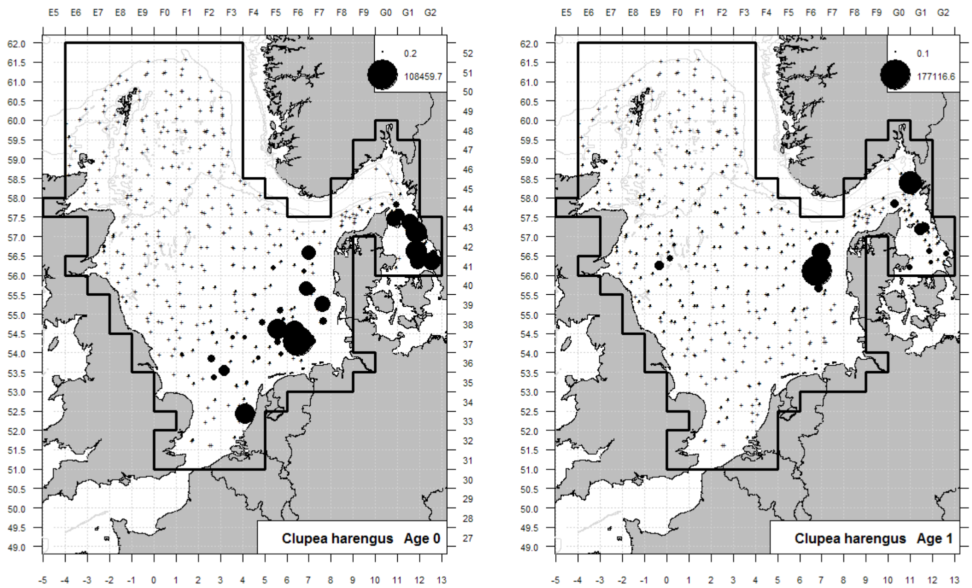


Figure 5.2.6.1f. Distribution of herring in the quarter 3 IBTS 2016 (thick line: herring index area in the 3rd quarter).

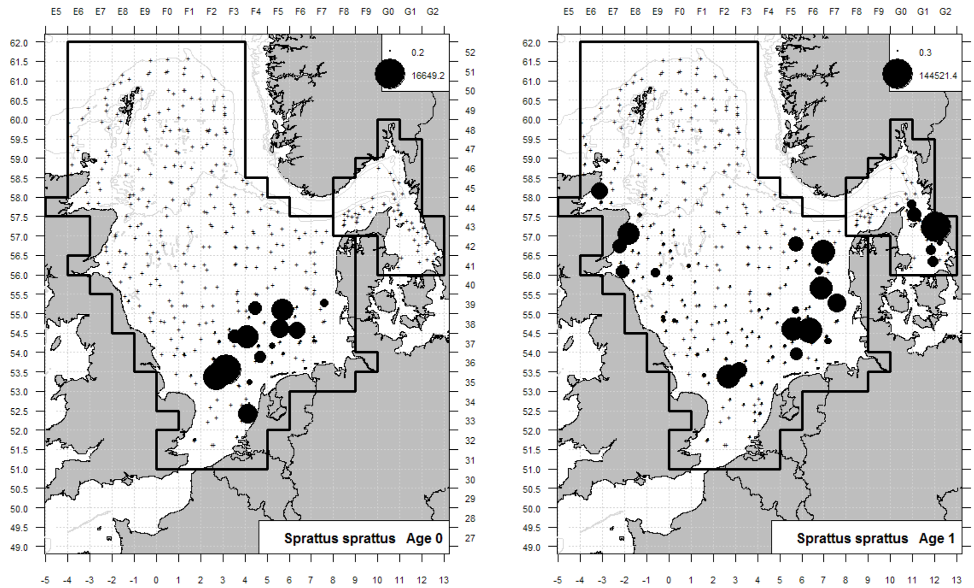


Figure 5.2.6.1g. Distribution of sprat in the quarter 3 IBTS 2016 (thick line: sprat index areas).

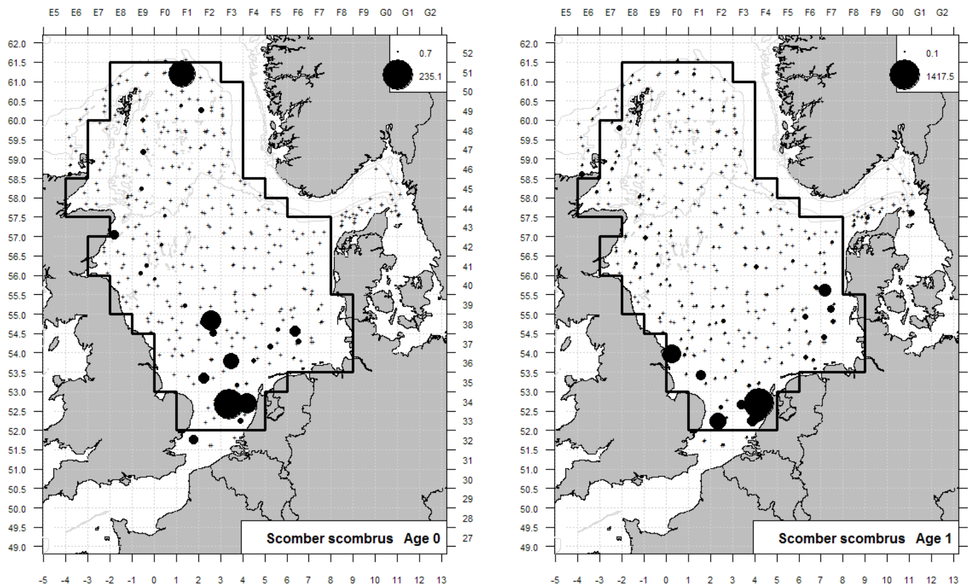


Figure 5.2.6.1h. Distribution of mackerel in the quarter 3 IBTS 2016 (thick line: mackerel index area).

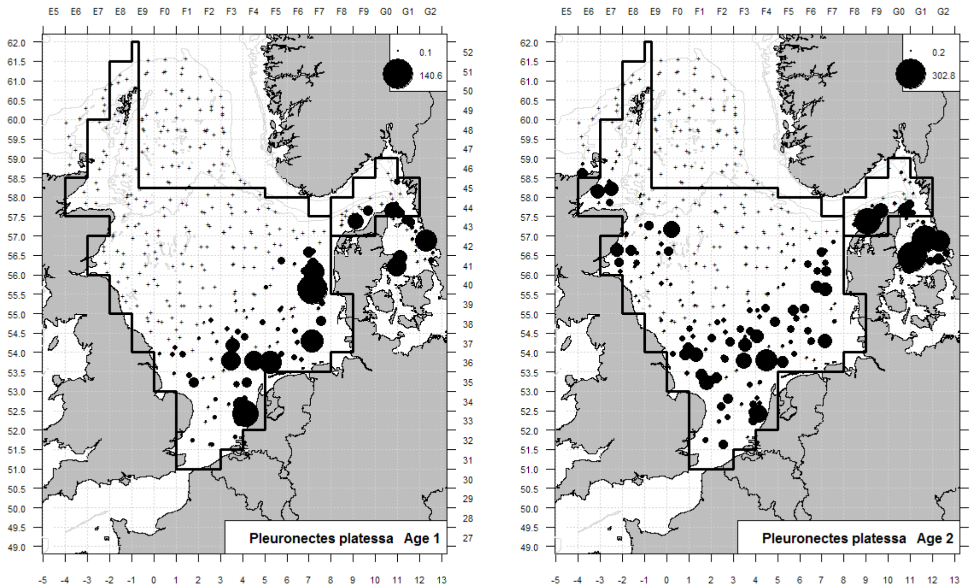


Figure 5.2.6.1i. Distribution of plaice in the quarter 3 IBTS 2016 (thick line: plaice stock assessment areas).

5.2.7 Planning and participation in 2017

All regularly contributing countries intend to participate in the quarter 3 2017 NS-IBTS survey program. Below is a table showing the expected program dates for each country for this year.

Country	Vessel	Dates
England	Cefas Endeavour	4 August to 2 September
Denmark	Dana	17 July to 3 August
Germany	Walther Herwig III	19 July to 17 August
Norway	Kristine Bonnevie	15 July to 13 August
Scotland	Scotia	10 August to 30 August
Sweden	Dana	4 August to 15 August

No major changes in the rectangle allocation scheme are planned. A continuation of the distribution of 15 and 30 min tows is suggested for 2017 (Figure 5.2.7.1) but has yet to be agreed by all participants. Thus, a final version of the sampling scheme will be provided to the survey participants by the NS-IBTS 3Q coordinator first in June 2017.

All participants are encouraged to record time to settle and time to haul, in addition to the normal parameters. If time permits, catch information for 0-minute tows (i.e. tows that are hauled as soon as the net settles on the bottom) are desired. Details on information to record can be found in section 11.1.6.

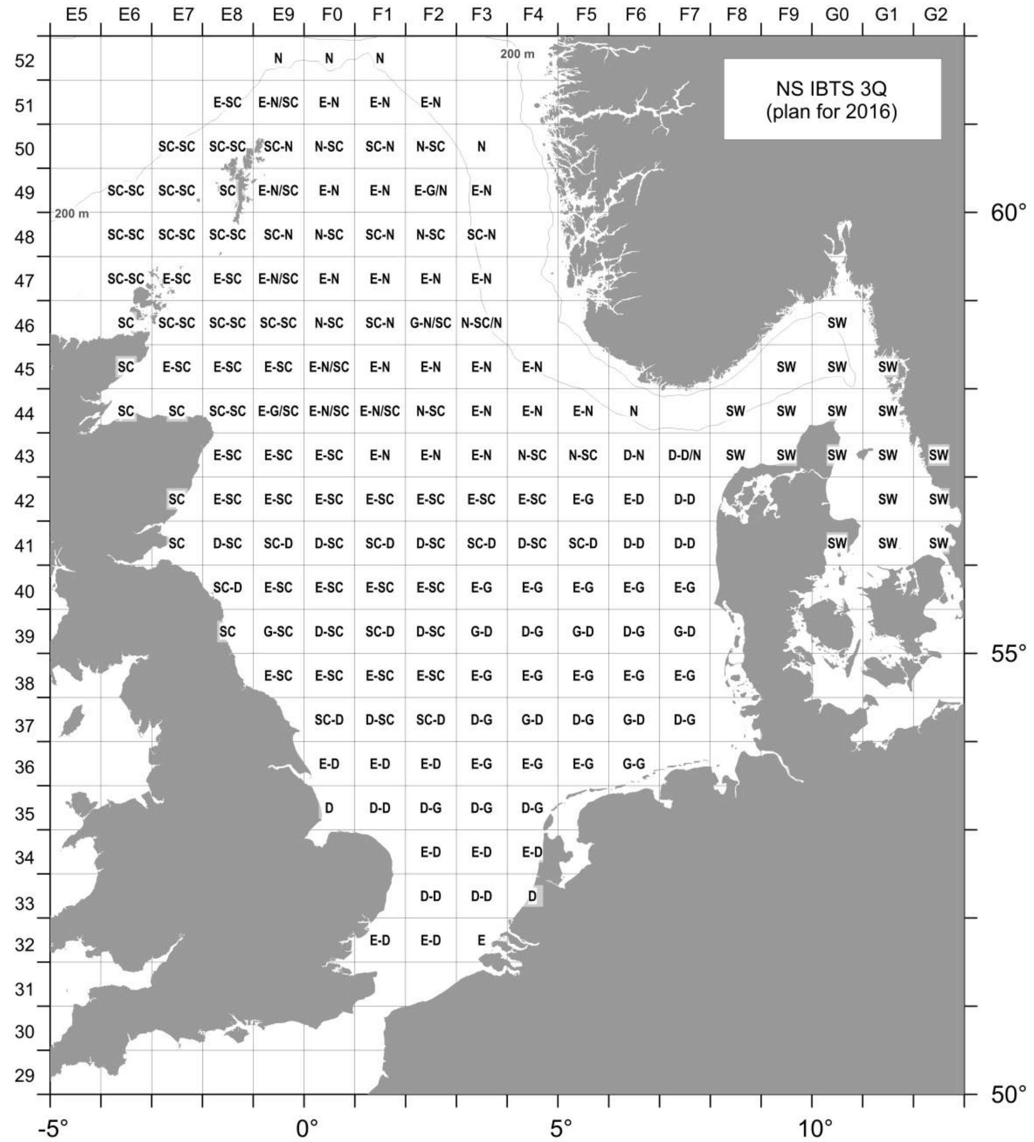


Figure 5.2.7.1. Tentatively planned rectangle allocation by country for the 3Q survey in 2017 (D: Denmark, E: England, G: Germany, N: Norway, SC: Scotland, SW: Sweden; country named first in a rectangle is supposed to conduct a standard 30 min tow whereas the second country should conduct a 15 min tow; preliminary version).

5.2.8 Other issues

5.2.8.1 Staff exchange

No staff exchange has occurred during the 2016 Q3 surveys, and no concrete plans are there yet to have an exchange in 2017. However, IBTSWG continues to encourage staff exchange.

5.2.8.2 Data exchange

It has been agreed that preliminary indices based on length splitting for the standard species will no longer exchanged during the Q3 survey since the final data for the NS-IBTS main target species (if not all species), including age information, are usually submitted to DATRAS within 2 to 3 weeks after completion of the survey.

5.3 Northeastern Atlantic

(Coordinator: Francisco Velasco)

5.3.1 General overview

In 2016, seven vessels from five countries performed 13 surveys along the Northeastern Atlantic IBTS area. A new survey, the Irish anglerfish and megrim survey (IE-IAMS-Q1) was presented last year to be considered to be coordinated by the IBTSWG, and the results from 2016 are presented together with a standard summary similar to that from the NeAtl surveys, although it only will be considered as a IBTSWG coordinated survey when the abundance indices are used by the relevant assessment working groups (namely WGCSE and WGBIE). Information will be also included as an annex on the new version of the NeAtl IBTS SISP manual that will replace the Manual for the International Bottom Trawl Surveys in the Western and Southern Areas Revision III (ICES, 2010), (see section 6.3).

A total of 1066 valid hauls, out of the 1057 hauls planned, were accomplished within 297 days distributed between the first, third and fourth quarters (Table 5.3.1.1 and Table 5.3.1.2). Besides, 107 hauls and 28 days were done by the RV Celtic Explorer during the mentioned IE-IAMS-Q1.

In 2016 all surveys were performed, including as in previous years three 1st quarter surveys (Scotland, Northern Ireland and Spanish survey on the Gulf of Cadiz), and also the usual 3rd quarter surveys (UK-ScoRock and SP-Porc) and 4th quarter surveys. The increase in number of hauls from last year is due to the fact that both the Irish and the French EVHOE survey completed all their planned hauls, which was not possible last year.

Table 5.3.1.1. Summary of surveys, hauls and days at sea per country performed in the IBTS NorthEastern Atlantic area in 2016

Country	Survey	Hauls				Days
		Planned	**Valid**	**Null**	**Total**	
UK-Scotland	UK-SCOWCGFS-Q1	60	63	2	65	17
	UK-SCOROC-Q3	40	48	-	48	8
	UK-SCOWCGFS-Q4	60	60	2	62	17
UK-North Ireland	UK-NIGFS-Q1	60	62	-	62	19
	UK-NIGFS-Q4	60	62	-	62	18
Ireland	IE-IAMS-Q1*	110	107	-	107	28
	IE-IGFS-Q4	45+125	172	8	180+1	41
France	FR-CGFS-Q4	74	73	2	75	15
	FR-EVHOE-Q4	155	157	4	161	44
Spain	SP-PORC-Q3	80	80	-	80+5	29
	SP-NSGFS Q4	116	115	1	116+19	35
	SP-GCGFS-Q1	41	44	2	46+5	11
	SP-GCGFS-Q4	41	45	1	46+4	12
Portugal	PT-PGFS-Q4	96	85	3	88	31
Total		1053	1066+107	25	1125+107	297+28

*** New survey presented to be coordinated by the IBTSWG when approved and used by the relevant assessment expert groups. Therefore is not included to the totals row.**

Table 5.3.1.2. Overview of the surveys performed during quarters 1, 3 and 4 on the Northeastern Atlantic IBTS area in 2016.

*** New survey presented to be coordinated by the IBTSWG when approved and used by the relevant assessment expert groups. Not included to the totals row.**

A summary of the biological sampling conducted within the IBTS NE Atlantic in 2016 is presented in Table 5.3.3.1.

5.3.2 Survey summaries by country

5.3.2.1 UK-Scotland: UK-SCOWCGFS-Q1(Western Division Bottom trawl Survey Q1)

Nation:	**UK-Scotland**	**Vessel:**	**Scotia**
Survey:	0316S (WC IBTS Q1)	Dates:	16 February–7March 2016

Cruise:	Q1 West Coast Scotland survey aims to: Collect data on the distribution, relative abundance and biological information (EU Data Directive 1639/2001) on haddock *Melanogrammus aeglefinus* and a range of other fish species in ICES Areas 6a and 7b. Obtain temperature and salinity data from the surface and near seabed at each trawling station Collect additional biological data in connection with the EU data collection framework (DCF).
Gear details:	GOV incorporating groundgear D was used at all stations. Sweeps were 97 m in all cases where the mean depth was >80 m (n = 55), otherwise 47 m sweeps were used (n = 8).The following parameters were recorded during each haul using SCANMAR: headline height, wing spread, door spread and distance covered. A bottom contact sensor was attached to the groundgear and downloaded following each haul.
Notes from survey (e.g. problems, additional work etc.):	**Demersal Survey** The 2016 survey design was random-stratified with primary trawl locations randomly distributed within 10 sampling strata. Trawls were undertaken within a radius of 5 nautical miles to the specified sampling position and as near to the actual point as was practicable. If for any reason the trawl could not be undertaken at the primary site then a replacement was taken from a list of secondary random positions. There were 65 trawls undertaken (Table 5.3.2.1.1) with all fishing taking place during daylight hours. A total of 63 valid hauls were achieved. There were 2 foul hauls encountered. One (haul 99) in stratum Green 1for which a valid substitute (haul 100) was made while the other (haul 126) was in stratum Pink where no substitute was possible. Regular communication was maintained with commercial static gear (crab creel) fishers working off the North coast, and in the Windsock (Cod Box). Due to very heavy static gear presence to the north of Cape wrath it was necessary to drop three adjacent stations there and undertake substitutes taken from secondary positions elsewhere in the stratum (Green 1). Figure 5.3.2.1.1 displays sampling strata, trawl locations and haul numbers. cpue figures for all major commercial and several non-commercial species can be located within Table 5.3.2.1.2 to Table 5.3.2.1.5. A record of biological observations collected by species can also be located in Table 5.3.2.1.6. The CTD (seabird19+) was deployed at 61 out of the 63 valid trawling stations in order to obtain a temperature and salinity profile to within approximately 5 m of the seabed. There was 1 deployment prior to a haul (haul 129) that was subsequently foul. For 1 station (haul 131) sea conditions were too poor to undertake CTD deployment. The thermo-salinograph was running throughout the entire survey to record surface temperature and salinity data. All the pelagic otoliths, and the majority of the otoliths from the main commercial species, were aged at sea. All litter picked up in the trawl was classified, quantified and recorded then retained for appropriate disposal ashore. **Visitor Participation and Other Projects:**

	• Aberdeen University participation: All smooth-hounds *Mustelus asterias* (n = 22) were examined as part of PhD focusing on the migration patterns and trophic ecology of the genus. Stomach contents were retained along with potential prey items from the catch and muscle, liver, vertebrae and blood tissue samples. These samples will be used to determine the short-term and long-term movements of *Mustelus* following stable isotope analyses. • Pelagic fish sample collection Approximately 6 kg each of mackerel and herring were frozen for environmental monitoring (CRCE Scotland, Glasgow) • Isopod preservation Approximately 12 isopods (various species) were treated with RNA later and frozen for transcriptome examination (Aberdeen University)
No. fish species recorded and notes on any rare species or unusual catches:	A total of 85 species were caught for an overall catch weight of ~33.5 tonnes. Major components in approximate tonnes included: mackerel *Scomber scombrus* (7.7), haddock *Melanogrammus aeglefinus* (5.6), whiting *Merlangius merlangus* (2.8), herring *Clupea harengus* (2.8), boarfish *Capros aper* (2.5), and norway pout *Trisopterus esmarkii* (2.2). Some 1.3 tonnes of cod *Gadus morhua* were caught. Most of the mackerel came from one haul (haul 104, 5.4 tonnes).

Table 5.3.2.1.1. Number of stations surveyed/gear during 0316S

ICES Divisions	Strata	Gear	Stations Planned	Valid Stations Achieved	Additional Stations	Invalid Stations	% Stations Achieved	Comments
6a-7b	All	GOV-D	64	63	0	2	98	2 foul hauls 1 re-done, 1 not redone

Table 5.3.2.1.2. cpue of major components of combined catch

Species	Common name	kg/h	no/h
Scomber scombrus	Mackerel	261.0	1334
Melanogrammus aeglefinus	Haddock	191.0	815
Merlangius merlangus	Whiting	96.9	847
Clupea harengus	Herring	95.7	902
Capros aper	Boarfish	83.6	1616
Trisopterus esmarkii	Norway Pout	73.9	5332
Trachurus trachurus	Horse Mackerel	51.6	323
Scyliorhinus canicula	Lesser Spotted Dogfish	49.4	88
Gadus morhua	Cod	44.1	20
Merluccius merluccius	Hake	24.1	28
Pollachius virens	Saithe	17.1	17
Chelidonichthys cuculus	Red Gurnard	16.9	57
Micromesistius poutassou	Blue Whiting	16.6	501

Eutrigla gurnardus	Grey Gurnard	11.6	123
Molva molva	Ling	9.5	6
Argentina sphyraena	Lesser Argentine	9.3	138
Dipturus intermedia	Flapper Skate	9.1	3
Pleuronectes platessa	Plaice	7.5	43
Loligo spp.	Long Finned Squid	7.0	48
Squalus acanthias	Spurdog	6.9	8

Table 5.3.2.1.3. cpue indices (no./10 hrs) by year class of major commercial demersal species

Age	Cod	Haddock	Whiting	Saithe	N. Pout
0	0.0	0.0	0.0	0.0	0.0
1	4.7	560.0	3226.0	0.0	32 452.0
2	56.1	6963.0	3485.0	30.9	16 778.0
3	65.4	344.0	576.0	80.0	504.0
4	44.6	39.1	148.0	41.9	70.8
5	5.7	23.0	83.8	6.0	0.0
6	2.4	9.4	42.4	2.3	0.0
7	2.3	618.0	25.3	2.3	0.0
8	0.0	4.5	2.6	0.3	0.0
9	0.0	1.6	0.0	0.0	0.0
10	0.0	0.6	0.0	0.0	0.0
11	0.0	3.5	0.0	1.5	0.0

Table 5.3.2.1.4. Indices (numbers/10 hrs fishing) of 1-groups as above since 2011

Species	2011	2012	2013	2014	2015	2016
Cod	0.5	14.0	20.0	11.4	8.2	4.7
Haddock	23.8	147.0	52.5	529.0	6800.0	560.0
Whiting	222.0	3441.0	552.0	5805.0	2545.0	3226.0
Saithe	0.0	0.0	0.4	0.0	0.0	0.0
N. Pout	1726.0	10119.0	42379.0	21365.0	46492.0	32452.0

Table 5.3.2.1.5. cpue indices (kg/hrs fishing) of major demersal species since 2011

Species	2011	2012	2013	2014	2015	2016
Cod	9.6	21.2	29.3	11.6	72.5	44.1
Haddock	148.8	153.4	180.0	113.7	169.2	191.0
Whiting	49.3	46.9	63.8	35.0	58.7	96.9
Saithe	10.8	6.1	15.2	25.0	24.0	17.1
N. Pout	280.9	131.1	130.7	125.8	65.4	73.9

Table 5.3.2.1.6. Numbers of biological observations per species collected during 0316S. These consist of length, weight, sex, and age.

Species	No.	Species	No.
Melanogrammus aeglefinus	1342	†*Dipturus flossada*	24
Merlangius merlangus	963	†*Dipturus intermedia*	77
Gadus morhua	509	†*Leucoraja naevus*	77
Pollachius virens	217	†*Mustelus asterias*	22
Trisopterus esmarkii	438	†*Raja brachyura*	15
Clupea harengus	564	†*Raja clavata*	122
Sprattus sprattus	372	†*Raja montagui*	184
Scomber scombrus	254	†*Squalus acanthias*	226
**Merluccius merluccius*	167	**Chelidonichthys cuculus*	69
**Pleuronectes platessa*	140	‡*Mullus surmuletus*	1
**Pollachius pollachius*	23	‡*Scophthalmus maximus*	4
**Trachurus trachurus*	90	‡*Scophthalmus rhombus*	4

*** length, sex, maturity and otoliths retained (a subset to be aged at a later date)**

† length, weight, sex and externally determined maturity only

‡ length, weight, sex, maturity

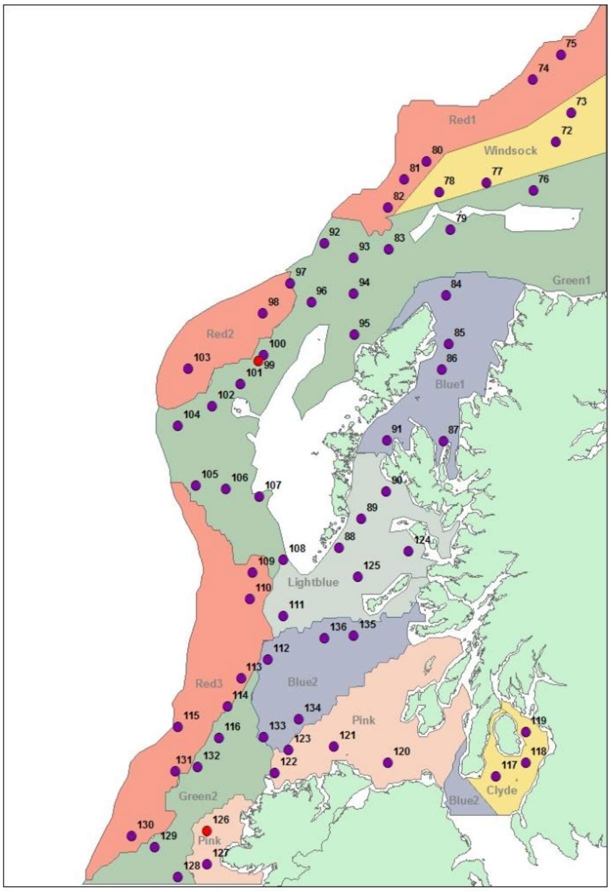


Figure 5.3.2.1.1. 0316S survey map showing survey strata (coloured polygons), approximate mid-points of haul positions valid (purple circles) and foul (red circles) with haul numbers.

5.3.2.2 UK-Scotland: UK-SCORoc-Q3(West of Scotland Rockall Survey Q3)

Nation:	**UK-Scotland**	**Vessel:**	**Scotia**
Survey:	1116S (Rockall Haddock)	Dates:	28 Aug – 06 Sep 2016

Cruise:	Q3 Rockall 2016 survey aims to: Collect data on the distribution, relative abundance and biological information (EU Data Directive 1639/2001) on haddock *Melanogrammus aeglefinus* and a range of other fish species in ICES Areas 6b. Obtain temperature and salinity data from the surface and near seabed at selected trawling stations Collect additional biological data in connection with the EU data collection framework (DCF). To undertake sediment sampling on an opportunistic basis when the vessel was not fishing
Gear details:	GOV incorporating groundgear D was used at all stations. Sweeps were 97m in all cases. The following parameters were recorded during each tow using SCANMAR: headline height, wing spread, door spread and distance covered. A bottom contact sensor was attached to the groundgear and downloaded each tow.
Notes from survey (e.g. problems, additional work etc.):	The 2016 survey design was random-stratified with primary trawl locations randomly distributed within 4 sampling strata defined by depth contour: 0–150 m, 150–200 m, 200–250 m, 250–350 m. Trawls were undertaken within a radius of 5 nautical miles to the specified sampling position and as near to the actual point as was practicable. If for any reason the trawl could not be undertaken at the primary site then a replacement was taken from a list of secondary random positions. There were 49 trawls undertaken (Table 5.3.2.2.1) with all fishing taking place during daylight hours. The total includes 2 additional hauls made outside the survey area were undertaken in response to observations of haddock from these areas during the Rockall anglerfish survey of April 2016 (cruise 0416S). Hauls 354 (370 m on the west side of the bank), and haul 363 (380 m on the southeast side of the bank) contained 31.9 kg and 12.8 kg of haddock respectively. All analysis and data to follow refers to valid hauls made within the standard survey area only. Figure 5.3.2.2.2 displays sampling strata, trawl locations and haul numbers. Ages were recorded for haddock, mackerel *Scomber scombrus*, whiting, cod and saithe along with sex, and weight data. Data on other species sampled for biological information are summarized in Table 5.3.2.2.5. Haddock recruitment was observed spread over the upper bank (Figure 5.3.2.2.2) however hauls 329 and 340 exhibited particularly large amounts of 0-groups, the largest capture of these in fact over the history of the survey. This is reflected in the overall cpue index for this year (Figure 5.3.2.2.1) which is high compared to recent years. The index for 1-groups this year however follows the relatively poor recruitment observed in 2015. Catches of 2 to 4 year old fish were of a generally consistent level over the survey area. There were a small catches of haddock ages 7 years or older however the survey encountered very few between the ages of 5-6 years. Again these are consistent with observations over the previous several years. CTD casts (n = 18) were made at selected stations to give a representative coverage of the bank over the depth range surveyed. Sediment samples were attempted from a total of 51 positions during periods when the vessel was not fishing. Of these 31 produced viable sediment samples over a depth range of 134-489m (Figure 5.3.2.2.2). All otoliths were aged back at the marine lab.

	All litter picked up in the trawl was classified, quantified and recorded then retained for appropriate disposal ashore. W. Hunt from University College Cork recorded sightings of marine megafauna throughout the survey. Although conditions were often suboptimal there were 27 sighting events consisting of an estimated 262 individual animals, largely odontocetes (Table 5.3.2.2.6). Of particular interest were two sightings of unidentified tuna: one over the continental shelf to the west of the Hebrides and one over Rockall Bank itself.
No. fish species recorded and notes on any rare species or unusual catches:	Overall a total of 52 species were caught during the survey for a total catch weight of ~32 tonnes. There were large catches overall of blue whiting (*Micromesistius poutassou*, ~13.6 tonnes), haddock (~7.8 tonnes) and grey gurnards (~3.5 tonnes). Few cod (*Gadus morhua*, ~83kg) and saithe (*Pollachius virens*, ~50kg) were caught. As with the previous three years small amounts of whiting (*Merlangius merlangius*, ~23kg) were observed, many of them being 0-group fish. Catch per unit of effort (cpue) of major species are summarized in Table 5.3.2.2.2 to Table 5.3.2.2.5.

Table 5.3.2.2.1. Number of stations surveyed/gear

ICES Divisions	Strata	Gear	Stations Planned	Valid Stations Achieved	Additional Stations	Invalid Stations	% Stations Achieved
6b	All	GOV-D	40	47	2*	0	112

*** 2 additional hauls outside survey area.**

Table 5.3.2.2.2. cpue data (all strata combined) for major species caught during 1216S

Species	mean	mean
	kg/h	no/h
Micromesistius poutassou	671.0	8412.0
Melanogrammus aeglefinus	363.0	5662.0
Eutrigla gurnardus	160.0	604.0
Sebastes viviparus	123.0	1976.0
Trisopterus minutus	56.8	1042.0
Gadiculus argenteus thori	52.8	1906.0
Chimaera monstrosa	26.3	21.2
Argentina sphyraena	25.5	383.0
Lophius piscatorius	16.5	5.3
Dipturus flossada	16.4	3.2
Helicolenus dactylopterus	16.2	214.0
Molva molva	15.9	4.9
Lepidorhombus whiffiagonis	12.2	61.8
Microstomus kitt	9.4	90.3

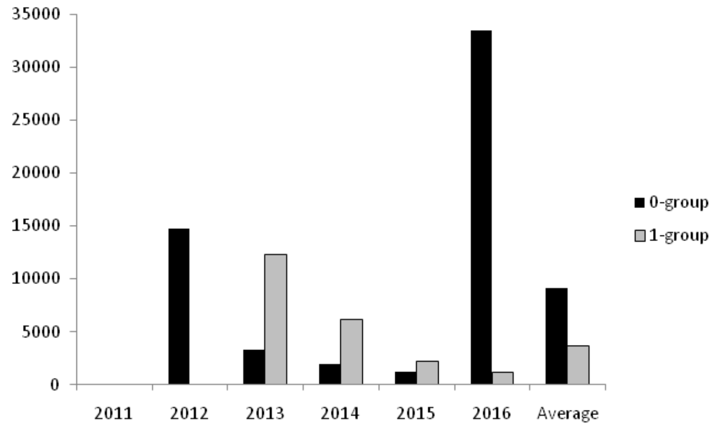


Figure 5.3.2.2.1. Indices of 0 and 1-group haddock at Rockall in 2015 shown relative to the previous years and the average since 2011 (beginning of new survey design)

Table 5.3.2.2.3. Rounded cpue indices (no. per 10 hrs fishing) by age for Rockall haddock 2011–2016 (actual values)

Age	2011	2012	2013	2014	2015	2016
0	5.3	14779.0	3248.0	1926.0	1212.0	33441.0
1	16.3	2.2	12259.0	6146.0	2238.0	1154.0
2	138.0	8.5	7.9	5275.0	5390.0	1403.0
3	17.9	55.8	22.1	3.8	4195.0	2444.0
4	68.0	9.6	36.6	0.0	0.0	1703.0
5	101.0	59.3	22.6	8.8	0.0	13.6
6	816.0	32.0	28.0	0.0	8.6	0.8
7	2.6	413.0	71.7	6.6	0.5	3.5
8	2.7	5.3	273.0	6.4	6.4	0.8
9	2.7	0.4	0.5	94.3	1.6	1.9
10	0.0	0.0	0.0	0.5	42.2	2.8
11	0.0	5.8	1.1	0.6	0.5	16.4
12	0.0	0.0	1.0	0.0	0.0	0.5
13	0.0	0.0	0.0	1.0	0.0	0.0

Table 5.3.2.2.4. Rounded cpue indices (no. per 10 hrs fishing) by age for other species of major commercial interest

Age	Whiting	Cod	Saithe
0	250.0	0.0	0.0
1	0.8	0.0	0.0
2	0.0	0.3	0.0
3	0.2	0.5	0.0
4	0.4	0.5	0.0
5	0.0	0.0	0.0
6	0.0	0.0	0.0
7	0.0	0.3	0.0
8	0.0	0.0	0.0
9	0.0	0.0	0.0
10	0.0	0.0	0.0
11	0.0	0.0	0.0
12	0.0	0.0	0.3
13	0.0	0.0	1.0
14	0.0	0.0	0.7

Table 5.3.2.2.5. Numbers of biological observations per species collected during 1216S. Data are weight/length/sex/maturity/age (see note*). Numbers in brackets include the data collected from the two hauls out of the standard survey area

Species	Biodata	Species	Biodata
Gadus morhua	6	*Dipturus flossada*	68 (69)*
Melanogrammus aeglefinus	1260 (1285)	*Dipturus nidarosiensis*	3 (4)*
Merlangius merlangius	56	*Leucoraja fullonica*	8*
Pollachius virens	4	*Raja clavata*	20*
Scomber scombrus	13		

*** Age data not collected.**

Table 5.3.2.2.6. Megafauna encountered during sightings on 1216S

Species	No. of sighting events	Estimated no. of individuals
Balaenoptera physalus (Fin whale)	3	3
Balaenoptera acutorostrata (Minke whale)	1	1
Unidentified baleen whale	1	1
Tursiops truncatus (Bottlenose dolphin)	2	20
Delphinus delphis (Common dolphin)	12	131
Stenella coeruleoalba (Striped dolphin)	2	15
Lagenorhynchus albirostris (White-beaked dolphin)	2	17
Unidentified dolphin	3	34
Unidentified tuna	2	40

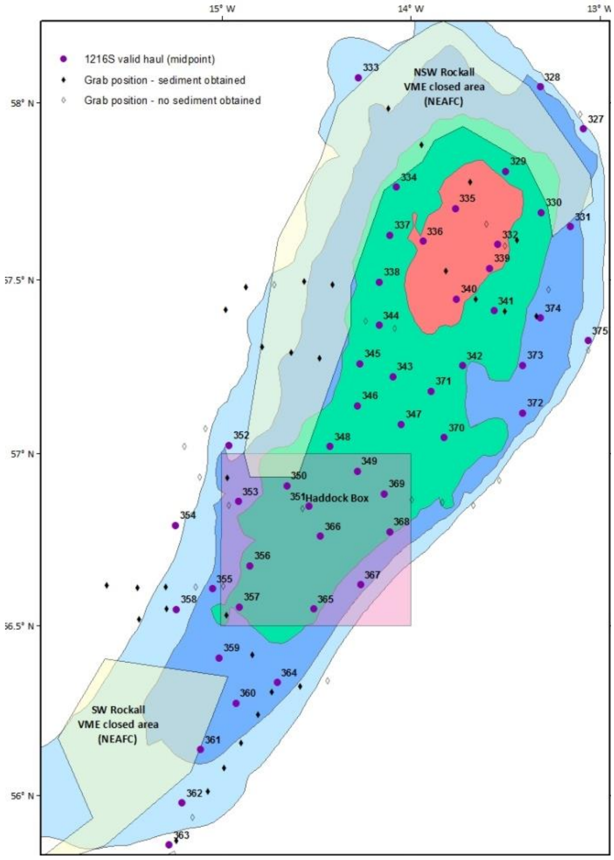


Figure 5.3.2.2.2. Survey strata, NEAFC closed areas, trawl positions with haul numbers of stations and grab positions undertaken at Rockall during 1116S. Red area = 0–150 m, green = 150–200 m, blue = 200–250 m, light blue = 250–350 m and white ≥350 m (outside the standard survey area)

5.3.2.3 UK-Scotland: UK-SCOWCGFS-Q4 (Western Division Bottom trawl Survey Q4)

Nation:	**UK - Scotland**	**Vessel:**	**Scotia**
Survey	1716S (WC IBTS Q4)	Dates:	17 November - 7 December 2016

Cruise	Q4 Scottish Western Coast 6a random stratified survey aims to collect data on the distribution, relative abundance and biological information (in connection with EU Data Directive 1639/2001) on a range of fish species in ICES Areas 6a and 7b. Age data were collected for cod, haddock, whiting, saithe, hake, horse mackerel (scad), Norway pout, herring, mackerel and sprat. A CTD was deployed at each trawl station (except 2) to collect temperature and salinity profiles.
Gear details:	The GOV incorporating the standard "Exocet" kite was used throughout the cruise with groundgear "D" (Rock-hoppers). Sweeps were 110m except where the water depth was ≤80 m where 60 m sweeps were deployed. Headline height, wingend and door spread were monitored by SCANMAR acoustic instrumentation and distance covered using the vessels GPS navigation system. The density of fish entering the mouth of the trawl was monitored by a SCANMAR acoustic trawl eye system and a self-recording bottom contact sensor was attached to groundgear centre and monitored contact with the seabed.
Notes from survey (e.g. problems, additional work etc.):	The 2016 survey design was the same as that used since 2011 using a random-stratified survey design with primary trawl locations randomly distributed within 12 sampling strata (see Figure 5.3.2.3.1 below). Trawls were undertaken on suitable ground as near to the specified sampling position as was practicable and within a radius of 5 nautical miles of the sample position. If for any reason the trawl could not be undertaken at the primary site due to poor ground or static gear such as creels then the nearest replacement was chosen from a list of secondary random positions (Table 5.3.2.3.1). Throughout the survey all fishing was carried out during daylight commencing each day at first light. During the cruise two hauls were classified as foul, one (403) due to significant pelagic fish marks entering the trawl after blockup resulting in ~1Tonnes caught after 3 minutes; the other (411) due to the trawls top sheet being significantly torn. Two alternatives were found in the same strata to compensate for the loss of these hauls however, One further haul was dropped (in strata GY) due to creels with no suitable alternative available. Sweep length was altered according to bottom depth. 80m is the cut off for deploying the 110m sweep rig, standardizing the configuration with the Irish 6a survey. This resulted in 14 out of the 60 valid tows being completed using the 60m sweep rig and the remaining deeper 46 stations completed using the 110m sweep rig. All demersal and pelagic otoliths were processed at sea but were subsequently aged back at the institute. All haul summary data and length frequencies were entered at sea via the Electronic Data Collection system. A CTD was deployed at 58 stations to obtain a vertical temperature and salinity profile. However, one deployment was abandoned due to problems with the vessels dynamic positioning system and another due to creels in close proximity to the vessel.
Number of fish species recorded and notes on any rare species or unusual catches:	A total of 83 species were caught during the survey with an overall catch weight of 38.2 tonnes. There were large catches overall of haddock (~7.53 tonnes), Norway pout (~4.05 tonnes), horse mackerel (~4.39 tonnes), mackerel (~4.29 tonnes) and whiting (~3.26 tonnes). See Table 5.3.2.3.2 and **Table 5.3.2.3.3** with cpue results for main species. Biological data were recorded for a number of species in accordance with the requirements of the EU Data Regulations (see Table 5.3.2.3.4). Catch of significant note:

	Haul 390 where the cod catch was ~2.5 tonnes which represented 73.5% of the overall cod caught (~3.4 tonnes) during the survey. The total catch of spurdog increased with 1354 tonnes (~52 per hour) caught during 2016 compared to 228 tonnes (~7 per hour) during the 2015 survey.
Number of fish species recorded and notes on any rare species or unusual catches:	A total of 83 species were caught during the survey with an overall catch weight of *38.2* tonnes. There were large catches overall of haddock (~7.53 tonnes), Norway pout (~4.05 tonnes), horse mackerel (~4.39 tonnes), mackerel (~4.29 tonnes) and whiting (~3.26 tonnes). Biological data were recorded for a number of species in accordance with the requirements of the EU Data Regulations. Catch of significant note: Haul 390 where the cod catch was ~2.5 tonnes which represented 73.5% of the overall cod caught (~3.4 tonnes) during the survey. The total catch of spurdog increased with 1354 tonnes (~52 per hour) caught during 2016 compared to 228 tonnes (~7 per hour) during the 2015 survey.

Table 5.3.2.3.1. Number of stations fished

ICES Division	Strata	Gear	Stations planned	Valid stations achieved	Additional stations	Invalid stations	% Stations achieved
6a	11	GOV-D	56	57	0	2	102
7b	1	GOV-D	4	3	0	0	75

Table 5.3.2.3.2. cpue indices (no./10hrs) by year class for major species Q4 WC survey in 2016

Age	No/10 hours				
	Cod	Haddock	Whiting	Saithe	N. Pout
0	0.4	826.1	5262.3	1.4	74968.0
1	6.2	935.5	2415.4	0.6	12274.8
2	34.9	6191.3	2300.2	14.1	2904.4
3	45.4	203.8	259.4	8.9	0.0
4	118.9	34.2	83.2	5.2	0.0
5	14.9	59.5	115.4	3.0	0.0
6	5.8	6.9	29.3	2.1	0.0
7	3.2	588.4	13.2	1.8	0.0
8	0.0	0.0	0.3	0.5	0.0
9	0.0	1.5	0.0	0.9	0.0
10	0.0	0.0	0.0	0.0	0.0
11	0.0	0.5	0.0	0.0	0.0

Table 5.3.2.3.3. cpue indices (numbers/10hrs fishing) of 1-groups for Q4 since 2011

Species	2011	2012	2013*	2014	2015	2016
Cod	10.0	19.8	14.0	23.7	28.2	6. 2
Haddock	39.2	114.8	69.6	678.7	9955.9	935.5
Whiting	119.5	964.0	125.0	1517.8	2793.6	2415.4
Saithe	0.0	1.1	0.0	0.4	5.0	0.6
Norway Pout	2192.5	7213.9	1343.9	2669.7	14 814.3	12 274.8

*** Q4 survey 2014 was not completed only covered half of the sampling area**

Table 5.3.2.3.4. Q4 SCOWCGFS biological sampling 2016. Data are weight/length/sex/maturity/age

Species	Nos	Species	Nos
Gadus morhua	273**	*Sprattus sprattus*	290**
Merlangius merlangus	858**	*Galeorhinus galeus*	5*
Melanogrammus aeglefinus	1383**	*Scophthalmus maximus*	1*
Merluccius merluccius	325**	*Scophthalmus rhombus*	2*
Trisopterus esmarkii	524**	*Raja brachyura*	17*
Pollachius virens	98**	*Leucoraja naevus*	83*
Molva molva	70**	*Dipturus intermedia*	52*
Zeus faber	40**	*Dipturus flossada*	2*
Scomber scombrus	393	*Raja clavata*	131*
Clupea harengus	476	*Raja montagui*	173*
Trachurus trachurus	271	*Mustelus asterias*	12*

*** where age data were not collected**

**** where no maturity data collected**

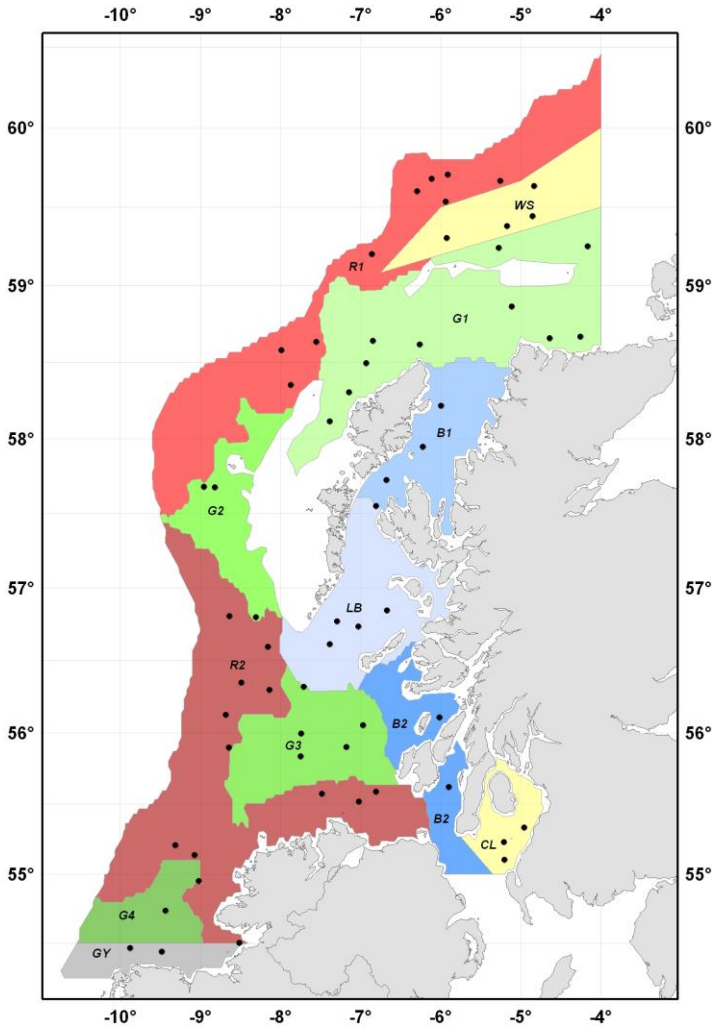


Figure 5.3.2.3.1. Valid trawl stations completed during the Q4 WC – IBTS 2016 (1716S). Note - The colour shading indicates the 12 different sampling strata covered by this survey.

5.3.2.4 UK – Northern Ireland: Northern Irish Groundfish Survey Q1 2016 – Q1NIGFS

Nation:	**UK - Northern Ireland**	**Vessel:**	**RV Corystes**
Survey:	10/16	Dates:	1–20 March 2016

Cruise	Q1 Irish Sea survey aims to collect data on the distribution, relative abundance, and biological information of commercial fish in 7a. The primary species are cod, haddock and whiting, herring and plaice.
Gear details:	Rock-hopper otter trawl with a 17 m footrope fitted with 250 mm non-rotating rubber discs. SCANMAR sensors were fitted to gear and trawl parameters recorded, this included trawl eye and wing end distance sensor.
Notes from survey (e.g. problems, additional work etc.):	Despite the extreme windy weather at the start of the survey, steady progress was made. Very little gear damage and calm sea conditions from the middle of the survey meant no fishing time was lost. Temperature and salinity were recorded at each station (Figure 5.3.2.4.1). Additional work included quantifying external parasite loads in whiting and cod by area and collected tissue samples from cod and hake for a genetics study.
Number of fish species recorded and notes on any rare species or unusual catches:	Overall, 75 species of fish were recorded during the survey.

The stations fished per fished per ICES division are presented in **Table 5.3.2.4.1** while

Table 5.3.2.4.2 summarizes the samples collected during the survey to respond to the DCF requirements.

Table 5.3.2.4.1. Stations fished (aim: to complete 62 valid tows per survey)

ICES Division	Strata	Gear	Tows Planned	Valid	Additional	Invalid	% stations fished
7a		Otter trawl	62	62	0	0	100
	Total		62	62	0	0	100

Table 5.3.2.4.2. Number of biological samples, maturity and age material

Species	Age and Maturity	Species	Age and Maturity
Gadus morhua	420	*Squalus acanthias*	11
Melanogrammus aeglefinus	1035	*Chelidonichthys cuculus*	126
Pleuronectes platessa	312	*Microstomaus kitt*	124
Merlangius merlangus	1265	*Lepidorhombus whiffiagonis*	2
Merluccius merluccius	26		
Scophthalmus rhombus	48	**Raja brachyura*	19
Conger conger	7	**Leucoraja naevus*	45
Pollachius pollachius	16	**Raja montagui*	133
Zeus faber	4	**Raja clavata*	169

***maturity only**

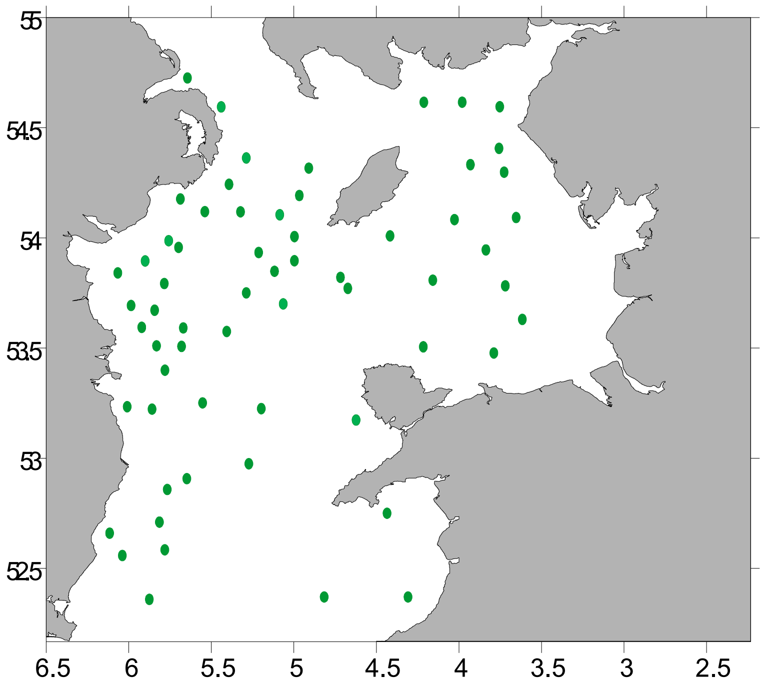


Figure 5.3.2.4.1. Map of valid survey stations completed during the 2016 Northern Irish quarter 1 groundfish survey

5.3.2.5 UK – Northern Ireland: Northern Irish Groundfish Survey Q4 2016 – Q4NIGFS

Nation:	**UK - Northern Ireland**	**Vessel:**	**RV Corystes**
Survey:	41/16	Dates:	3–20 October 2016

Cruise	Q4 Irish Sea survey aims to collect data on the distribution and relative abundance, and biological information of commercial fish in 7a. The primary species are cod, haddock and whiting, herring and plaice.
Gear details:	Rock-hopper otter trawl with a 17m footrope fitted with 250 mm non-rotating rubber discs. SCANMAR sensors were fitted to gear and trawl parameters recorded, including trawl eye and wing end distance sensors.
Notes from survey (e.g. problems, additional work etc.):	Relatively good weather meant very little fishing time was lost overall. **Figure 5.3.2.5.1** shows a map of the station performed. Additional work included quantifying external parasite loads in whiting and cod by area. Due to some problems to the count footage during the Nephrops Underwater Camera Survey in August, 2 m beam trawls were deployed at selected sites. Information collected was used for ground-truthing against camera footage.
Number of fish species recorded and notes on any rare species or unusual catches:	Overall, 59 species of fish were recorded during the survey. A basking shark was caught at station 56, approximate length and weight were recorded and was returned to sea alive.

The stations fished per ICES division are presented in Table 5.3.2.5.1 while Table 5.3.2.5.1 summarizes the samples collected during the survey to respond to the DCF requirements.

Table 5.3.2.5.1. Stations fished (aim: to complete 62 valid tows per survey)

ICES Division	Strata	Gear	Tows planned	Valid	Additional	Invalid	% stations fished
7a	All	Rock-hopper	62	62	0	0	100
	Total		62	62	0	0	100

Table 5.3.2.5.2. Number of biological samples, maturity and age material

Species	Age and Maturity	Species	Age and Maturity
Gadus morhua	45	*Pollachius pollachius*	2
Melanogrammus aeglefinus	800	*Zeus faber*	19
Pleuronectes platessa	216	*Chelidonichthys cuculus*	38
Merlangius merlangus	1190	*Microstomaus kitt*	19
Merluccius merluccius	4		
Scophthalmus rhombus	16	**Raja montagui*	85
Scophthalmus maximus	6	**Raja clavata*	93
Conger conger	19	**Raja brachyura*	13
Squalus acanthias	35	**Leucoraja naevus*	11

***maturity only**

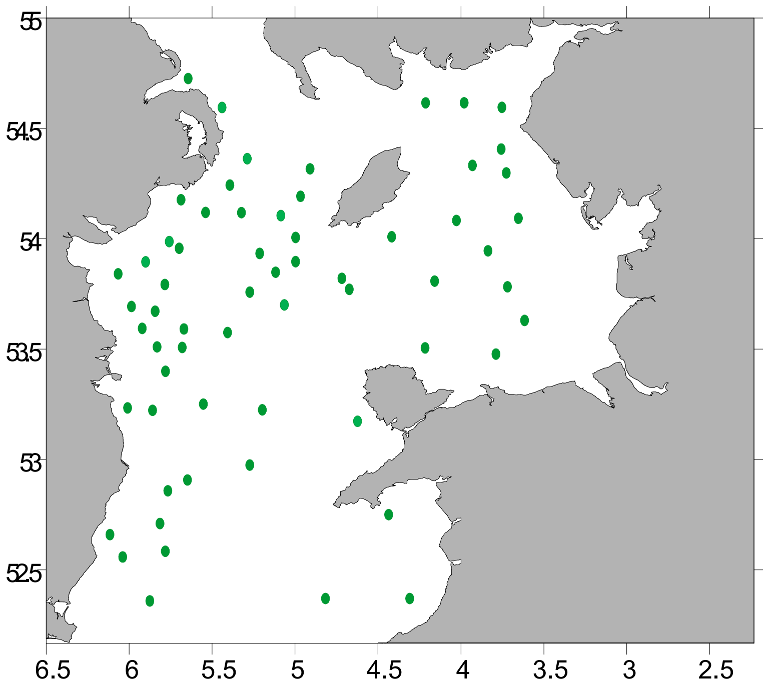


Figure 5.3.2.5.1. Map of valid survey stations completed during the 2016 Northern Irish quarter 4 groundfish survey

5.3.2.6 Ireland: Irish Anglerfish and Megrim Survey Q1 – IAMS2016

Nation:	**Ireland**	**Vessel:**	**Celtic Explorer**
Survey:	IAMS-Q1	Dates:	4th– 25thJan (7b,c,j,k) 25th Feb – 6hMar (6a)

Cruise	The main objective of the Q1 Irish Anglerfish and Megrim Survey survey is to obtain abundance and biomass indices for anglerfish (Lophius piscatorius and L. budegassa) megrim (Lepidorhombus whiffiaginis and L. boscii) in 6a (south of 58°N) and 7 (west of 8°W), Table **5.3.2.6.1** and Figure 5.3.2.6.1 summarize the tows planned and performed by ICES Division and gear, and all the area surveyed. Table **5.3.2.6.2** presents the biological samples collected during the survey, while Table 5.3.2.6.3 presents the abundance indices in weight and number with a comparison with the results in the last 4 years. The stock assessment working group WGBIE expects to use this survey in future assessments of anglerfish and megrim, once the time-series is long enough (the survey series started in 2016). Table 5.3.2.6.3 and Table 5.3.2.6.4 present the results of the survey regarding abundances of main species.
Gear details:	The trawl is based on a standard commercial otter trawl used in the anglerfish fishery and is described in detail in Reid *et al. (*2007).
Notes from survey (e.g. problems, additional work etc.):	There was some technical downtime and 2 days were lost due to bad weather. The weather was variable and forced some changes to the survey plan but the spatial coverage was good and the target number of stations was achieved. Planned CTD transects not carried out due to time limitations. There was only one haul with significant gear damage (broken headline). At the start of the survey the weak link in the tickler broke a number of times on soft ground; the link was replaced by a stronger one which didn't break since.
Number of fish species recorded and notes on any rare species or unusual catches:	In 2016, 78 species of fish, 31 elasmobranch, 6 cephalopod and 30 other species/groups were recorded. No particularly rare or unusual species were encountered.

Table 5.3.2.6.1. Stations fished (aim to complete 110 valid tows per year)

ICES Divisions	Strata	Valid Tows	Stratum area (km^2)	Swept-area (km^2)
6a	6a_Shelf_L	15	38 424	6.479
6a	6a_Shelf_M	8	4441	3.716
6a	6a_Slope_H	7	3114	3.670
6a	6a_Slope_M	11	3044	6.468
7bcjk	7_Shelf_H	27	50 764	12.597
7bcjk	7_Shelf_L	5	42 034	2.557
7bcjk	7_Shelf_M	6	14 621	2.769
7bcjk	7_Slope_H	19	35 768	9.896
7bcjk	7_Slope_M	9	29 406	5.416
Total		107	221 616	53.568

Table 5.3.2.6.2. Biological samples (length, weight, sex, maturity and age material)

Species	No.	Species	No.
Dipturus flossada *	85	*Molva molva*	159
Dipturus intermedia **	148	*Pleuronectes platessa*	280
Gadus morhua	123	*Pollachius pollachius*	36
Glyptocephalus cynoglossus *	193	*Pollachius virens*	108
Lepidorhombus boscii *	80	*Raja brachyura* *	5
Lepidorhombus whiffiagonis	786	*Raja clavata* *	292
Leucoraja naevus *	642	*Raja montagui* *	211
Lophius budegassa	884	*Scophthalmus maximus* **	16
Lophius piscatorius	1417	*Scophthalmus rhombus* *	15
Melanogrammus aeglefinus	601	*Solea solea*	2
Merlangius merlangus	239	*Squalus acanthias**	106
*Merluccius merluccius**	1009	*Zeus faber**	159
*Microstomus kitt**	82		

*** maturity: length, weight, sex, and maturity**

**** length and weight only**

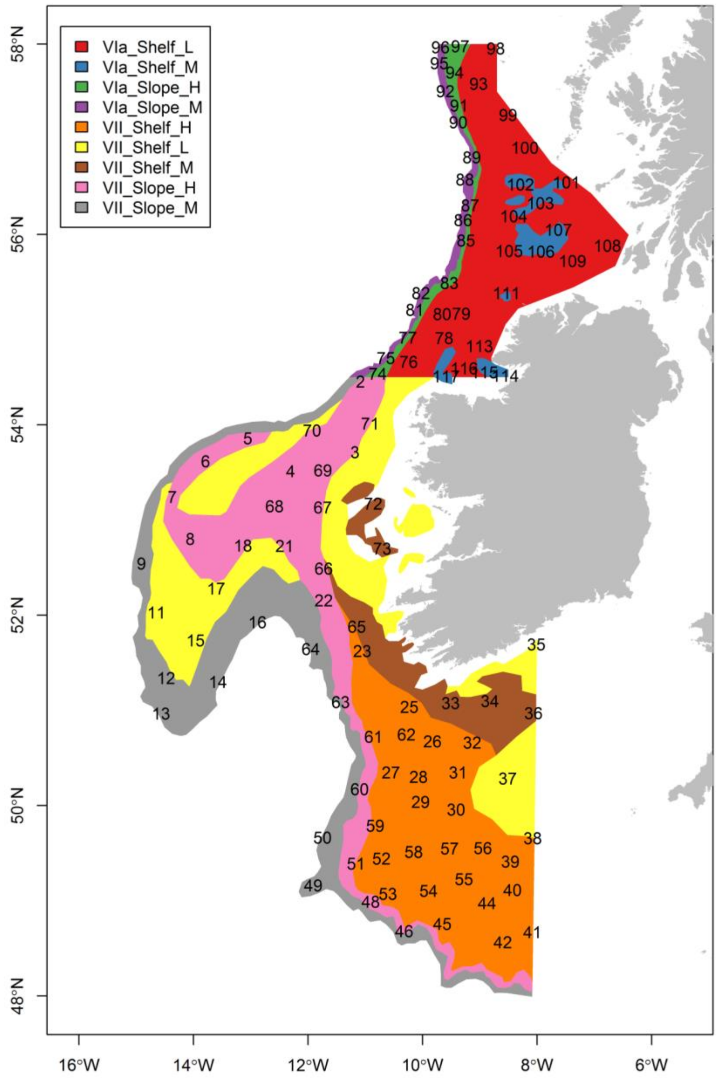


Figure 5.3.2.6.1. Map of valid survey stations completed by the Irish Anglerfish and Megrim Survey in 2016. The numbers refer to the haul number

Table 5.3.2.6.3. Summary statistics by stratum. Stratum area is given in km², Num hauls is the number of valid hauls in each stratum. Swept-area is the total area swept between the doors in each stratum (in km²), catch numbers are given for *L. piscatorius* (MON), *L. budegassa* (WAF) and *L. whiffiagonis* (MEG)

Stratum	Stratum area	Num hauls	Swept-area	Catch num MON	Catch num WAF	Catch num MEG
6a_Shelf_L	38 424	15	6.8	122	18	38
6a_Shelf_M	4 441	8	3.7	213	60	23
6a_Slope_H	3 114	7	3.7	430	78	345
6a_Slope_M	3 044	11	6.5	208	0	237
7_Shelf_H	50 764	27	12.6	137	428	345
7_Shelf_L	42 034	5	2.6	55	9	41
7_Shelf_M	14 621	6	2.8	91	101	87
7_Slope_H	35 768	19	9.9	189	173	257
7_Slope_M	29 406	9	5.4	64	1	7
Total	221 616	107	53.6	1509	868	1380

Table 5.3.2.6.4. Estimated numbers (millions) and biomass (kT) in the survey area, with CV and confidence intervals (Low: CIlo and high: CIhi). Only fish >500g live weight (approximately 32 cm) were included in the estimate

	L piscatorius		*L budegassa*	
	6a	7	6a	7
NumMln	4.67	8.56	0.48	5.24
NumCV	19.9%	28.5%	29.7%	13.7%
NumCIlo	2.84	3.79	0.20	3.83
NumCIhi	6.49	13.34	0.75	6.64
BiomKT	6.37	22.58	0.58	8.92
BiomCV	18.8%	12.3%	34.9%	14.3%
BiomCIlo	4.02	17.13	0.18	6.41
BiomCIhi	8.72	28.03	0.98	11.43

5.3.2.7 Ireland: Irish Groundfish Survey Q4 – IGFS2016

Nation:	Ireland	Vessel:	RV Celtic Explorer
Survey:	IGFS-Q4	Dates:	25 Sept – 6 Oct (6a) 14 Nov – 18 Dec (7b,g,j)

Cruise	The Q4 Irish Groundfish survey collects data on the distribution, relative abundance and biological parameters of commercial fish in 6a south, 7b and 7g,j north. The indicess currently utilized by assessment WG's are for haddock, whiting, plaice, cod, hake andsole. Survey data are also provided for white and black anglerfish, megrim, pollack, ling, blue whiting and a number of elasmobranchs as well as several pelagics (herring, horse mackerel and mackerel).
Gear details:	Two gear survey since 2004, using GOV groundgear "A" for areas 7b,g and j; and "D"for area 6a.
Notes from survey (e.g. problems, additional work etc.):	No significant weather disruption in during 2016 with only 1 day being lost in total, however continual moderate weather forced several changes to the planned optimal sequence of stations and reduced also the number of CTD transects from 4 to 1. One further day was lost due to a hydraulics failure which forced the vessel to port for repairs.
Number of fish species recorded and notes on any rare species or unusual catches:	In 2016, 82 species of fish, 19 elasmobranch, 12 cephalopod and 53 crustacean and 133 other species/groups were caught. The most significant change in 6a was a significant increase in flatfish for plaice and sole Kg/h (250% and 800% respectively). This reflects a particulalry poor result for both spp in 2015, but otherwise figures for 2016 are in keeping with the survey trend over recent years. Overall haddock, whiting and blue whiting show improvement over the 5yr trend, while hake, cod and sole are down in both weight and number per hour. For the west of Ireland and Celtic Sea the perception on the survey was that pelagic catches of herring and mackerel were significanntly reduced. This is reflected somewhat in the survey trend data and includes hake, but the reduction in cpue does not appear nearly as pronounced as the perception at sea. Whether stocks were not as aggregated as previous years may have influenced the overall impression on the survey. In contrast horse mackerel appears to have increased significantly with small increases in megrim, monk and sole.

Table 5.3.2.7.1 and Figure 5.3.2.7.1 summarize the tows planned and performed per ICES Division and gear, and the area surveyed. Table 5.3.2.7.2 presents the biological samples collected during the survey, while Table 5.3.2.7.3 presents the abundance indices in weight and number with a comparison with the results in the last 4 years.

Table 5.3.2.7.1. Stations fished (aim to complete 170 valid tows per year)

ICES Divisions	Strata	Gear	Tows planned	Valid	Additional	Invalid	% stations fished
6a	All	D	45	42	1	4	102
7b,c	All	A	38	39	0	0	110
7g	All	A	48	48	0	2	100
7j	All	A	40	43	0	2	110
Total			171	172	1	8	105

Table 5.3.2.7.2. Biological samples, length, weight, sex, maturity, and age material

Species	No.	Species	No.
*Chelidonichthys cuculus***	36	*Microstomus kitt*	845
Clupea harengus	317	*Molva molva*	132
*Conger conger***	103	*Pleuronectes platessa*	1336
Dicentrarchus labrax	25	*Pollachius pollachius***	24
*Dipturus flossada**	48	*Pollachius virens*	191
*Dipturus intermedia***	21	*Raja brachyura**	46
Gadus morhua	311	*Raja clavata**	326
*Glyptocephalus cynoglossus***	371	*Raja montagui**	1034
Lepidorhombus whiffiagonis	1438	*Scomber scombrus*	570
*Leucoraja naevus**	201	*Scophthalmus maximus***	58
Lophius budegassa	403	*Scophthalmus rhombus***	57
Lophius piscatorius	366	*Solea solea*	203
Melanogrammus aeglefinus	2776	*Squalus acanthias**	544
Merlangius merlangus	1972	*Trachurus trachurus*	1344
Merluccius merluccius	698	*Zeus faber***	341
Micromesistius poutassou	617		

*** maturity (lengh, weight, sex and maturity)**

**** length weight only (length and weight).**

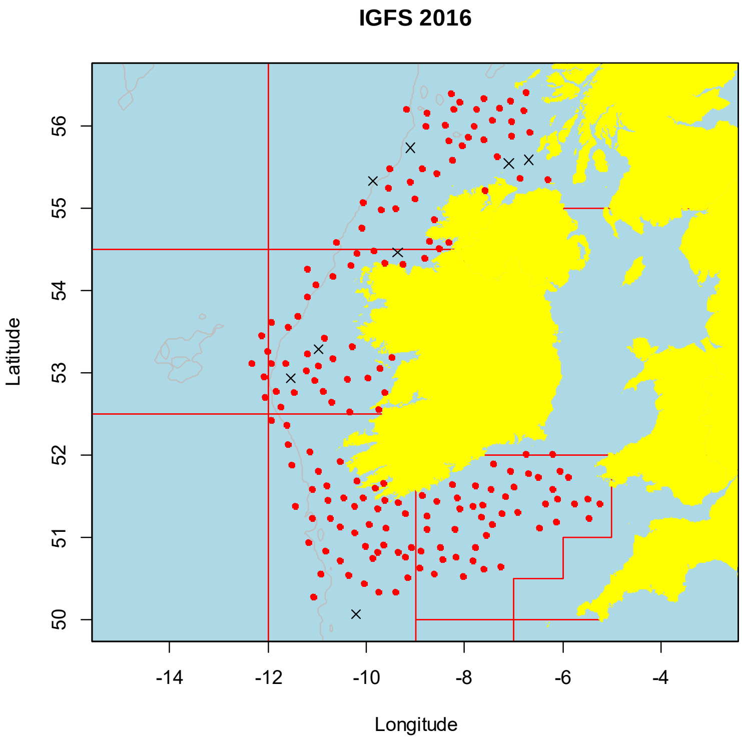


Figure 5.3.2.7.1. Map of Survey Stations completed by the Irish Groundfish Survey in 2016. Valid = red circles; Invalid = black crosses

Table 5.3.2.7.3. Abundances in biomass and number of main species during 2016 Irish Groundfish Survey compared with the fourth previous years

			Biomass index			Number index		
Species	Strata	Valid tows	y_i	y_i/y_{i-1}	$y_{(i,i-1)}/y_{(i-2,i-3,i-4)}$	y_i	y_i/y_{i-1}	$y_{(i,i-1)}/y_{(i-2,i-3,i-4)}$
			kg/H	%	%	No/H	%	%
Gadus morhua	6a	42	5.8	224.9	-23.9	4.4	218.9	-46.3
Melanogrammus aeglefinus	6a	42	512.5	-3.3	238.7	1928.2	-28.4	133.9
Clupea harengus	6a	42	165.5	-15.4	-16.6	1183.5	-9.1	-22.1
Merluccius merluccius	6a	42	8.0	2.0	-68.9	30.4	92.5	-78.3
Trachurus trachurus	6a	42	364.2	136.6	30.5	3035.4	0.2	200.7
Scomber scombrus	6a	42	162.8	-49.0	0.9	3603.5	50.4	34.0
Lepidorhombus whiffiagonis	6a	42	2.3	54.4	-7.6	8.7	58.7	9.1
Lophius piscatorius	6a	42	4.6	90.6	32.3	4.0	44.4	51.0
Pleuronectes platessa	6a	42	22.6	254.3	-12.5	129.8	254.6	-13.7
Solea solea	6a	42	0.7	804.1	-31.0	2.3	719.8	-34.2
Micromesistius poutassou	6a	42	84.0	-89.7	427.7	1947.0	-89.5	310.7
Merlangius merlangus	6a	42	289.7	-3.9	123.2	2194.9	13.7	43.6
Gadus morhua	7bgj	130	8.3	117.4	13.3	2.7	119.4	-11.0
Melanogrammus aeglefinus	7bgj	130	135.2	-1.9	13.0	554.1	-55.2	1.9
Clupea harengus	7bgj	130	2.0	-83.8	-72.6	46.1	-81.1	-54.9
Merluccius merluccius	7bgj	130	23.2	35.2	-42.6	259.2	67.0	-50.5
Trachurus trachurus	7bgj	130	158.6	-25.0	403.6	3350.1	-51.0	460.1
Scomber scombrus	7bgj	130	28.8	-46.8	-70.8	787.0	-16.1	-62.7
Lepidorhombus whiffiagonis	7bgj	130	4.8	26.7	29.5	35.1	63.3	66.5
Lophius piscatorius	7bgj	130	9.7	50.9	18.5	9.1	26.7	51.1
Pleuronectes platessa	7bgj	130	12.1	-18.4	45.0	67.9	-17.7	58.9
Solea solea	7bgj	130	0.8	56.4	51.2	2.5	26.3	11.7
Micromesistius poutassou	7bgj	130	83.3	45.8	34.3	1363.3	-5.2	-19.6
Merlangius merlangus	7bgj	130	85.9	-19.9	-26.1	805.0	-8.5	-27.7

Year estimate 2016 (y_i); previous year estimate 2015 (y_{i-1}); average of last two years estimate ($y_{(i,i-1)}$); average of the previous three year estimates 2012-14 ($y_{(i-2,i-3,i-4)}$). As results for survey trends are ratios they are quite sensitive to stocks with high variance, therefore comparing the 2 years vs. 5 years trend is advisable.

5.3.2.8 France: FR-CGFS-Q4 (The Channel Groundfish Survey Q4)

Nation:	**France**	**Vessel:**	**RV Thalassa**
Survey:	CGFS	Dates:	24 Sept – 8 Oct (ICES Division 7d)

Cruise	CGFS bottom trawl survey aims to collect data on the distribution and relative abundance, and biological information of commercial fish in the Eastern English channel (ICES Division 7d). The primary target species are plaice and red mullet, which abundance indices are estimated by age, as well as cod, whiting, sea bass, cuttlefish, squids, and elasmobranchs. Data are also collected for several other demersal and pelagic fish species and invertebrates. Since 2015, CTD and plankton nets are realized at each station.
Survey Design	This survey follows a fixed stratified sampling design, with 74 stations since 2015 (88 stations for the period 1988–2014) distributed among the ICES statistical rectangles used as strata, with the number of station per stratum depending of its surface.
Gear details:	GOV 36/47 with no kite (6 extra floats instead) and a groundgear with 250 mm bobbins. The trawl geometry was recorded during each haul with Marport sensors, and was about 4.7 meters of vertical net opening and 16m of horizontal opening (wing spread).
Notes from survey (e.g. problems, additional work etc.):	Weather conditions were pretty good during the survey, allowing to realize the following sampling: 75 trawls in the eastern English Channel with GOV 36 x 47 (Figure 5.3.2.8.1 and Table 5.3.2.8.1). 22 additional trawls in the Western English Channel (ICES Division 7e) with GOV 36 x 49 to test the efficiency of a tickler chain. A total number of 1029 biological samples (otoliths, illicia or scales) were collected from fish species (Table 5.3.2.8.2). Wastes were counted and weighted at each trawl station. Benthos and jellyfish were sorted, identified and counted at each trawl station. 84 hydrology stations (deploying hydrological probe, Niskin bottle and plankton WP2 net). 18 stations where microplastics were sampled with a Manta net. 28 benthic stations where 3 dredges where realized as well as a video profile of seabed. 158 samples of subsurface water, in order to get fish eggs, along the vessel trajectory. During daylight, two observers were also continuously recording seabirds and marine mammals.
Number of fish species recorded and notes on any rare species or unusual catches:	Over the eastern English Channel, 76 species of fish and cephalopods have been identified, and 93 taxa of benthic invertebrates (including commercial ones) and jellyfish have been identified. The preliminary results are characterized by a high dominance of horse mackerel, particularly in the central area, while the eastern part was dominated by both horse mackerel and mackerel. Coastal areas show a higher species richness than offshore (from 47 species per haul down to 16 species per haul). When integrated over the area, the dominance shows a similar pattern: dominance of horse mackerel both in biomass and abundance; the small forage fish dominate the community in term of abundance (sardine, sprat, anchovy, mackerel), while the large individuals of the elasmobranch species make them important for the biomass dominance.

Table 5.3.2.8.1. Stations fished during FR-CGFS 2016 survey

ICES Divisions	Strata	Gear	Tows planned	Valid	Additional	Invalid	% stations fished
7d	30F1	GOV 36/47	8	8			100
7d	29F1	GOV 36/47	8	8			100
7d	28F1	GOV 36/47	1	1			100
7d	30F0	GOV 36/47	7	7			100
7d	29F0	GOV 36/47	8	8		1	100
7d	28F0	GOV 36/47	5	5			100
7d	30E9	GOV 36/47	6	6			100
7d	29E9	GOV 36/47	7	7			100
7d	28E9	GOV 36/47	9	8		1	89
7d	27E9	GOV 36/47	8	8			100
7d	29E8	GOV 36/47	3	3			100
7d	28E8	GOV 36/47	3	3			100
7d	27E8	GOV 36/47	1	1			100
	Total		74	73		2	99

Table 5.3.2.8.2. Biological samples in the ICES Division 7d. Length, weight, sex, maturity and age material

Species	No.	Species	No.
Merlangius merlangus	227	*Chelidonichthys cuculus***	165
Gadus morhua	11	*Mulletus surmulletus*	104
Molva dypterygia	1	*Pleuronectes platessa*	336
Trisopterus luscus	29	*Solea solea*	51
**Dicentrarchus labrax*	103	*Scophthalmus rhombus*	1
		Scophthalmus maximus	1

*** scales**

**** for maturity only, no age material collected**

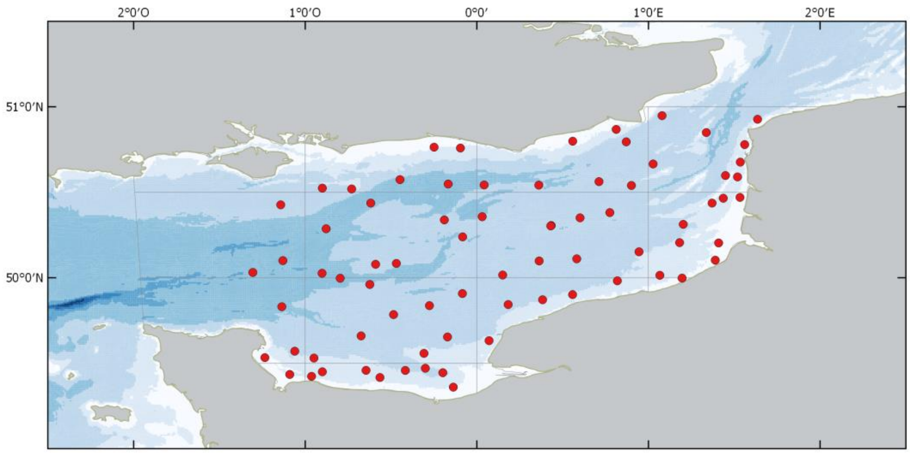


Figure 5.3.2.8.1. Sampling stations (red dots) of the FR-CGFS 2016 survey

5.3.2.9 France: FR-EVHOE-Q4(Celtic Sea/Bay of Biscay Groundfish Survey Q4)

Nation:	**France**	**Vessel:**	**Thalassa 2**
Survey:	EVHOE 2016	Dates:	17 October – 1 December 2016

Cruise	EVHOE Groundfish survey aims at collecting data on the distribution, relative abundance and biological parameters of all fish and selected commercial invertebrates in subareas 7f-j and 8a,b,d. The primary species are hake, monkfish, megrim, cod, haddock and whiting. Data are also collected for all other demersal, pelagic fish and cephalopods as well as for the whole invertebrate megafauna. From 2016 onward, sampling design is fixed, based on a previously randomly selected set of points based on bathymetric and sedimentary strata.
Gear details:	A GOV with standard Groundgear (A) but no kite replaced by 6 extra floats. Marport sensors for door, wing, and vertical net opening
Notes from survey (e.g. problems, additional work etc.):	We moved from a randomly stratified sampling strategy on an annual basis to a fixed one. The 2016 randomly selected set of points will be the reference for sampling stations to be utilized for the next years (Figure 5.3.2.9.1). As far as strata and the position and numbers of selected points are based on the same reference than previous years, modifications of sampling design won't theoretically be detectable in 2016 as compared to the whole time-series. The few sampled points into the deeper strata for the Celtic part (strata Cs7,Cc7 and Cn7) of the survey were not included into the new sampling design as well as the points sampled in some part of the shallowest strata of the bay of Biscay (*e.g.* points that were occasionally done into some enclosed bays). To complete strata coverage, 4 additional hauls have been added to the initial set of sampling points in the central-eastern part of the Celtic sea. Those points will be added to the fixed sampling design for the following years. A total of 161 hauls have been realized and 96% of them were validated (Table 5.3.2.9.1). 103 % of the initial program have been realized and validated (155 valid hauls of 150 planed). 6 hauls were not validated because of trawl damage or shorted hauls due to strong pelagic fish acoustic detection.

	A significant problem arose during the second part of the survey regarding fishing authorization in the Irish EEZ. Despite an initial demand that respected the submission schedule (initial demand in February) and follow-up messages, due to administrative delays we only obtained authorization during the survey (the 10th of November). We consequently had to change the sampling plan with 7 stations in southern Celtic Sea strata (Cs4 to Cs6) different from the originally selected one. During the survey following additional data collection have been performed: - A total number of 3805 biological samples (otoliths, scales and/or illicia) have been realized (Table 5.3.2.9.2). -Trawl geometry data (Marport sensors) have been collected during all the hauls. -155 CTD temperature and salinity profile - continuous records and 35 “profiles boxes” with multibeam echosounder to collect bathymetry and reflectivity data - mammals and birds observations during the legs 1 and 2. -Additional works, partly for MSFD, were realized at night mostly in the evening or early morning: 83 transect with CUFES device (Continuous Underwater Fish Egg Sampler) 5 Manta net hauls for collecting surface microplastics was put up during first and second leg samples with WP2 net for zoo and phytoplancton were collected during parts one and two. 55 vertical profiles with "SBE 19 Bathysonde" to collect temperature, phytoplancton, particle densities ... 15 Photo/Video transects with PAGURE sledge and 3 with SCAMPI for deeper areas 7 mesopelagic hauls at the shelf break 53 WP2 for zooplancton during the 2 first parts of the survey - Wastes were counted and weighted at each trawl station. - Benthos was sorted, identified, counted and weighted at the lowest taxonomic level (mostly species) for each trawled station.
Number of fish species recorded and notes on any rare species or unusual catches:	161 fish and cephalopods species were recorded. Additional work on selected species: muscle samples and stomach contents, sampling of illicia an otoliths for both *Lophius* species.

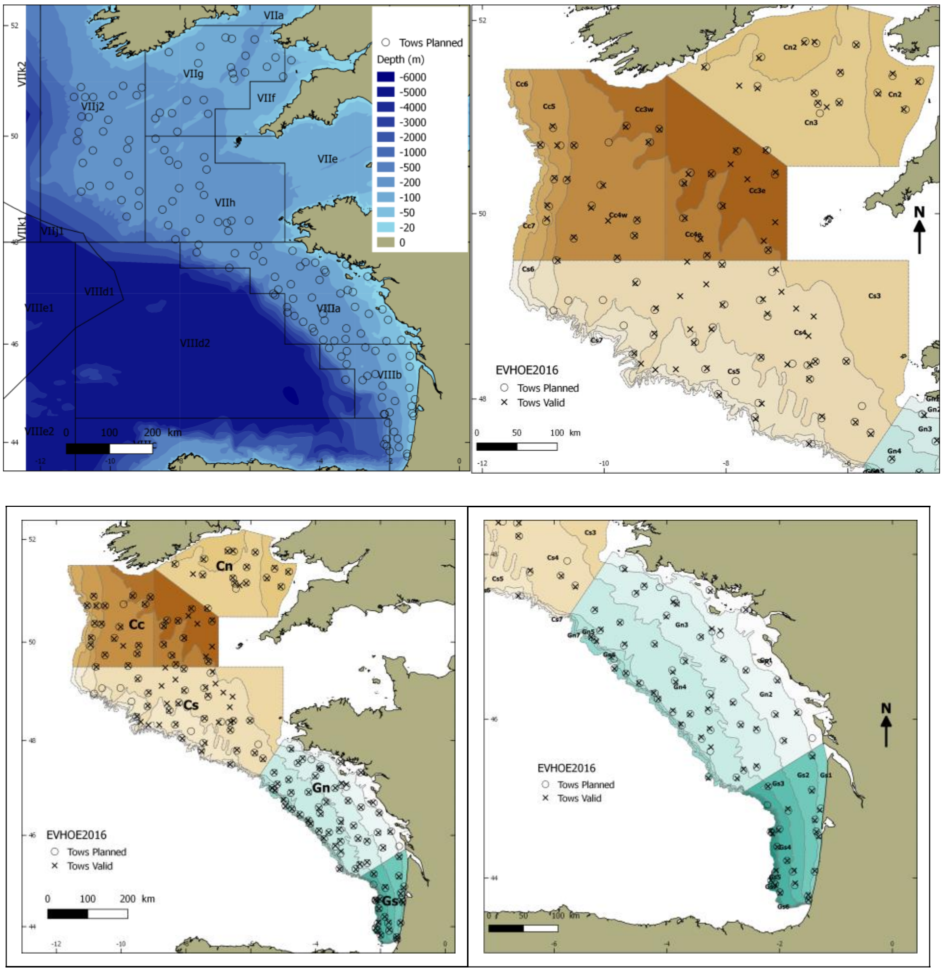


Figure 5.3.2.9.1. Planned stations in the fixed sampling plan (o) and validated tows (x) for EVHOE 2016. ICES areas as well as EVHOE strata (Gs, Gn, Cs, Cc, Cn) and substrata (numbers from 1 to 7 depending on bathymetric ranges) are indicated

Table 5.3.2.9.1. Stations fished per depth and geographical strata during FR-EVHOE 2016 survey

ICES Divisions	Strata	Gear	Tows planned	Tows realized	Valid	Additional	%.stations fished
7fghj	Cc3	GOV 36/47	8	11	10	3	125
	Cc4		15	17	17		113
	Cc5		4	4	4		100
	Cc6		3	3	3		100
	Cn2		7	7	7		100
	Cn3		8	9	9	1	113
	Cs4		20	26	26	6	130
	Cs5		7	6	6		86
	Cs6		4	4	3		75
8abd	Gn1	GOV 36/47	5	5	5		100
	Gn2		5	5	4		80
	Gn3		14	14	14		100

ICES Divisions	Strata	Gear	Tows planned	Tows realized	Valid	Additional	%.stations fished
	Gn4		20	20	20		100
	Gn5		3	3	3		100
	Gn6		2	2	2		100
	Gn7		2	2	2		100
	Gs1		3	3	3		100
	Gs2		6	6	6		100
	Gs3		4	4	3		100
	Gs4		4	4	4		75
	Gs5		2	2	2		100
	Gs6		2	2	2		100
	Gs7		2	2	2		100
Total	All		150	161	157	10	105

Table 5.3.2.9.2. Biological samples (length, weight, sex, maturity and age material) in the ICES Divisions 8ab and 7fghj

Species	Total number of samples	Type of material	% Sexed	%F	%I	%M	Size Type
Chelidonichthys cuculus	214	otolith	100	54.2	4.7	41.1	TL
Chelidonichthys lucerna	11	otolith	100	63.6	0	36.4	TL
Dicentrarchus labrax	170	scale	100	43.5	0	56.5	TL
Engraulis encrasicolus	113	otolith	100	72.6	0	27.4	TL
Gadus morhua	73	otolith	100	47.9	0	52.1	TL
Glyptocephalus cynoglossus	33	otolith	100	57.6	0	42.4	TL
Lepidorhombus whiffiagonis	385	otolith	100	60	5.2	34.8	TL
Lophius budegassa	102	illicia	100	38.2	31.4	30.4	TL
Lophius piscatorius	79	illicia	100	38	17.7	44.3	TL
Melanogrammus aeglefinus	506	otolith	100	50.2	9.3	40.5	TL
Merlangius merlangus	490	otolith	100	53.7	9.8	36.5	TL
Merluccius merluccius	965	otolith	100	46.6	13.4	40	TL
Microstomus kitt	155	otolith	100	58.7	0	41.3	TL
Molva molva	7	otolith	100	85.7	0	14.3	TL
Mullus surmuletus	48	otolith	100	43.8	8.3	47.9	TL
Nephrops norvegicus			100				CL

Species	Total number of samples	Type of material	% Sexed	%F	%I	%M	Size Type
Phycis blennoides	116	otolith	100	58.6	20.7	20.7	TL
Pleuronectes platessa	160	otolith	100	66.2	0	33.8	TL
Pollachius pollachius	4	otolith	100	100	0	0	TL
Pollachius virens	1	otolith	100	100	0	0	TL
Sardina pilchardus	77	otolith	100	53.2	0	46.8	TL
Scophthalmus maximus	8	otolith	100	50	0	50	TL
Scophthalmus rhombus	3	otolith	100	33.3	0	66.7	TL
Solea solea	85	otolith	100	55.3	0	44.7	TL

5.3.2.10 Spain: SP-PORC-Q3 (The Porcupine Groundfish Survey Q3)

Nation:	**SP (Spain)**	**Vessel:**	**RV Vizconde de Eza**
Survey:	SP-PORC-Q3 (P16)	Dates:	10 September - 11 October 2016

Cruise	Spanish Porcupine bottom trawl survey aims to collect data on the distribution and relative abundance, and biological information of commercial fish in Porcupine bank area (ICES Division 7b-k). The primary target species are hake, monkfish, white anglerfish and megrim, which abundance indices are estimated by age, with abundance indices also estimated for Nephrops, four-spot megrim and blue whiting. Data collection is also collected for several other demersal fish species and invertebrates.
Survey Design	This survey is random stratified with two geographical strata (northern and southern) and 3 depth strata (170-300 m, 301-450 m, 451-800 m). Stations are allocated at random according to the strata surface.
Gear details:	Porcupine baca 39/52 (Otter trawl gear)
Notes from survey (e.g. problems, additional work etc.):	Weather conditions were rough and poor during most of 2016 survey, especially during the second leg. A reduction in tow duration from 30 minutes after gear ground contact to 20 minutes has been implemented this year. Additional work undertaken included 82 CTD casts at most trawl stations, 1 within the non-trawlable area, and 8 in 4 perpendicular radials to obtain a general image of the hydrography.
Number of fish species recorded and notes on any rare species or unusual catches:	Overall a total of 94 fish species, 40 crustaceans, 30 molluscs, 26 echinoderms and 22 species of other invertebrates were identified.

Table 5.3.2.10.1 presents a summary of the stations performed per ICES division and Figure 5.3.2.10.1 shows the area surveyed with the hauls and CTDs carried out.

Table 5.3.2.10.2 contains the samples collected during the survey of the main DCF related species and **Table 5.3.2.10.3** contains the biomass and number abundance indices on 2016 survey also compared with results from the last 4 years.

Table 5.3.2.10.1. Stations fished (aim: to complete 80 valid tows per year)

ICES Divisions	Strata	Gear	Tows planned	Valid	Additional	Invalid	% stations fished
7b	All	Porcupine baca 39/52		5			
7c	All	Porcupine baca 39/52		38	2		
7k	All	Porcupine baca 39/52		37	3		
TOTAL	All	Porcupine baca 39/52	80	80	5	-	106 %

Table 5.3.2.10.2. Biological samples collected during Porcupine Bank 2016 Spanish survey. Data collected: length, weight, sex and maturity.

Species	Age	Species	Age
Merluccius merluccius	1072	Molva molva	52
Lepidorhombus whiffiagonis	784	*Conger conger*	23
Lepidorhombus boscii	300	*Helicolenus dactylopterus*	180
Lophius budegassa	36	*Phycis blennoides*	234
Lophius piscatorius	177	*Nephrops norvegicus**	431

*** No information on maturity nor age collected**

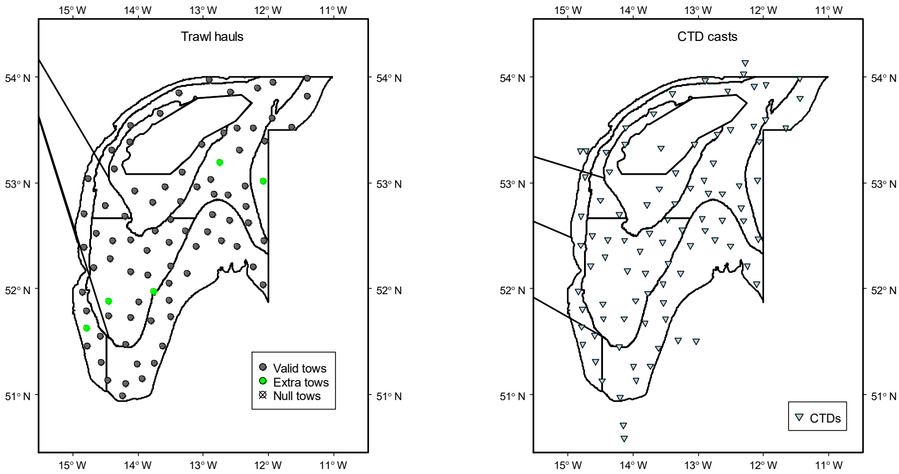


Figure 5.3.2.10.1. Trawl and CTD stations in Porcupine 2016 survey

Table 5.3.2.10.3. Abundances in biomass and number of main species during 2016 Spanish Porcupine Bank Survey compared with the fourth previous years

			Biomass index			Number index		
Species	**Strata**	**Valid tows**	y_i kg/0.5h	y_i/y_{i-1} %	$y_{(i,i-1)}/y_{(i-2,i-3,i-4)}$ %	y_i n/0.5h	y_i/y_{i-1} %	$y_{(i,i-1)}/y_{(i-2,i-3,i-4)}$ %
Merluccius merluccius	All	80	55.28	-19.3	-12.4	54.1	-19.7	-28.2
Lepidorhombus whiffiagonis	All	80	14.77	13	0.3	207.93	27.2	19.4
Lepidorhombus boscii	All	80	11.91	-16.4	7.1	120.27	-24.6	-11.1
Lophius budegassa	All	80	1.09	-38.4	-10.3	0.78	-12.4	-7.6
Lophius piscatorius	All	80	19.03	-3.9	6.7	5.18	3.2	2
Micromesistius poutassou	All	80	390.67	-40.5	83.1	4672.78	-44.4	125.6
Nephrops norvegicus	All	80	1.43	376.7	74.2	65.24	561	195.6

yi, year estimate (2016); yi-1, previous year estimate (2015); y(i,i-1), Average of last two year estimates (2016 and 2015); y(i-2,i-3,i-4), Average of the previous three year estimates (2014, 2013 and 2012).

5.3.2.11 Spain: SP-NSGFS-Q4 (Spanish North Coast Survey Q4)

Nation:	**SP (Spain)**	**Vessel:**	**RV Miguel Oliver**
Survey:	SP-NSGFS-Q4 (N16)	Dates:	17 September - 23 October 2016

Cruise	Spanish North Coast bottom trawl survey aims to collect data on the distribution and relative abundance, and biological information of commercial fish in ICES Divisions 8c and Northern 9a. The primary species are hake, monkfish and white anglerfish, megrim, four-spot megrim, blue whiting and horse mackerel abundance indices are estimated by age, with abundance indices also estimated for *Nephrops*, and data collection for other demersal fish and invertebrates.
Survey Design	This survey is random stratified with five geographical strata along the coast and 3 depth strata (70-120 m, 121-200 m, 201-500 m). Stations are allocated at random within the trawlable stations available according to the strata surface.
Gear details:	Standard baca 36/40 with Thyborøn doors
Notes from survey (e.g. problems, additional work etc.):	2016 was the fourth year the RV Miguel Oliver was used to perform the survey instead of the RV Cornide de Saavedra, after the intercalibration performed in 2012, results from the survey are in line with those from the time-series, showing the usual proportion of bentho-demersal species as megrims, skates, catfish. As in previous years, three additional hauls were undertaken to cover shallow stations between 30 and 70 m, and 14 deeper stations, between 500 and 700 m. Additional work undertaken included CTD casts at all trawl stations and dredges carried out with a boxcorer to create a grid of sediment and in some areas infauna samples (**Figure 5.3.2.11.1**). Seabirds census was also carried out during fishing manoeuvres. Analyses of stomach contents of main demersal species was performed in all hauls during the survey.
Number of fish species recorded and notes on any rare species or unusual catches:	A total of 240 species were captured, 88 fish species, 54 crustaceans, 45 molluscs, 32 echinoderms and 35 other invertebrates.

Table 5.3.2.11.1 presents a summary of the stations performed per ICES division and Figure 5.3.2.11.1 shows the area surveyed with the hauls, CTD, dredge and stations carried out. Table 5.3.2.11.2 contains the samples collected during the survey of the main DCF related species and Tan;e 5.3.2.11.3 contains the biomass and number abundance indices on 2016 survey also compared with results from the last 4 years.

Table 5.3.2.11.1. Stations fished (aim: to complete 116 valid tows per year)

ICES Divisions	Strata	Gear	Tows planned	Valid	Additional	Invalid	% stations fished
8c	All	Standard baca 36/40	96	95	17	-	99%
9a North	All	Standard baca 36/40	20	19	2	1	100 %
TOTAL			116	115	19(1)	1	106 %

(1) 19Additional hauls on shallow and deep grounds

Table 5.3.2.11.2. Biological samples collected during the 2016 groundfish survey on the northern Spanish shelf. Data and samples: length, weight, otolith, sex and maturity

Species	No.	Species	No.
Merluccius merluccius	883	*Scomber scombrus*	361
M. merluccius (northern stock 8ab)	9	*Mullus surmuletus*	77
Lepidorhombus whiffiagonis	447	*Scomber colias*	66
Lepidorhombus boscii	510	*Zeus faber*	64**
Lophius budegassa	57	*Trisopterus luscus*	219
Lophius piscatorius	40	*Helicolenus dactylopterus*	169
Trachurus trachurus	642	*Phycis blennoides*	153
Micromesistius poutassou	1007	*Conger conger*	170**
Engraulis encrasicolus	140	*Sardina pilchardus*	172

(*) Otoliths read for the ALK.

(**) Otoliths and vertebrae, only the former read for John Dory.

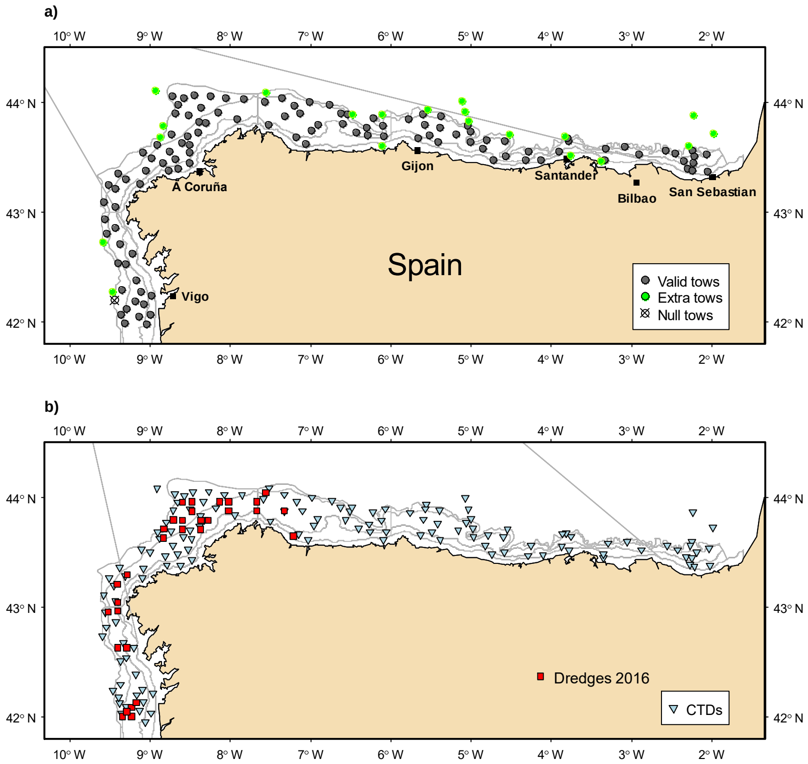


Figure 5.3.2.11.1. a) Trawl stations in northern Spanish Shelf 2016 survey, b) CTD and dredge stations in relation to trawl stations.

Table 5.3.2.11.3. Abundance indices in biomass and number during 2016 survey compared with previous years in the time-series

			Biomass index			Number index		
Species	**Strata**	**Valid tows**	y_i kg/0.5h	y_i/y_{i-1} %	$y_{(i,i-1)}/y_{(i-2,i-3,i-4)}$ %	y_i n/0.5h	y_i/y_{i-1} %	$y_{(i,i-1)}/y_{(i-2,i-3,i-4)}$ %
Merluccius merluccius	9aN	19	12.84	-14.8	40.9	302.9	-48.4	59.7
Lepidorhombus boscii	9aN	19	6.63	49.0	19.2	125.3	34.6	50.4
L. whiffiagonis	9aN	19	0.07	250.0	-3.6	0.9	840.0	15.6
Lophius budegassa	9aN	19	0.02	-77.8	-78.6	0.3	383.3	38.2
Lophius piscatorius	9aN	19	0.02	-85.7	-76.9	0.2	21.4	-40.4
Micromesistius poutassou	9aN	19	45.60	-69.5	140.9	1051.2	-75.0	72.4
Trachurus trachurus	9aN	19	24.05	381.0	296.9	224.6	344.3	238.0
Scomber scombrus	9aN	19	8.45	997.4	3.2	130.1	2482.1	7.3
Nephrops norvegicus	9aN	19	0.02	100.0	-25.0	0.2	50.0	-7.7
Merluccius	8c	95	6.59	-25.0	51.3	192.5	-26.0	52.4

merluccius								
Lepidorhombus boscii	8c	95	4.46	-4.1	-31.3	78.7	5.4	-18.2
L. whiffiagonis	8c	95	3.26	46.2	30.7	51.9	39.9	227.2
Lophius budegassa	8c	95	0.61	-6.2	-45.1	0.4	2.4	-63.9
Lophius piscatorius	8c	95	0.93	-30.6	-38.5	0.3	-50.7	-72.3
Micromesistius poutassou	8c	95	128.94	-32.3	99.2	2916.2	-62.6	106.2
Trachurus trachurus	8c	95	27.08	-70.7	264.5	607.1	-74.0	265.4
Scomber scombrus	8c	95	0.37	-84.4	-65.0	2.5	-91.9	-69.3
Nephrops norvegicus	8c	95	0.04	-19.0	-10.0	0.8	7.7	-4.3

y_i, year estimate (2016); y_{i-1}, previous year estimate (2015); $y_{(i,i-1)}$, Average of last two year estimates (2016 and 2015); $y_{(i-2,i-3,i-4)}$, Average of the previous three year estimates (2014, 2013 and 2012).

5.3.2.12 Spain: SP-GCGFS-Q1 (Spanish Gulf of Cadiz Bottom trawl Survey Q1)

Nation:	**SP (Spain)**	**Vessel:**	**Miguel Oliver**
Survey:	SP-GCGFS-Q1 (ARSA 0316)	Dates:	21 February– 06 March 2016

Cruise	Spanish Gulf of Cadiz bottom trawl survey aim to collect data on the distribution, relative abundance and biological information of commercial fish, crustaceans and cephalopods in the Gulf of Cadiz area (ICES Division 9a). The primary species are hake, horse mackerel, mackerel, Spanish mackerel, wedge sole, sea breams and crustaceans as rose and red shrimps, Norway lobster and cephalopod molluscs. Data and abundance indices are also estimated and reported for other demersal fish species and invertebrates.
Survey Design	This survey is random stratified with 5 depth strata (15-30m, 31-100m, 101-200 m, 201-500 m, 501-800 m). Stations are allocated at random within the trawlable stations available according to the strata surface.
Gear details:	Standard baca 36/40 with Thyborøn doors
Notes from survey (e.g. problems, additional work etc.):	Sediment samples were collected with a collector attached to the groundgear. Temperature and salinity data were also collected during each tow with a CTD attached to the gear.
Number of fish species recorded and notes on any rare species or unusual catches:	A total of 365 species were captured, 128 fish species, 53 crustaceans, 65 molluscs, 65 echinoderms and 54 other invertebrates.

Table 5.3.2.12.1 presents a summary of the stations performed per ICES division and **Figure 5.3.2.12.1** shows the area surveyed with the hauls, CTD, dredge and stations carried out.

Table 5.3.2.12.2 lists the samples collected during the survey of the main DCF related species. Table 5.3.2.12.3 and Table 5.3.2.12.4 presents the biomass and number abundance indices from 2016 1st quarter survey and compares with results from the last 4 years.

Table 5.3.2.12.1. Stations fished (aim: to complete 41 valid tows per year)

ICES Divisions	Strata	Gear	Tows planned	Valid	Additional	Invalid	% stations fished
9a	All	Standard baca 36/40	45	44	5	2	98 %
Total			45	44	5	2	98 %

Table 5.3.2.12.2. Number of biological samples, data and samples on maturity and age material

Species	Age	Species	Age
Merluccius merluccius	315	*Illex coindeti**	201
*Merluccius merluccius**	1199	*Todaropsis eblanae**	309
Parapenaeus longirostris *	1564	*Sepia officinalis**	239
*Nephrops novergicus**	529	*Octopus vulgaris* *	153

*** Only maturity information collected, no otoliths collected**

Table 5.3.2.12.3. Variance in catch rates and estimates of sampling precision

Species	Strata	Valid tows	M catch Kg/hour	RSE	M catch no./hour	RSE
Merluccius merluccius	All	44	6.5	0.11	91.8	1.7
Micromesistius poutassou	All	44	74.4	5.96	2851.2	229.5
Nephrops norvegicus	All	44	1.1	0.07	48.1	3.1
Parapenaeus longirostris	All	44	0.7	0.03	145.7	4.3
Loligo vulgaris	All	44	0.7	0.03	7.1	0.6
Octopus vulgaris	All	44	1.8	0.07	2.9	0.1
Sepia officinalis	All	44	2.1	0.08	5.9	0.3

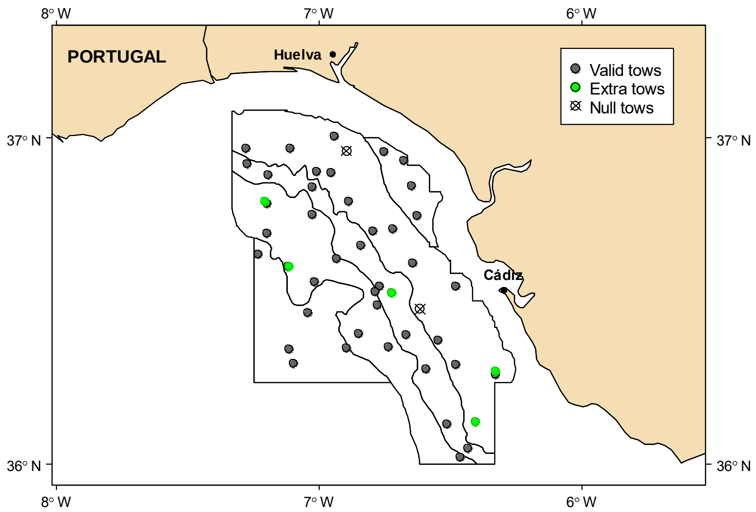


Figure 5.3.2.12.1. Map of trawl stations performed during Gulf of Cadiz spring (Q1) survey.

Table 5.3.2.12.4. Biomass and number estimates and time-series comparisons in SP-GCGFS Q1

			Biomass index			Number index		
Species	**Strata**	**Valid tows**	y_i kg/0.5h	y_i/y_{i-1} %	$y_{(i,i-1)}/y_{(i-2,i-3,i-4)}$ %	y_i n/0.5h	y_i/y_{i-1} %	$y_{(i,i-1)}/y_{(i-2,i-3,i-4)}$ %
Merluccius merluccius	All	44	6.01	9.3	27.3	83.2	8.7	2.9
Micromesistius poutassou	All	44	0.16	-99.1	182.8	1.2	-99.7	223.8
Nephrops norvegicus	All	44	0.78	136.4	375.7	21.3	79.0	373.1
Parapenaeus longirostris	All	44	0.90	-54.5	-32.7	208.8	-33.6	-22.0
Octopus vulgaris	All	44	1.40	-84.3	272.8	1.7	-88.9	400.0
Loligo vulgaris	All	44	0.50	28.2	-16.0	3.5	77.7	-37.2
Sepia officinalis	All	44	1.17	-53.0	4.2	3.8	-45.4	28.7

y_i, year estimate (2016); y_{i-1}, previous year estimate (2015); $y_{(i,i-1)}$, Average of last two year estimates (2016 and 2015); $y_{(i-2,i-3,i-4)}$, Average of the previous three year estimates (2014, 2013 and 2012).

5.3.2.14 Spain: SP-GCGFS-Q4 (Spanish Gulf of Cadiz Bottom trawl Survey Q4)

Nation:	**SP (Spain)**	**Vessel:**	**Miguel Oliver**
Survey:	GC_Autumn 2016 (ARSA)	Dates:	30 October–12 November 2016

Cruise	Spanish Gulf of Cadiz bottom trawl survey aim to collect data on the distribution, relative abundance and biological information of commercial fish, crustaceans and cephalopods in the Gulf of Cadiz area (ICES Division 9a). The primary species are hake, horse mackerel, mackerel, Spanish mackerel, wedge sole, sea breams and crustaceans as rose and red shrimps, Norway lobster and cephalopod molluscs. Data and abundance indices are also estimated and reported for other demersal fish species and invertebrates.
Survey Design	This survey is random stratified with 5 depth strata (15-30m, 31-100m, 101-200 m, 201-500 m, 501-800 m). Stations are allocated at random within the trawlable stations available according to the strata surface.
Gear details:	Standard baca 36/40 with Thyborøn doors
Notes from survey (e.g. problems, additional work etc.):	Sediment samples were collected with a collector attached to the groundgear. Temperature and salinity data were also collected during each tow with a CTD attached to the gear. Additionally 58 CTD casts were carried out in the survey area.
Number of fish species recorded and notes on any rare species or unusual catches:	Overall, 156 species of fish, 59 of crustacean and 64 of mollusc, 27 echinoderms and 59 other invertebrates were recorded during the survey.

Table 5.3.2.14.1 presents a summary of the stations performed per ICES division and Figure 5.3.2.14.1 shows the area surveyed with the hauls, CTD, dredge and stations carried out.

Table 5.3.2.14.2 presents a list of the samples collected during the survey of the main DCF related species.

Table 5.3.2.13.3 and Table 5.3.2.14.4 contain the biomass and number abundance indices from 2016 4th quarter survey and compares with results from the last 4 years.

Table 5.3.2.14.1. Stations fished (aim: to complete 41 valid tows per year)

ICES Divisions	Strata	Gear	Tows planned	Valid	Additional	Invalid	% stations fished
9a	All	Standard baca 36/40	45	45	4	1	100 %
TOTAL			45	45	4	1	100 %

Table 5.3.2.14.2. Number of biological samples, maturity and age data collected

Species	Age	Species	Age
Merluccius merluccius	229	*Todaropsis eblanae**	37
*Merluccius merluccius**	937	*Sepia officinalis**	109
*Parapenaeus longirostris **	640	*Octopus vulgaris **	255
*Nephrops novergicus**	360	*Loligo vulgaris**	51
*Illex coindeti**	44	*Loligo forbesi**	183

***maturity data only**

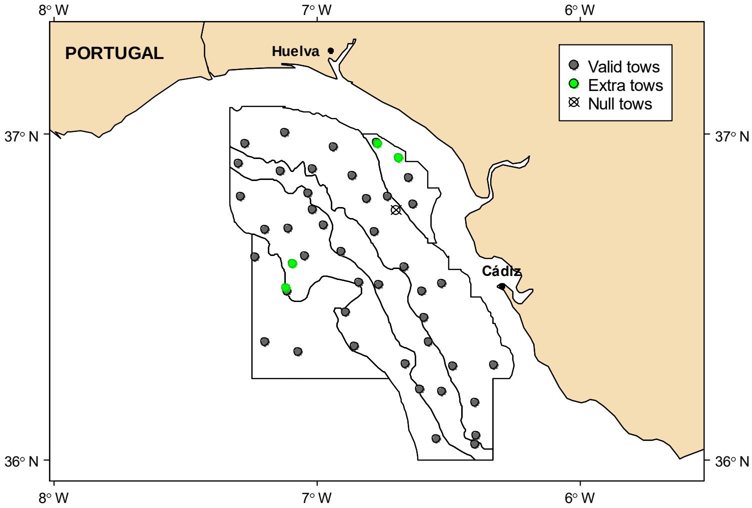


Figure 5.3.2.14.1. Map of trawl stations performed during Gulf of Cadiz Autumn (Q4) survey.

Table 5.3.2.14.3. Variance in catch rates and estimates of sampling precision

Species	Strata	Valid tows	M catch Kg/hour	RSE	M catch no./hour	RSE	Comments
Merluccius merluccius	All	44	5.9	0.14	111.5	4.1	
Micromesistius poutassou	All	44	30.6	1.08	378.0	14.7	
Nephrops norvegicus	All	44	0.8	0.00	24.5	1.5	
Parapenaeus longirostris	All	44	0.3	0.01	49.5	3.7	
Loligo vulgaris	All	44	2.0	0.02	16.3	0.7	
Octopus vulgaris	All	44	4.1	0.04	6.4	0.6	
Sepia officinalis	All	44	0.8	0.10	2.2	0.1	

Table 5.3.2.14.4. Biomass and number estimates and time-series comparisons in SP-GCGFS Q4

			Biomass index			Number index		
Species	Strata	Valid tows	y_i kg/0.5h	y_i/y_{i-1} %	$y_{(i,i-1)}/y_{(i-2,i-3,i-4)}$ %	y_i n/0.5h	y_i/y_{i-1} %	$y_{(i,i-1)}/y_{(i-2,i-3,i-4)}$ %
Merluccius merluccius	All	44	9.33	-25.5	131.3	95.9	-66.4	166.7
Micromesistius poutassou	All	44	6.19	104.3	18.1	174.5	677.2	-27.1
Nephrops norvegicus	All	44	0.37	-46.4	156.5	14.7	-45.3	149.6
Parapenaeus longirostris	All	44	0.59	-16.9	-73.9	68.7	-49.7	-81.1
Octopus vulgaris	All	44	1.07	-77.8	-2.3	2.1	-66.3	-52.4
Loligo vulgaris	All	44	1.42	44.9	-33.1	12.6	-4.4	28.9
Sepia officinalis	All	44	0.78	-71.2	16.9	1.2	-80.8	-13.9

yi, year estimate (2016); yi-1, previous year estimate (2015); y(i,i-1), Average of last two year estimates (2016 and 2015); y(i-2,i-3,i-4), Average of the previous three year estimates (2014, 2013 and 2012).

5.3.2.15 Portugal: PT-PGFS-Q4 (Portuguese Autumn Groundfish Survey Q4)

Nation:	**Portugal**	**Vessel:**	**RV Noruega**
Survey:	Autumn 2016	Dates:	19 October 2016 – 18 November 2016

Cruise	Autumn Groundfish survey aims to estimate the abundance and distribution of recruits of hake and horse mackerel, indices of abundance and biomass of the most important commercial species, biological parameters, e.g. maturity, ages, sex-ratio, weight, food habits and biodiversity indicators. The primary species are hake, horse mackerel, blue whiting, mackerel and Spanish mackerel. Other data are also collected for several other demersal fish species and invertebrates.
Area	Portuguese continental waters (Div. 9a), from 20 to 500 m depth.
Survey design	96 fishing stations, 66 at fixed (grid) positions and 30 at random. Tow duration is 30 min, with a trawl speed of 3.5 knots, during day light. Temperature is recorded with a CTD (Conductivity, Temperature, Depth) equipment at the end of each haul
Gear details	NCT (Norwegian Campbell Trawl) gear with rollers in the groundrope. The mean horizontal opening between the wings is 14.7 m and the mean vertical opening is 4.4 m. Codend mesh size is 20 mm.
Notes from survey (e.g. problems, additional work etc.)	2 stations could not be performed due to static gears present in the area. 6 stations could not be performed due to constraints with mechanical failure. 70 CTDs Stations were recorded. SCANMAR sensors were used in some stations, due to loss of mini transponder.
Number of fish species recorded and notes on any rare species or unusual catches:	Overall, 105 species of fish, 15 of cephalopods and 26 of crustaceans were recorded during the survey. 40 species of other groups were recorded, e.g. Echinodermata, Cnidarians, Bivalves, Gastropods, Polychaeta, Ascidians and Nudibranchia.

Table 5.3.2.15.1 presents a summary of the stations performed per ICES division and Figure 5.3.2.15.1 shows the area surveyed with the hauls, CTD, dredge and stations carried out.

Table 5.3.2.14.2 presents the number samples collected during the survey of the main DCF related species.

Table 5.3.2.14.3 contains the biomass and number abundance indices from 2016 quarter survey and compares with results from the last 4 years.

Table 5.3.2.15.1. Stations fished in PTGFS 2016.

ICES Divisions	Strata	Gear	Tows Planned	Valid	Invalid	% stations fished	Comments
9a	ALL	NCT	96	85	3	92	Also available by depth and geographical strata

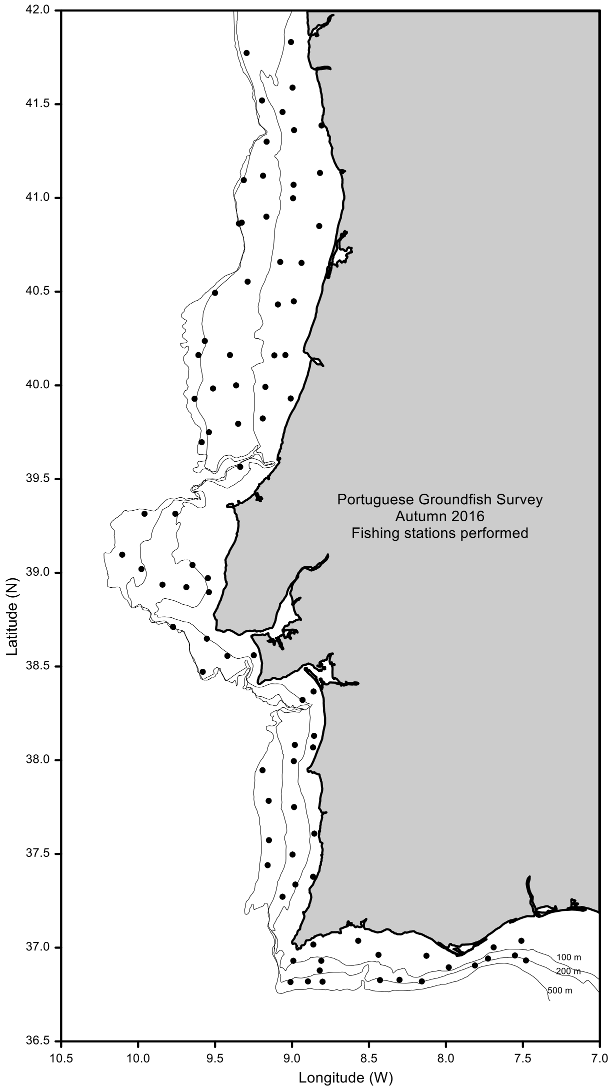


Figure 5.3.2.15.1. Map of sampling grid and station positions.

Table 5.3.2.15.2. Number of biological samples (maturity and age material)

Species	Samples*	Maturity	Otoliths	Species	Samples*	Maturity	Otoliths
Boops boops	10	268	243	*Pagellus acarne*	15	264	231
Chelidonichthys cuculus	16	59	59	*Pagellus erythrinus*	7	180	153
Helicolenus dactylopterus	9	238	198	*Sardina pilchardus*	14	251	162
Illex coindetii	11	27		*Scomber colias*	20	260	223
Lepidorhombus boscii	9	59	54	*Scomber scombrus*	21	213	188
L. whiffiagonis	4	8	7	*S. cantharus*	21	315	282
Loligo vulgaris	31	142		*Trachurus trachurus*	31	921	454
Merluccius merluccius	50	1945	887	*Trisopterus luscus*	9	103	101
Micromesistius poutassou	20	816	308	*Zeus faber*	41	144	134
Mullus surmuletus	17	48	40				

*** Number of hauls sampled**

Table 5.3.2.15.3. Biomass and number estimates and comparison over the last years

Biomass and number estimates

			Biomass index			Number index		
Species	**Strata**	**Valid tows**	y_i kg/0.5h	y_i/y_{i-1} %	$y_{(i,i-1)}/y_{(i-2,i-3,i-4)}$ %	y_i n/0.5h	y_i/y_{i-1} %	$y_{(i,i-1)}/y_{(i-2,i-3,i-4)}$ %
Merluccius merluccius	9a	85	17.9	-51.8	15.8	174.1	-71.1	21.7
Trachurus trachurus	9a	85	15.9	-63.7	-31.4	237.9	-83.9	19.6
Trachurus picturatus	9a	85	6.4	-88.8	174.4	77.6	-95.2	210.0
M. poutassou	9a	85	54.1	-46.3	163.1	1042.1	-58.9	160.8
Scomber scombrus	9a	85	0.8	-28.3	-68.4	135.2	174.5	-52.6
Scomber colias	9a	85	7.0	84.7	-54.3	19.5	87.5	-61.3
Lepidorhombus boscii	9a	85	0.1	1.1	26.0	2.2	5.1	40.4
L. whiffiagonis	9a	85	0.0	27.1	397.0	0.1	-0.3	61.1
Lophius budegassa	9a	85	0.3		630.7	0.0		21.0
Lophius piscatorius	9a	85	0.0			0.0		
Nephrops norvegicus	9a	85	0.2	310.7	104.2	2.8	221.3	83.4

y_i, year estimate (2015); y_{i-1}, previous year estimate (2014); $y_{(i,i-1)}$, Average of last two year estimates (2015 and 2014); $y_{(i-2,i-3,i-4)}$, Average of the previous three year estimates (2013, 2011 and 2010, for no survey in 2012).

5.3.3 Results

5.3.3.1 Biological samples

Table 5.3.3.1.1 gives an overview of the number of biological samples as reported per country/survey within the Northeastern Atlantic area (in Section 0).

Table 5.3.3.1.1. Number of individuals sampled for maturity and/or age in 2016 surveys on NEatlIBTS

	UK-Sco			UK-NIGFS		Irl	Fr		Sp				Pt
	Q1	**Q3**	**Q4**	**Q1**	**Q4**	**IGFS**	**CGFS**	**EVHOE**	**Porc**	**NS**	**GC Q1**	**GC Q4**	**PGFS**
Target species													
Clupea harengus	564		476			317							
Gadus morhua	509	6	273**	420	45	311	11	73					
Lepidorhombus boscii									300	510			54
L. whiffiagonis				2		1438		385	784	447			7
Lophius budegassa						403		102[2]	36[2]	57[2]			
Lophius piscatorius						366		79[2]	177[2]	40[2]			
M. aeglefinus	1342	1260	1383**	1035	800	2766		506					
Merlangius merlangus	963	56	858**	1265	1190	1972	227	490					
Merluccius merluccius	167*		325**	26	4	698		965	1072	892	315/1199	229/937	887
*Nephrops norvegicus**									431*		529*	360*	
Pollachius virens	217	4	98**			191		1					
Scomber scombrus	254	13	393			570				361			188
Sprattus sprattus	372		290**										
Trachurus trachurus	90		271			1344				642			454
Trisopterus	438		524**										

esmarkii													
Additional species													
Chelidonichthys cuculus	69*			126	38	36	165	214					59
Chelidonichthys lucerna								11					
Conger conger				7	19	103			23	170			
Dicentrarchus labrax						25	103	170					
*Dipturus. batis cf. flossada**	24	68*	2*			48*							
*D. batis cf.intermedia**	77		52*			21							
*Dipturus nidarosiensis**		3*											
Engraulis encrasicolus								113		140			
*Galeorhinus galeus**			5*										
G. cynoglossus						371		11					
Helicolenus dactylopterus									180	169			198
*Illex coindeti**											201	44	27
*Leucoraja fullonica**		8											
*Leucoraja naevus**	77		83	45	11	201							
*Loligo forbesi**												183	
*Loligo vulgaris**												51	142
Micromesistius poutassou						617				1007			308

Microstomus kitt				124	19	845		155					
Molva dypterygia							1						
Molva molva			70			132		7	52				
Mullus surmuletus	1						104	48		77			40
*Mustelus spp.**	22		12										
*Octopus vulgaris**											153	255	
*Parapeeus longirostris**											1564	640	
Phycis blennoides								116	234	153			
Pleuronectes platessa	140			312	216	1336	336	160					
Pollachius pollachius	23			16	2	24		4					
*Raja brachyura**	15		17	19	13	46							
*Raja clavata**	122	20*	131	169	93	326							
*Raja montagui**	184		173	133	85	1034							
Sardi pilchardus								77		172			162
Scomber colias										66			223
Scophthalmus maximus	4		1*		6	58	1	8					
Scophthalmus rhombus	4		2*	48	16	57	1	3					
*Sepia officilis**											239	109	
Solea solea						203	51	85					
*Squalus acanthias**	226			11	35	544							

Todaropsis eblanae						309	37	
Trisopterus luscus					219			101
Zeus faber	40**	4	19	341	64			134

*** Samples collected for maturity only**

**** No maturity data collected**

(2) Otoliths + Illicia

5.3.4 Additional activities

Table 5.3.4.1 gives an overview of the Additional activities performed in 2016 as reported per country/survey within the Northeastern Atlantic area (in Section 0).

Table 5.3.4.1 Additional activities performed in 2016 as reported per country/survey within the NEatlIBTS.

	UK-Sco			UK-NIGFS		Irl	Fr		Sp				Pt
	Q1	Q3	Q4	Q1	Q4	IGFS	CGFS	EVHOE	Porc	NS	GC Q1	GC Q4	PGFS
CTD (Temp+salinity)	1	1	1	1	1	1	1	1	1	1	1	1	1
Seafloor Litter	1	1	1	1	1	1	1	1	1	1	1	1	1
Water sampler (Nutrients)							1	X					
Egg samples (Small fine-meshed ringnet, CUFES)							1						
Non-commercial benthic invertebrates				1	1	1	1	1	1	1	1	1	1
Observers: mammals, birds							1	1	X	1			
Additional biological data on fish	X	X	X	X	X		X	X	X	X		X	X
Fish stomach contents				X	X		X	X		1	X	X	X
Benthic samples (boxcore, video, dredge)		1					X	X	X	X			
Zoo and phytoplankton							1	1					
Jellyfish				X	X	X	1	X	X				1
Hydrological transect						1				X	X	X	
Acoustic for fish species	X		X					X	X				X
Multibeam: seabed mapping								1	X				X

1: Every year, 2: biannual, 3 every three years, X: occasional

5.3.5 Participation planned for 2017

Table 5.3.3.1.1 below, presents the expected dates for the Northeastern Atlantic IBTSurveys.

Table 5.3.3.1.1. Dates foreseen for 2017/2018 NeAtl Surveys

Survey	Code	Starting	Ending	Expected hauls	Planned Intercal.
UK-Scotland West (spring)	UK-SCOWCQ1	15-02-18	07/03/18	60	-
UK-Scotland Rockall	UK-SCROCQ3	02-09-17	13/09/17	40	-
UK-Scotland West (aut.)	UK - SCOWCQ4	13/11/17	03/12/17	60	-
UK-North Ireland (aut.)	UK-NIGFS Q4	02-10-17	23-10-17	60	-
UK-North Ireland (spring)	UK-NIGFS Q1	12-02-18	04-03-18	60	-
Ireland - Groundfish Survey 6a	IE-IGFS	03-10-17	14-10-17	45	-
Ireland - Groundfish Survey 7bgj	IE-IGFS	05-11-17	09-12-17	125	-
France – EVHOE	FR-EVHOE	25-10-17	11-12-17	155	-
France - Eastern Channel	FR-CGFS	06-10-17	23-10-17	74	-
Spain – Porcupine	SP-PORC	22-08-17	24-09-17	80	-
Spain - North Coast	SP-NSGFS	17-09-17	23-10-17	116	-
Spain - Gulf of Cádiz (Spring)	SP-GCGFS Q1	21-02-18	06-03-18	41	-
Spain - Gulf of Cádiz (Aut.)	SP-GCGFS Q4	30-11-17	12-12-17	41	-
Portugal (Aut.)	PT-PGFS	03-09-17	03-11-17	96	-

Intercal: intercalibration between vessels

5.3.6 Other business

5.3.6.1 Changes in tow duration UK-NIGFSQ4 and SP-PorcGFS

As proposed in 2016 IBTSWG (ICES, 2016) tow duration was reduced in both surveys, to 18 minutes in the case of UK-NIGFS, 20 minutes in the case of Porcupine survey. In both cases catches were reduced and work on board was easier to accomplish while no immediate effect on representability of the samples was observed, after 2017 surveys, the possible effects on length distributions and or taxonomical diversity will be explored.

5.3.6.2 Coordination of IAMS by IBTSWG

As agreed in IBTSWG 2016 meeting (ICES, 2016), results and information from the Irish Anglerfish and Megrim Survey (IE-IAMS) has been included in this report with a summary similar to the *official* NeAtlIBTS surveys (see section 5.3.2.6)

References

ICES, 2010. Manual for the International Bottom Trawl Surveys in the Western and Southern Areas Revision III Agreed during the meeting of the International Bottom Trawl Survey Working Group 22–26 March 2010, Lisbon. Addendum 2: ICES CM 2010/SSGESST:06. 58 pp.

ICES 2016. Report of the International Bottom Trawl Survey Working Group (IBTSWG). ICES CM 2016/SSGIEOM:24. 292 pp.

Reid, D.G., Allen, V.J., Bova, D.J., Jones, E.G., Kynoch, R.J., Peach, K.J., Fernandes, P.G., Turrell, W.R., 2007. Anglerfish catchability for swept-area abundance estimates in a new survey trawl. ICES Journal of Marine Science 64, 1503–1511. doi:10.1093/icesjms/fsm106

5.4 Combined North Sea and Northeastern Atlantic survey results

Catches from latest bottom trawl surveys (IBTS) in the North Sea and the Northeastern Atlantic areas covered by the IBTS (Table 5.4.1 and Figure 5.4.1) are mapped and presented in Annex 5. As in last year report, the plots presenting a summary of the length distributions per ICES divisions and survey, had been updated including their evolution between 2011 and 2016 (see an example in Figure 5.4.2), this year surveys and ICES divisions are ordered north to south.

The distribution maps show results with the usual patterns from other years. Most remarkable results are the lack of cod recruits (<23 cm) out of the North Sea. While on the other hand, hake recruits (>20 cm) are relatively abundant on the French "Grande Vasiere", but also on the Celtic Sea and even on the Scottish West Coast survey. Recruitment of both species of anglers (*L. piscatorius* and *L. budegassa*) appears to be relatively important in the Celtic Sea while it is scarce on the Iberian. Other species and stocks do not present so remarkable differences.

Table 5.4.1. Species for which distribution maps have been produced, with length split for prerecruit (0-group) and post-recruit (1+ group) where appropriate. The maps cover all the area encompassed by surveys coordinated within the IBTSWG (North Sea and Northeastern Atlantic Areas)

Scientific name	Common name	Code	Figs No.	Length Split (< cm)
Clupea harengus	Herring	HER	8-10	17.5
Gadus morhua	Atlantic Cod	COD	2-4	23
Galeorhinus galeus	Tope Shark	GAG	48	
Galeus melastomus	Blackmouthed dogfish	DBM	56	
Lepidorhombus whiffiagonis	Megrim	MEG	20-22	21
Leucoraja naevus	Cuckoo Ray	CUR	44-45	
Lophius budegassa	Black-bellied Anglerfish	WAF	29-31	20
Lophius piscatorius	Anglerfish (Monk)	MON	26-28	20
Merlangus merlangius	Whiting	WHG	35-37	20
Melanogrammus aeglefinus	Haddock	HAD	5-7	20
Merluccius merluccius	European hake	HKE	11-13	20
Micromesistius poutassou	Blue whiting	WHB	38-40	19
Mustelus spp.	Smooth Hounds	SDS	49	
Nephrops norvegicus	Norway Lobster	NEP	41	
Pleuronectes platessa	European Plaice	PLE	32-34	12
Raja clavata	Thornback ray (Roker)	THR	50-51	
Raja microocellata	Painted/Small Eyed Ray	PTR	52	
Raja montagui	Spotted Ray	SDR	53	
Raja undulata	Undulate Ray	UNR	54	
Scomber scombrus	European Mackerel	MAC	17-19	24
Scyliorhinus canicula	Lesser Spotted Dogfish	LSD	42-43	
Scyliorhnus stellaris	Nurse Hound	DGN	55	
Sprattus sprattus	European sprat	SPR	57-58	
Squalus acanthias	Spurdog	DGS	46-47	
Trachurus picturatus	Blue Jack Mackerel	JAA	60	
Trachurus trachurus	Horse Mackerel (Scad)	HOM	14-16	15
Trisopterus esmarkii	Norway pout	NPO	59	

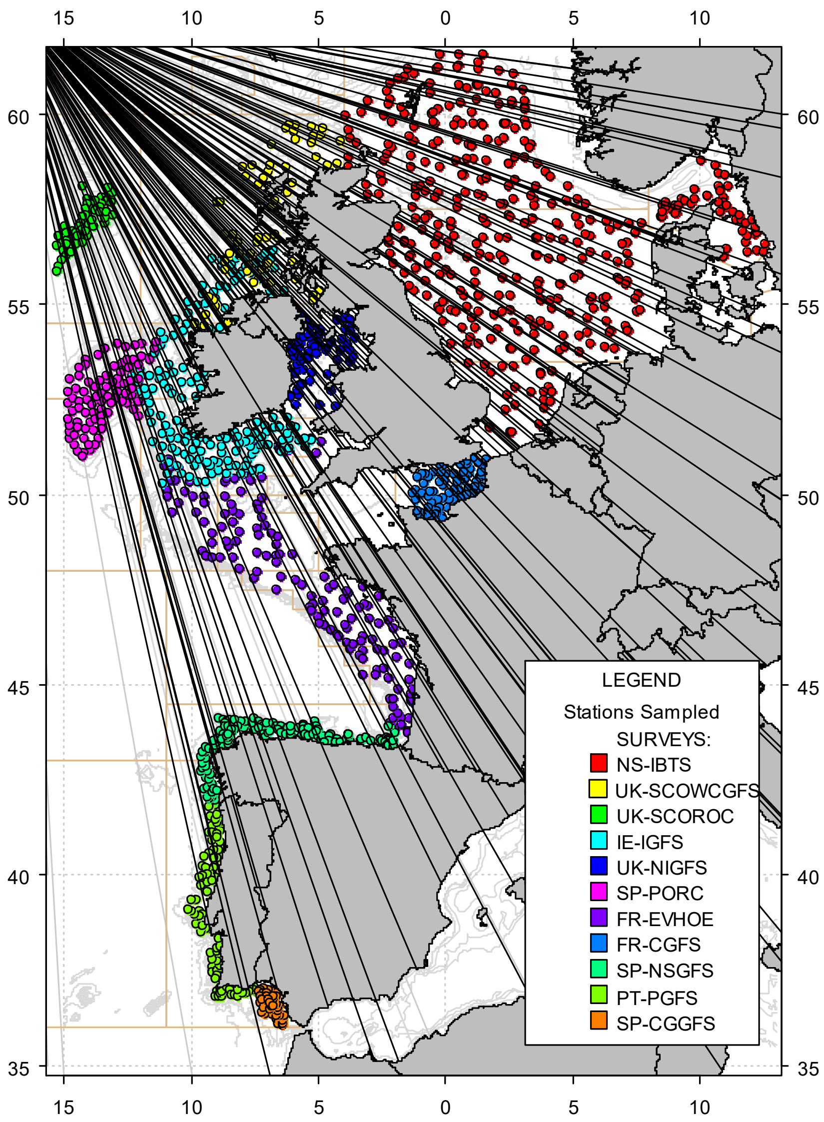


Figure 5.4.1. Station positions for the IBTS carried out in the Northeastern Atlantic and North Sea area in summer/autumn of 2016.

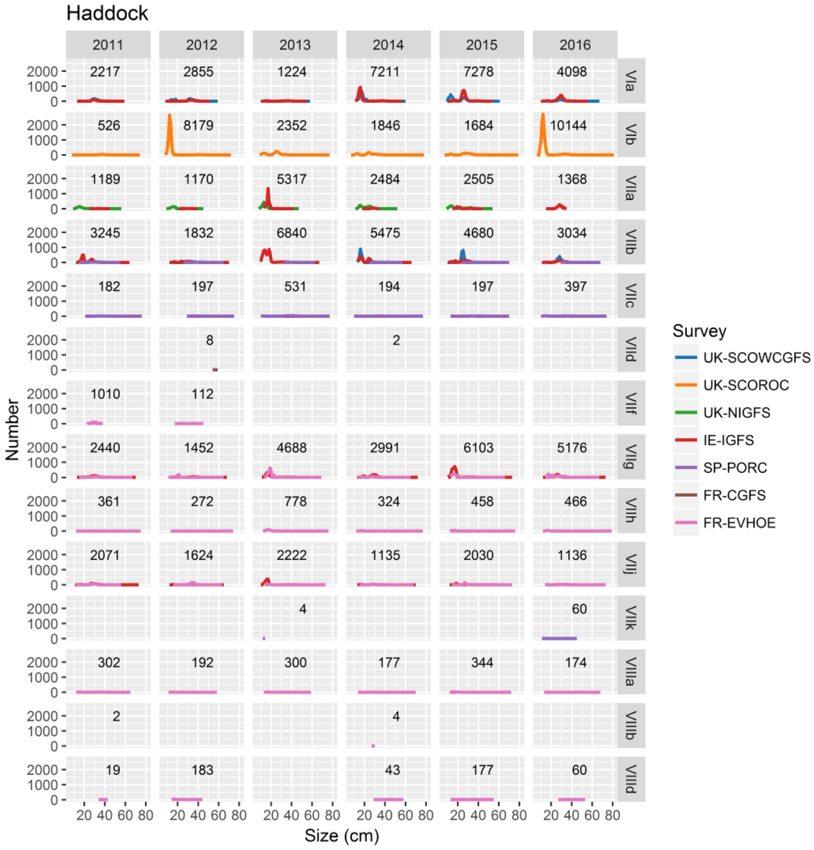


Figure 5.4.2. Example of the length distribution graphs per ICES subareas and surveys presented in Annex 6: Length distributions of haddock, *Melanogrammus aeglefinus*, per ICES Subarea in the NeAtl surveys (North Sea IBTS not included) during the last six years, each panel presents the surveys occur-ring. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the lines do not reflect proportional abundance in all the areas but within each survey. The number in each panel corresponds to the sum of the mean stratified number of individuals caught in one-hour haul in the surveys carried out in that subdivision.

Combined distribution maps for 27 fish and 1 crustacean species and corresponding length frequencies for surveys conducted in the 3rd or 4th quarter 2016 (1 NS-IBTS, 10 NeAtl IBTS) are shown in Annex 5.

6 Survey Manuals (ToR b)

6.1 Manual for the North Sea IBTS

The revision of the NS-IBTS manual is almost completed. The last outstanding issues are updates of several maps and provision of country specific trawl geometry plots such as available for Denmark (WD1).

6.2 Manual for the Midwater Ringnet sampling during NS-IBTS Q1

A 3rd revision of the manual is almost completed and it is expected that the updated manual is available prior to the 1st quarter NS-IBTS in 2018.

6.3 Manual for the Northeast Atlantic IBTS

6.3.1 Planning to submit the update of the manual

The last revision of the NeAtlIBTS manual dates back to 2010, the Revision III of the Manual for the International Bottom Trawl Surveys in the Western and Southern Areas (ICES, 2010). An attempt to update the manual was done in 2014 and the revised version was refereed as a scientific project publication highlighting some problems in the design and procedures of the protocols and uses that actually occur in the surveys. This revision was useful to mark these problems and identify issues that had to be solved. Nevertheless, the idea of the manuals, both the North Sea IBTS, and the NeAtlIBTS, is to document and to put out the procedures, protocols and materials including vessels and gears adopted for each survey within the NeAtlIBTS Surveys. With the manuals, survey protocols and procedures are documented and available to the scientific community and the users of the information and the data available in DATRAS. At the same time the manuals review products emerging from the surveys and possible uses.

With this in mind, after IBTSWG 2017 meeting it was decided to review and complete the last draft of the manual discussed during the last year and submit this draft in July, to be adopted and published by the ICES within the SISP series.

6.3.2 Additions and changes proposed to be adopted in version

6.3.2.1 Gear behaviour plots

As discussed during last year, and finally agreed this year, graphs of gear geometry for each individual survey, containing models of the main gear parameters will be included in the new revision of the manual. Examples of these graphs produced with an R package that uses the DATRAS HH format are included in Annex 6 of this report:

- Door spread and wing spread vs. depth and between them;
- Vertical openingvs.depth.

Other graphs presenting:

- Warp ~ depth;wait |
- Estimated distance per haul based on tow duration/ towing speed.

The R package will be included in and/or will be taken from the models and results obtained within the swept-area section in the last IBTSWG reports (ICES, 2016).

These models and equations will be also useful to estimate missing values of these parameters within the time-series to help to produce swept-area per trawl and abundance per swept-area as a DATRAS product.

6.3.2.2 New tables

A Table including additional activities carried out in each survey have been reviewed and classified as annual, biennial, triennial or occasional when they are not done in a regular basis.

6.3.2.3 Annex with surveys proposed to be coordinated by NeAtlIBTS

Last year Irish Marine Institute presented a new monkfish and megrim trawl survey (IE-IAMS see section see section 5.3.2.6), as a result the information to include a new section in the manual was required to the Marine Institute, this information will be included as an annex to the NeAtlIBTS Manual until the survey is officially taken under the IBTS umbrella.

References

ICES, 2010. Manual for the International Bottom Trawl Surveys in the Western and Southern Areas Revision III Agreed during the meeting of the International Bottom Trawl Survey Working Group 22–26 March 2010, Lisbon. Addendum 2: ICES CM 2010/SSGESST:06. 58 pp.

ICES 2016. Report of the International Bottom Trawl Survey Working Group (IBTSWG). ICES CM 2016/SSGIEOM:24. 292 pp.

7 DATRAS and related topics on data quality (ToR c)

7.1 DATRAS progress and development

(Vaishav Soni, Anna Osypchuk)

Recent updates and improvements of DATRAS include:

- cpue per swept-area calculation procedure, documentation on algorithms for interpolation of missing observations and corresponding products will be released not later than 1 September 2017. The products will note whether the swept-area estimates are based on door spread or wing spread.
- North Sea roundfish area 7 has been extended to include rectangle 44F6 (Figure 7.1.1) which then will now also be included in the corresponding DATRAS products, i.e. cpue by age and haul.
- An archiving procedure of submissions and version checking has been implemented (Figure 7.1.2).
- Marine litter product for trawl surveys combining HH records and Litter data have become available.
- Development of the Rockall and SW-IBTS data product has been ongoing, and the Marine Scotland Science Laboratory and the ICES Data Centre are going to arrange a 5-day workshop on knowledge exchange exercises in June 2017. Calculated data shall soon be published on the DATRAS download page.

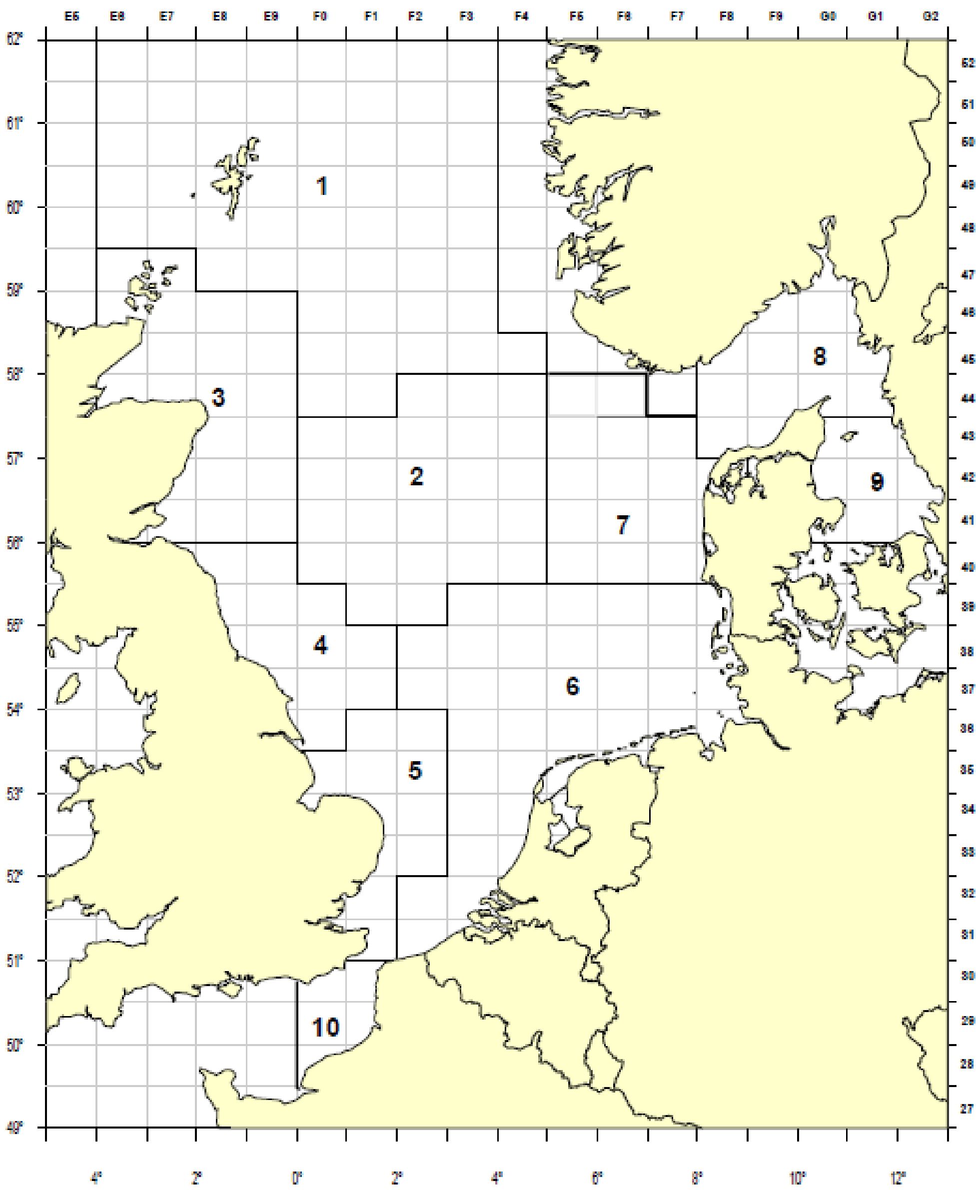


Figure 7.1.1 North Sea roundfish areas revised.

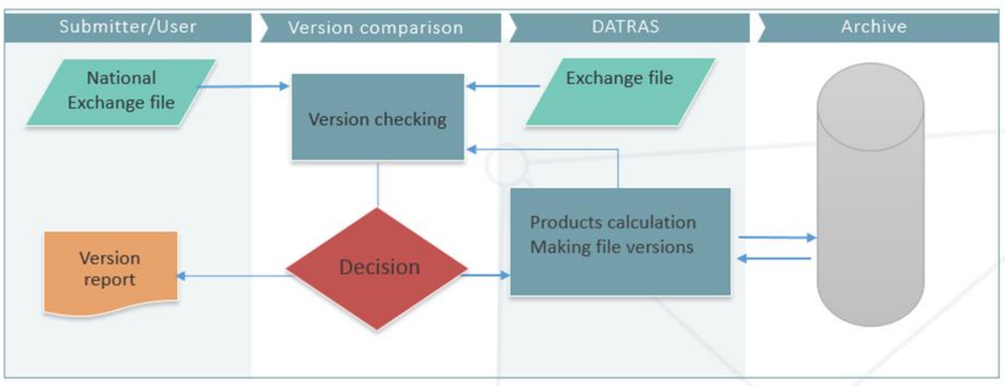


Figure 7.1.2 Setup of DATRAS version controlling utility.

Age length key (ALK) substitution management for the NS-IBTS shall be automatized in future and IBTSWG suggests that the respective stock coordinators should be asked for advice on this issue. The current procedure is as follows (Henrik Sparholt):

1) A table with no. of otoliths by species and Roundfish (RF) area is inspected to see which cells (i.e. species * RF) are missing or has below 25 otoliths. If zero otoliths → there will always be a substitution with data from other RFs, following the procedure given below.

2) The age data table mentioned above is compared with a table with no./h of fish caught, by species and RF. If the number of otolith for a given cell is low, but the number caught is high special care has to be taken to check whether the given otolith data are sufficiently good, i.e. spread out over length and ages and extensive enough. If not a substitution is made.

3) All ALKs are inspected manually and if there are only a few age groups represented or the length range is limited a substitution is made.

4) A substitution is actually a supplementation. Age data from neighbouring RF's are used. Often only one or a few with the largest set of age data are used.

5) For saithe all age data are merged and applied to all RFs.

6) For mackerel often the situation is the same as for saithe.

7) The manual inspection of data is also a quality control procedure where peculiarities are spotted. Often individual outliers or bulks of data not consistent with the rest of data are spotted. These data are then looked into and send back to the country of origin for checking. Manual inspection of the alk data is often a way of identifying missing data submission from a country, appearing as some RFs in the otolith table without age data.

The substitution can probably be simplified by deciding that a substitution for a given RF is made by age data from all neighbouring RFs. This will mean that:

RF 1	will be supplemented by data from	RF 2, 3
RF2	“	RF 1, 3, 4, 6, 7
RF3	“	RF 1, 2, 4
RF4	“	RF 2, 3, 5, 6
RF5	“	RF 4, 6
RF6	“	RF 2, 4, 5, 7
RF7	“	RF 2, 6
RF8	“	RF 7, 9
RF9	“	RF 8.

There are probably also some possibilities for using the age data table and the length data tables mentioned above to come up with algorithms like “if No/h is larger than X% of total and number of age data points are less than Y then do this and that substitutions”.

Borrowing for roundfish area 10, which was added first in 2009, is mainly made from roundfish areas 5 and 6 (Figure 7.1.1.).

7.2 Data quality checks of recent NS-IBTS data

7.2.1 Species names and codes

(Rupert Wienerroither)

The issues found are listed below:

France

- wrong species name
  - *Myoxocephalus scorpioides* should be *Myoxocephalus scorpius*
- Reported twice (same N, station, length range):
  - "Microchirus" and *Microchirus variegatus*
  - "Callionymus" and *Callionymus lyra*
- several (non-obligatory) invertebrate species reported

Denmark

- wrong species name
  - *Lycodes vahlii* should be *Lycodes gracilis*
- wrong code for *Raja brachyura*

Scotland

- some (non-obligatory) invertebrates reported
  - Pandalus
  - Crangon
  - *Necora puber*

Germany

- *Malacocephalus laevis* (Q3) record needs to be checked

Sweden

- wrong species name (Q3 not Q1)
  - *Lycodes vahlii* should be *Lycodes gracilis*
- lengths
  - Ammodytes 30 cm: change to Ammodytidae

England

- several (non-obligatory) invertebrates reported
- wrong species name/taxa level
  - "Argentinidae" can be reported as "Argentina"
  - *Lycodes vahli* should be *Lycodes gracilis*
  - *Illex illecebrosus* should be *Illex coindetii*
  - "Echiichthys" can be reported as *Echiichthys vipera*
  - "Eutrigla" can be reported as *Eutrigla gurnardus*

Species names general

- Gasterosteus aculeatus (DEN, FRA, NED) vs. Gasterosteus aculeatus aculeatus (GER)
- Gadiculus thori (SCO) vs. Gadiculus argenteus (rest)

- Microchirus (Microchirus) variegatus (SCO) vs. Microchirus variegatus (rest)
- *Loligo forbesi* (SWE; SCO, GER, ENG, NED) should be *Loligo forbesii*

7.2.2 Catch weight by category

Data checks on the units for reporting catch weight by category have yet not been completed by all countries and for all years back in time.

7.3 Marine Litter

7.3.1 GOV

(Ralf van Hal)

In WD9 a visualization is given of the litter catches by subcategory (C-TS-rev) in the DATRAS database (2012–2016, OSPAR assessment output). The first figures are based only on data in the Dutch EEZ as the analysis started with a Dutch request for their national MSFD. The later figures are showing all the North Sea IBTS data in the DATRAS database. Five countries have fished on the Dutch EEZ (NED, FRA, DEN, GFR, and ENG) of which GFR and ENG only did a small number of hauls. The NED, FRA and DEN did a very similar amount of hauls in the Dutch EEZ. The number of items by subcategory however clearly differs. FRA never had more than 1 item per subcategory per haul, while DEN only had a small number of hauls in which more than 1 item per subcategory was caught. The NED data shows a large number of hauls with multiple items per subcategory per haul. This raised the question if countries are actually doing the same thing on board. Looking at all the North Sea data, the picture of inconsistency between countries is shown as well, between more than only these three countries.

Following discussion in the group it became clear that there are indeed inconsistencies between the methods on board. The overall conclusion of the discussion was that stricter guidelines are required, preferably including a field guide showing how to categorize specific litter items.

Another conclusion of the discussion was that all the analysis done within the OSPAR context using number of items per km² is flawed owing to the differences between the countries. This analysis can be used an indication of the which methods can be used in future when all countries are doing the same, but these analyses cannot be used as current results or assessment outputs.

When these conclusions were discussed with the OSPAR marine litter contact persons, he promised a stricter guideline would be provided shortly after our IBTSWG meeting. He also explained his intentions to start an ICES WG (WGML: WG marine litter) and asked for support for this plan. IBTSWG is willing to support this idea of a WGML that would improve on the guidelines, create a field guide, and checks the data provided to the marine litter database in DATRAS.

7.3.2 MIK

(Bastian Huwer)

Marine litter has been sorted form the Danish MIK samples collected during the 1Q NS-IBTS since 2014. This has been a national DTU Aqua initiative. The results were presented at WGEGGS2 and in the 1Q NS-IBTS 2017 all other countries collected marine litter from the MIK as well and/or sent samples to DTU Aqua for analyses (Table 7.3.2.1). For this purpose, an internal manual had been provided. The results obtained so far identified the Danish and Swedish west coast as sink area for marine litter (Figure 7.3.2.1) and confirmed results from beach litter monitoring. However, the inclusion of the collection and analysis of marine litter from MIK samples in the routine program would require additional funding.

Table 7.3.2.1. Marine litter in MIK samples, 1Q NS-IBTS

Nation	n stations	n stations with litter	% stations with litter	n litter items	avg n litter items/station
DK	86	56	65	229	2.7
DE	146	10	7	14	0.1
NL	76	22	29	35	0.5
SC	96	7	7	16	0.2
SE	66	23	35	84	1.3
NO	84	no data available yet			
FR	101	no data available yet			
TOTAL	**470**	**118**	**25**	**378**	**0.8**

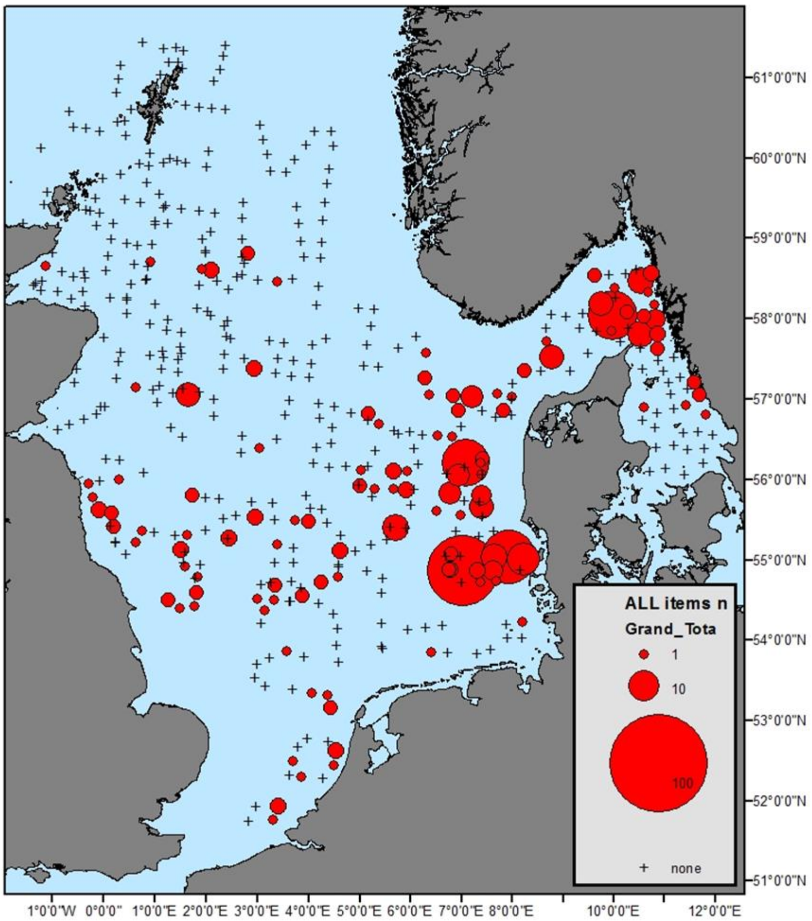


Figure 7.3.2.1. Distribution of marine litter 1Q NS-IBTS 2017 (all subcategories (total number per station), without stations taken by Norway and France for which the data are not yet available).

7.4 Cephalopod identification guides

(Anne Sell, Chris Lynam, Rupert Wienerroither)

Several IBTS participants have encountered problems with an easy and correct identification of cephalopod species in the past. IBTSWG members have now exchanged national field guides (Germany, England and Norway) and the information in these practical identification guides may be collated.

7.5 Status of WKSEATEC

(Dave Stokes)

WKSEATEC (Workshop on recent developments for improving data collection and data quality at sea) will be held at ICES HQ, 11–15 September 2017 (tentative dates; Chair/contact: Dave Stokes). So far, about 12 institutes have expressed their interest for participation.

8 Development of a swept-area based index (ToR d)

Data checking and provision of interpolation routines for missing observations required for swept-area based cpue products is now almost completed. Using the new DATRAS products for the period 2004 to present, analysis on e.g. the effect of variable sweeps lengths and on a comparison of swept-area based abundance indices with haul time-based indices shall be presented at the next IBTSWG meeting.

9 Sweep length and other gear issues (ToR e)

9.1 Effects of a tickler chain in the GOV 36/49 in the Western English Channel

(Morgane Travers-Trolet and Fabien Morandeau)

For setting the survey protocol for the Western English Channel (new bottom trawl survey to be initiated in 2018), some gear trials were realized right after the CGFS survey (October 2016) in order to test the effects of a tickler chain in front of the groundgear of GOV 36/49. This test was based on professional fishers' habits of in the area (one or multiple tickler chains are used depending on the sediment type) and aimed at quantifying the effects of using a tickler chain on the catches of benthic fish in general and anglerfish in particular. During the 5 available days at sea, 8 paired tows were completed with the GOV 36/49 in the western English Channel, with each station sampled with and without a tickler chain (a 15 m chain with rubber disks in the 5 m of the middle). Underwater video observations of the gear behaviour were also captured with EROC during 4 additional tows. Each of the 16 hauls has been analysed on board, by sorting and weighting the different species caught. The number of individuals and biomass of benthic species were compared between hauls with and without tickler chain.

Catches with or without a tickler chain do not vary much for benthic species, except for *Arnoglossus imperialis* where the number of fish caught with tickler chain is 6 to 7 times higher and for *Microstomus kitt* where the number of fish caught with tickler is surprisingly half of what is caught without tickler chain. Concerning anglerfish, no significant difference was observed, with the number of individuals per tows varying between 0 and 2 independently of the presence or not of the tickler chain. As a synthesis, it appears that the overall number of individuals caught was low – as was the number of paired tows - and no clear pattern was corroborated across all species considered.

Furthermore, on the last day of the trials, stations on coarser sediments were sampled and the tickler chain broke at some point during the tow, while no damage was recorded on the gear without tickler chain when deployed at the same station. When the tickler chain breaks, the same catchability is not maintained over the entire tow, and on a standard IBTS protocol this station would be classified as invalid. Thus, based on the lack of evidence of increased catchability across all benthic species when a tickler chain is used, and based on the higher risk of having invalid stations (by breaking the tickler chain), it was concluded that a tickler chain should not be added to the GOV 36/49 for sampling the Western English Channel during the new bottom trawl survey to come.

9.2 New survey trawl

(Robert Kynoch, Dave Stokes, Finlay Burns)

Discussions around poor IBTS survey coverage in the Western Channel (7e-h) have been ongoing for a number of years. This has also been a core objective of the Ifremer proposed CAMANOC survey in that area. A resource issue in addressing that gap in coverage was the need to reallocate some hauls from the EVHOE survey to the channel area, raising concerns at WGCSE (Working Group on Celtic Seas Ecoregion) of a potential drop in data available for the survey indices, and for cod in particular. Furthermore, the other survey in that area, the Irish IGFS, had limited possibility to increase sampling due to the IBTS survey design of a 10nmi buffer zone between hauls.

In seeking a constructive solution discussion turned to maximizing efficiency of each haul where data are imperative for assessments and the possibility for additional hauls is limited. The known concerns around GOV trawl efficiency for some species, and other technical issues, have also been well documented by the SG on Survey Trawl Standardization (SGSTS). Furthermore, clear guidelines are given in the SGSTS 2005 Report on criteria for designing a simple to operate, easy to repair survey trawl with as minimal variation in geometry as is practical.

A number of IBTS members have indicated the requirement to replace vessels in the foreseeable future so this presents an obvious requirement and opportunity to review time-series and integrate some calibration work whether keeping or changing a survey trawl. The proposal from the Celtic Sea area where indices such as those for cod are almost presence/absence of one fish, is that it is important to have the option to address optimizing sampling at every haul if and when the window of opportunity arises during a vessel retirement for example.

Given the context above past members of SGSTS, UK (Scotland), presented results of gear trials undertaken to allow pelagic and demersal trawling using the same set of trawl doors, during Scottish herring acoustic surveys, on RV Scotia.

Currently, the pelagic trawl (PT160) is used on all MSS acoustic surveys to validate acoustic marks observed on the echosounder. This is currently deployed using the Süberkrüb trawl doors (4.83 m^2 x 763 kg). The justification in this case behind a new configuration has been driven by a requirement for a trawl door capable of both pelagic (surface and midwater) and demersal trawling. FRV Scotia can only deploy one door type at a time and so this was seen as a way of avoiding the lengthy process of switching between door types. Furthermore, as a new demersal trawl was required the opportunity was taken to trial a new trawl design (BT237) which had been constructed and was cognoscente of earlier recommendations. Trials were carried out on FRV Scotia during 12 days during October 2016.

The new demersal trawl was designed with a headline height of >4.5 m, wing spread >18m and of a groundgear of 25 m in length and incorporating 350 mm rock-hopper discs. The trawl door surface area (SA) required to spread this net was estimated to be 4 m^2 whereas for the PT160 it was estimated to be 3 m^2. The design and manufacturer selected for the trials were Thyborøn Type 20 VF 'Flipper' doors with a convertible surface area using small (open/close) flaps built into its rear edge that alter the surface area of the door. It also has the ability to surface fish a pelagic trawl which is not possible with the Süberkrüb door.

The gear trials on RV Scotia had 3 main objectives:

1) Establish if PT160 with the new flipper doors has the same gear performance in spread (door/wing end) and opening similar to the Süberkrüb doors.
2) To adjust warp and backstrop attachment points to understand the optimum configuration to surface fish (<10 m) with the PT160.
3) To establish if the combination of new doors and BT237 could operate effectively to demersal fish during herring acoustic surveys.

During the trials it was noted that for both trawls the flipper doors were found to be extremely stable. The optimum configuration for the PT160 trawl was 3 m^2 SA and the upper two warp towing points (Holes 4 and 5) and BT237 the SA of 4 m^2 and the lowest warp towing point (Hole 1). The mean gear parameters are presented below:

	Demersal (BT237)		Pelagic (PT160)	
Water depth (m)	78	86	Surface	Mid water
Door spread (m)	94	97	21	
Wing spread (m)	28	27		
Headline height (m)	5.1	5.4		
Speed over ground (kts)	3.7	3.7		

To further develop the new demersal trawl, engineering performance trials will be undertaken during the Scottish IBTS Q4 survey 2017. This will provide a direct comparison with the GOV trawl using the standard Morgere polyvalent trawl doors.

Actions and Recommendations

To further develop the current IBTS requirements and build on the recent experience implementing a new design and gear trials from Marine Scotland Science the following actions are proposed.

1) To further assist the design process of a new survey trawl UK (Scotland) will undertake gear geometry trials during the 2017 IBTS Q4 survey.

2) UK (Scotland), Ireland and France will organize a gear workshop to develop a new survey trawl design, utilizing the road map established by the survey trawl project (ICES 2009), and report back to IBTSWG in 2018.

References

ICES 2005. Report of the Study Group on Survey Trawl Standardization (SGSTS). ICES CM 2005/FTC:09. 127 pp.

ICES 2009. International Bottom Trawl Survey Working Group (IBTSWG). ICES CM 2009/RCM:04. 241 pp.

10 Evaluate the present scheme of collection of age and other biological data (ToR f)

10.1 Revision of otoliths collection scheme in NS-IBTS

Following last year's suggestion, the collection of otoliths in Q1 and Q3 surveys for the North Sea has been made by tow instead by roundfish area, but no further analysis on a possible reduction of the total required amount of otoliths and the most appropriate length class intervals by species has been carried out in the last year.

10.2 Maturity code reporting in NS-IBTS

As part of WKNSEA 2017, the maturity data of plaice was used to produce a maturity ogive. The analyses done for this indicated significant differences between IBTS Q1 countries determining plaice maturity in the same area, implying observer effect. Denmark and the Netherlands indicated similar results, while the maturity data of these two countries differed from Germany and France. The recommendation of the WKNSEA is to discuss these differences and when this is indeed an observer effect propose how to solve this issue.

To discuss the maturity issue an overview of the maturity information collected in last years was created and presented in the Tables 10.2.1 to 10.2.3. From this overview it is clear that France is reporting their maturity information in the old 4 scale, however discussing this it is clear that they use the 6 scale but report it with the wrong codes. A clear look at the plaice maturity data indicated that only two countries have reported 65 (skipped spawning). This might be an area effect in the case of Sweden but this is unlikely for Germany as they overlap with other countries. As this inconsistency was quickly spotted we also looked at a number of other species and see similar inconsistencies in reporting skipped spawning for herring and whiting.

The results of the WKNSEA and the quick overview below clearly indicate observer/country differences. The discussion on this issue indicated that all countries are aware of the WGBIOP guidelines and training activities and all countries believe they are correctly following this.

Table 10.2.1. Plaice maturity data of 2012-2017 by country.

	Maturity stage code / Numbers reported to DATRAS								
	1	**2**	**3**	**4**	**61**	**62**	**63**	**64**	**65**
DEN	0	0	0	0	521	447	667	514	0
FRA	530	1259	1296	1205	0	0	0	0	0
GFR	0	0	0	0	385	528	815	335	124
NED	0	0	0	0	427	150	616	495	0
NOR	0	0	0	0	182	36	40	53	0
SCO	0	0	0	0	0	0	0	0	0
SWE	0	0	0	0	1750	1199	728	126	212

Table 11.2.2. Herring maturity data of 2012–2017 by country.

	Maturity stage code / Numbers reported to DATRAS									
	1	2	3	4	6	61	62	63	64	65	66
DEN	0	0	0	0	0	2340	540	17	58	0	3
FRA	830	597	192	567	4	0	0	0	0	0	0
GFR	777	1181	20	7	0	1672	1123	17	150	210	7
NED	0	0	0	0	0	1689	270	70	472	0	5
NOR	454	79	8	796	7	445	119	6	144	656	2
SCO	530	134	3	540	0	781	219	1	523	0	0
SWE	0	0	0	0	0	5569	853	238	94	281	36

Table 11.2.3. Whiting maturity data of 2012–2017 by country.

	Maturity stage code / Numbers reported to DATRAS										
	1	2	3	4	6	61	62	63	64	65	66
DEN	0	0	0	0	0	479	989	171	64	0	0
FRA	616	3512	1081	12	1	0	0	0	0	0	0
GFR	0	0	0	0	0	1217	2830	443	2	19	3
NED	0	0	0	0	0	825	970	2152	171	0	1
NOR	0	0	0	0	0	572	1916	383	197	21	2
SCO	0	0	0	0	0	1240	3671	297	11	24	2
SWE	0	0	0	0	0	749	848	35	0	4	3

Actions and Recommendations

IBTSWG recommends redistributing the latest WGBIOP guidelines to the various labs and organising some training sessions in the near future, which needs to be attended by IBTS seagoing staff members.

11 Survey design (ToR g)

11.1 Tow duration

11.1.1 Overview

(Kai Wieland, Jennifer Devine)

IBTSWG 2015 agreed to conduct an experiment on tow duration during the NS-IBTS Q3 2015. Evidence exists for other surveys that benefitted from changing to shorter tow duration (see IBTSWG Report 2015 section 10.3. for a thorough discussion on the pros and cons). The majority of the IBTSWG considered the risk that the experiment would impair the quality of the long-term survey dataset sufficiently small to be outweighed by the expected advantages. Since this was largely supported by preliminary analyses conducted on the data of the 2015 experiment, the IBTSWG decided during its 2016 meeting to continue using a mixture of 30 and 15 min tows during the NS-IBTS Q3 2016.

In order to warrant a thorough comparison with the current methodology, a plan was formulated whereby in each ICES rectangle one of the two assigned hauls would remain a 30 min tow whereas the duration of the second would be reduced to 15 minutes. England and Sweden decided to retain tow duration for all of their hauls at 30 min and thus no combinations of two durations were planned for the Skagerrak, which is almost exclusively covered by Sweden. The 15 min tows were either placed in rectangles in which England was required to conduct a 30 min tow and in the remaining rectangles not allocated to England, a balanced share by rectangle of nominal 30 and 15 min tows were distributed among the other countries. This was achieved for most rectangles (Figure 11.1.1), but the overall proportion of 15 min tows conducted by Denmark, Germany, Norway and Scotland differed between 53% and 76% in 2015 and between 54% and 76% in 2016.

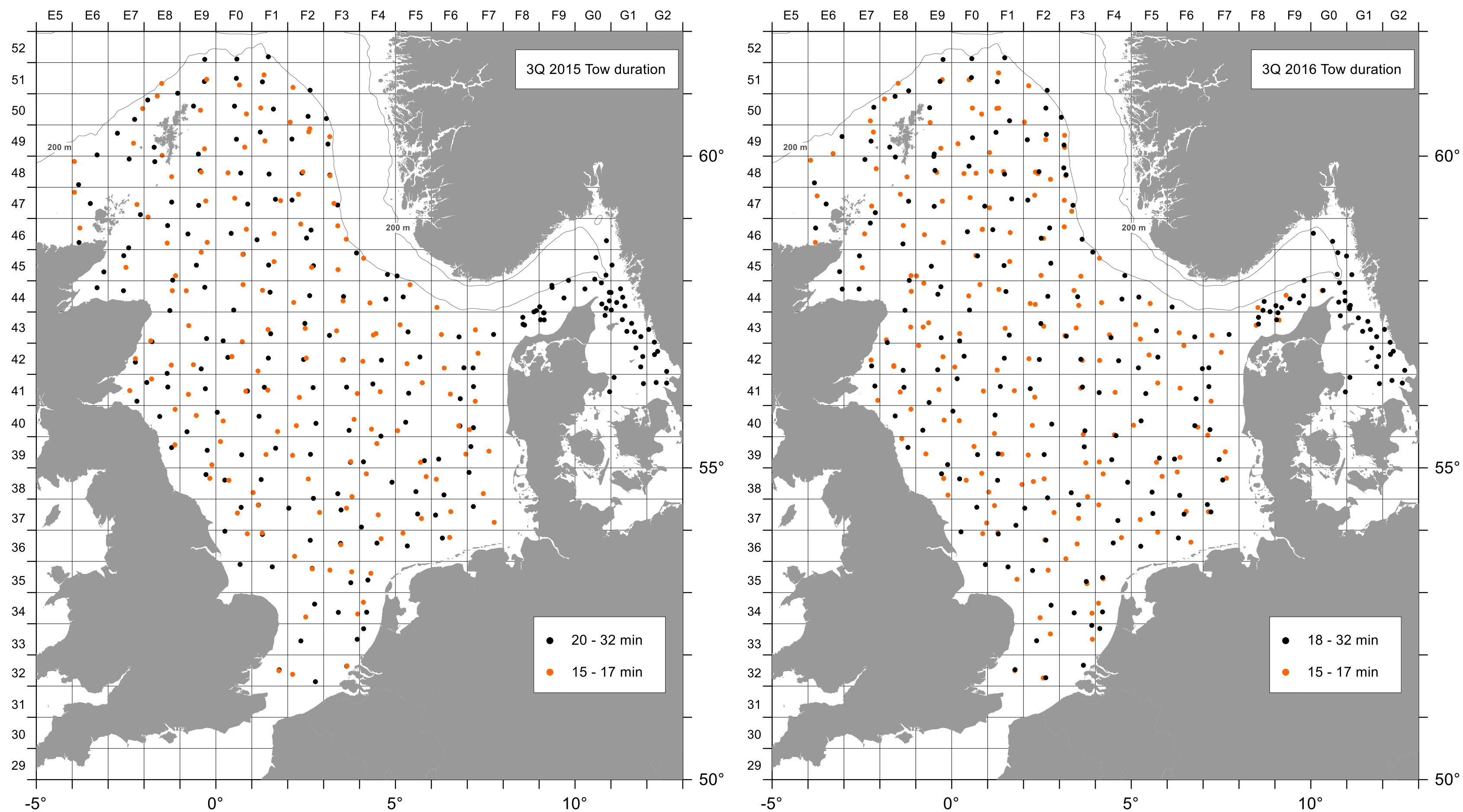


Figure 11.1.1. Achieved distribution of hauls by tow duration, NS-IBTS 3Q2015 and 3Q2016.

However, realized tow duration differed in several cases from the nominal tow duration (Figure 11.1.2) due to various reasons such as poor seabed substratum or early hauling when strong signals on the echosounder indicated the risk for obtaining very large catches.

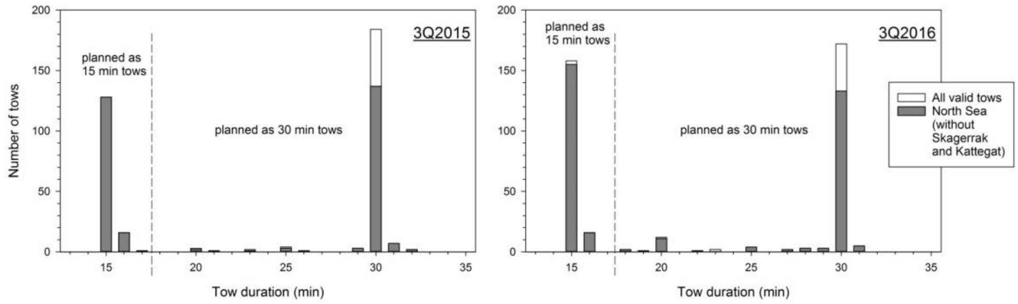


Figure 11.1.2. Frequency distribution of tow durations, NS-IBTS 3Q2015 and 3Q2016.

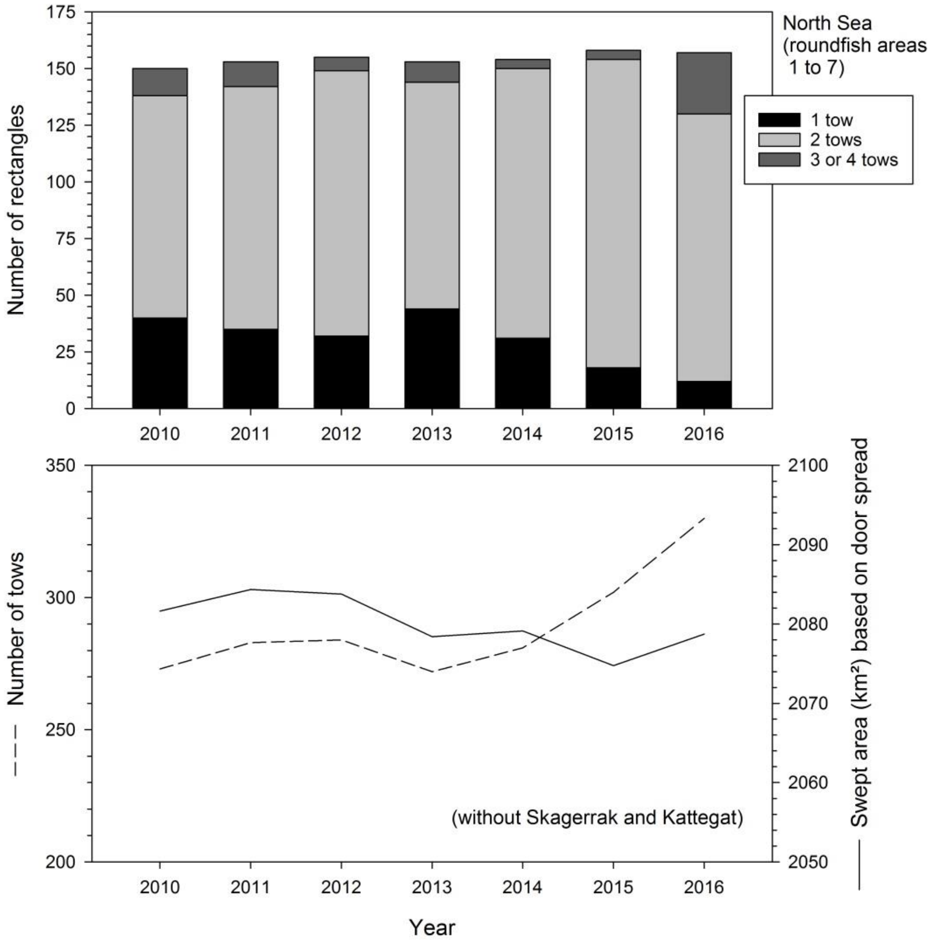


Figure 11.1.3. Changes in survey coverage and effort, NS-IBTS 3Q 2010 to 2016.

The time saved due to the shorter tows was used by Germany and Norway in 2015 to extend their normal area coverage, while Denmark and Scotland made additional hauls, primarily in rectangles where they are the only country fishing. This approach continued in 2016 and additional short tows were conducted whenever possible by most nations. Overall, the implementation of the short tows resulted in a larger number of rectangles covered and a more balanced distribution of tows between the rectangles than in previous years (Figure 11.1.3, upper panel) together with a considerably larger number of tows (Figure 11.1.3, lower panel). On the other hand, in both 2015 and 2016, the total area fished was below that covered in 2014 when solely nominal 30 min tows were used (Figure 11.1.3, lower panel).

11.1.2 Effect on catch rates and mean length

(Kai Wieland, Finlay Burns, Jennifer Devine, Michael Pennington)

Two different approaches were used to update the analysis from the previous year on the effect of tow duration on catch rates and size of NS-IBTS target species: i) GAM's using all hauls from roundfish areas 1 to 7 and including the effect of several covariates, such as depth, vessel and geographical position on catches in number by age, in addition to swept-area by tow, and ii) comparing total catch and mean length by species for paired stations within a certain distance limit. Method i) was applied to cod and whiting (WD3) and haddock and Norway pout (WD4) using data from both years. Method ii) was applied to catches and mean length by species for mackerel, sprat, herring, plaice and saithe (WD5).

The updated analyses for cod and whiting followed suggestions received from WGISDAA. The results for the 'best' models confirmed the previous findings that tow duration did not have a significant effect on the catch rates for any of the age groups of cod and whiting. Similar results were found for haddock and Norway pout although here the model diagnostics highlighted problems with ages 4 and 5 in Norway pout. Data for these age groups were sparse and a high amount of zero-catches were recorded.

The analysis completed for mackerel, sprat, herring, plaice and saithe and using the data from 3Q 2016 largely confirmed the results of the same analysis reported during IBTSWG 2016 and using the Q3 2015 data. The analyses were based on true pairs of short (15 - 17 min) and long (29 - 31 min) tows within a distance of 5 or 10 km. Here, catches were standardized to towing time but not to swept-area and thus vessel effects may play a role considering the different door spread to depth ratios of the different vessels (see section 5.2.5). Furthermore, differences in depth, which may occur even in a short distance (see section 11.2.2) within the pairs should be considered in any future analyses.

In summary, no indications were found that the 15 min tows were less efficient than the standard 30 min tows. However, all the analyses are still based on a relatively limited amount of data, and it was agreed that more data are needed before conclusive results can be obtained. Nonetheless, the WD authors were encouraged to extend their analyses with the present data to other species in order to allow a comparison between the GAM and the pairwise approach and to present the results at the next WGISDAA meeting.

11.1.3 Catches in 'zero-minute' tows

(Chris Lynam, Kai Wieland)

England conducted six experimental 'zero-minute' tows during the 3Q NS-IBTS 2016 (WD6). Catches of the tows were highly variable ranging from 16.5 to 251 kg (fish, shellfish and benthic bycatch) where the highest catch was dominated by herring (191 kg). Towing time outside that of the nominal tow duration, i.e. shooting and hauling time added, ranged between 17 and 39 min depending on depth (17 to 148 m). These values appears to be quite high compared to the nominal tow duration but may differ between countries, and the IBTSWG is planning to collect more information on this issue in particular for the various vessels participating in the NS-IBTS (see section 11.1.6).

It has been argued previously (see e.g. IBTSWG report 2015) that there is a catch outside the nominal tow duration and that this 'zero tow length catch' is proportionally larger for the 15 min tows than for the 30 min tows. The 'end effect' depends on various factors, mainly on depth but also on winch speed and the time the trawl requires to attain stable geometry after landing on the bottom, and its impact on the total catch depends on the fine scale spatial distribution of the target species along the trawl track. Hence, correction factors for shorter tows are very difficult to establish, and in surveys where the standard tow duration has been reduced the impact of the 'end effect' has usually been ignored because the benefits of shorter tows and the larger number of tows in terms of overall precision exceed the disadvantage of an unknown contribution of the catch outside the nominal tow duration.

11.1.4 Effect on species richness and fish length indicators

(Finlay Burns, Meadhbh Moriaty)

The analysis on species richness and fish length indicators combined the data from both the 3Q2015 and the 3Q2016 NS-IBTS (WD7). Species richness and mean number of species per haul were found to be significantly higher in the long tows than for the short tows, which is likely to be related to the reduced swept-area covered by the short tows (figure 11.1.4.1). However, the total number of fish species recorded in the 3Q NS-IBTS was higher in both 2015 and 2016 than in the preceding year (table. 11.1.4, figure 11.1.4.2). This may be explained by the decision of various countries to utilize any time saved on the survey to undertake additional short tows in additional habitats and/or depths (see sections 11.1.1 and 11.1.2).

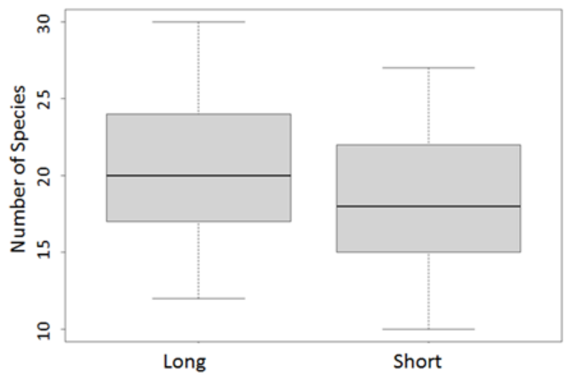


Figure 11.1.4.1 Spread of species recorded by both long and short hauls, 3Q2015 and 2016 NS-IBTS combined, roundfish area 1 to 7.

Table 11.1.4 Total number of species collected in the 3Q NS-IBTS 2010 – 2016, roundfish area 1 to 7.

Year	Total Number of Species
2010	81
2011	81
2012	83
2013	80
2014	82
2015	86
2016	92

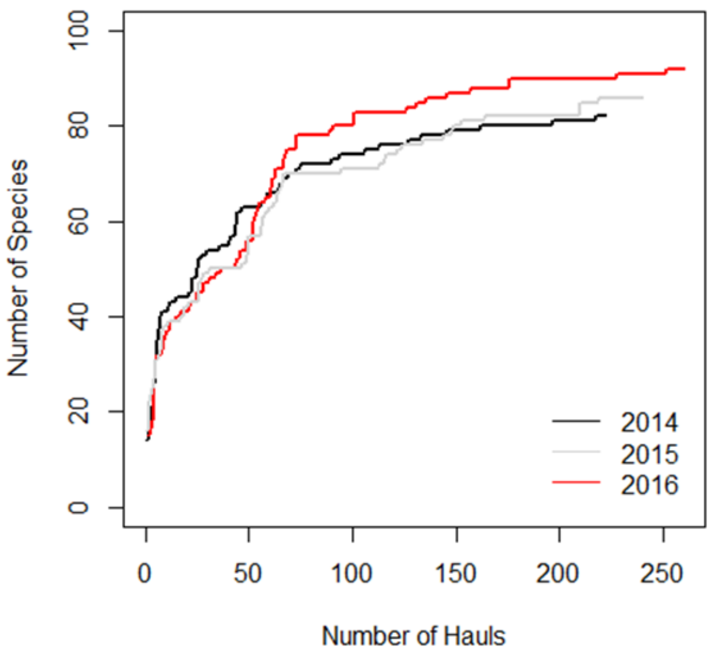


Figure 11.1.4.2 Cumulative number of species for the 3Q NS-IBTS 2014 – 2016 (short and long hauls combined, roundfish area 1 to 7).

The rectangle averaged Large Fish Indicator (LFI) was lower in the short tows than for the long tows in 2015 but the opposite was the case in 2016. When both years were combined the analysis showed a significant difference between the two haul categories with the short category having overall a higher LFI (Figure 11.1.4.3). No significant differences in mean abundance, Mean Maximum Length and Typical length were detected.

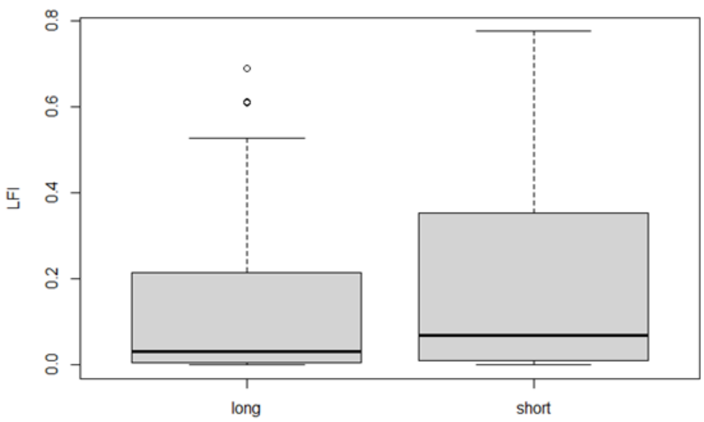


Figure 11.1.4.3 LFI indicator for short and long hauls, 3Q2015 and 2016 NS-IBTS combined, roundfish area 1 to 7.

11.1.5 Conclusions

(Finlay Burns, Jennifer Devine, Anne Sell, Kai Wieland)

So far, there have been no indications that the 15 min tow area is less representative than the standard 30 min tows when comparing the catch rates of target species in the 3Q NS-IBTS. Absence of a significant effect, however, does not necessarily mean that there is no impact. Furthermore, no analyses have yet been conducted to study the effect of the mixture of short and long tows on the precision of the survey indices of the target species, its' within-survey consistency and a potential impact of 'zero-minute' catches on this.

To attain the same or similar level of total species richness with 15 min tows would require a substantial increase in the overall number of tows compared with the typical number of 'standard' 30 minute tows. The intention is, however, not to move to solely 15 minute tows. Fishing at additional habitats and depths using the saved time due to the introduction of the short tows has likely affected the numbers of species recorded in the last two years. This has been one of the hypotheses prior to the start of the experiment that increased coverage within diverse habitats through additional hauls would lead to recording more species. Hence, a 3Q NS-IBTS with the mix of short and long tows may indeed be problematic with regards to its use in providing consistent biodiversity indicators, which are consistent over the time-series it would however provide additional information of the true diversity of groundfish species within the survey area. At present, the 1Q NS-IBTS is likely to be the preferred platform to report on biodiversity indices, as it is used for standard MFSD indicator analyses anyway (Lynam pers. comm.). Nevertheless, a comparison of the biodiversity reported in Q1 and Q3 surveys may well be useful in evaluating possible effects of inconsistency or bias.

The issue of tow duration has generated a great deal of discussion and has raised several concerns not least from other ICES and OSPAR expert groups who are understandably concerned as to what impact continuing with a mix of planned 15 and 30 minute tows might have on existing biodiversity indicators (see sections 11.4 and 11.5). In light of this it may well be worth considering whether in the meantime it might be worthwhile to revert back to only standard 30 minute tows. It is also anticipated that in the near future substantive modifications will in any case be made to the survey involving the development of a new standard survey trawl (see section 9.2), an extension to the standard survey area (section 11.5) as well as the creation of biologically meaningful strata with randomly sampled stations (see section 11.2).

It is however also accepted that the value of these new additional short hauls is beyond question as regards progressing these aforementioned survey design (e.g. precision of the indices for target species) and ecosystem objectives (e.g. additional coverage of different habitats or depths). Cessation of the planned 15 and 30 min tow durations and a subsequent return to the pre-2015 situation would affect on the IBTSWG's ability to answer such questions in future.

11.1.6 Collection of data on unquantified trawl times and future zero tow length (end effect) experiments

(Finlay Burns, Kai Wieland)

Subsequent to discussions at the IBTSWG 2017 meeting surrounding the potential inter - vessel variability of unquantified trawl time on IBTS surveys, the group requests that during the NS-IBTS in 3Q2017 and possibly also 1Q2018, all nations record additional information during the trawl deployment and retrieval process. The rationale is to better understand this variability and to provide an accurate estimation of the total time required for each vessel to successfully complete a 30 minute trawl. To ensure true and accurate comparability between vessels it is crucial that this process is completed in a consistent and standardized way. The start of the deployment process and therefore the first time stamp will be determined by the exact moment when the trawl warps are started, releasing the trawl doors into the water. The end of the process and therefore the final time stamp will similarly be determined by the point at which the trawl doors are back out of the water and the trawl winches have stopped. This should result in 4 times being recorded for each haul.

1) Deployment start time – Trawl winches start and doors start to move away from vessel
2) Trawl start time – start of nominal 30 minute tow
3) Trawl finish time – finish of nominal 30 minute tow
4) Retrieval finish time – Trawl winches stop and doors arrive back at vessel

This is the minimum number of observations required for the comparative analysis, however the IBTSWG encourages all participants to record as much information from each trawl deployment as is practicable and specifically regarding the time the net is on the bottom prior to and subsequent to the recorded haul start and finish times. A protocol template spreadsheet for recording this information will be provided to survey participants prior to the Q3 North Sea IBTS in June 2017.

If time allows during the Q3 NS-IBTS in 2017 or the Q1 NS-IBTS in 2018, the IBTSWG recommends that participants also undertake several zero-minute trawls using the method described in Kingsley (2001) and Battaglia *et al.* (2006). The preference would be for multiple 'zero-minute' deployments to be completed along single extended trawl tracks rather than single deployments being carried out at multiple locations because the former allow estimating the variance within a sampled location. Full documentation for these tows is essential, i.e. position, vessel speed (SOG) and trawl geometry (vertical opening, door and/or wing spread) should be recorded with the highest possible resolution in time.

Recorded trawl time data from all survey participants should be sent to the NS-IBTS survey coordinators upon completion of the survey. The results shall be presented at the IBTSWG meeting in 2018.

This type of work is crucial to the NS-IBTS due to its multinational design but cruise leaders for the NeAtl-IBTS are encouraged to collect similar data as far as possible.

References

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Kingsley, M.C.S. (2001): Studies in 2001 on the End effect of the Skjervøy 3000 Trawl in the West Greenland Shrimp Survey. NAFO SCR Doc. 01/177 Serial No. N4566, 7 pp.

11.2 Stratification

11.2.1 Exploring options for (post-) stratification of the North Sea IBTS – initial steps

(Anne Sell, Julia Wischnewski, Holger Haslob)

For the North Sea IBTS, an initial set of analyses was performed to explore options to improve the quality of survey products through a stratification applied in hindsight to already collected data ('post-stratification'). These analyses are based on a 10-yr time-series, where the average distribution patterns of the selected species during either Q1 or Q3 served as a reference, and the overall mean cpue (individuals caught per h of trawl) was applied as the reference for comparisons between stratification schemes. Simplifying the details of the actual IBTS sampling, which involves a systematic arrangement of stations by rectangle, the present design was considered being basically un-stratified, and was compared to two alternative stratification schemes: one splitting the survey area into two sections along the 50-m depth contour, and another one using strata as defined for the ecosystem model 'Atlantis' (Hufnagl *et al.* 2014), as proposed during the EU-funded project JMP (see www.informatiehuismarien.nl/projecten/joint-monitoring/), and later by WKPIMP (ICES 2016), compare Figure 11.2.1.1.

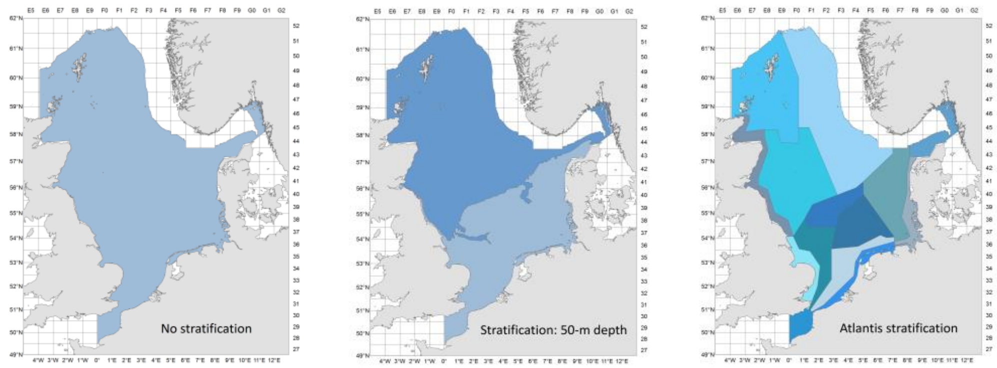

Figure 11.2.1.1: Post-stratification schemes, explored with respect to options to improve quality of abundance data (overall cpue).

When using the confidence interval as a measure of quality (certainty) of the survey product, here exemplified through the mean of the cpue for the entire survey area, it turns out that the effect of reducing the number of samples per stratum in many cases outweighs or even overrides the effect of reducing the variance within the separate strata. Therefore, although the latter results in meaningful ecological information, which could be used, e.g. to calculate encounter probabilities between predator and prey (Figure 11.2.2.2, top panel), there may be no overall gain in certainty of the simulated survey product "mean cpue". However, complicating factors, in particular the dominance of zero-inflated data (Figure 11.2.1.2, bottom panel), have not yet been considered, and are planned to be included as a next step.

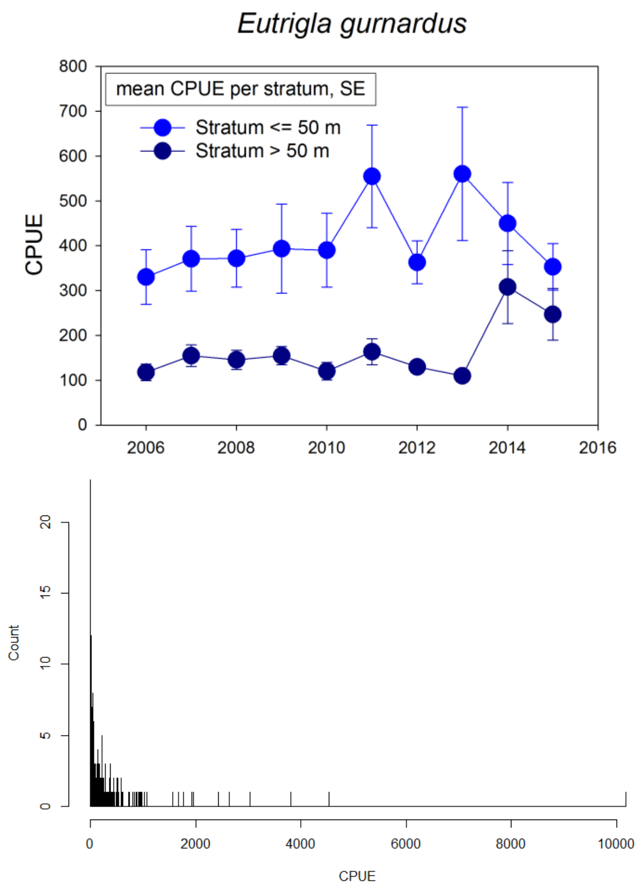

Figure 11.2.1.2: cpue (n/h) of grey gurnard in two depth strata of the North Sea, over a 10-yr period (top panel; compare strata in Figure 11.2.1.1). Example for zero-inflation of abundance data of grey gurnard (bottom panel; IBTS 2015 Q3, entire survey area, ~350 stations).

Future analysis may further consider to use swept-area based catch rates (instead of cpue in n/h) which would then allow to calculate total abundance by stratum and for the entire survey area with the corresponding estimated of precision using the standard formulae for stratified surveys from Cochran (1977).

References

Cochran, W.G. (1977) Sampling Techniques. 3rd edition. Wiley . 448 pp.

Hufnagl, M., Fulton, E.J., Gorton, R., Keth, A., Kempf, A., Le Quesne, W.J., Kreus, M., Garcia-Carreras, B., Savina-Rolland, M., Pinnegar, J.K., Peck, M. (2014). ATLANTIS 1 - North Sea. In: Holistic framework(s) for assessing multiple drivers. Deliverable 5.1.3 of the EU project VECTORS. www.marine-vectors.eu.

ICES. 2016. Report of the Workshop to plan an integrated monitoring Programme in the North Sea in Q3 (WKPIMP), 22-26 February 2016, ICES HQ, Copenhagen, Denmark. ICES CM 2016/SSGIEOM:11. 48 pp.

11.2.2 Within-rectangle variation of species composition and catch rates

(Kai Wieland, Anne Sell)

Independently of larger patterns in the broad distribution of habitats, which may serve as a basis for (post-) stratification of IBTS hauls (see section 11.2.1), variation may still exist on a smaller spatial scale.

Usually, ICES depth gradients in the North Sea are moderate, but a few rectangles exist, in which depth gradients are considerable. Examples are the regions bordering the Norwegian Trench, as well as some areas off the British coast. Therefore, on the example of five rectangles in the southwestern North Sea, initial investigations have been made to explore the potential effect of strong depth differences between the hauls undertaken in one rectangle. To exclude a possible vessel effect, this initial test has been performed on rectangles in which – contrary to the typical allocation of hauls – one vessel (Dana) has sampled multiple stations (WD 8). Although the total number of samples in this analysis is limited, the results indicate that large depth gradients can be expected to affect catch size as well as species composition. Overall, within the investigated rectangles, deep stations were characterized by larger catches with higher species richness.

While a comprehensive analysis of comparable conditions of within-rectangle variance is still missing, other studies exist, which have looked into small-scale variance within ICES rectangles. The German Small-scale Bottom Trawl Survey (GSBTS) applies the same methods as the North Sea IBTS, but with a sampling intensity of around 20 hauls per 10 x 10 nautical mile area, instead of 2 hauls per ~ 30 x 30 nautical miles (Ehrich *et al.,* 2007). The variability of the species composition of hauls within this smaller scale can be rather large, but in most cases, it appears to be rather linked to the randomness in taking catches from a patchy fish distribution (e.g. Stelzenmüller *et al.,* 2005). The "boxes" of the GSBTS are chosen in an attempt to represent one depth zone rather uniformly throughout their area. However, effects of local differences in the sediment composition have been observed, within the GSBTS boxes (Temming *et al.,* 2004), as well as during a study investigating community structure in the Dogger Bank (Sell and Kröncke, 2013). It is likely that the stations analysed in Working Document #8 differed not only in depth, but also in sediment type. Yet, the effect would need to be studied in depth in the rectangles concerned, in order to derive statistically sound conclusions, which remove possible random effects.

References

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Sell, A.F. & Kröncke, I. (2013). Correlations between benthic habitats and demersal fish assemblages — A case study on the Dogger Bank (North Sea). Journal of Sea Research 80: 12–24.

Stelzenmüller, V., Ehrich, S. & Zauke, G.P. (2005): Effects of survey scale and water depth on the assessment of spatial distribution patterns of selected fish in the northern North Sea showing different levels of aggregation. - Marine Biology Research, 1: 375-387.

Temming, A., Götz, S., Mergardt, N. & Ehrich, S. (2004): Predation of whiting and haddock on sandeel: aggregative response, competition and diel periodicity. - Journal of Fish Biology, 64: 1351-1372.

11.2.3 Post-stratification of the NS-IBTS proposed for OSPAR fish community indicators

(Chris Lynam)

For the greater North Sea, it has been proposed to apply IBTS data for several community level indicators in preparation for the OSPAR Intermediate Assessment in 2017 (IA2017). For two indicators, which concern the size composition of fish communities and the species composition, a post-stratification of the North Sea survey data has been suggested to capture the major changes in community structure and pressure. These two indicators are:

1) the 'Mean Maximum Length' of fish and elasmobranchs (this is an arithmetic mean weighted by biomass), which captures change in species composition and thus suitable for use under descriptor MSFD D1 [biodiversity], and

2) the 'Typical Length' of fish and elasmobranchs (a geometric mean length weighted by biomass), which captures change in size structure within communities and thus suitable for use under descriptor MSFD D4 [foodwebs].

Both indicators are calculated independently for the demersal and the pelagic fish communities and long-term trends investigated by strata (Figure 11.2.3.1). During testing of the indicators by OSPAR ICG-COBAM, the full Atlantis strata (Figure 11.2.1.1) were considered, but NS-IBTS survey data were found to be limited in spatial coverage such that coastal areas could not be reliably evaluated. In addition, strong correlation was found between indicators across multiple strata in the southern North Sea. Therefore, the Atlantis strata were simplified down to the following 6 strata:

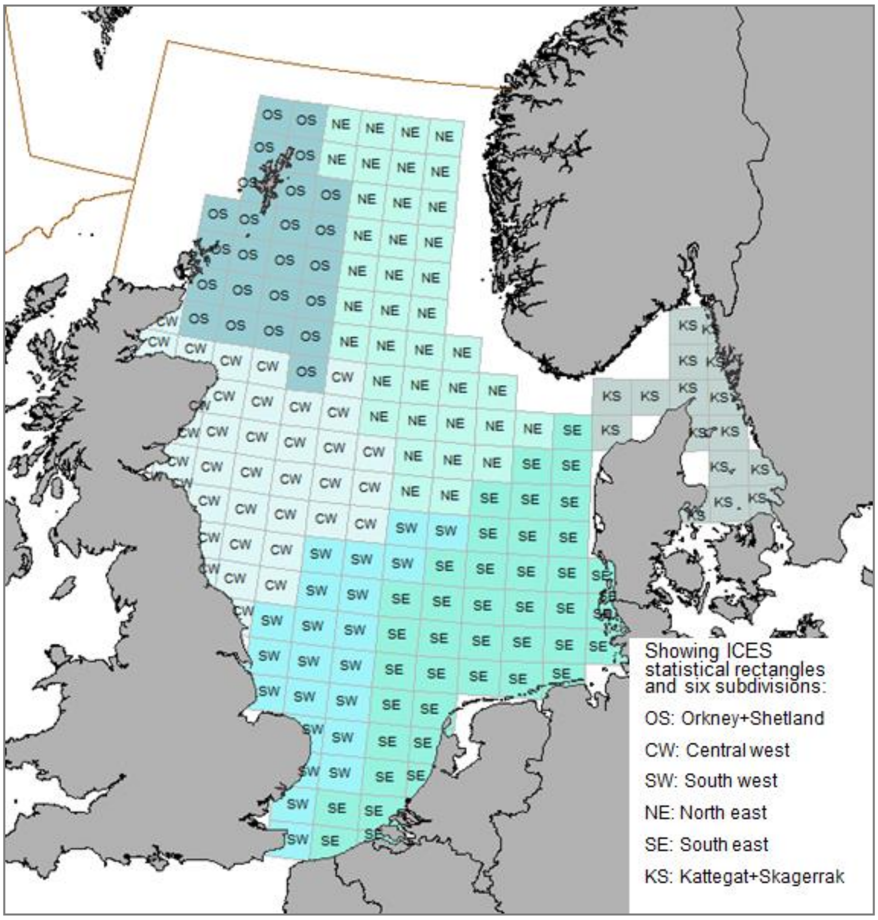

Figure 11.2.3.1. Atlantis strata simplified into six ecological subdivisions for fish communities, proposed to be used for the calculation of two fish community indicators for the OSPAR intermediate assessment 2017.

In contrast to the procedure outlined above for Mean Maximum Length and Typical Length, the proposed assessment of the Large Fish Indicator (LFI) within the IA2017 averages haul level data by ICES statistical rectangles and scales up directly to the entire North Sea, without further subdividing of the survey area.

11.2.4 Sampling stratification study for the western English Channel

(Morgane Travers-Trolet, Tiphaine Mille, Bruno Ernande)

Using the data available for the western English Channel (60 hauls from CAMANOC 2014 and CGFS 2015), multivariate analyses was conducted to identify relatively homogeneous clusters over the area that could be used as strata. As the gear targets the benthic community, a first filter was applied to remove pelagic species. Then 2 sets of data were considered: the first one only includes 23 species for which the survey could be used in stock assessment, the second one includes all benthic and demersal fish/cephalopod species, if they are present in at least 10% of the stations. A multivariate regression tree (MRT) has been applied to the two abundances matrices. This method allows the clustering of multivariate data constrained by some explanatory variables, in this case with depth and sediment type (Figure 11.2.4.1). Two different analyses were conducted: by focusing on species abundances (with chord distance) and by focusing on presence/absence of species (with Ochiai's distance).

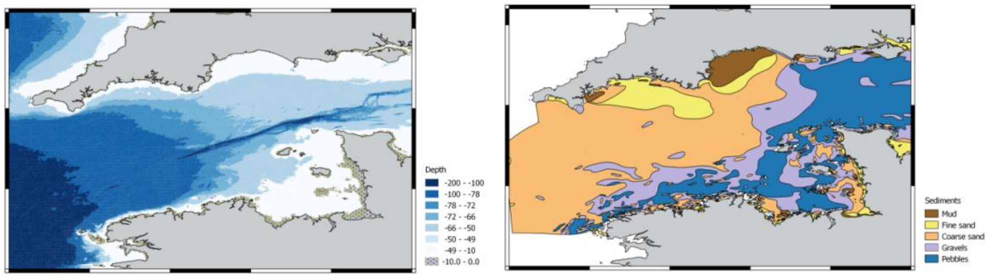

Figure 11.2.4.1: Environmental variables (depth and sediment type) used for constraining the stratification.

Clustering differs between the 4 cases (2 sets of data x 2 analyses), but some physical thresholds appeared in several MRT. Regarding depth, the following isobaths have been identified: 49 m, 50 m (twice), 66.5 m (twice), 71.5 m (twice), 78 m and 100.5 m. Regarding sediment types, gravels and pebbles are always in the same leaf and often coarse sand, fine sand and mud have been combined (with one exception of fine sand combined to coarse sand and pebbles). By combining these limits, maintaining space continuity and with the will of keeping the total numbers of strata relatively low, 6 strata were defined for the Western English Channel (Figure 11.2.4.2). At this stage however, the number of stations per stratum is planned to be proportional to their surface (evenly distributed over the area), therefore the stratification proposed here will be mainly used for indices computation.

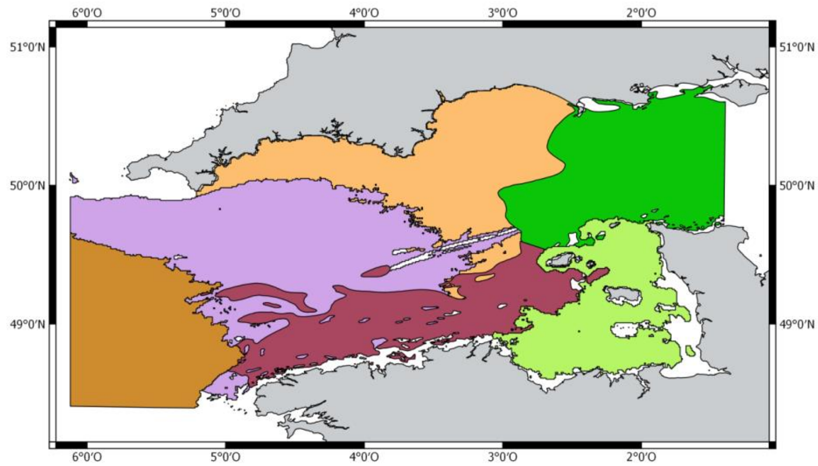

Figure 11.2.4.2: Spatial distribution of the combination of the four clustering analyses.

11.3 Fish communities in the Eastern English Channel and North Sea (ECLIPSE project)

(Arnaud Amber)

The 'ECLIPSE' project has main objectives: i) describing the spatio-temporal dynamics of fish communities at three spatial scales (Estuary of the Bay of Somme, the Eastern English Channel and the North Sea); ii) to assess respective effects of biophysical drivers and fishing pressure on the structure of fish communities, and iii) to anticipate the response of fish communities to various climate change scenarios within each of these three ecosystems. Background information can be found in Auber *et al.*, 2015 and Auber *et al*., 2017.

The presentation at the IBTSWG 2017 meeting focused on the first and third objective in the North Sea. Some results were presented about the temporal variation of the gamma diversity in the North Sea and about the spatial heterogeneity of communities (i.e. obj. i). The structure of the North Sea fish community changed throughout the survey period with an increase in the rate of change in the late 1900s and early 2000s (Figure 11.3.1). According to the coordinates on the first principal component, this community change was mainly characterized by a decrease in the abundance of Norway redfish, Cod, Witch flounder, Common skate, Eelpout, Whiting, Haddock, Pouting, and by an increase in the abundance of Dogfish, Grey gurnard, Red mullet, Anchovy, Yellow sole, and Yellow gurnard (Figure 11.3.1). In addition to the temporal dynamics, the spatial heterogeneity of fish communities was described. Clustering analyses revealed an important spatial structuring with 4 clusters of communities highly related to depth (Figure 11.3.2). The figure 11.3.2 also indicates the species composition of each cluster. Such a representation therefore gives a simple overview of all species distribution. Additional analyses indicated that spatial heterogeneity was near to 7 times higher than the temporal variability. After that, the methodological approach relative to the third objective (i.e. future response to climate change scenarios) was presented. It both concerned the habitat model design and the computation of North Seawater temperature anomalies from today to the end of this century (based on the combination between 6 General Circulation Models and the 4 greenhouse gas emissions scenarios). The resulting 24 SST rising scenarios were then used for selecting three scenarios (‘optimist’, based on the minimum predicted SST anomaly each year; ’intermediate’, based on the median predicted SST anomaly each year; ’pessimist’ based on the maximum predicted SST anomaly each year) that will be used for habitat models (Figure 11.3.3). For each of the three scenarios, the SST anomalies were computed for two periods: ‘short term (2002–2040) and long term (2080–2100) at the entire North Sea scale (i.e. hypothesis of homogeneous SST rising; Table 11.3.1), but also at the ICES rectangle scale (i.e. hypothesis of heterogeneous SST rising). Habitat models are currently in progress. Next steps in the project are notably the importance to look at the functional diversity patterns in order to better identify bio/ecological traits that mostly explain the response to forcing factors.

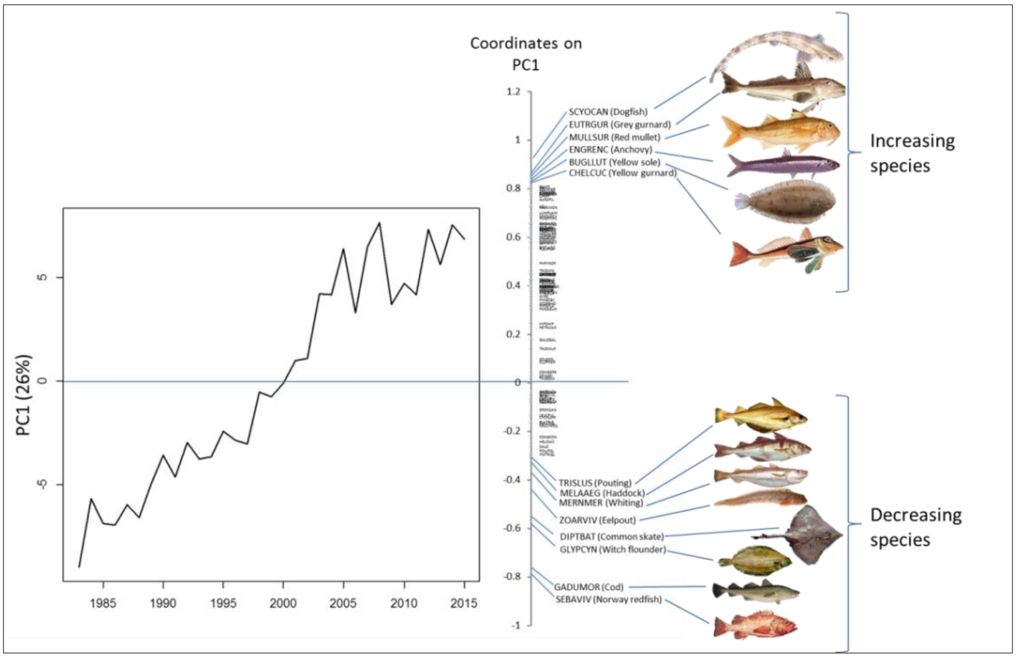

Figure 11.3.1. Temporal dynamics of the North Sea fish community from 1983 to 2015 and most contributive species to the community's change. PC1 is used here as an index of community structure.

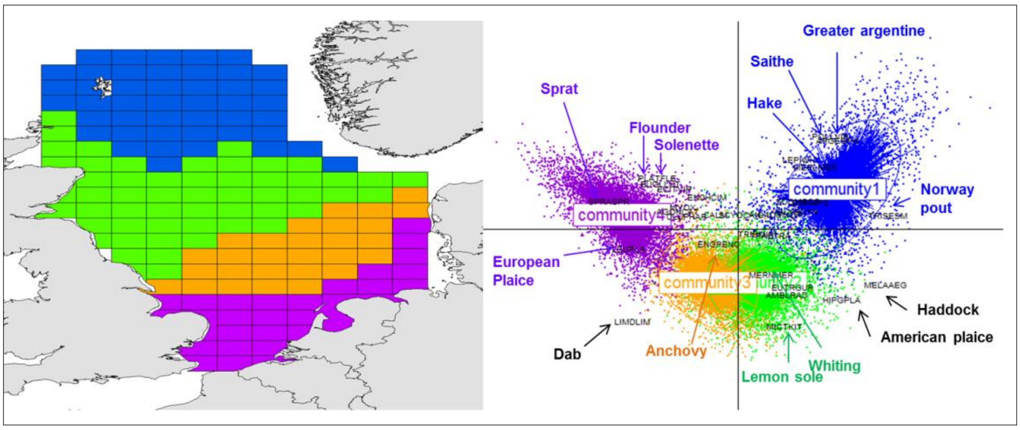

Figure 11.3.2. Spatial heterogeneity of fish communities in the North Sea and species composition within each cluster.

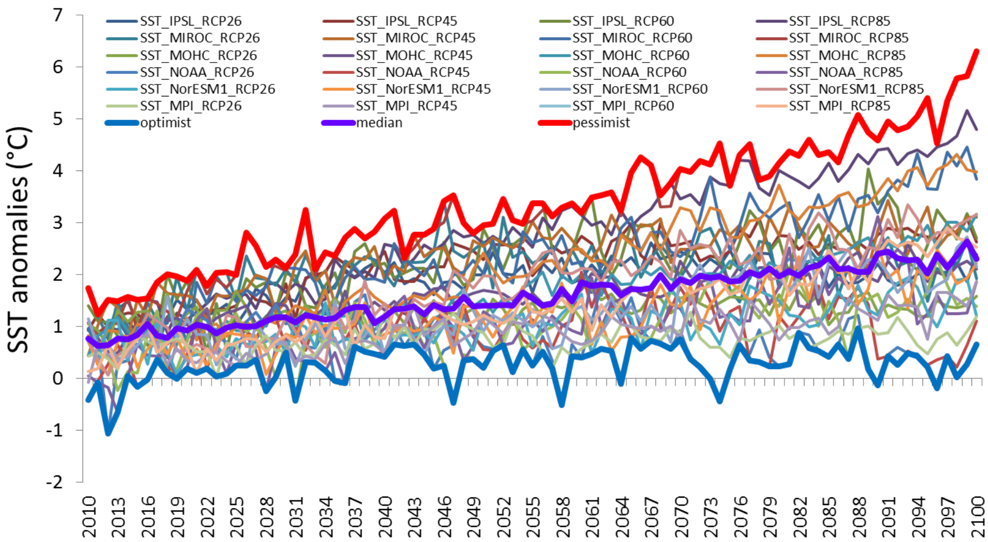

Figure 11.3.3. Predicted SST anomalies compared with the contemporary period (1980-2010) from 2010 to 2100 in the North Sea (where it is assumed that SST rising is homogeneous).

Table 11.3.1. Predicted SST anomalies compared with the contemporary period (1980-2010) for the 3 selected scenarios in the North Sea.

	optimist	intermediate	pessimist
short-term (2020-2040)	+ 0.193 C°	+ 1.117 C°	+ 2.409 C°
long-term (2080-2100)	+ 0.384 C°	+ 2.223 C°	+ 4.867 C°

References

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Auber, A., Gohin, F., Goascoz, N., Schlaich, N. 2017. Decline of cold-water fish species in the Bay of Somme (English Channel, France) in response to ocean warming. Estuarine, Coastal and Shelf Science 189: 189-202.

11.4 Outcome from WGISUR

IBTSWG were informed on the new ToR's of WGISUR and its new meeting structure combining ordinary meetings with workshops having a focus on particular areas and surveys. Here, in particular the meeting planned for 2019 should be of interest for NS-IBTS members because this meeting will include a workshop on the organization an integrated monitoring in the North Sea.

11.5 Outcome from WGINOSE

One ToR of WGINOSE 2017 was the development of integrated ecosystem monitoring in the North Sea by e.g. the redesign of the IBTS Q3 survey. The IBTS surveys are under increasing pressure to provide data for ecosystem objectives from multiple user groups, but communication on a unified plan has been lacking. Because of this, it was agreed that the needs or objectives should be collated into a road map that can be used to investigate a survey redesign that would meet ecosystem objectives without detriment to the current survey objectives (as outlined in the NS-IBTS manual). WGINOSE therefore made two recommendations: one to all ICES working groups that have stated their desire to modify the survey for ecosystem objectives to provide a road map (or collate needs) to present to the IBTSWG, the second to the IBTSWG to incorporate the needs of various user groups into their survey design ToR. WGINOSE has also requested that IBTSWG consider extending their survey into the Norwegian Trench and English Channel so that the entire North Sea ecosystem is covered.

12 Data overviews (ToR h)

Generic issues on data overviews and the type of information collected of the North Sea and the NeAtlantic IBTS are provided in the respective survey manuals.

In relation to how survey data have informed the assessment and advisory process for any specific stocks assessed by ICES Expert Groups, the annual report of the relevant assessment working groups, or benchmark reports, should be consulted.

13 Data reporting guidelines and Input to WKSUREP (ToR i)

The information on the data collected on the annual surveys coordinated by IBTSWG is already collated in a standardized format and are presented in separated sections for the North Sea IBTS in the 1st and 3rd quarter and the NeAtlantic IBTS in the annual reports.

Since 2014, IBTSWG has provided a summary of noticeable observations from the most recent NS-IBTS surveys and expectations related to the planning of the coming surveys. This summary has sent to the relevant assessment working groups shortly after the annual IBTSWG meeting. Since no response from the respective assessment WG chairs have been received such summaries are no longer provided.

The NS-IBTS and NeAtlantic survey manuals are currently being revised. Along with these revisions reporting guidelines and specifications for data formats will be updated.

14 Revisions to the work plan and justification

The swept-area based cpue products for the NS-IBTS has been delayed due to incomplete interpolation routines for missing values for a few countries and surveys. Swept-area based products available from DATRAS are now expected to be delivered in year 3.

15 Next meeting

The IBTSWG plans to meet at the Marine Institute in Galway, Ireland, 19 to 23 March 2018.

Annex 1: List of participants

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Annex 2: Agenda adopted

Monday, 27/3				
12:30		Start, setting-up IT	Plenary	
13:00		Welcome and housekeeping, ToR's Adoption of agenda	***Introduction:***	***Kai, Corina***
13:15		**ToR a** - Survey coordination	Plenary	
		Status of reports on previous surveys (Northeastern Atlantic 2016, NS Q1 2017, NS Q3 2016)	***Lead:***	***Fran, Ralf, Jennifer***
13:30		**ToR b – Survey Manuals** Status of SISP's updates: - Northeast Atlantic - North Sea - MIK - Marine litter	Plenary ***Lead:***	 ***Fran*** ***Jennifer*** ***Matthias*** ***Ralf***
14:00		**ToR g – Survey design** Fish communities in the Eastern English Channel and North Sea (ECLIPSE project)	Plenary ***Presentation:***	 ***Arnaud***
14:30		COFFEE		
15:00		**ToR b – Survey Manuals** Prepare updates - Northeast Atlantic - North Sea - MIK	Subgroups ***Lead:***	 ***Fran*** ***Jennifer*** ***Matthias***
17:00		**ToR a** – Survey coordination	Subgroups	
		Prepare reports on previous surveys - Northeast Atlantic - North Sea	 ***Lead:***	 ***Fran*** ***Ralf/Jennifer***

Tuesday, 28/3				
09:00		**ToR c** – DATRAS related topics	*Plenary*	
		Changes and improvements in DATRAS	***Lead/Presentation:***	***Vaishav***
		Correction of HH (and HL/CA) records 2004 to present and before 2004		***National repre-sentatives***
		NS-IBTS ALK substitution man-agement in DATRAS data warehouse		***Anna***
		Other data related issues: Inclusion of NS rectangle 44F6 in RF7 Coverage of NS rectangles 31F1 and 31F2 in CGFS and/or NS-IBTS Q3		
10:30	COFFEE			
11:00		**ToR c** – DATRAS related topics (cont.)	*Plenary*	
12:00		**ToR f** – Collection of age and other biological data Plaice Maturity issue	*Plenary* ***Presentation***	 ***Ralf***
12:30	Lunch			
13:30		**ToR's a** and **b**	*Plenary*	
		SISP for MIK, Revision of MIK index calcula-tion (WGISDAA, WKHERLARS), Marine litter in MIK samples	***Presentations:***	***Matthias*** ***Bastian***
15:00	Coffee			
15:30		**ToR d** – Swept-area index and **ToR e** – Effect of variable sweep lengths, groundgears etc.) CGFS intercalibration - Benthic fish and video observations Trials on doors for pelagic and demersal trawls	*Plenary* ***Lead:*** ***Presentations:***	 ***Kai*** ***Morgane*** ***Rob***
		Discussion on progress and decisions on future work	*Plenary*	
17:00		**ToR's a** and **b**	***Subgroups***	
		Preparation of SISP's Northeast Atlantic and North Sea and reports on previous surveys	***Lead:***	***Corina /Fran Ralf/Jennifer***

Wednesday, 29/3				
9:00		**ToR g** - Survey design	_Plenary_	
		Results from tow duration experiment – catch rates	***Presentations:***	***Kai*** ***Finlay*** ***Jennifer***
10:30	COFFEE			
11:00		**ToR g** - Survey design (cont.)	_Plenary_	
		Results from tow duration experiment - catch rates(cont) Results from tow duration experiment - biodiversity	***Presentations:***	***Chris*** ***Chris*** ***Finlay***
		Survey stratification		***Kai*** ***Anne*** ***Morgane*** ***Chris***
12:30		Consider outcome from: - WGISUR - WGINOSE	***Lead/Presentation:***	 ***Ralf*** ***Jennifer***
13:00	LUNCH			
14:00		**ToR a** - Survey coordination	_Subgroups_	
		Planning the next surveys: - Northeast Atlantic 2017 - North Sea 3Q 2017 and North Sea 1Q 2018	***Lead:***	 ***Fran*** ***Jennifer, Ralf***
15:00	COFFEE			
15:30		Preparing reports: ToR a: - Northeastern IBTS 2016 - NS 1Q 2017 - NS 3Q 2016 ToR c: DATRAS related issues ToR f: Biological data ToR g: Survey design	_Subgroups_ ***Lead:***	 ***Fran, ….*** ***Ralf, …*** ***Jennifer, ….*** ***Vaishav, , …*** ***NN*** ***Anne, Kai, Dave***

Thursday, 30/3				
9:00		**Outstanding issues**	Plenary	
		Discussion and presentations, e.g. Staff exchange	***Report:***	***Arnaud***
		ToR h Data Views		
		ToR i Input to WKSUREP		
		Response to recommendations from other WG's	***Lead:***	***Corina, Kai***
10:30	COFFEE			
11:00		Cephalopods guide		***Anne***
11:30		Presentation of draft report for:	Plenary	
		Survey sections for **ToR a** (Survey coordination) **ToR b** (Manuals)	***Lead:***	***Fran, Jennifer, Ralf*** ***Jennifer, Kai***
12:00		Presentation of draft report for:	Plenary	
		ToR d (Swept-area index)	***Lead:***	***Dave, Finlay***
		ToR e (Effect of variable sweep lengths, groundgears etc.)	***Lead:***	***Dave, Finlay***
		ToR f (Collection of biological data)	***Lead:***	***Ralf***
		ToR g (Survey design)	***Lead:***	***Kai, Anne, Finlay, Chris***
		Discussion and decisions on future work for ToR's d, e, f and g		
13:00	LUNCH			
14:00		Presentation of draft report for:	Plenary	
		ToR c (DATRAS)	***Lead:***	
		Species identification errors		***Rupert***
14:30		Status of WKSEATEC	***Presentation***	***Dave***
15:00	COFFEE			
15:15		Action list review		***Kai, Corina***
16:00		Preparing reports		

Friday, 31/3				
9:00		Update of remaining parts of report, e.g.	Plenary	
		Date and venue of next meeting, Recommendations and action list	***Lead:***	***Corina, Kai***
10:30	COFFEE			
11:00		Report	Plenary	
		Change / adoption of final sections	***Lead:***	***ToR coordinators*** ***Corina, Kai***
13:00		Closure of the meeting		

Annex 3: Recommendations

Recommendation	Adressed to
1. Distribution of the latest guidelines on maturity staging to various labs and organize training workshops as soon as possible, preferably before the 1Q NS-IBTS	WGBIOP, SSGIEOM
2. Etablish a joint workshop (WGFTFB and IBTSWG) and flume tank experiments for developing an new standard survey trawl and rigging for the NS-IBTS and the NE Atlantic IBTS	SSGIEOM, WGFTFB
3. Advice on collection of benthic species not yet included in the list of mandatory species	BEWG
4. Advice on improving the standardization of marine litter and provision categoriesf a photographic fieldguide for the identification of marine litter categories	SSGIEOM, WGML (new)
5. Provide a list of assessment working groups and other experts groups that are using IBTS data from a particular survey	ACOM, SSGIEOM, ICES Data Centre
6. Advice on automation of the current ALK substitution process for the 1Q mand 3Q NS-IBTS	WGNSSK
7. Advice on updated analysis of the effect of tow duration on catch rates and species richness from the 3Q NS-IBTS in 2015 and 2016	WGISDAA

Annex 4: Action list

	Action	Addressed to	Action latest before
1	Information to National Institutes and ICES assessment WG's (WGNSSK, HAWG, WGSAM) on the plan for continuation of using a balanced mixture of 30 and 15 min tows in the 3Q NS-IBTS 2017.	National representatives, NS-IBTS 3Q coordinator	15 April 2017, Feedback to coordinator by 1 June 2017
2	Input to flex file for NS-IBTS swept-area and finishing the corresponding DATRAS product.	National survey data providers (completed except for Norway)	1 September 2017
3	NS-IBTS correction of errors or data gaps identified: - Catch weight by category raising factors - Maximum length Re-submission of survey data to DATRAS if necessary or report directly to ICES data centre (e.g. catch weight by category units).	National survey data providers	Ongoing
4	Cleaning of pre-2004 NS-IBTS data in DATRAS database and adding missing information for Q1 1990-2003 and for Q3 1992-2003. Re-submissions may also include other missing information such as gear parameters and environmental data (incl. check of data units).	National survey data providers	In progress
5	Update of NS-IBTS survey manual. To be proof read by the other NS subgroup members. Submission to ICES SISP series	Anne, Jennifer	1st June 2017 1st July 2017
6	Add missing information on the GOV rigging to NS-IBTS survey manual.	Rob, Finlay	1st June 2017
7	Update of Northeast Atlantic IBTS survey manual. To be proof read by the other NeAtl subgroup members. Submission to ICES SISP series	Fran	1st June 2017 1st July 2017
8	Response to recommendations and requests from other ICES WG's.	IBTSWG chairs	Ongoing until next meeting
9	Provide country-specific limits of gear geometry (door spread, wing spread, net opening) in respect to depth (± 1 standard error for e.g. 10 m depth bins).	National representatives (in co-ordination with Jennifer for the NS-IBTS)	1st June 2017
10	Review the gear monitoring for NeAtl IBTS: Tidal flow and other related factors.	Morgane, Dave, Rob, Pia	Ongoing until next meeting
11	Collect data on trawl settling and lifting times	National WG	Ongoing

	(unquantified trawl time) and conduct zero tow length trials	members	until next meeting
12	Submit application for the flume tank workshop to ICES	Rob, Kai	1st September 2017

Annex 5: Maps of species distribution and length frequencies

(Francisco Velasco, Francisco Baldó)

Table A.5.1. Species for which distribution maps have been produced, with length split for prerecruit (0-group) and post-recruit (1+ group) where appropriate. The maps cover all the area encompassed by surveys coordinated within the IBTSWG (North Sea and Northeastern Atlantic Areas).

Scientific	Common	Code	Fig No	Length Split (< cm)
Clupea harengus	Herring	HER	8-10	17.5
Gadus morhua	Atlantic Cod	COD	2-4	23
Galeorhinus galeus	Tope Shark	GAG	48	
Galeus melastomus	Blackmouthed dogfish	DBM	56	
Lepidorhombus boscii	Four-Spotted Megrim	LBI	23-25	19
Lepidorhombus whiffiagonis	Megrim	MEG	20-22	21
Leucoraja naevus	Cuckoo Ray	CUR	44-45	
Lophius budegassa	Black-bellied Anglerfish	WAF	29-31	20
Lophius piscatorius	Anglerfish (Monk)	MON	26-28	20
Merlangus merlangius	Whiting	WHG	35-37	20
Melanogrammus aeglefinus	Haddock	HAD	5-7	20
Merluccius merluccius	European hake	HKE	11-13	20
Micromesistius poutassou	Blue whiting	WHB	38-40	19
Mustelus spp.	Smooth Hounds	SDS	49	
Nephrops norvegicus	Norway Lobster	NEP	41	
Pleuronectes platessa	European Plaice	PLE	32-34	12
Raja clavata	Thornback ray (Roker)	THR	50-51	
Raja microocellata	Painted/Small Eyed Ray	PTR	52	
Raja montagui	Spotted Ray	SDR	53	
Raja undulata	Undulate Ray	UNR	54	
Scomber scombrus	European Mackerel	MAC	17-19	24
Scyliorhinus canicula	Lesser Spotted Dogfish	LSD	42-43	

Scyliorhnus stellaris	Nurse Hound	DGN	55	
Sprattus sprattus	European sprat	SPR	57-58	
Squalus acanthias	Spurdog	DGS	46-47	
Trachurus picturatus	Blue Jack Mackerel	JAA	60	
Trachurus trachurus	Horse Mackerel (Scad)	HOM	14-16	15
Trisopterus esmarkii	Norway pout	NPO	59	

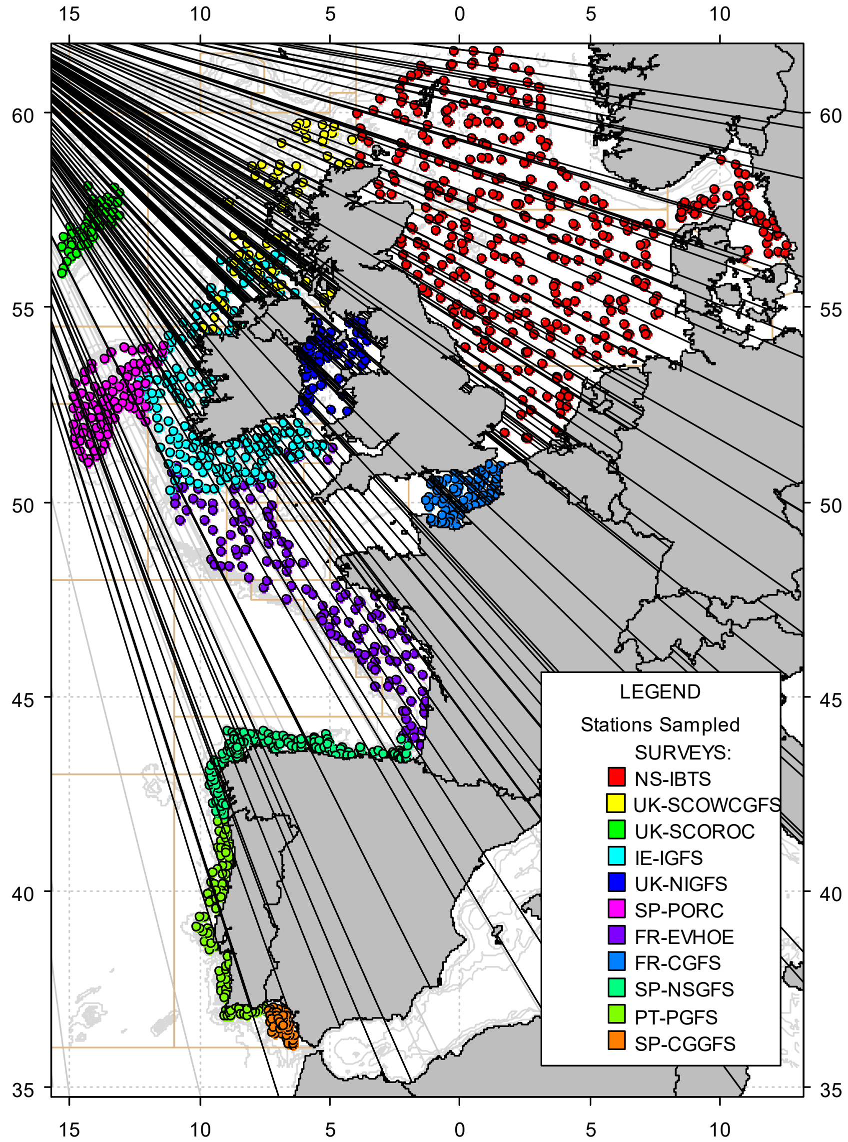

Figure A.5.1. Station positions for the IBTS carried out in the Northeastern Atlantic and North Sea area in summer/autumn of 2016. Quarters 3 and 4

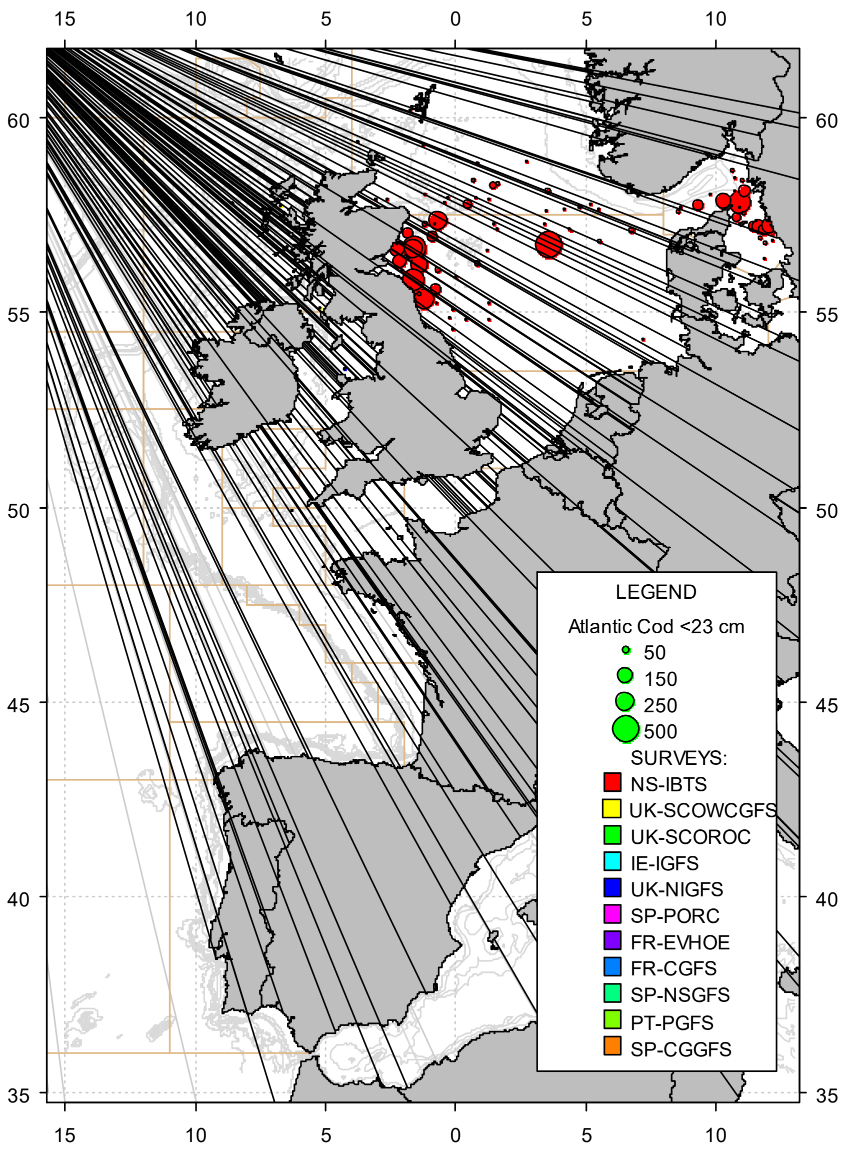

Figure A.5.2. Catches in numbers per hour of 0-group Cod, *Gadus morhua* (<23cm), in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

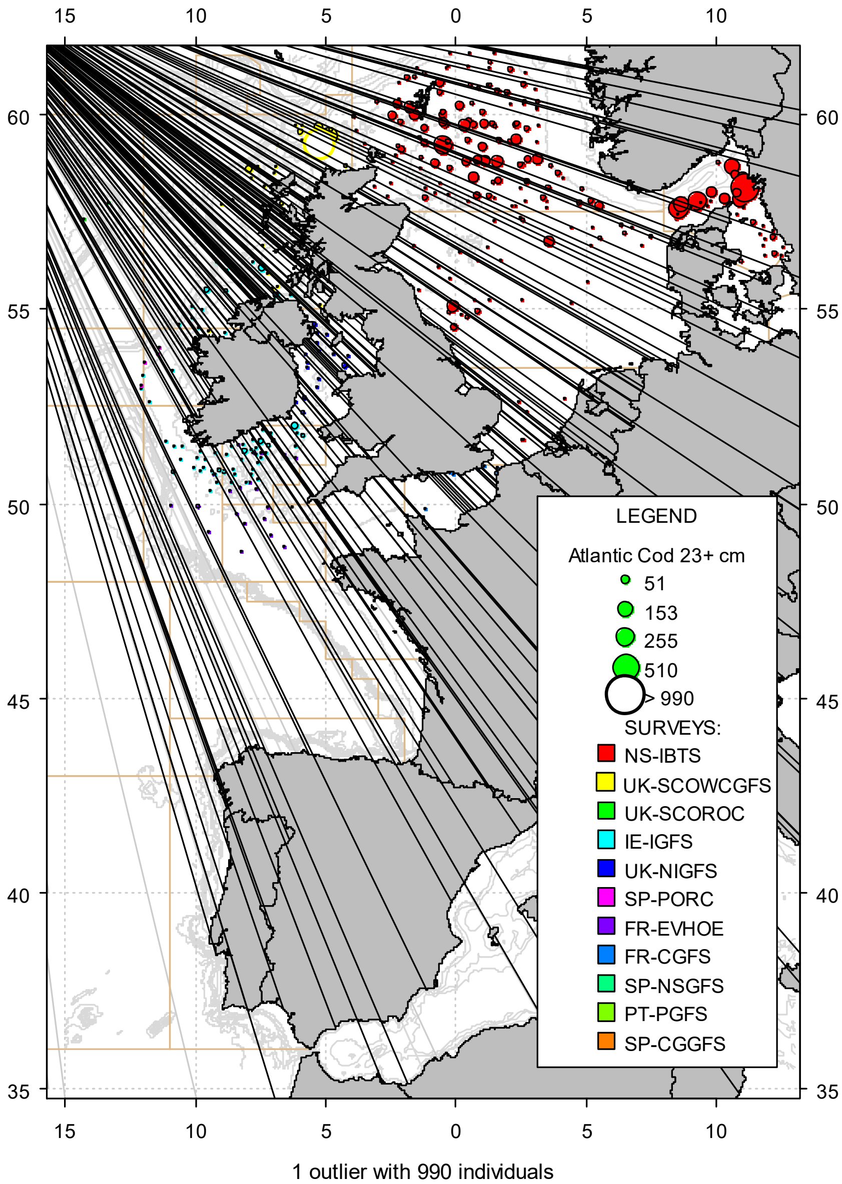

Figure A.5.3. Catches in numbers per hour of 1+ cod, *Gadus morhua* (≥23cm), in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

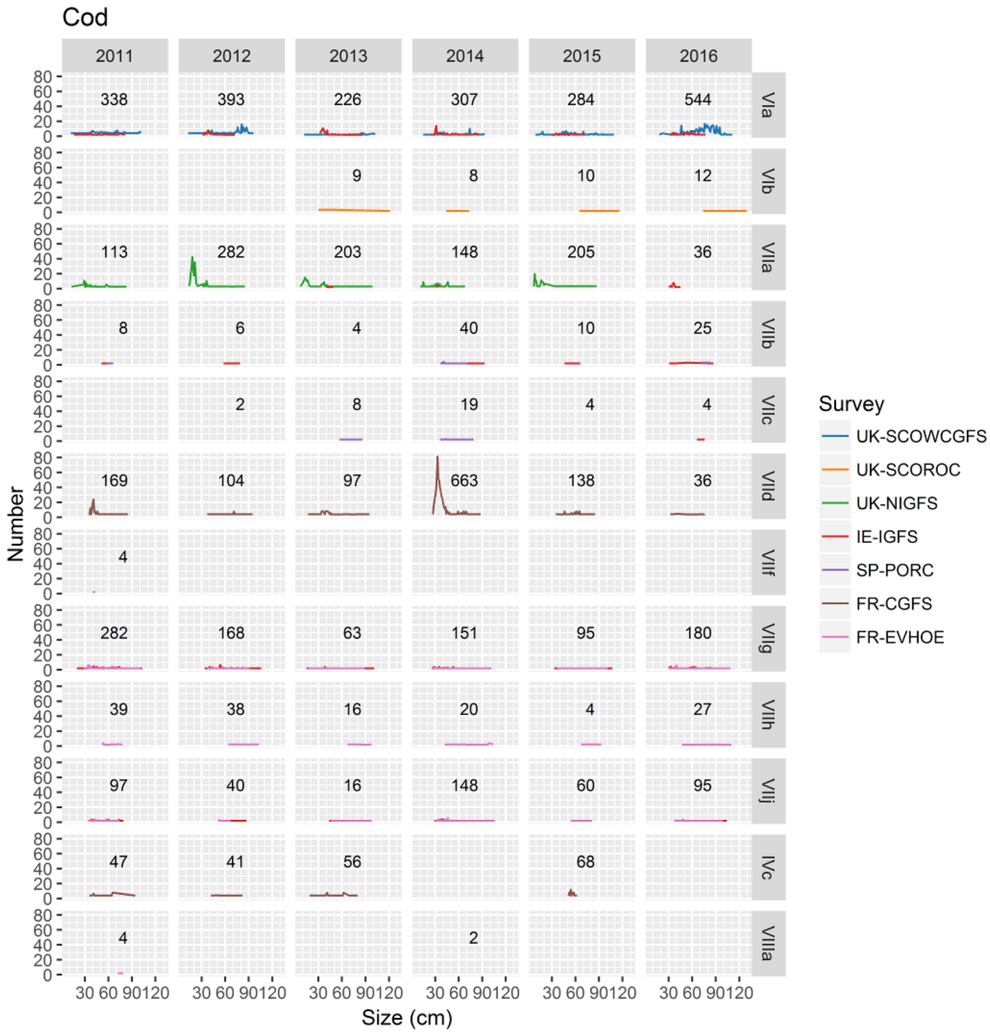

Figure A.5.4. Length distribution of cod, *Gadus morhua*, per ICES Subarea in the NeAtl surveys (North Sea IBTS not included) during the last six years, each panel presents the surveys occurring. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the lines do not reflect proportional abundance in all the areas but within each survey. The number in each panel corresponds to the sum of the mean stratified number of individuals caught in one hour haul in the surveys carried out in that subdivision.

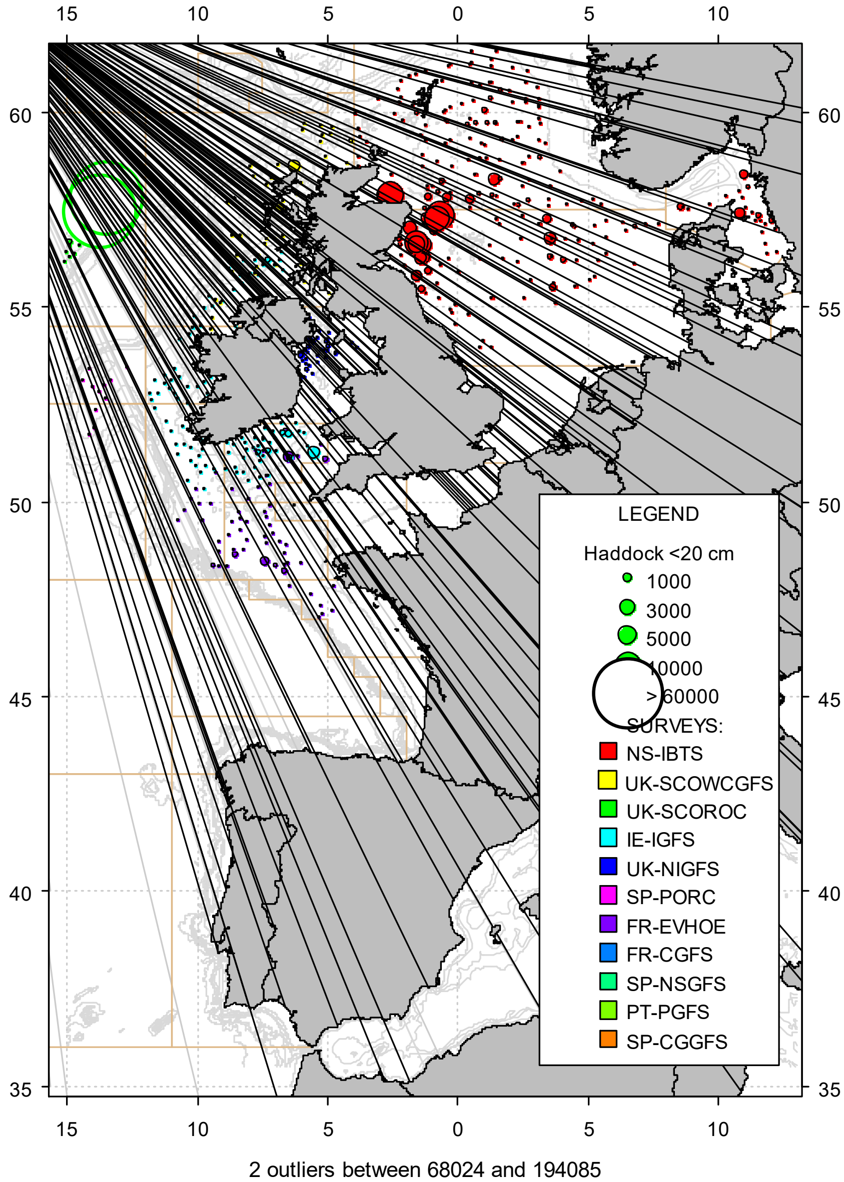

Figure A.5.5. Catches in numbers per hour of 0-group haddock, *Melanogrammus aeglefinus* (<20cm), in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

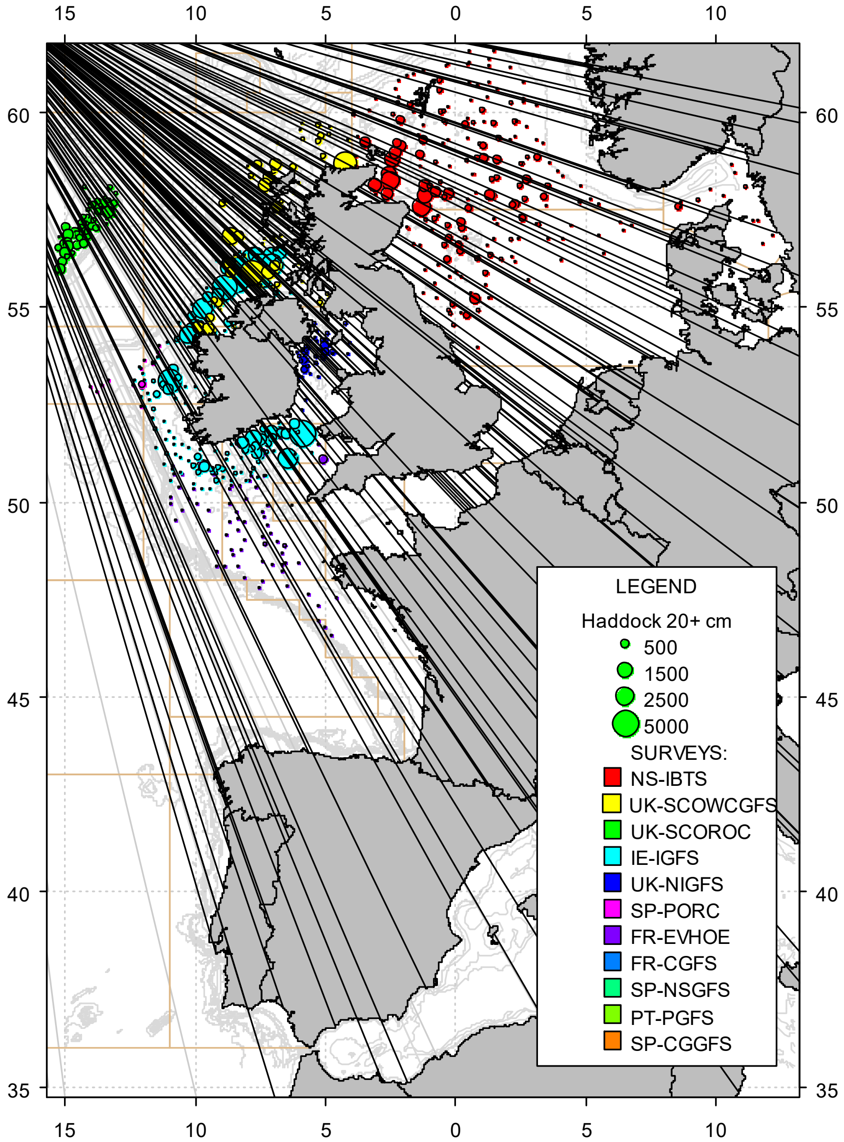

Figure A.5.6. Catches in numbers per hour of 1+ group haddock, *Melanogrammus aeglefinus* (≥20cm), in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

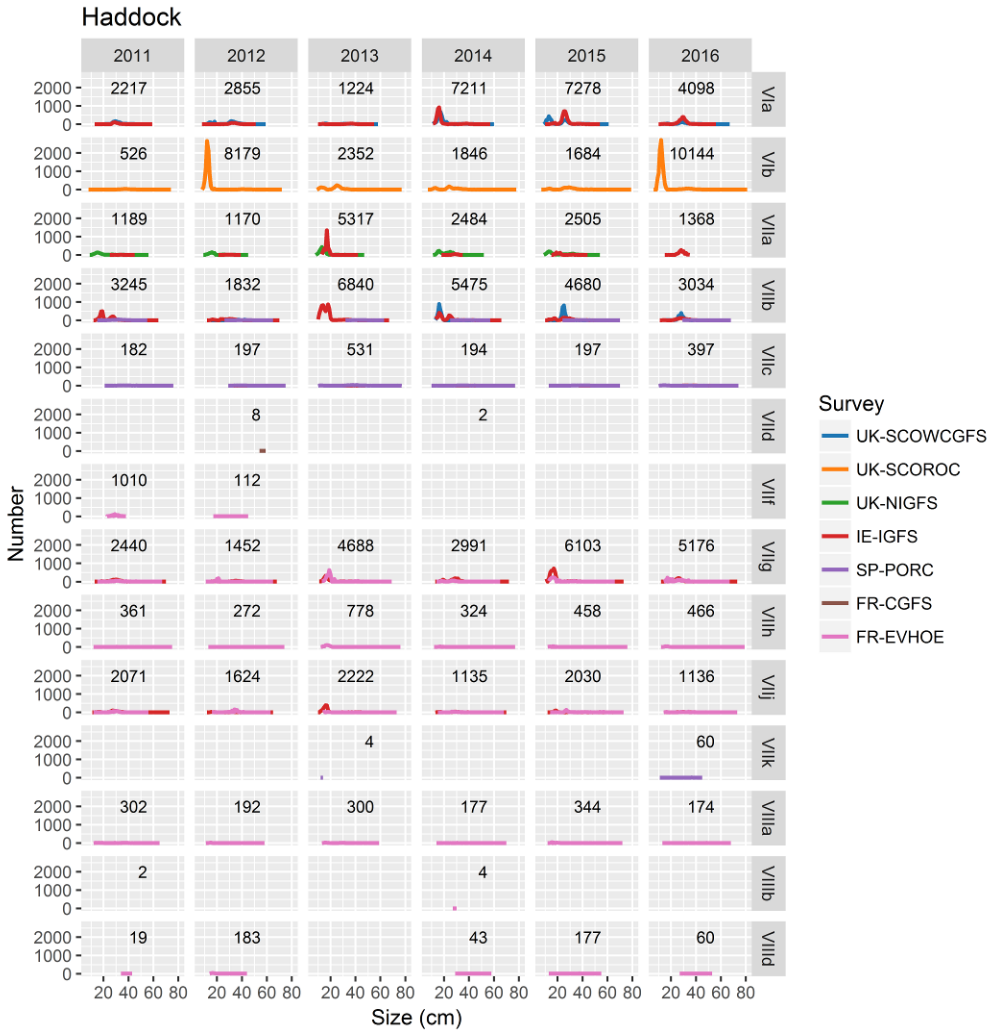

Figure A.5.7. Length distribution of haddock, *Melanogrammus aeglefinus* per ICES Subarea in the NeAtl surveys (North Sea IBTS not included) during the last six years, each panel presents the surveys occurring. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the lines do not reflect proportional abundance in all the areas but within each survey. The number in each panel corresponds to the sum of the mean stratified number of individuals caught in one hour haul in the surveys carried out in that subdivision.

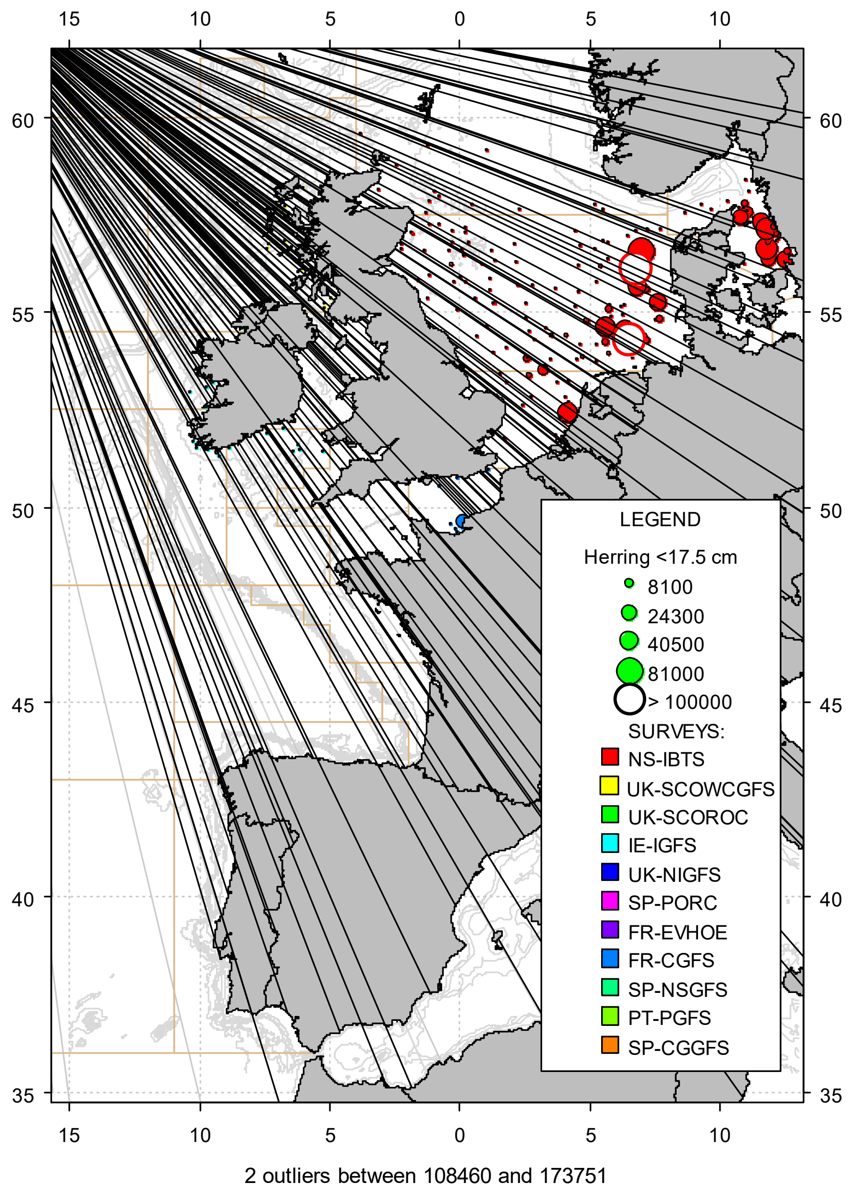

Figure A.5.8. Catches in numbers per hour of 0-group herring, *Clupea harengus* (<17.5 cm), in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

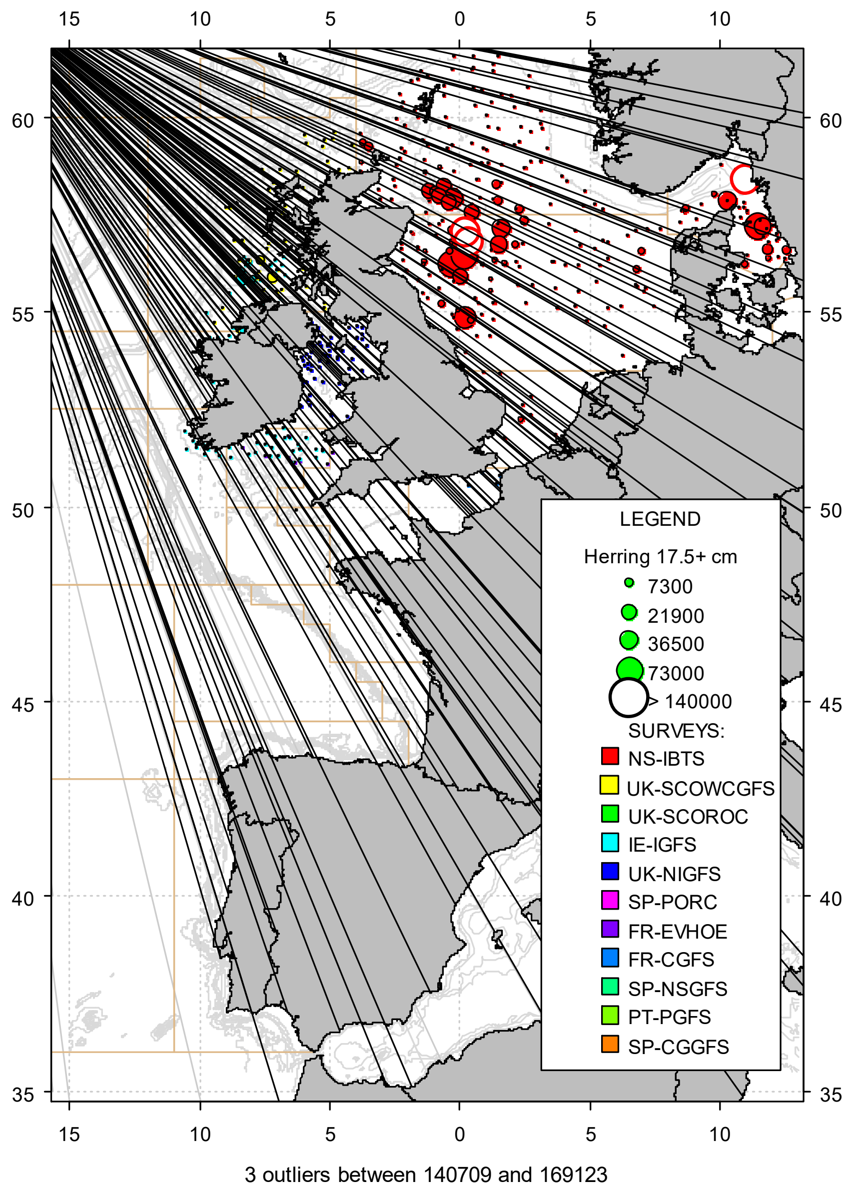

Figure A.5.9. Catches in numbers per hour of 1+ group herring, *Clupea harengus* (≥17.5 cm), in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

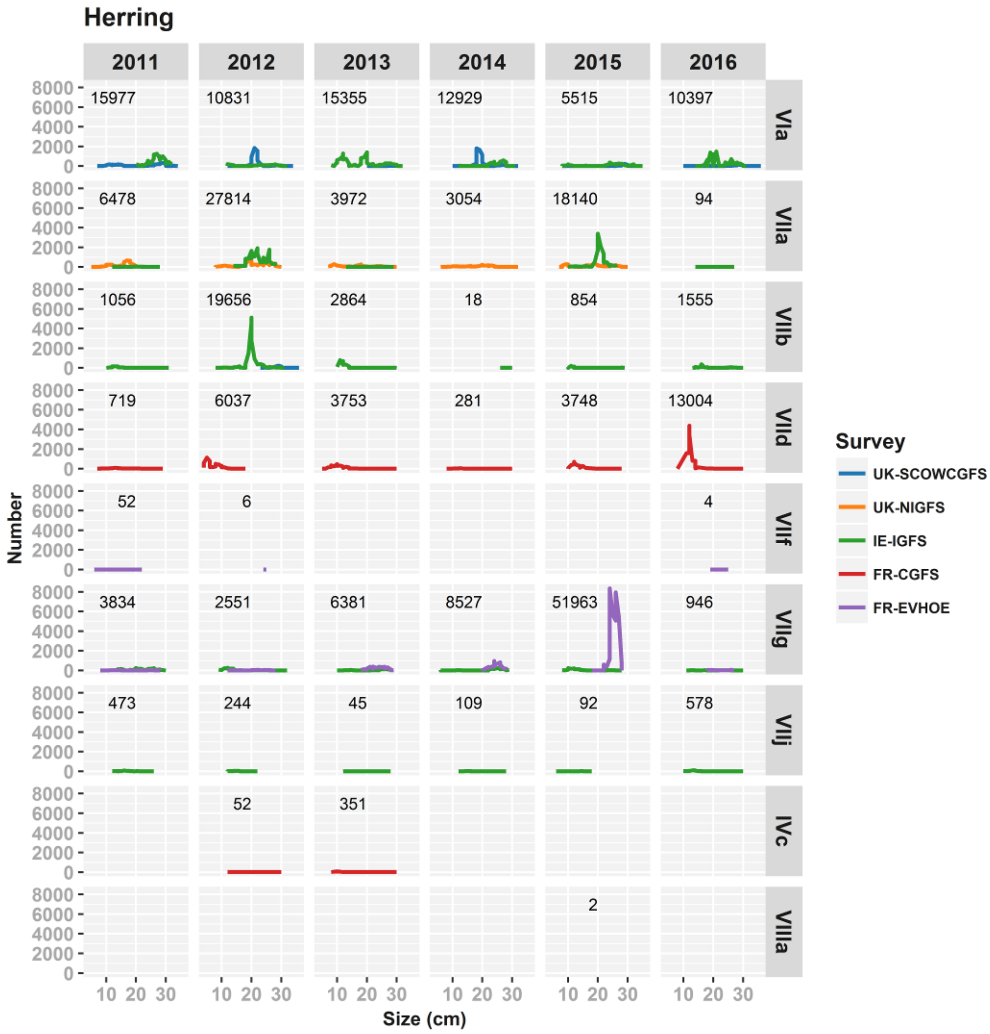

Figure A.5.10. Length distribution of herring, *Clupea harengus* per ICES Subarea in the NeAtl surveys (North Sea IBTS not included) during the last six years, each panel presents the surveys occurring. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the lines do not reflect proportional abundance in all the areas but within each survey. The number in each panel corresponds to the sum of the mean stratified number of individuals caught in one hour haul in the surveys carried out in that subdivision.

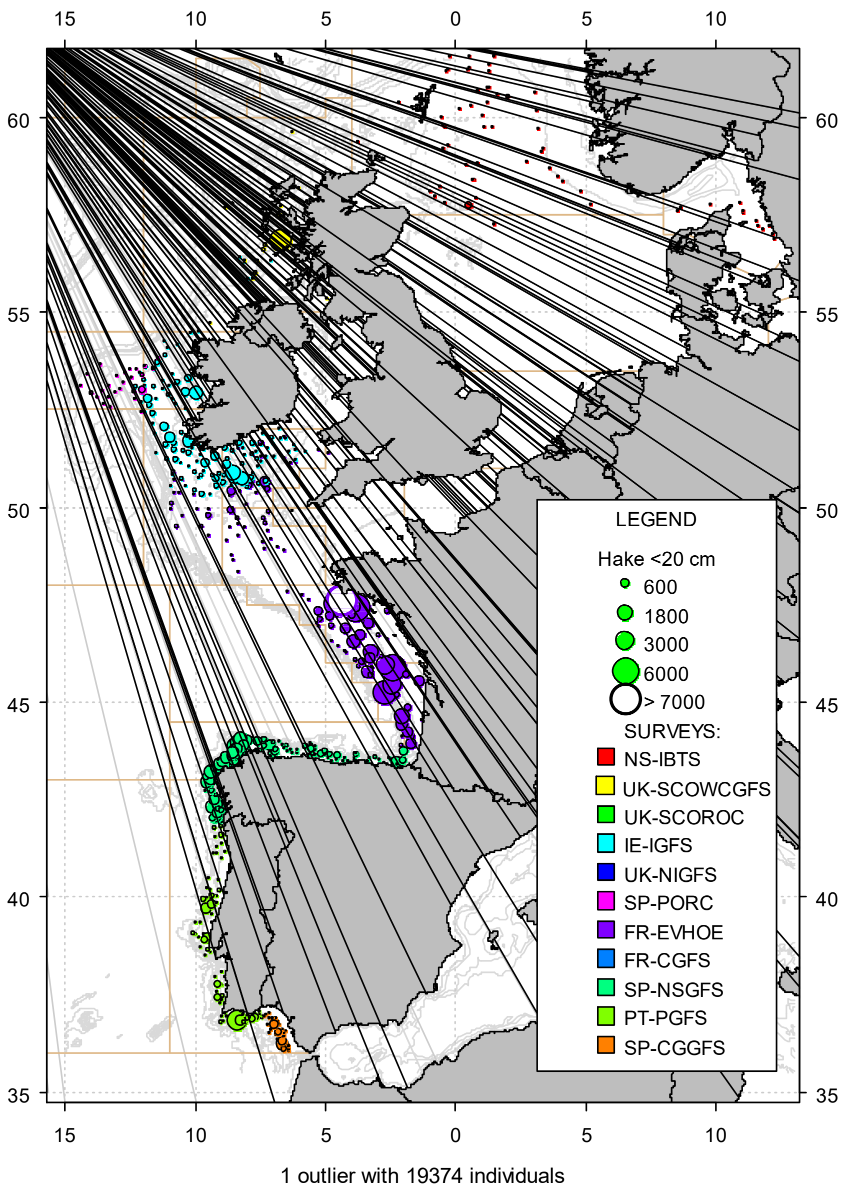

Figure A.5.11. Catches in numbers per hour of 0-group Europan hake, *Merluccius merluccius* (<20cm), in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

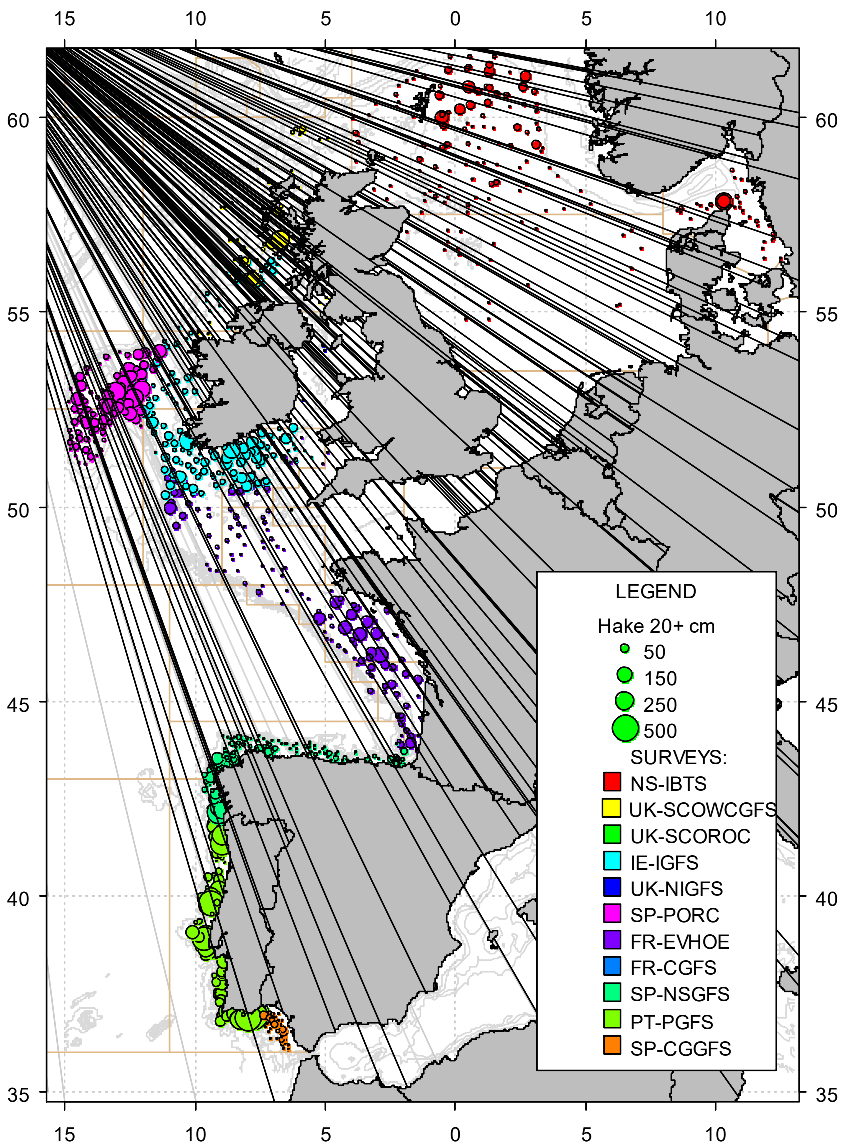

Figure A.5.12. Catches in numbers per hour of 1+ group hake, *Merluccius merluccius* (≥20cm), in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

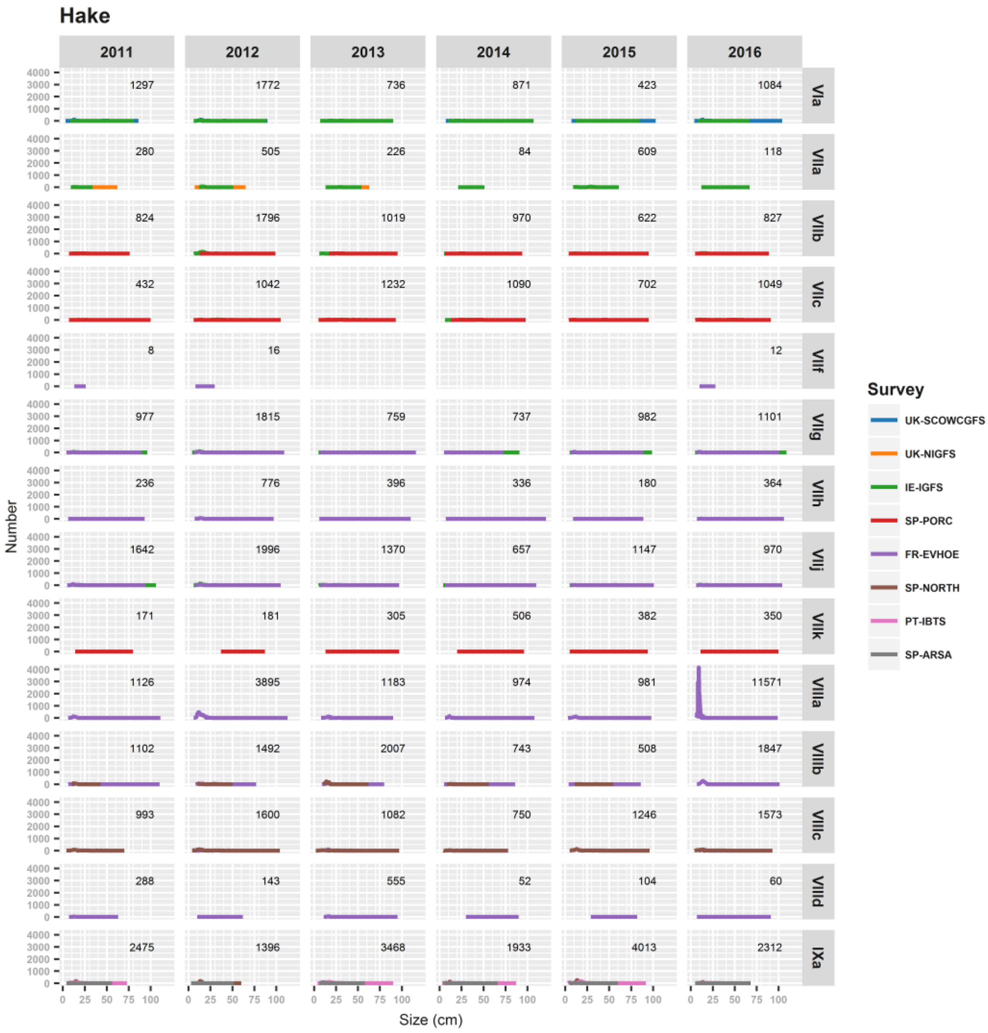

Figure A.5.13. Length distribution of hake, *Merluccius merluccius* per ICES Subarea in the NeAtl surveys (North Sea IBTS not included) during the last six years, each panel presents the surveys occurring. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the lines do not reflect proportional abundance in all the areas but within each survey. The number in each panel corresponds to the sum of the mean stratified number of individuals caught in one hour haul in the surveys carried out in that subdivision.

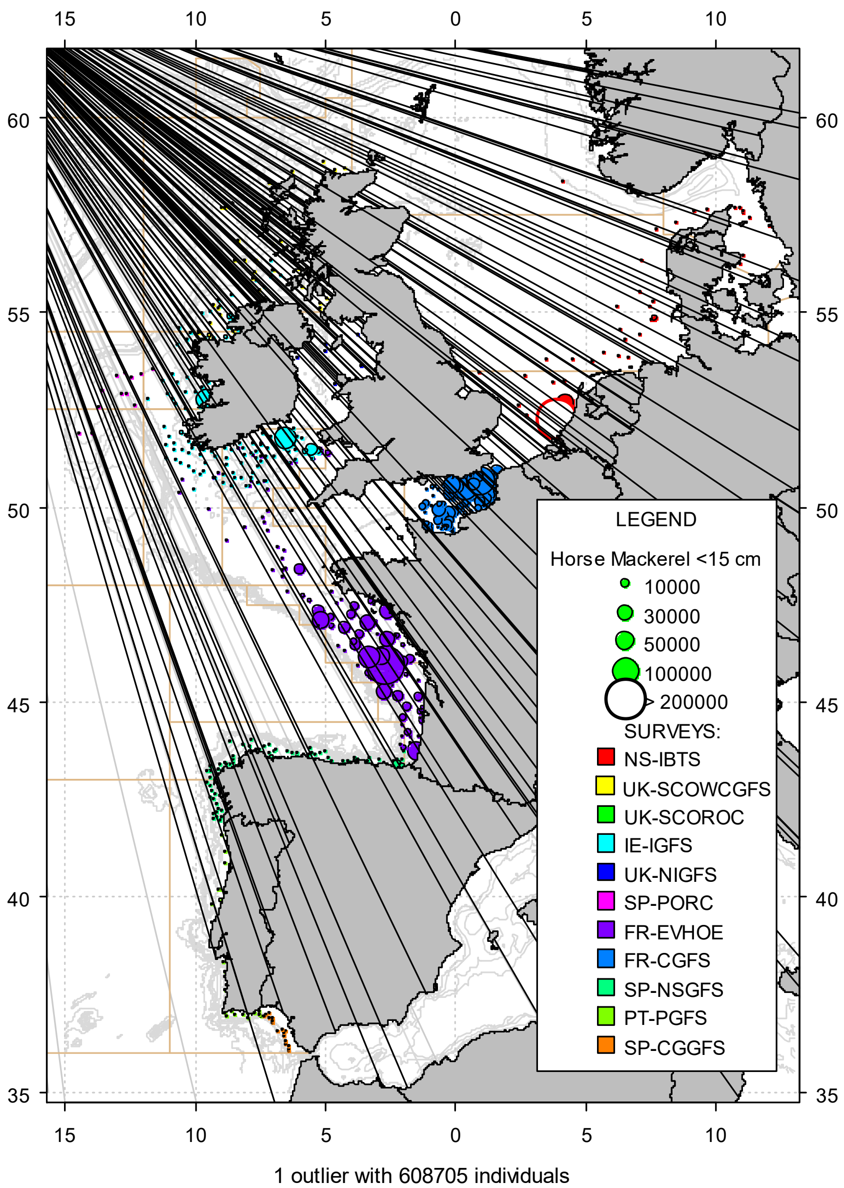

Figure A.5.14. Catches in numbers per hour of 0-group horse mackerel, T*rachurus trachurus* (<15 cm), in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

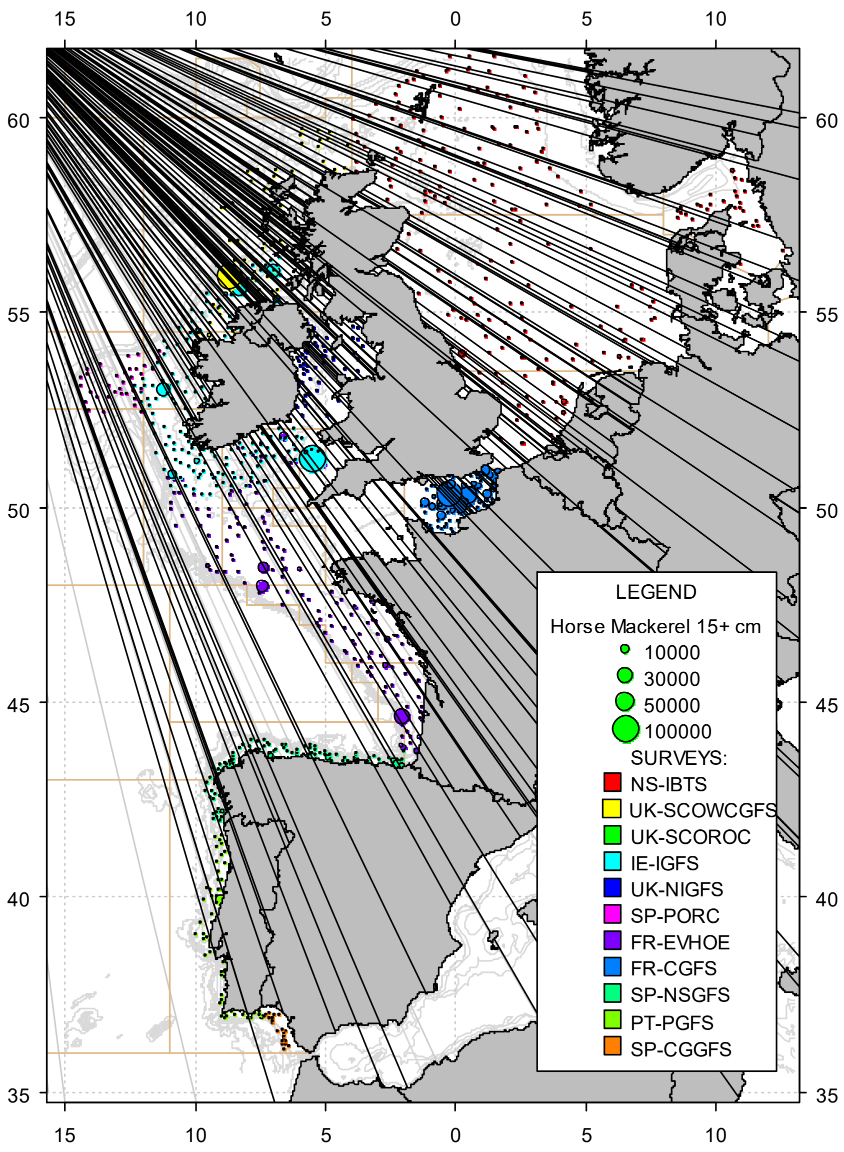

Figure A.5.15. Catches in numbers per hour of 1+ group horse mackerel, *Trachurus trachurus* (≥ 15 cm), in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

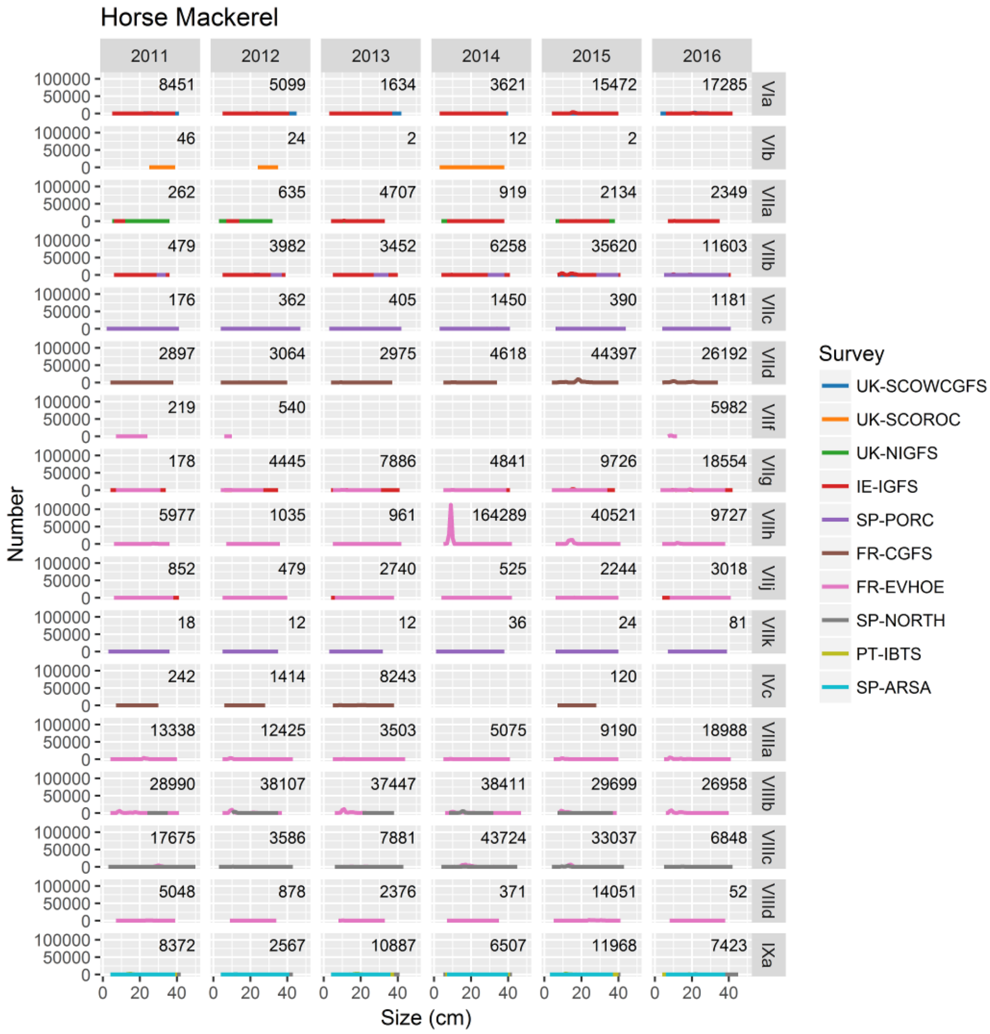

Figure A.5.16. Length distribution of horse mackerel, *Trachurus trachurus* per ICES Subarea in the NeAtl surveys (North Sea IBTS not included) during the last six years, each panel presents the surveys occurring. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the lines do not reflect proportional abundance in all the areas but within each survey. The number in each panel corresponds to the sum of the mean stratified number of individuals caught in one hour haul in the surveys carried out in that subdivision.

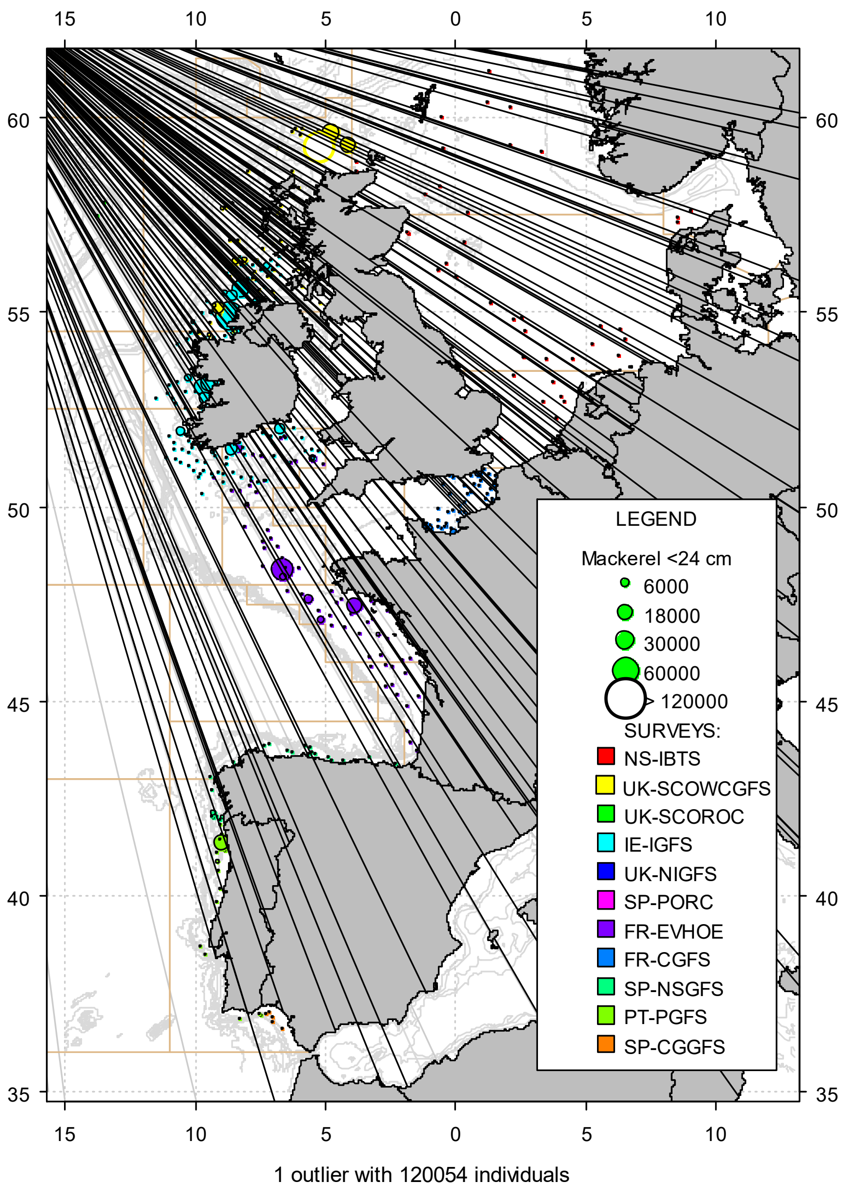

Figure A.5.17. Catches in numbers per hour of 0-group mackerel, *Scomber scombrus* (<24 cm), in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

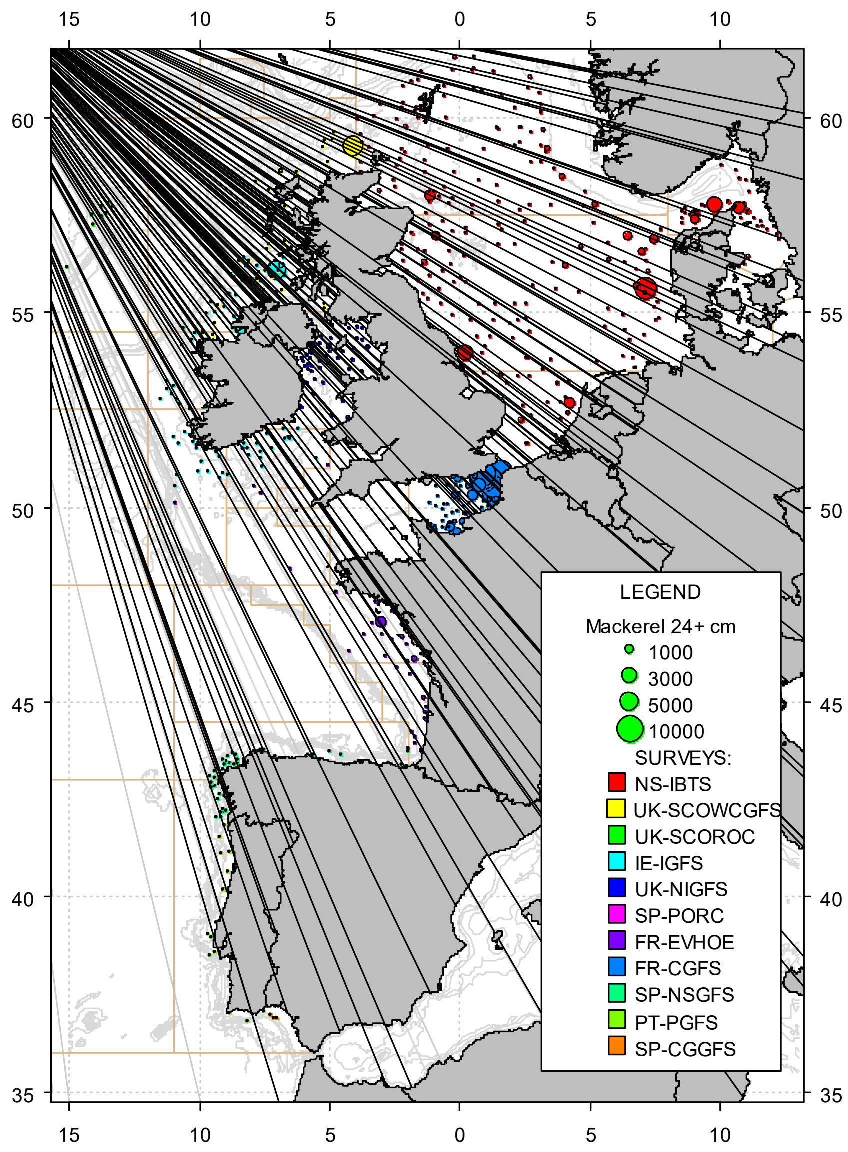

Figure A.5.18. Catches in numbers per hour of 1+ group mackerel, *Scomber scombrus* (≥24 cm), in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

Figure A.5.19. Length distribution of mackerel, *Scomber scombrus* per ICES Subarea in the NeAtl surveys (North Sea IBTS not included) during the last six years, each panel presents the surveys occurring. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the lines do not reflect proportional abundance in all the areas but within each survey. The number in each panel corresponds to the sum of the mean stratified number of individuals caught in one hour haul in the surveys carried out in that subdivision.

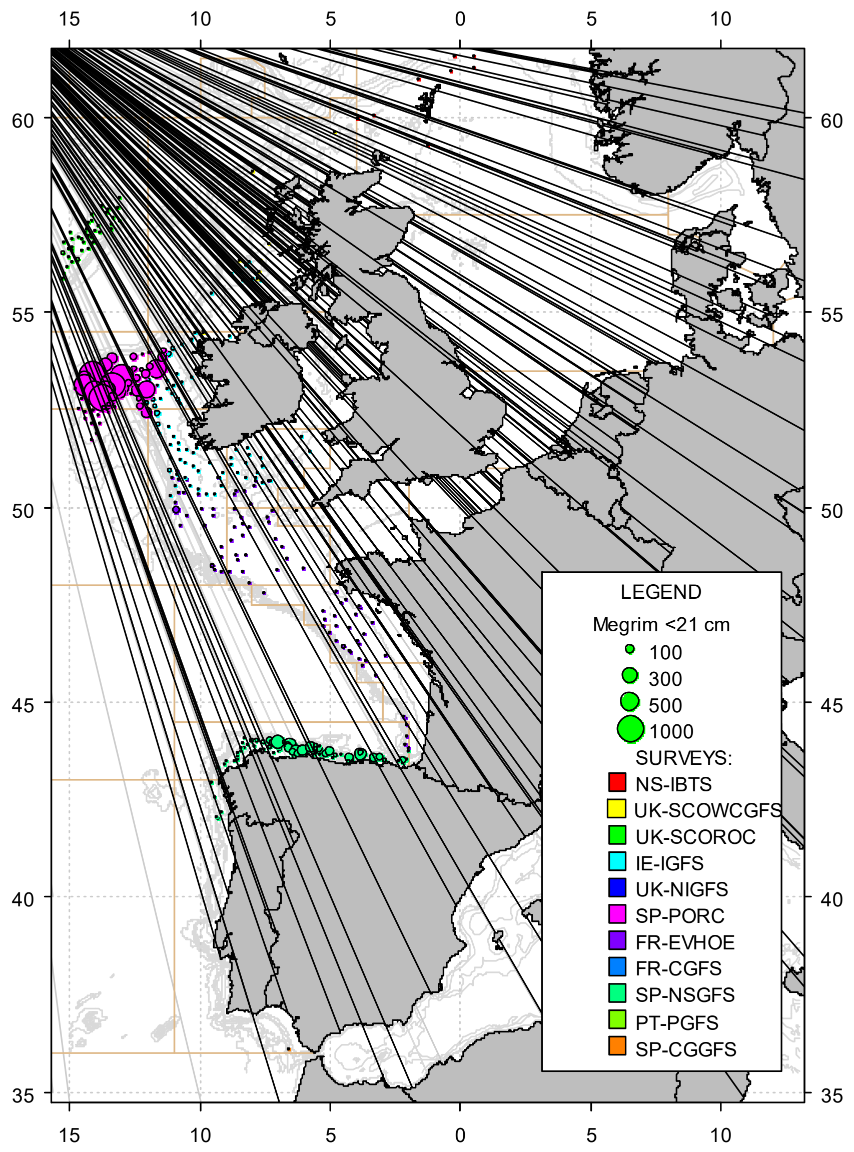

Figure A.5.20. Catches in numbers per hour of megrim recruits, *Lepidorhombus whiffiagonis* (<21 cm), in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

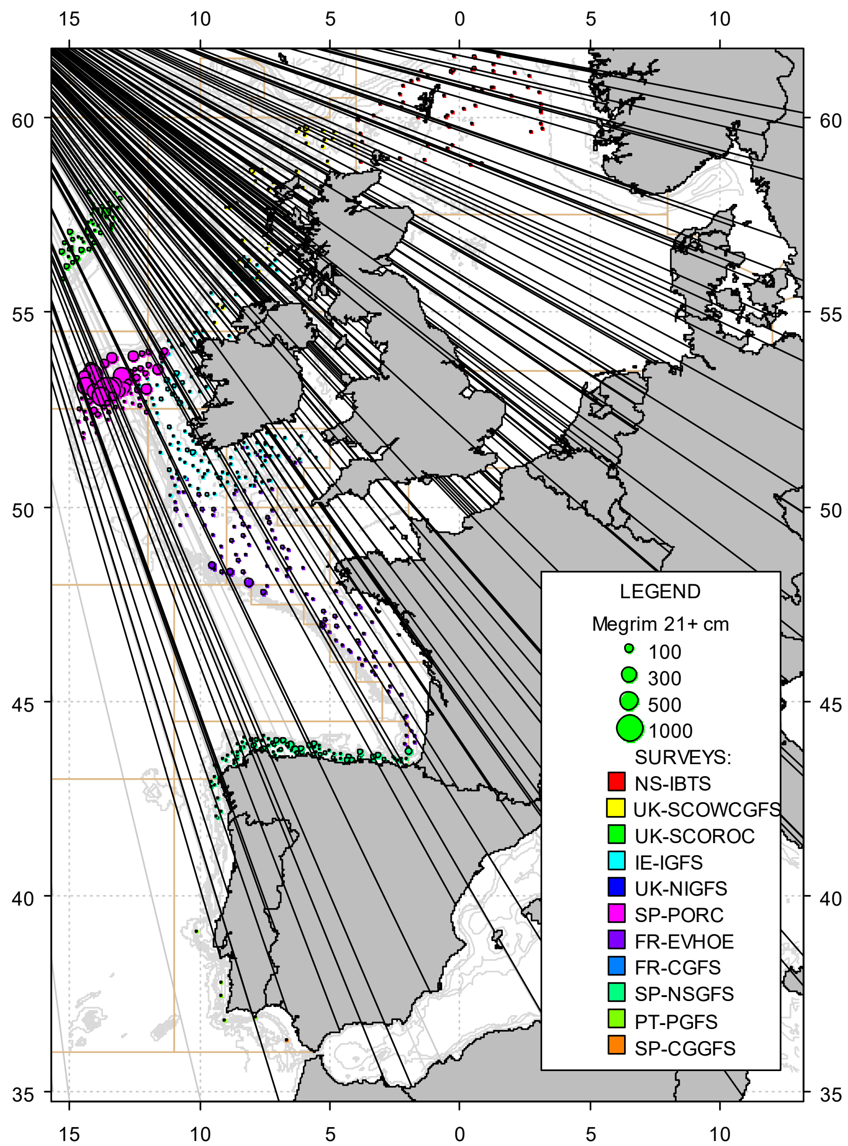

Figure A.5.21. Catches in numbers per hour of 2+ group megrim, *Lepidorhombus whiffiagonis* (≥21cm), in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

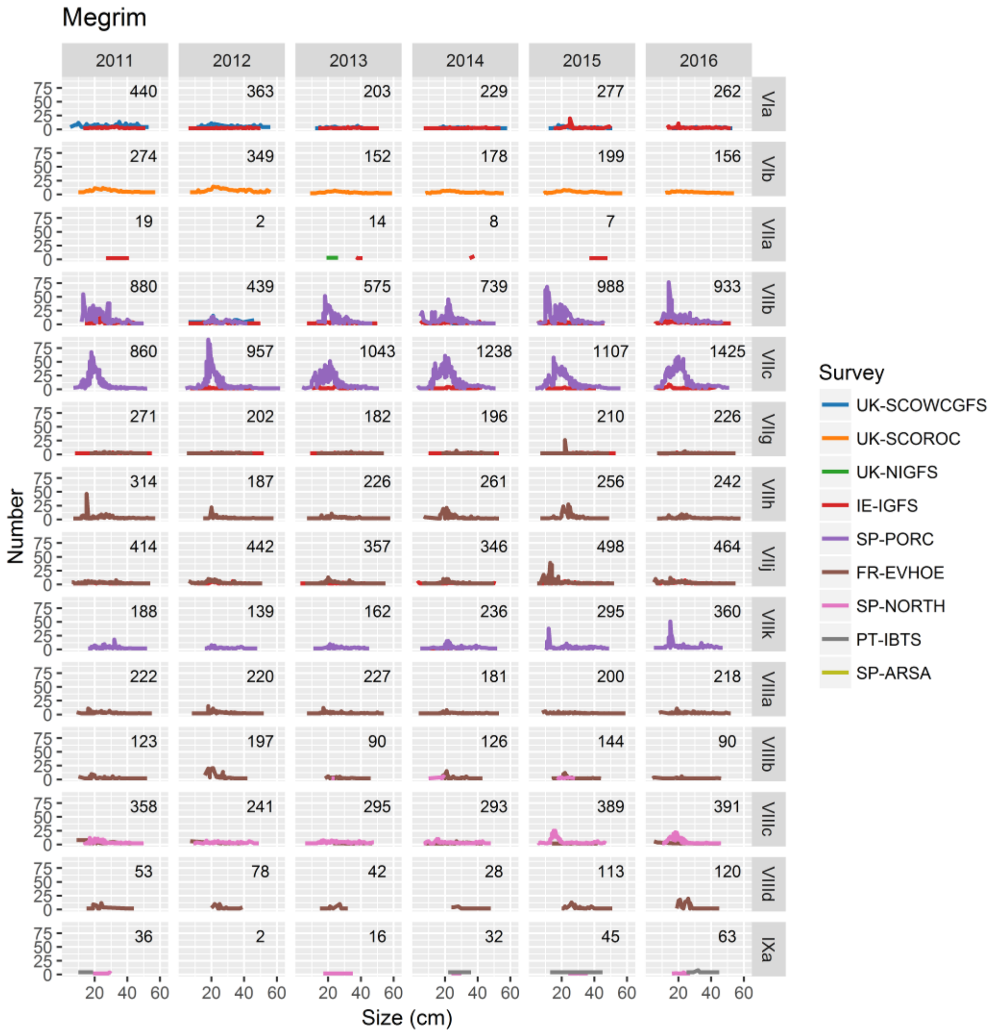

Figure A.5.22. Length distribution of megrim, *Lepidorhombus whiffiagonis*, per ICES Subarea in the NeAtl surveys (North Sea IBTS not included) during the last six years, each panel presents the surveys occurring. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the lines do not reflect proportional abundance in all the areas but within each survey. The number in each panel corresponds to the sum of the mean stratified number of individuals caught in one hour haul in the surveys carried out in that subdivision.

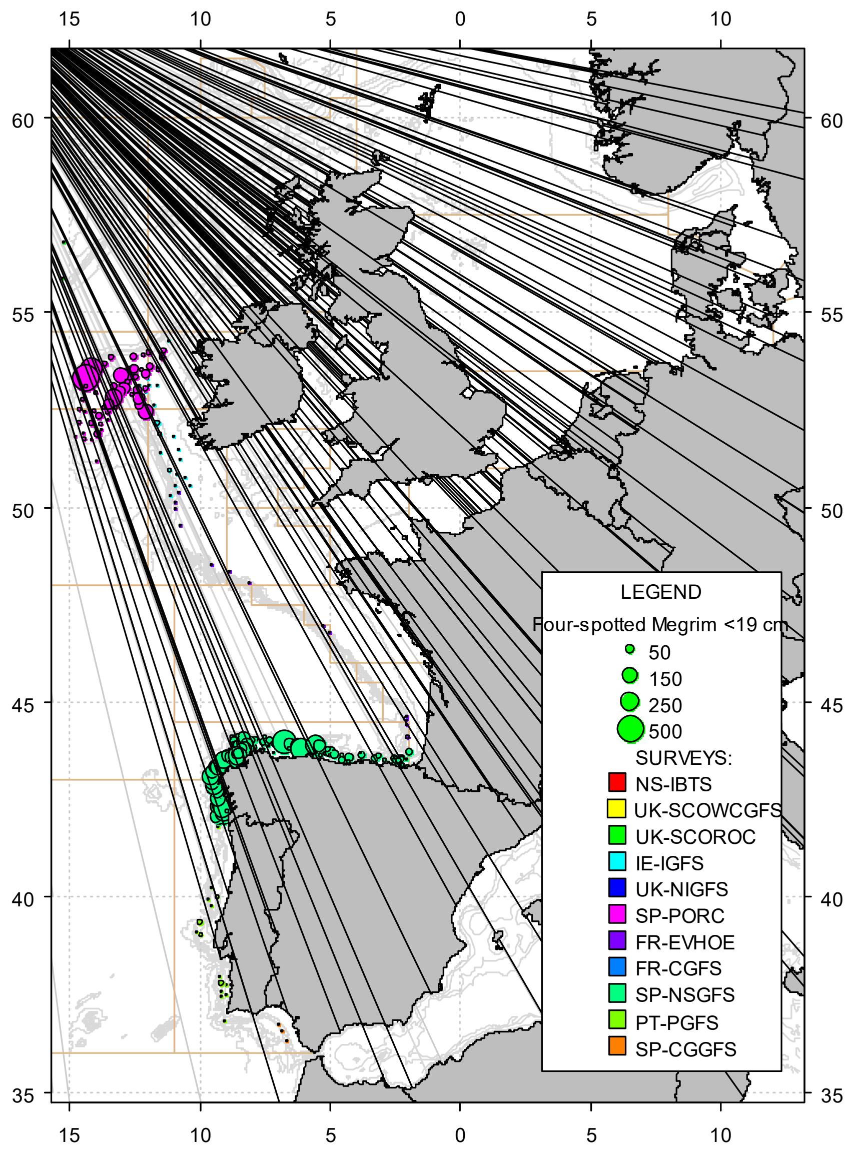

Figure A.5.23. Catches in numbers per hour of recruits of four-spotted megrim, *Lepidorhombus boscii* (<19 cm), in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

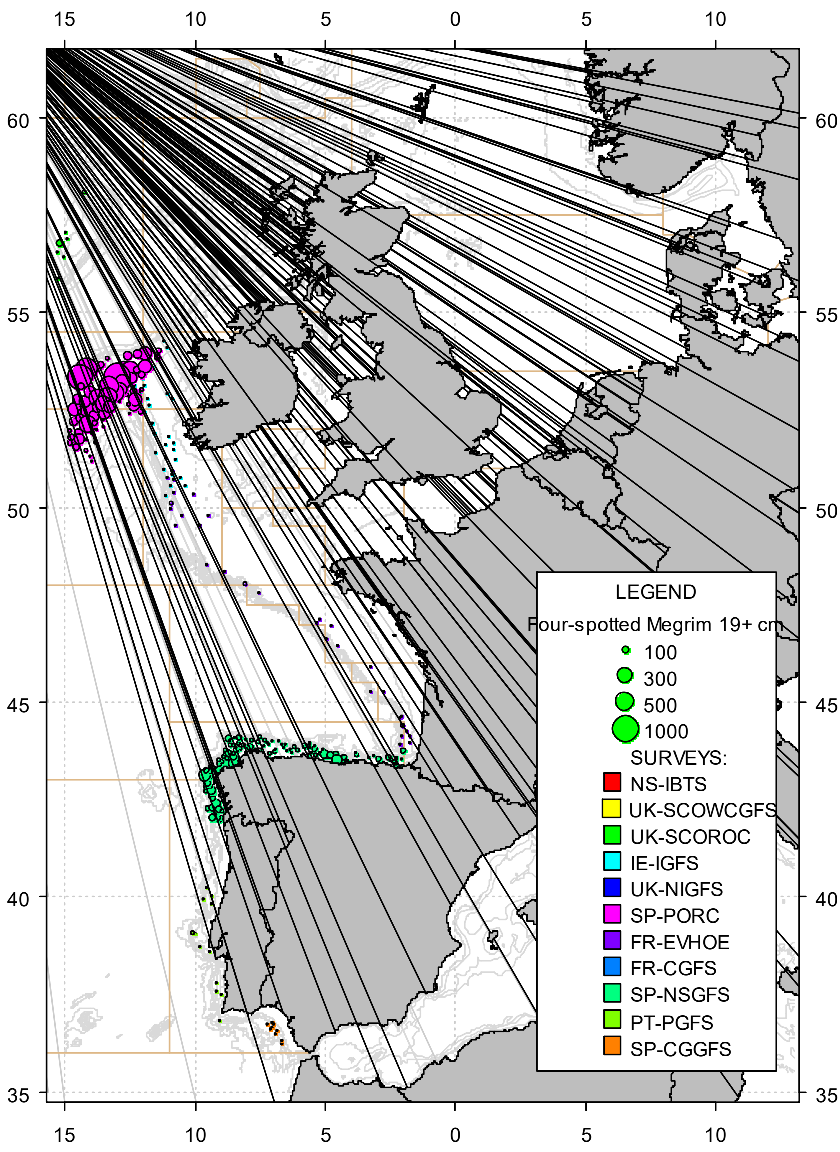

Figure A.5.24. Catches in numbers per hour of 2+ group four-spotted megrim, *Lepidorhombus boscii* (≥19 cm), in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

Figure A.5.25. Length distribution of four-spotted megrim, *Lepidorhombus boscii*, per ICES Subarea in the NeAtl surveys (North Sea IBTS not included) during the last six years, each panel presents the surveys occurring. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the lines do not reflect proportional abundance in all the areas but within each survey. The number in each panel corresponds to the sum of the mean stratified number of individuals caught in one hour haul in the surveys carried out in that subdivision.

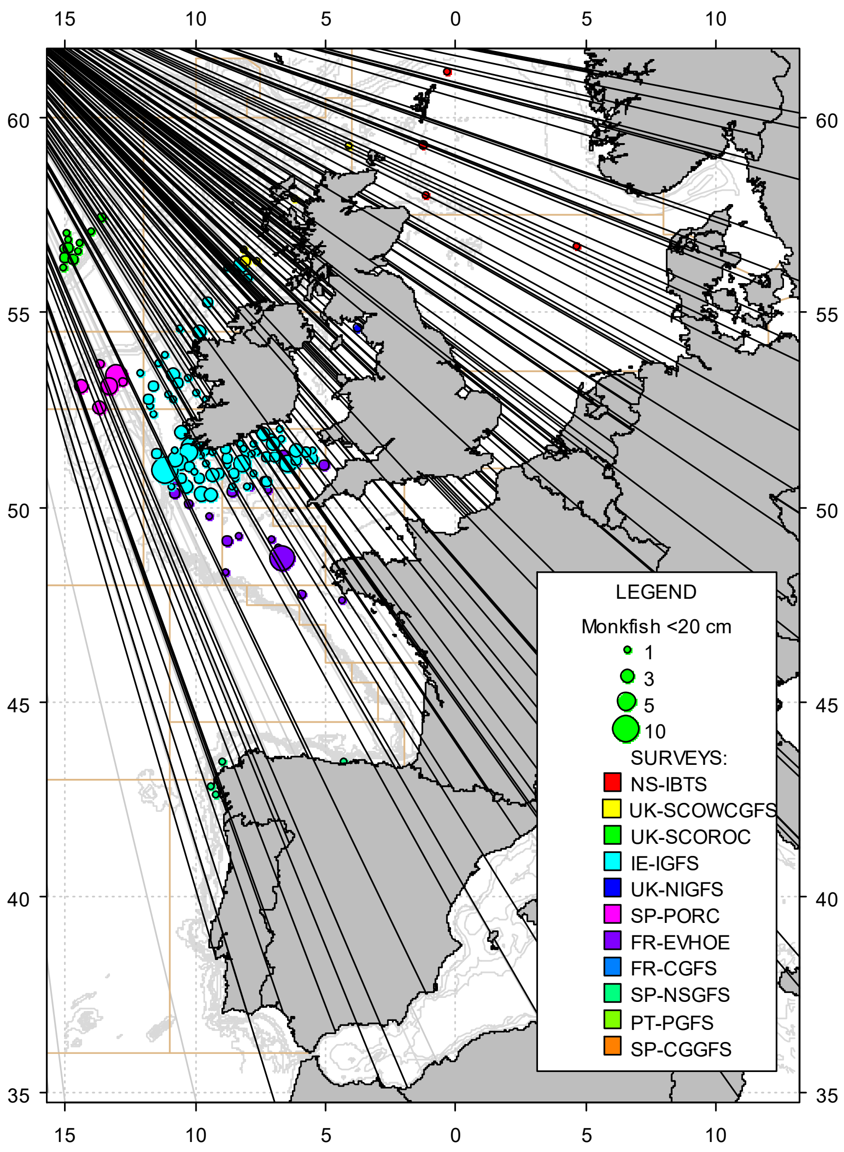

Figure A.5.26. Catches in numbers per hour of 0-group monkfish, *Lophius piscatorius* (<20 cm), in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

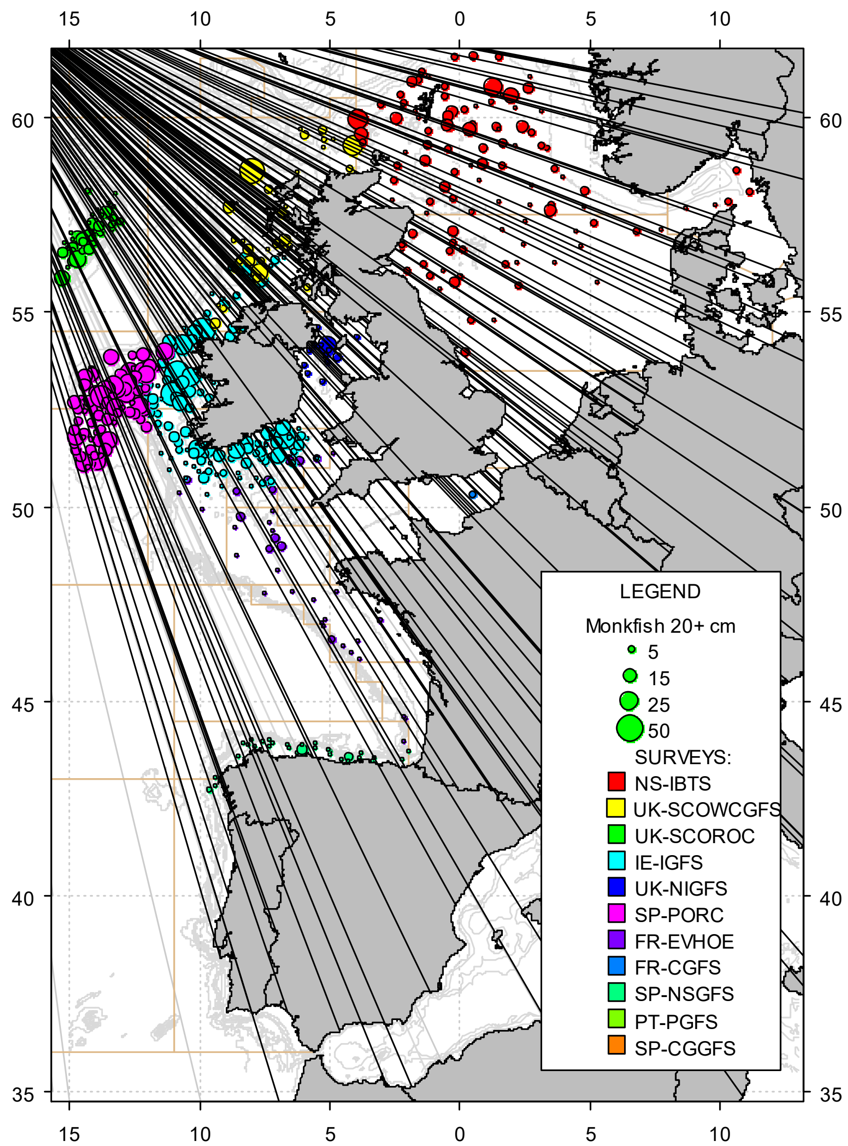

Figure A.5.27. Catches in numbers per hour of 1+ group monkfish, *Lophius piscatorius* (≥20 cm), in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

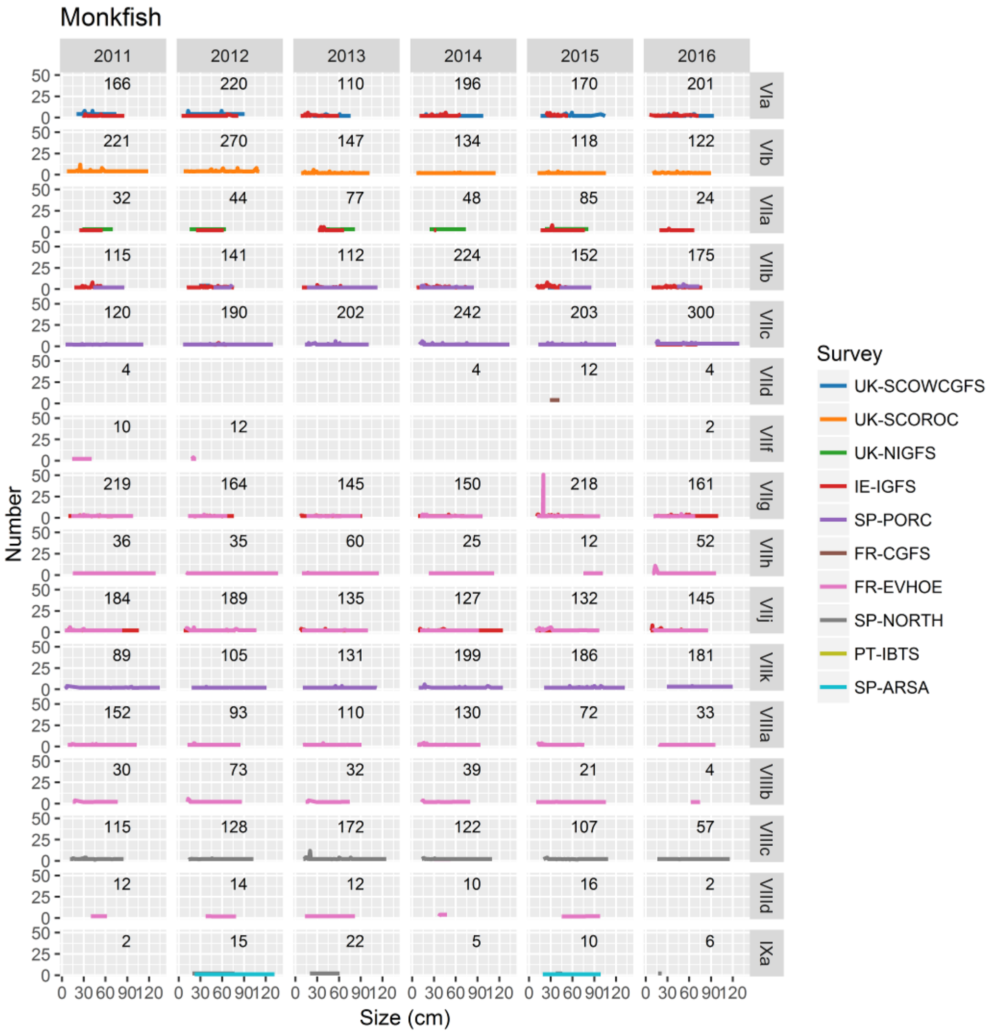

Figure A.5.28. Length distribution of monkfish, *Lophius piscatorius*, per ICES Subarea in the NeAtl surveys (North Sea IBTS not included) during the last six years, each panel presents the surveys occurring. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the lines do not reflect proportional abundance in all the areas but within each survey. The number in each panel corresponds to the sum of the mean stratified number of individuals caught in one hour haul in the surveys carried out in that subdivision.

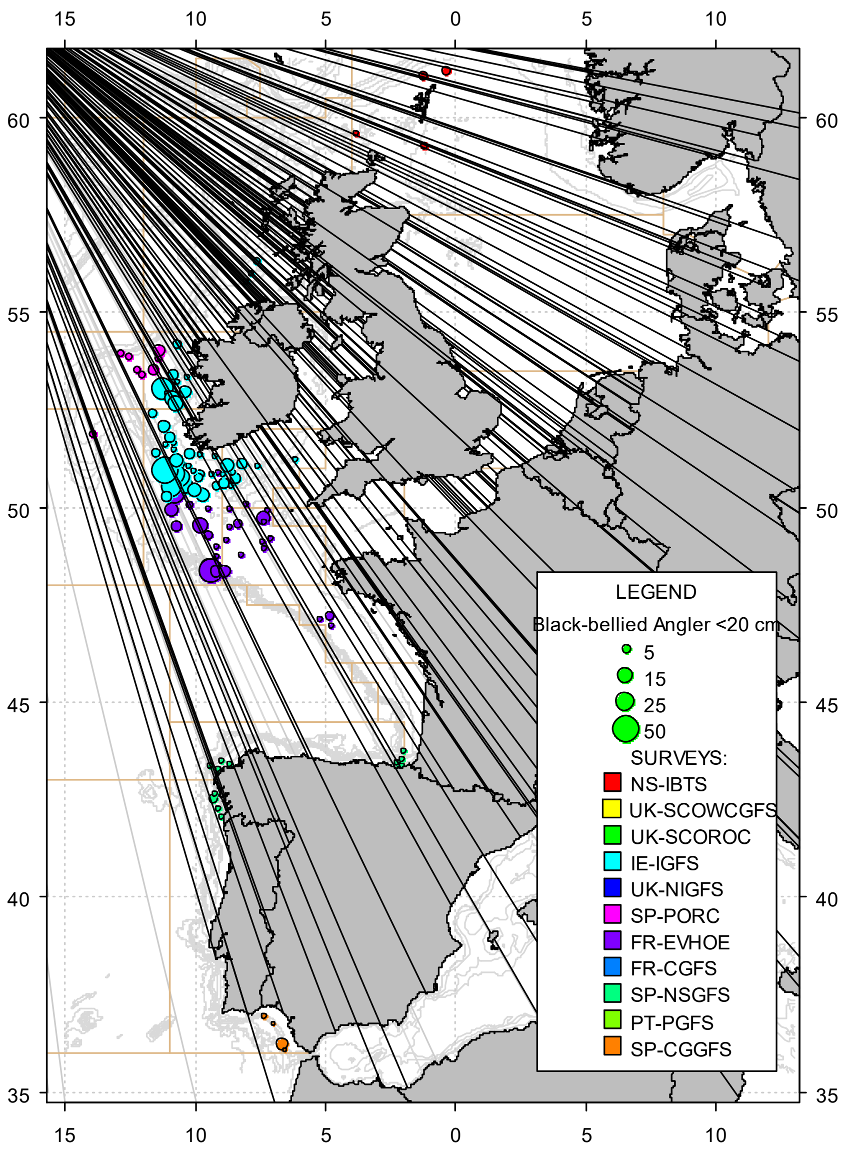

Figure A.5.29. Catches in numbers per hour of 0-group black-bellied anglerfish, *Lophius budegassa* (<20 cm), in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

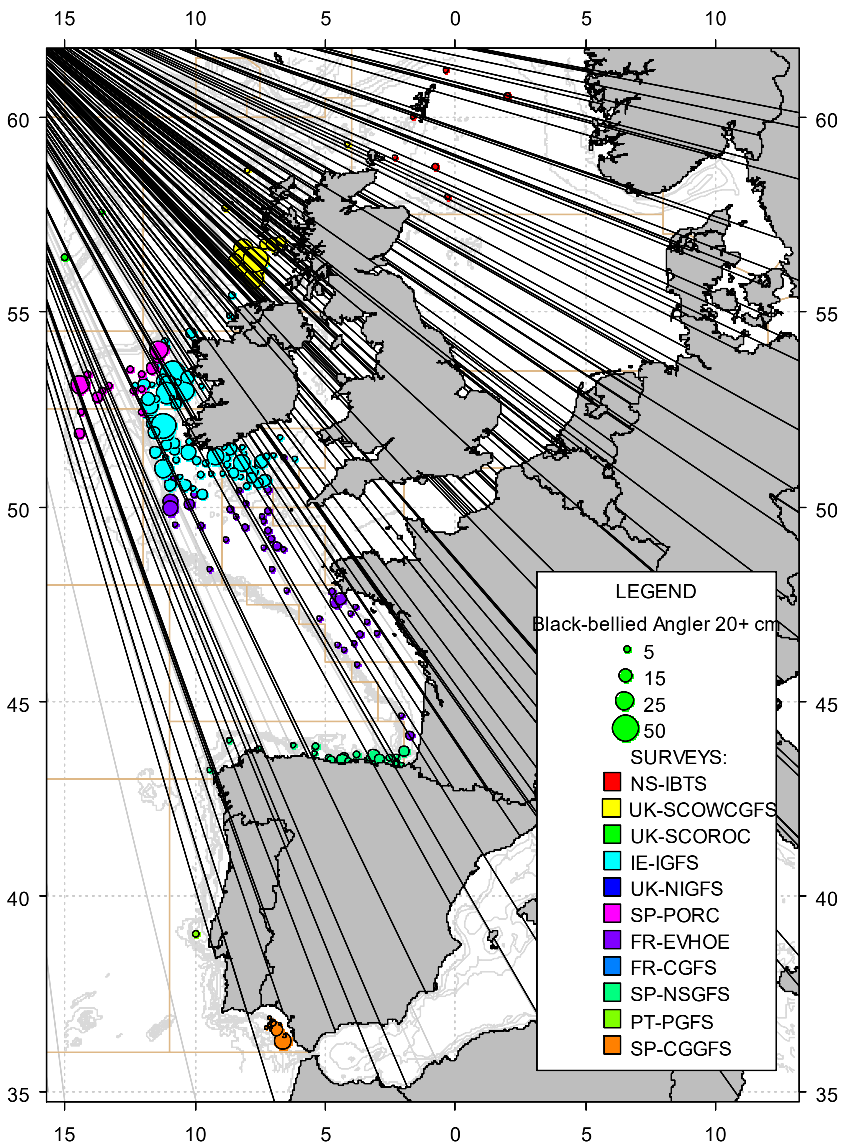

Figure A.5.30. Catches in numbers per hour of 1+ group black-bellied anglerfish, *Lophius budegassa* (≥20 cm), in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

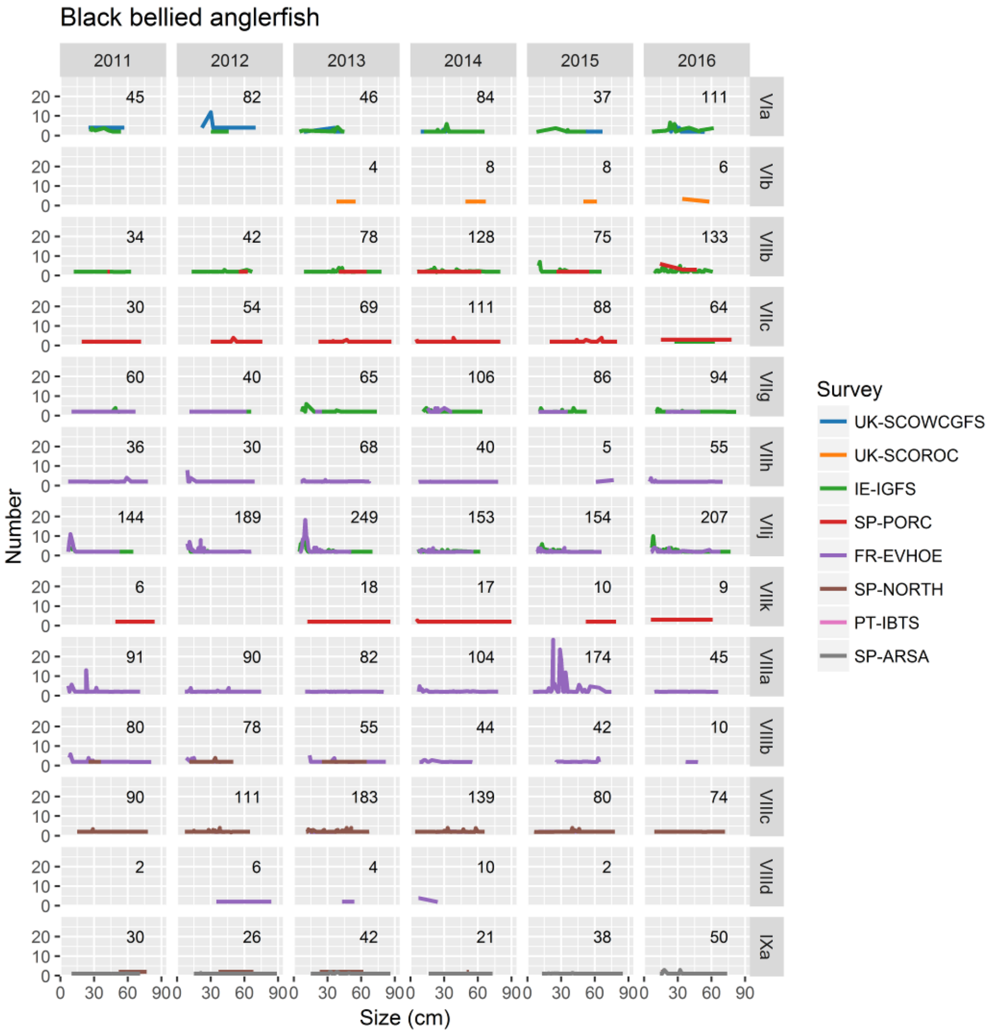

Figure A.5.31. Length distribution of black-bellied anglerfish, *Lophius budegassa*, per ICES Sub-area in the NeAtl surveys (North Sea IBTS not included) during the last six years, each panel presents the surveys occurring. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the lines do not reflect proportional abundance in all the areas but within each survey. The number in each panel corresponds to the sum of the mean stratified number of individuals caught in one hour haul in the surveys carried out in that subdivision.

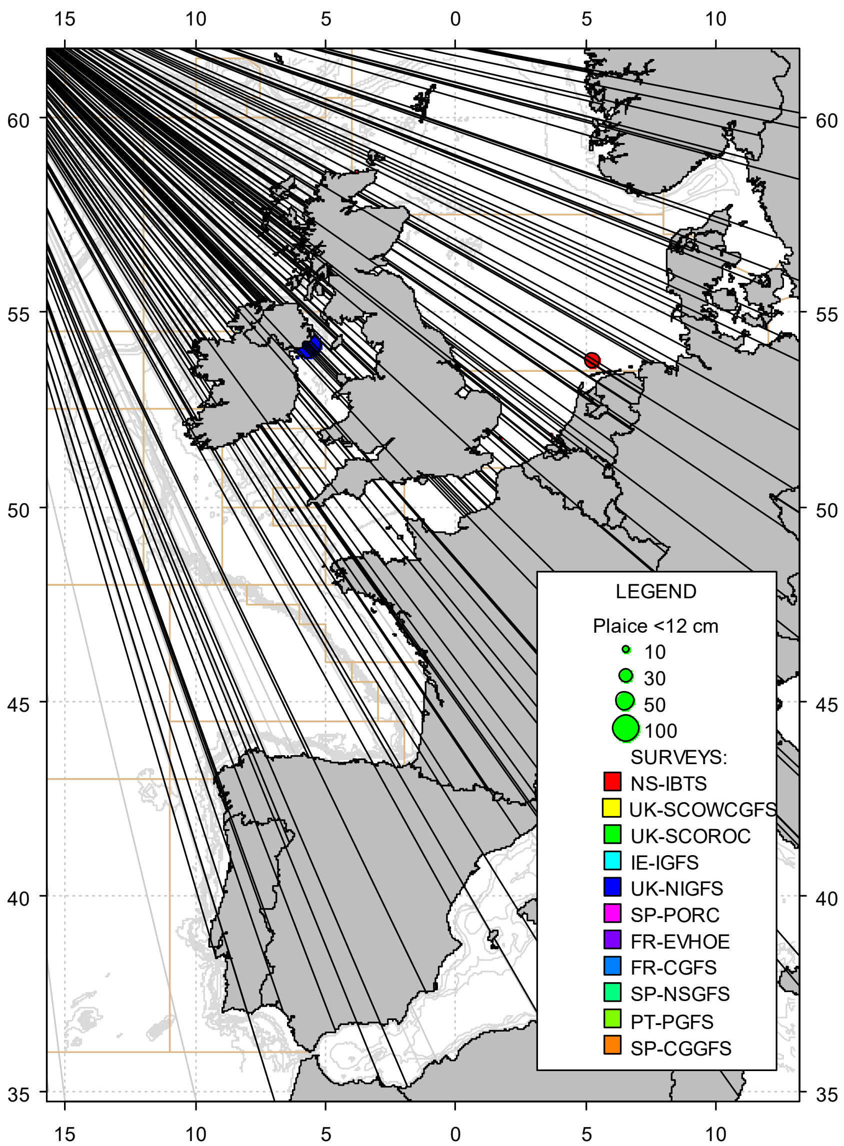

Figure A.5.32. Catches in numbers per hour of 0-group plaice, *Pleuronectes platessa* (<12 cm), in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

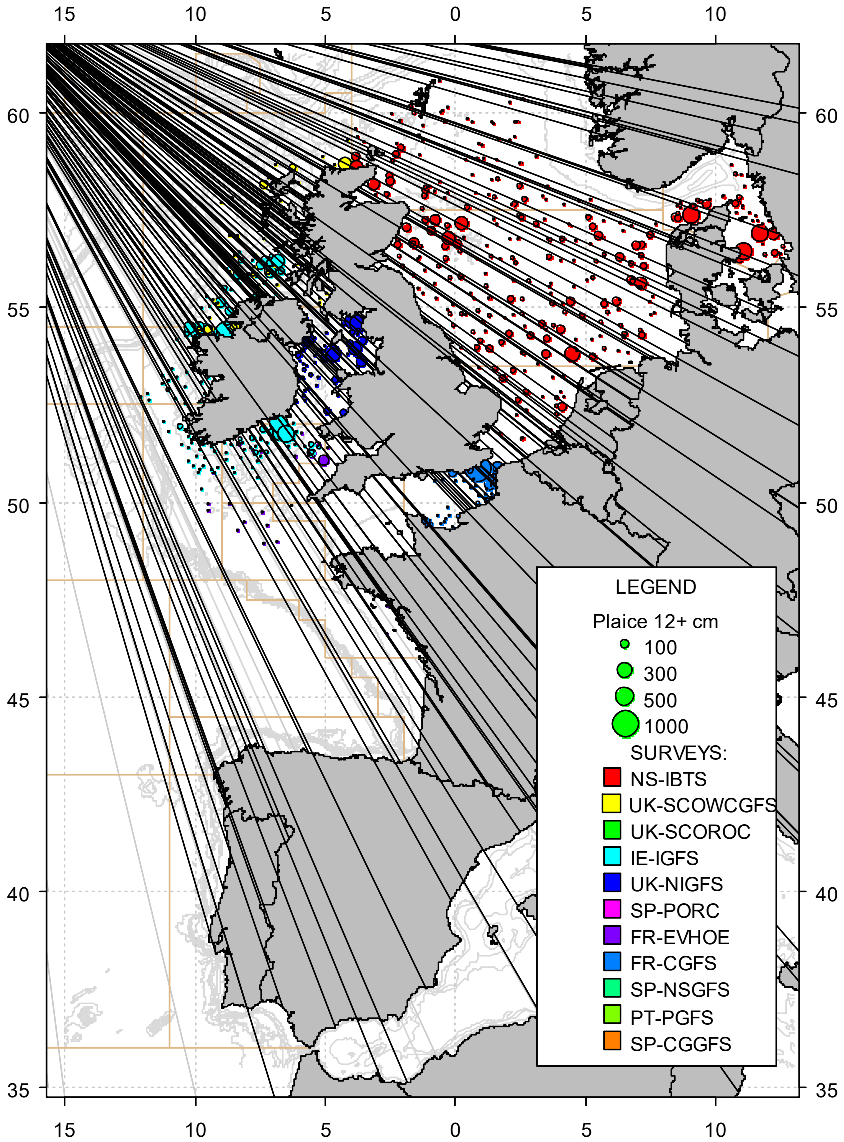

Figure A.5.33. Catches in numbers per hour of 1+ group plaice, *Pleuronectes platessa* (≥12 cm), in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

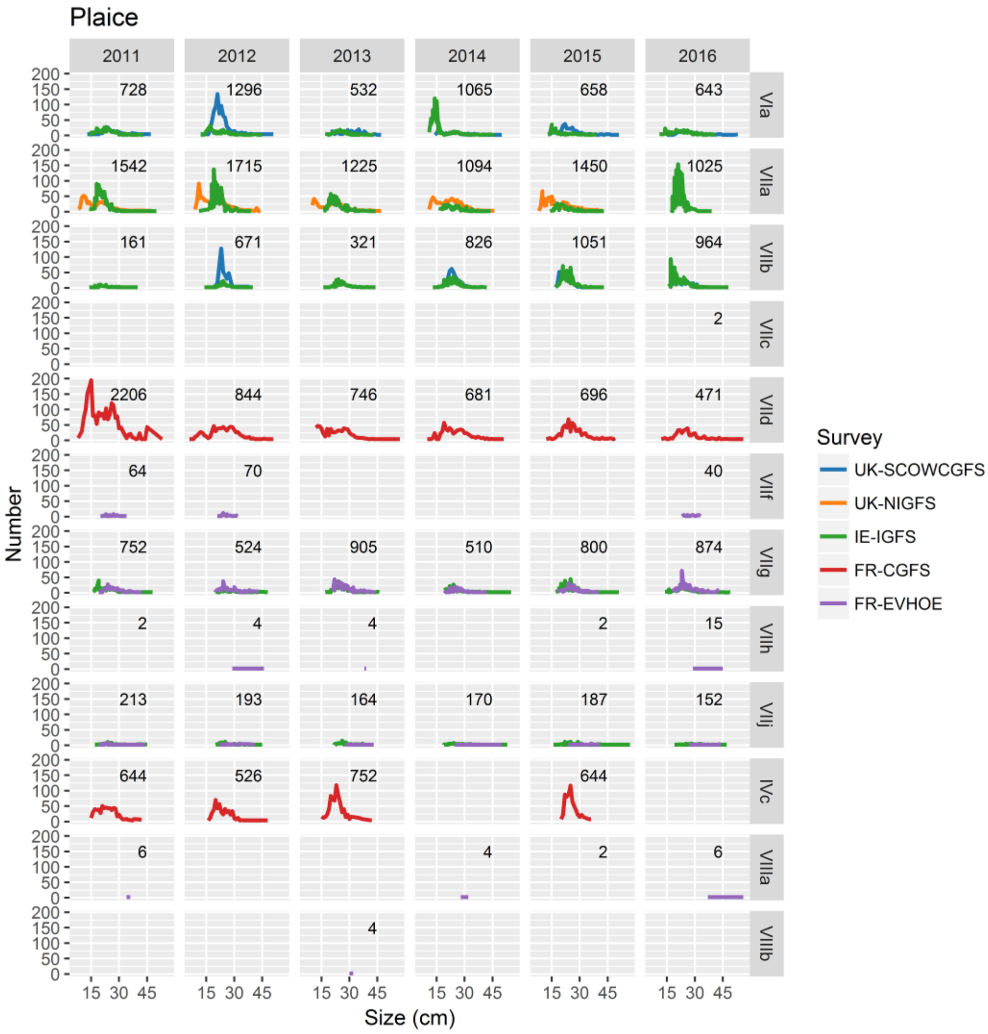

Figure A.5.34. Length distribution of plaice, *Pleuronectes platessa*, per ICES Subarea in the NeAtl surveys (North Sea IBTS not included) during the last six years, each panel presents the surveys occurring. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the lines do not reflect proportional abundance in all the areas but within each survey. The number in each panel corresponds to the sum of the mean stratified number of individuals caught in one hour haul in the surveys carried out in that subdivision.

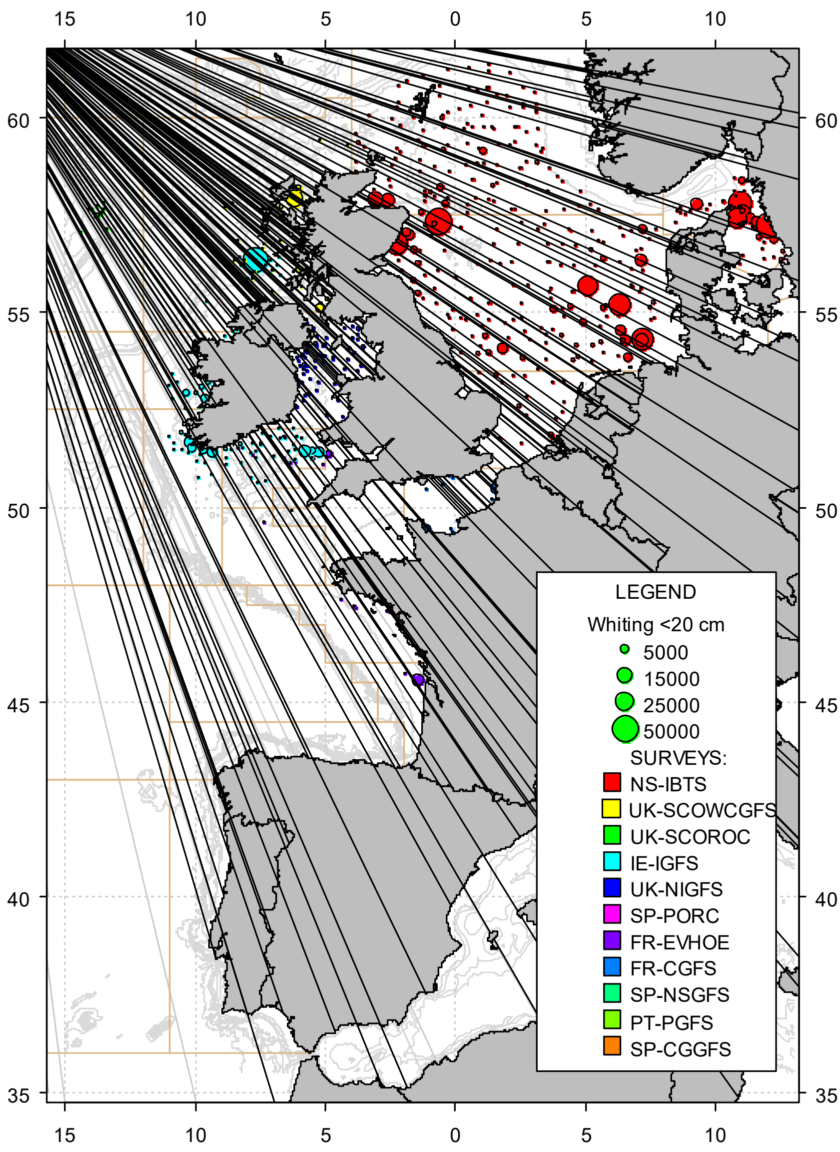

Figure A.5.35. Catches in numbers per hour of 0-group whiting, *Merlangius merlangus* (<20 cm), in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

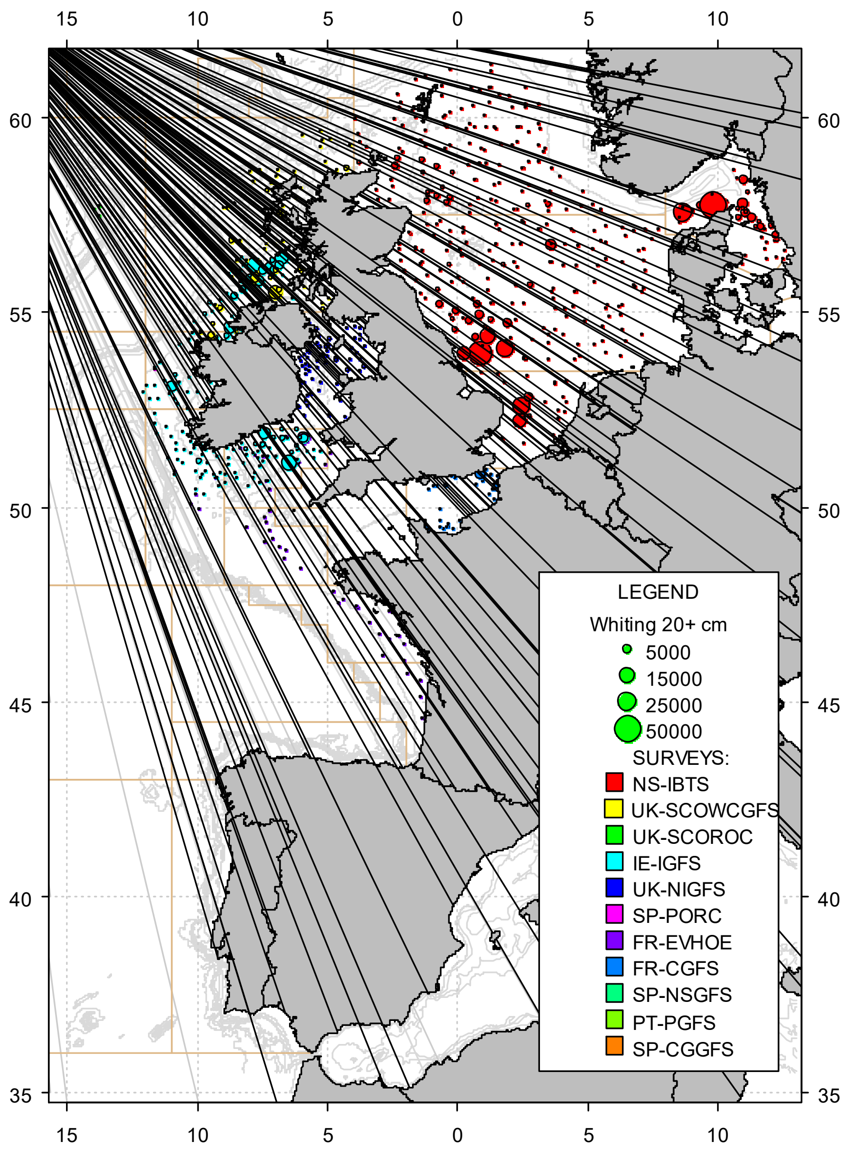

Figure A.5.36. Catches in numbers per hour of 1+ group whiting, *Merlangius merlangus* (≥20 cm), in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

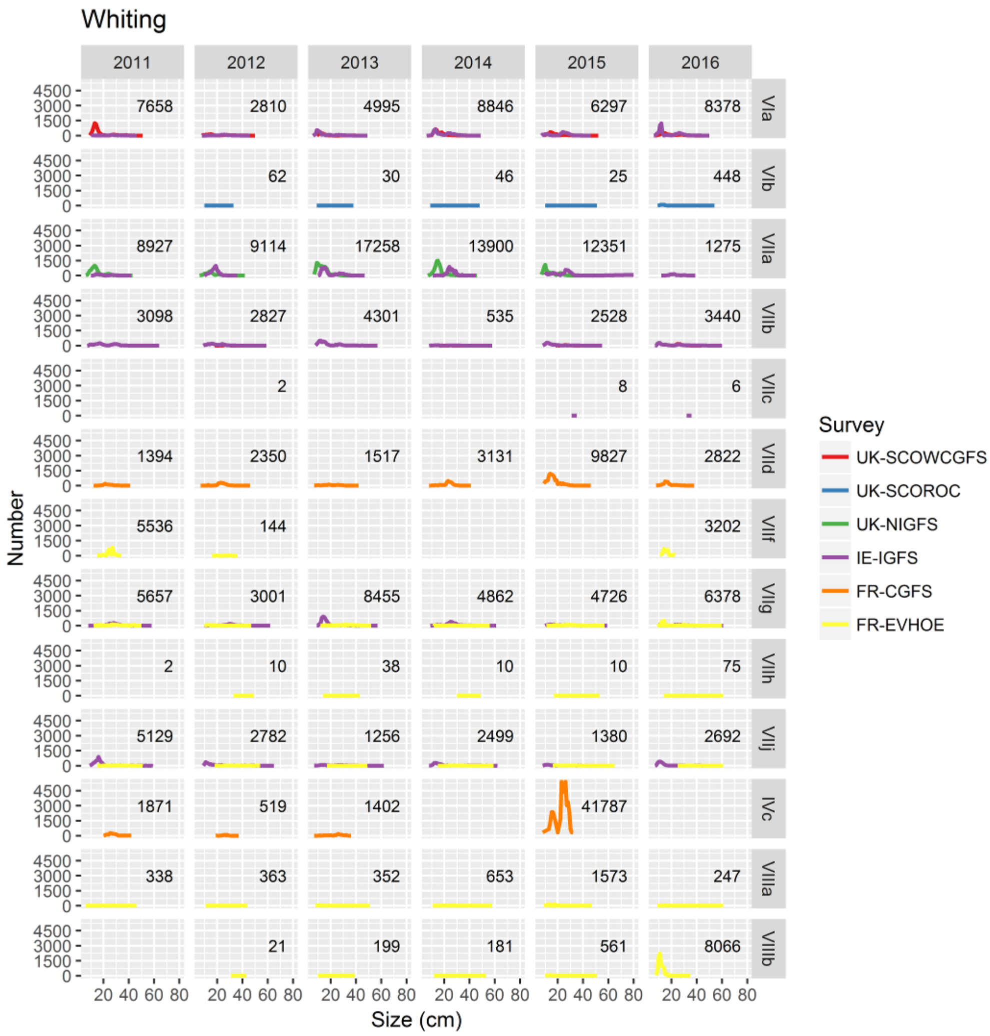

Figure A.5.37. Length distribution of whiting, *Merlangius merlangus*, per ICES Subarea in the NeAtl surveys (North Sea IBTS not included) during the last six years, each panel presents the surveys occurring. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the lines do not reflect proportional abundance in all the areas but within each survey. The number in each panel corresponds to the sum of the mean stratified number of individuals caught in one hour haul in the surveys carried out in that subdivision.

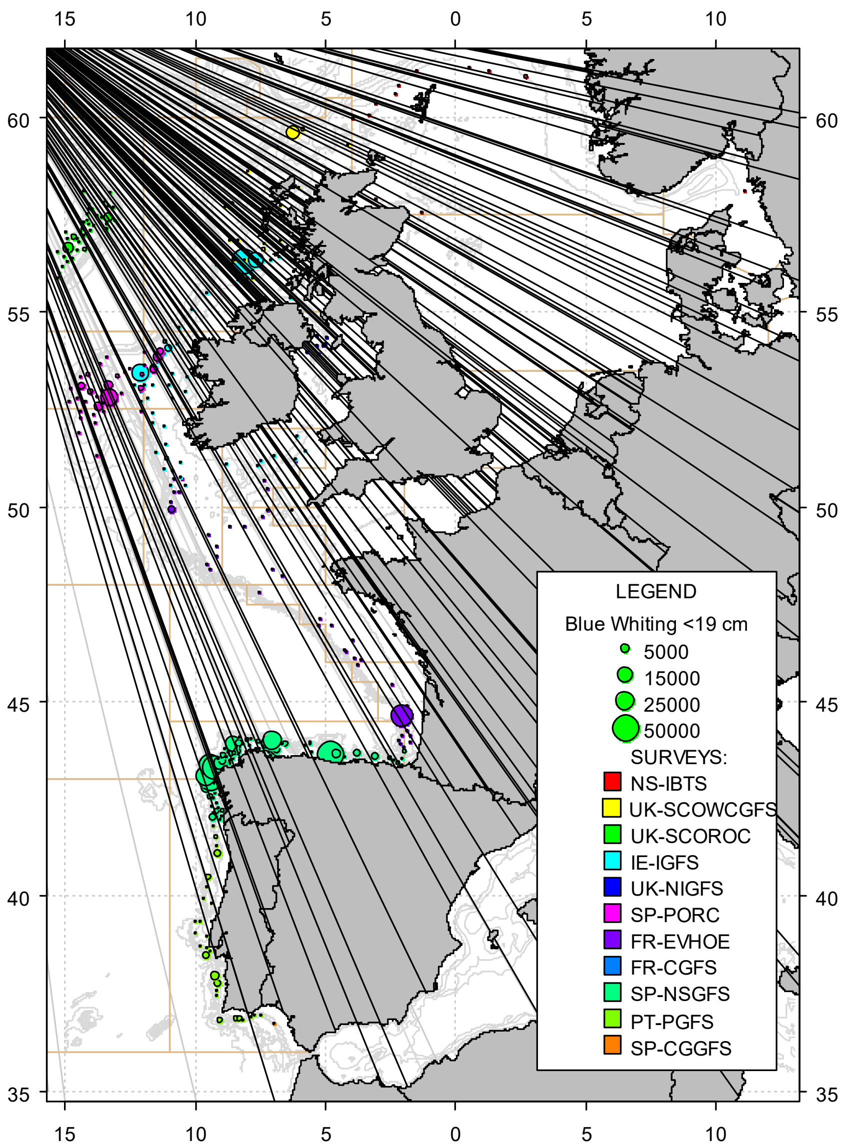

Figure A.5.38. Catches in numbers per hour of 0-group blue whiting, *Micromesistius poutassou* (<19 cm), in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

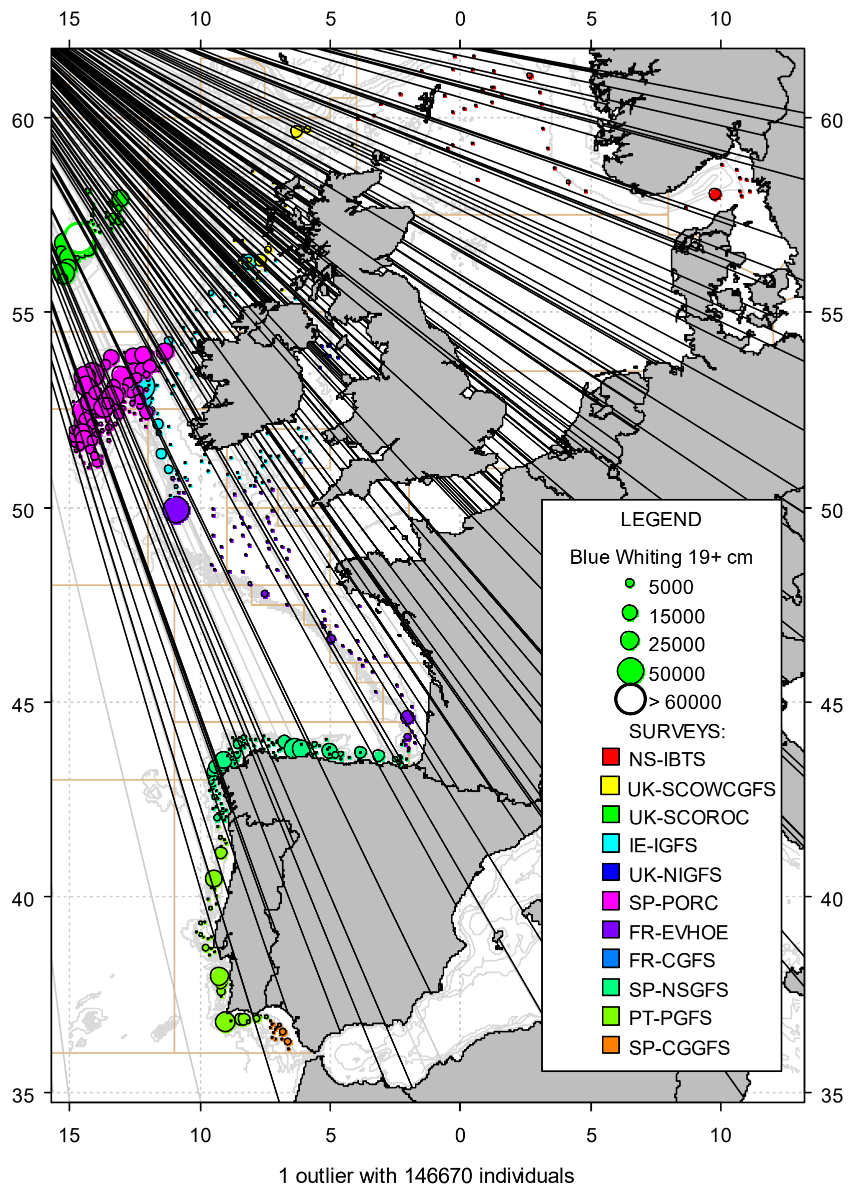

Figure A.5.39. Catches in numbers per hour of 1+ group blue whiting, *Micromesistius poutassou* (≥19 cm), in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

Figure A.5.40. Length distribution of blue whiting, *Micromesistius poutassou*, per ICES Subarea in the NeAtl surveys (North Sea IBTS not included) during the last six years, each panel presents the surveys occurring. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the lines do not reflect proportional abundance in all the areas but within each survey. The number in each panel corresponds to the sum of the mean stratified number of individuals caught in one hour haul in the surveys carried out in that subdivision.

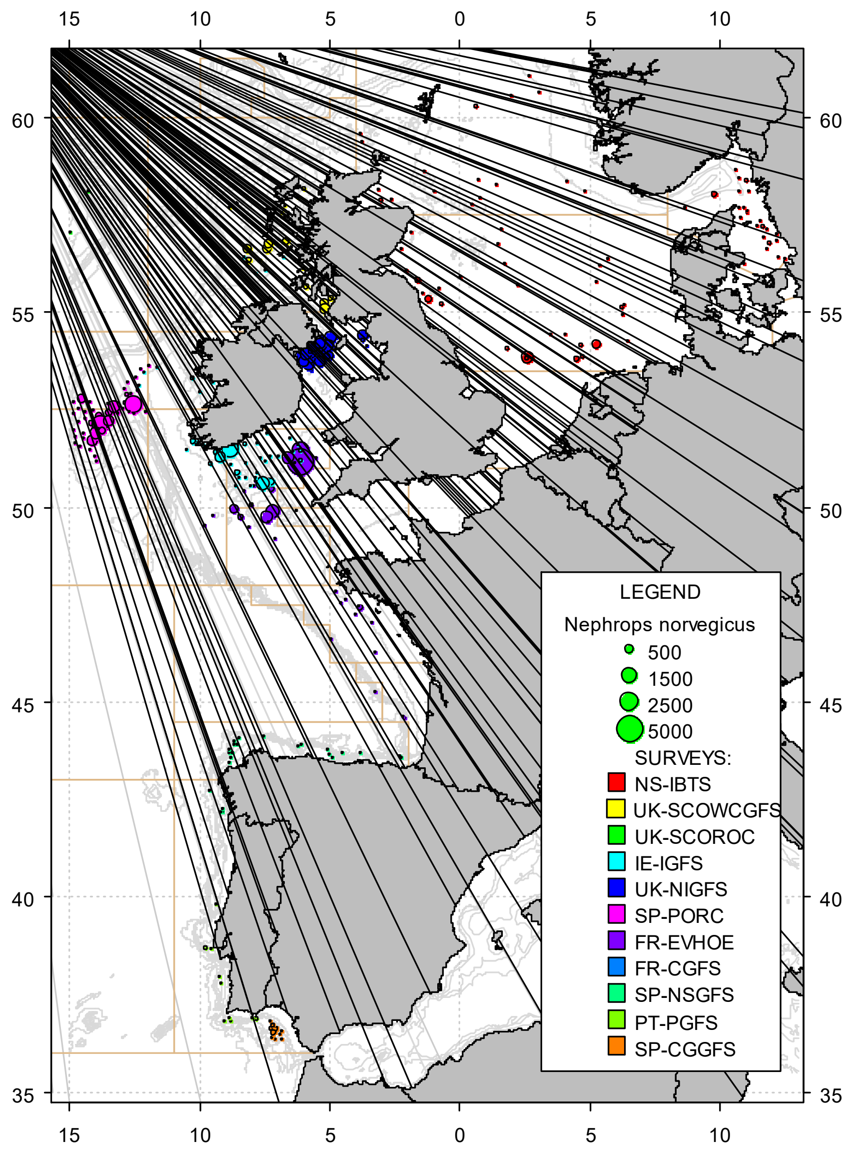

Figure A.5.41. Catches in numbers per hour of Norway lobster, *Nephrops norvegicus*, in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

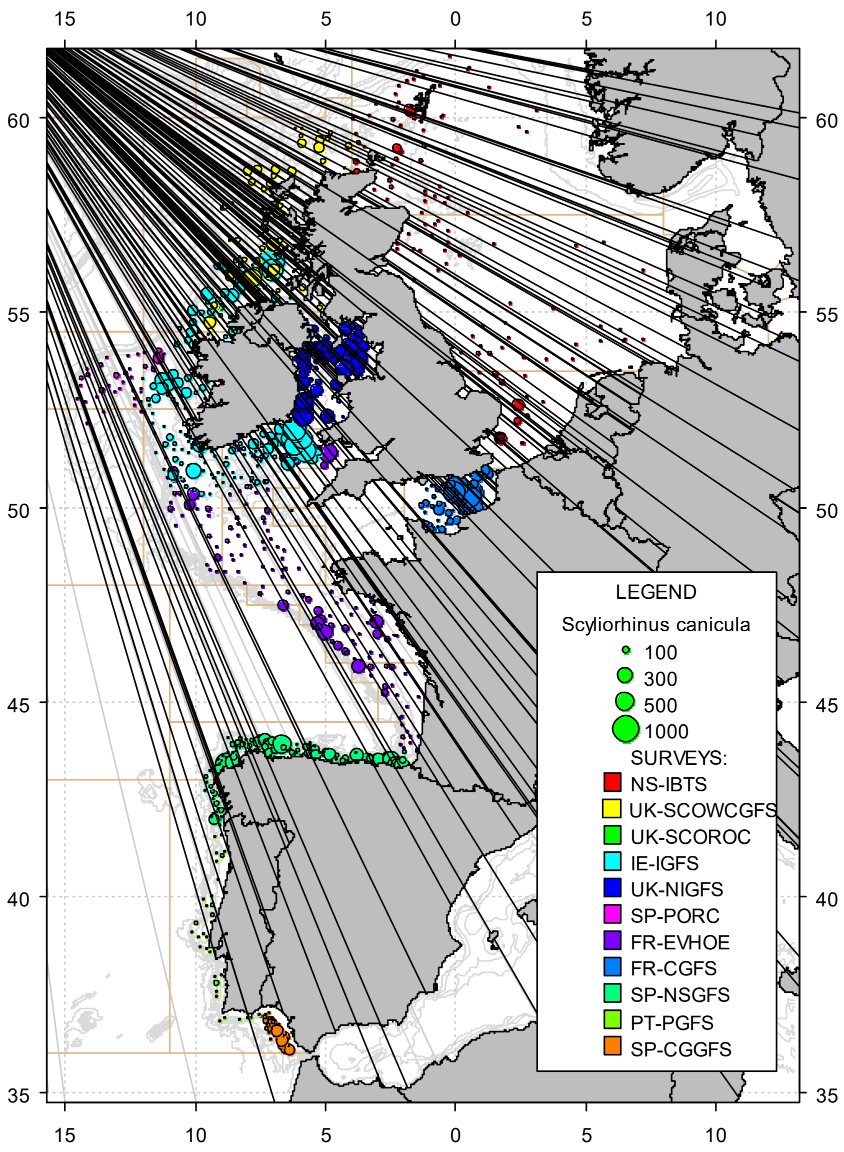

Figure A.5.42. Catches in numbers per hour of lesser spotted dogfish, *Scyliorhinus canicula*, in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

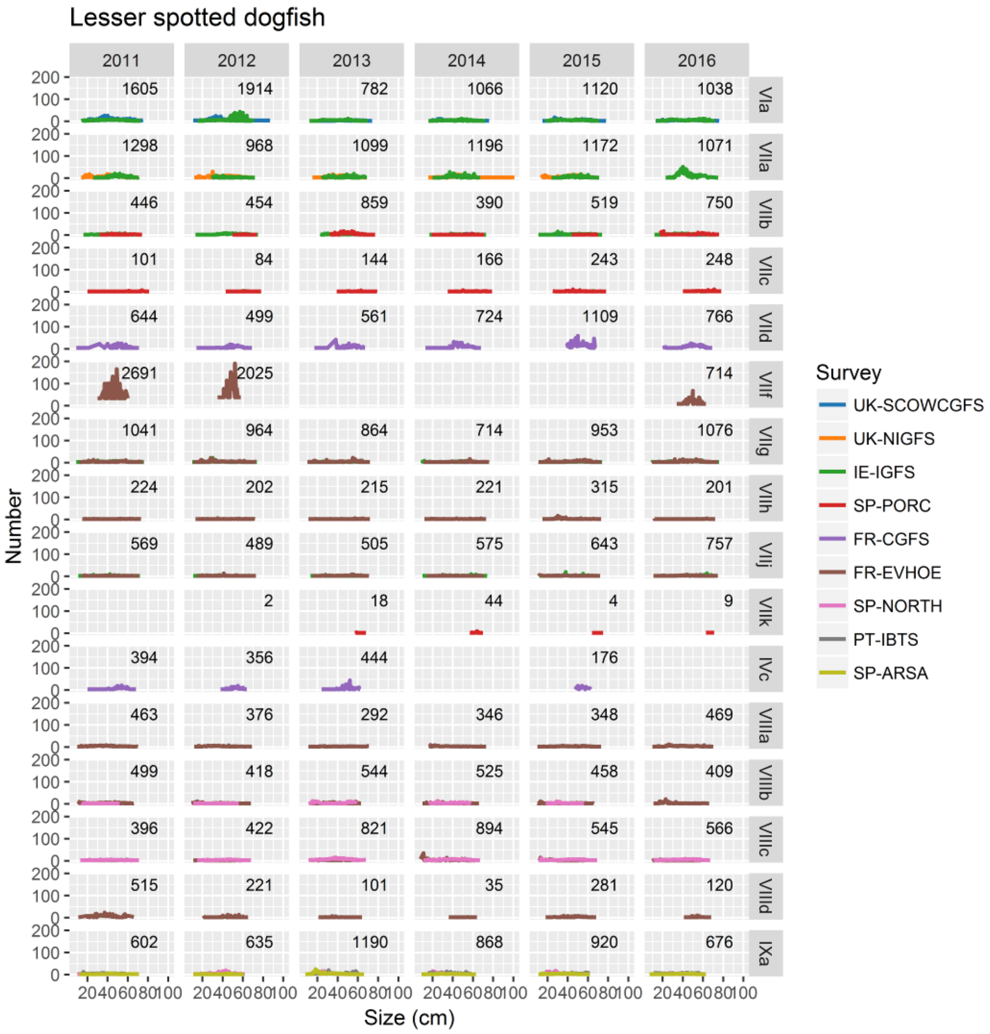

Figure A.5.43. Length distribution of lesser spotted dogfish, *Scyliorhinus canicula*, per ICES Subarea in the NeAtl surveys (North Sea IBTS not included) during the last six years, each panel presents the surveys occurring. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the lines do not reflect proportional abundance in all the areas but within each survey. The number in each panel corresponds to the sum of the mean stratified number of individuals caught in one hour haul in the surveys carried out in that subdivision.

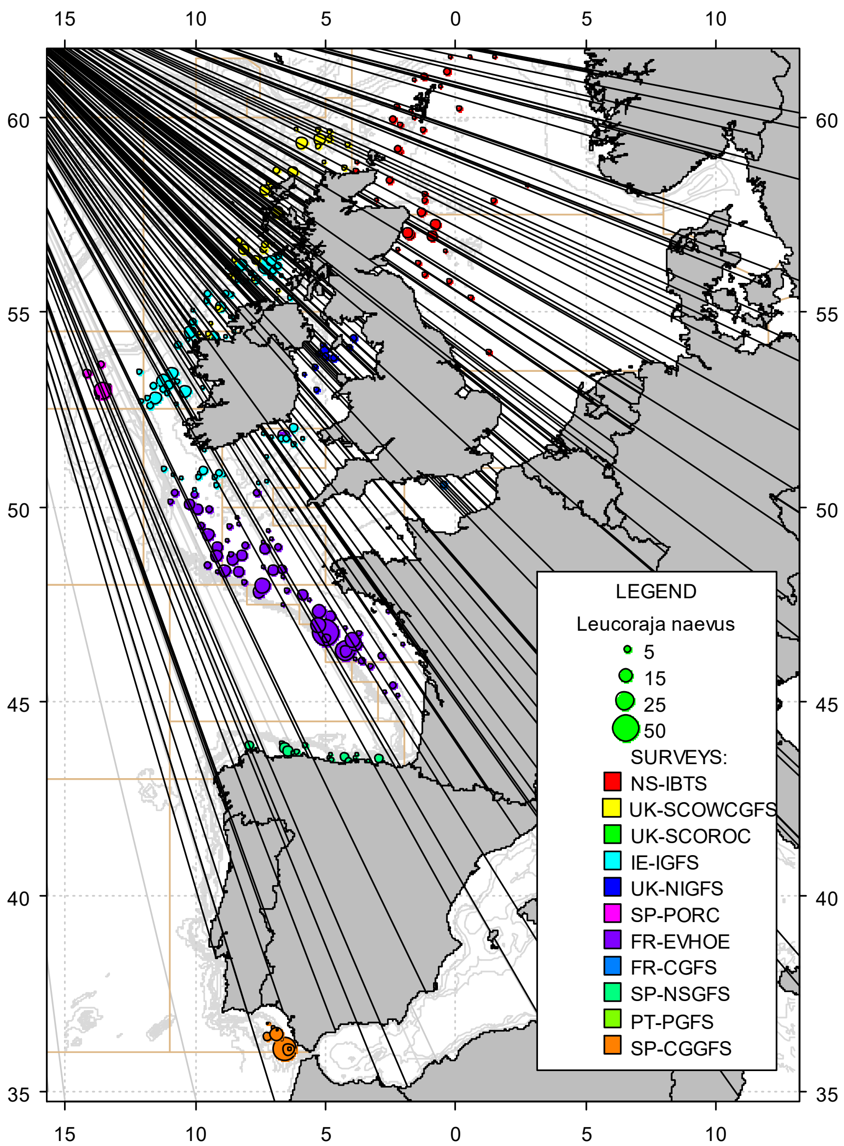

Figure A.5.44. Catches in numbers per hour of cuckoo ray, *Leucoraja naevus*, in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

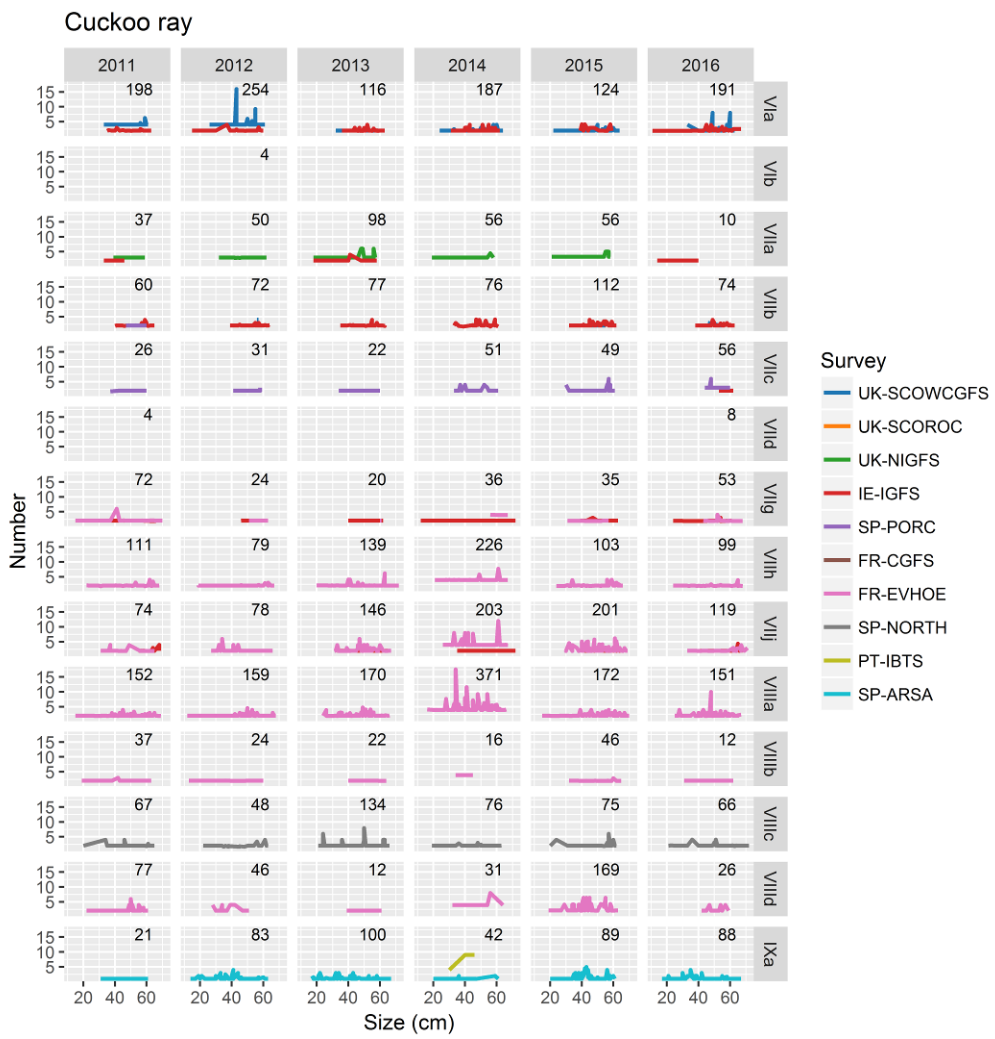

Figure A.5.45. Length distribution of cuckoo ray, *Leucoraja naevus*, per ICES Subarea in the NeAtl surveys (North Sea IBTS not included) during the last six years, each panel presents the surveys occurring. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the lines do not reflect proportional abundance in all the areas but within each survey. The number in each panel corresponds to the sum of the mean stratified number of individuals caught in one hour haul in the surveys carried out in that subdivision.

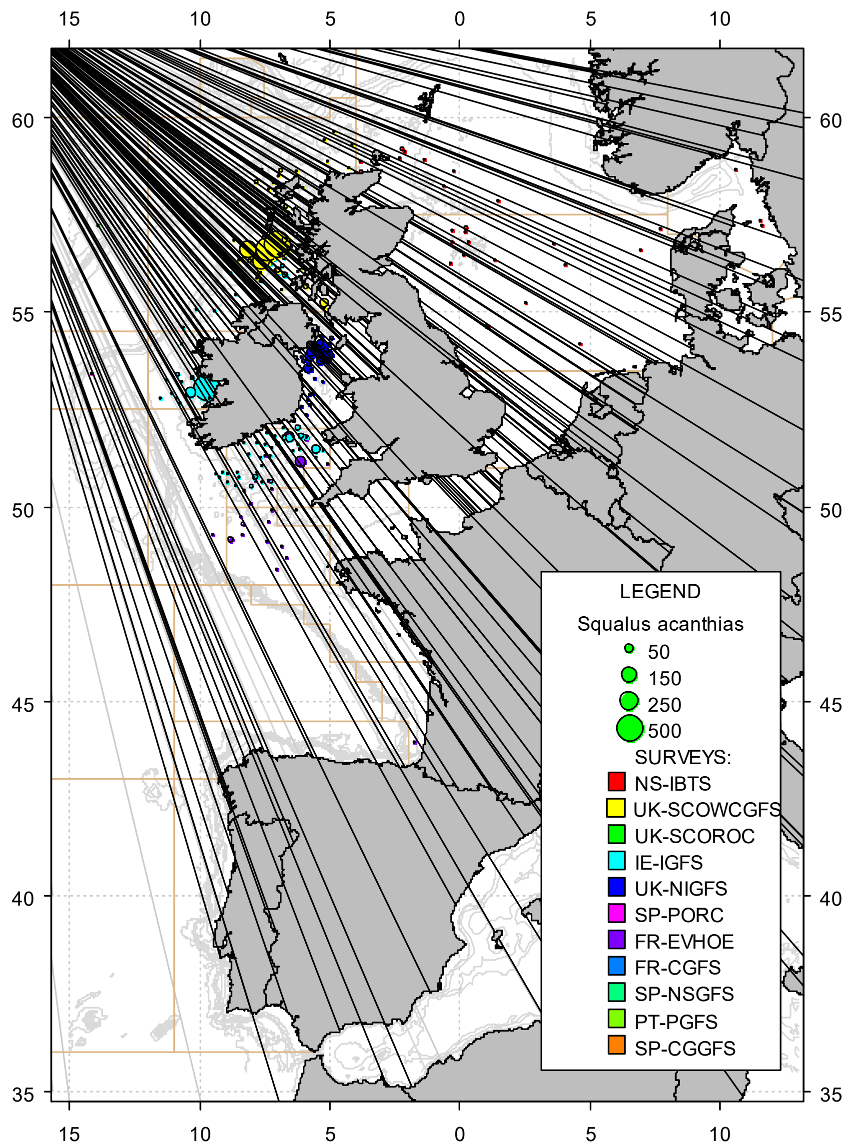

Figure A.5.46. Catches in numbers per hour per hour of spurdog, *Squalus acanthias*, in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

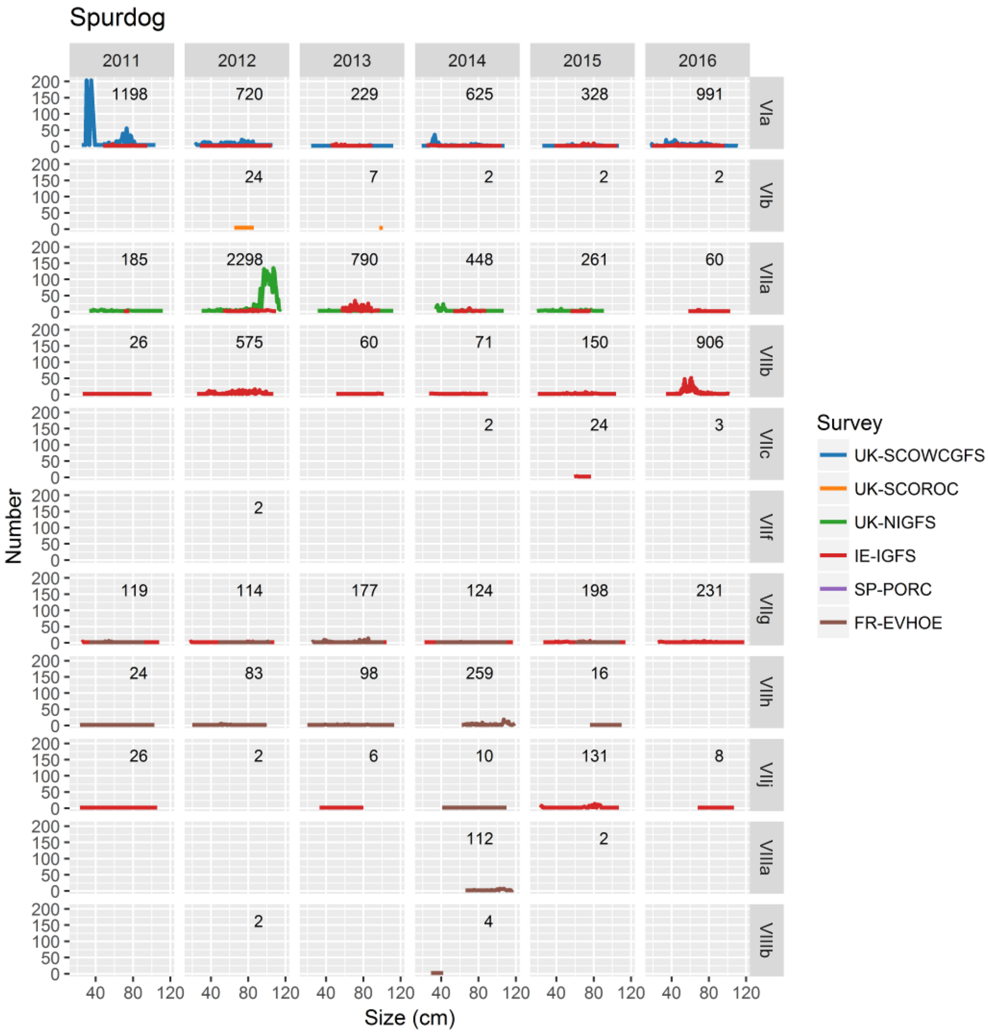

Figure A.5.47. Length distribution of spurdog, *Squalus acanthias*, per ICES Subarea in the NeAtl surveys (North Sea IBTS not included) during the last six years, each panel presents the surveys occurring. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the lines do not reflect proportional abundance in all the areas but within each survey. The number in each panel corresponds to the sum of the mean stratified number of individuals caught in one hour haul in the surveys carried out in that subdivision.

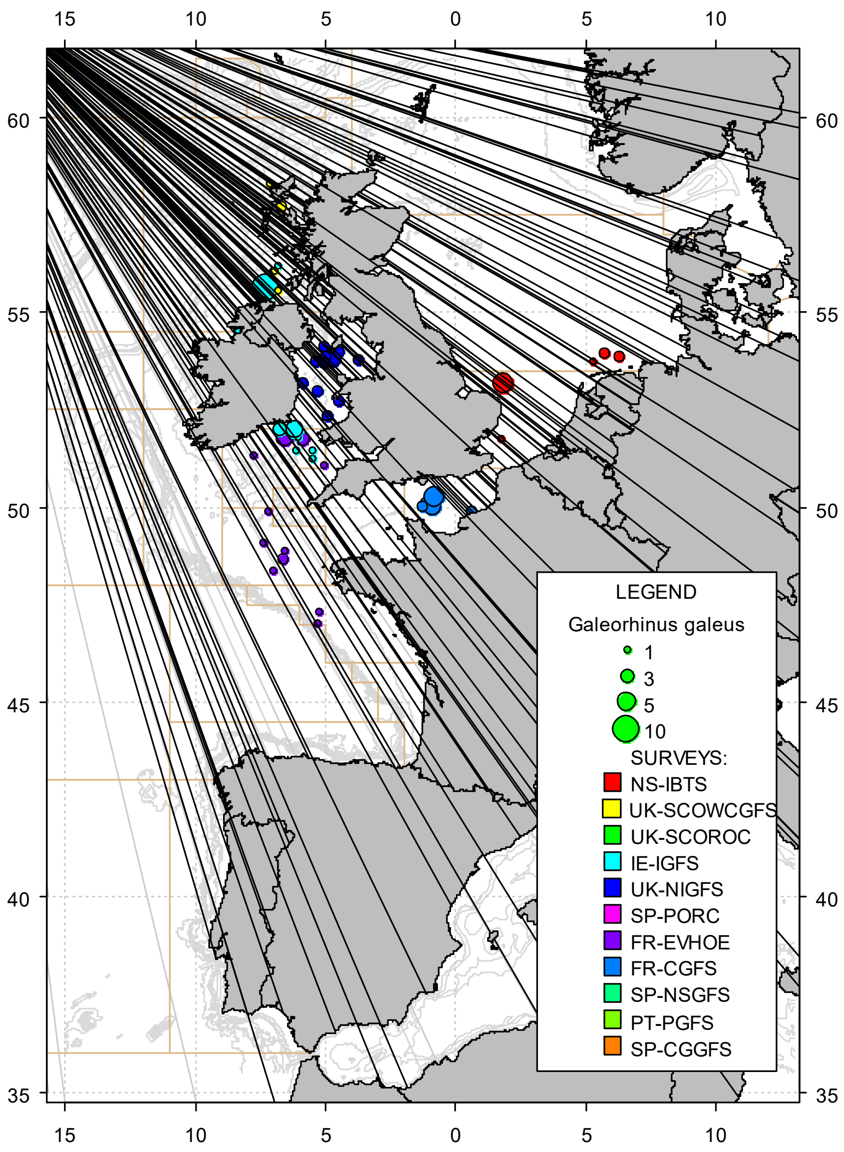

Figure A.5.48. Catches in numbers per hour per hour of tope, *Galeorhinus galeus*, in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

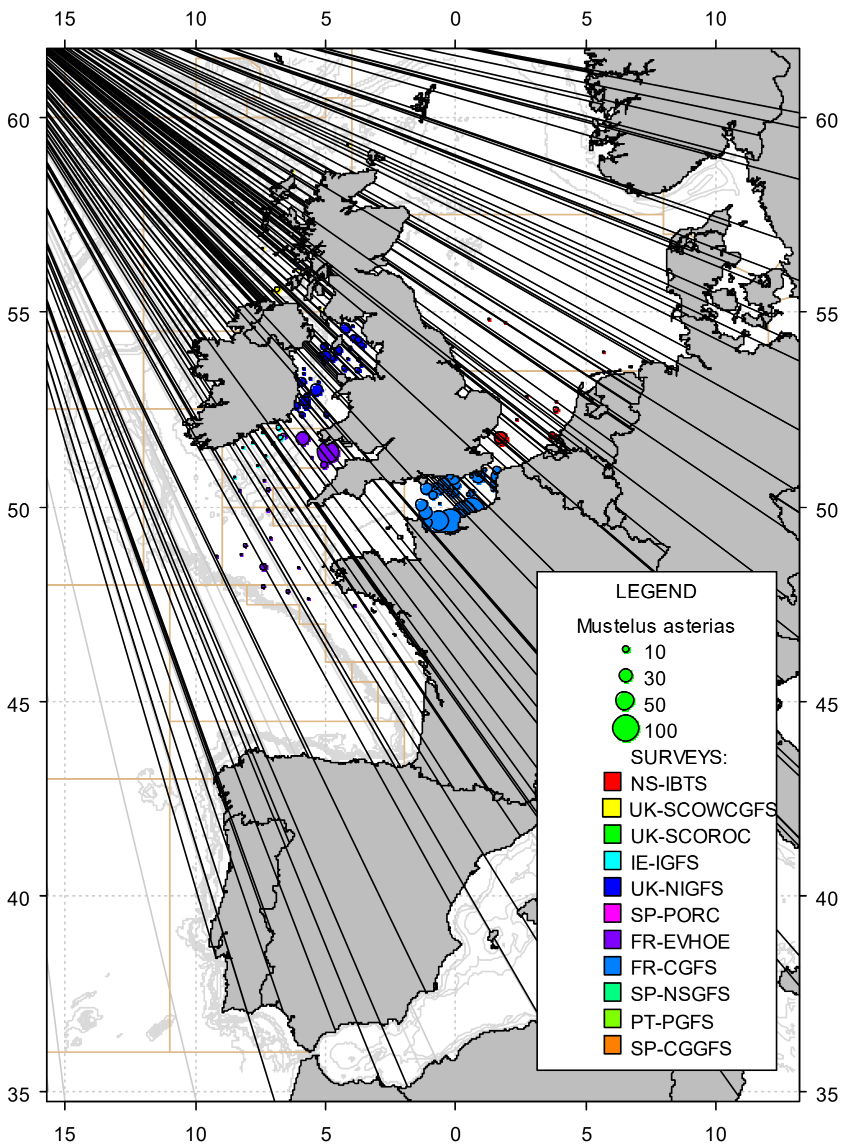

Figure A.5.49. Catches in numbers per hour per hour of smooth-hound, *Mustelus* spp. in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey. Data from the northern part of the region are assumed to refer to *M. asterias*, and the southernmost record likely to be *M. Mustelus*.

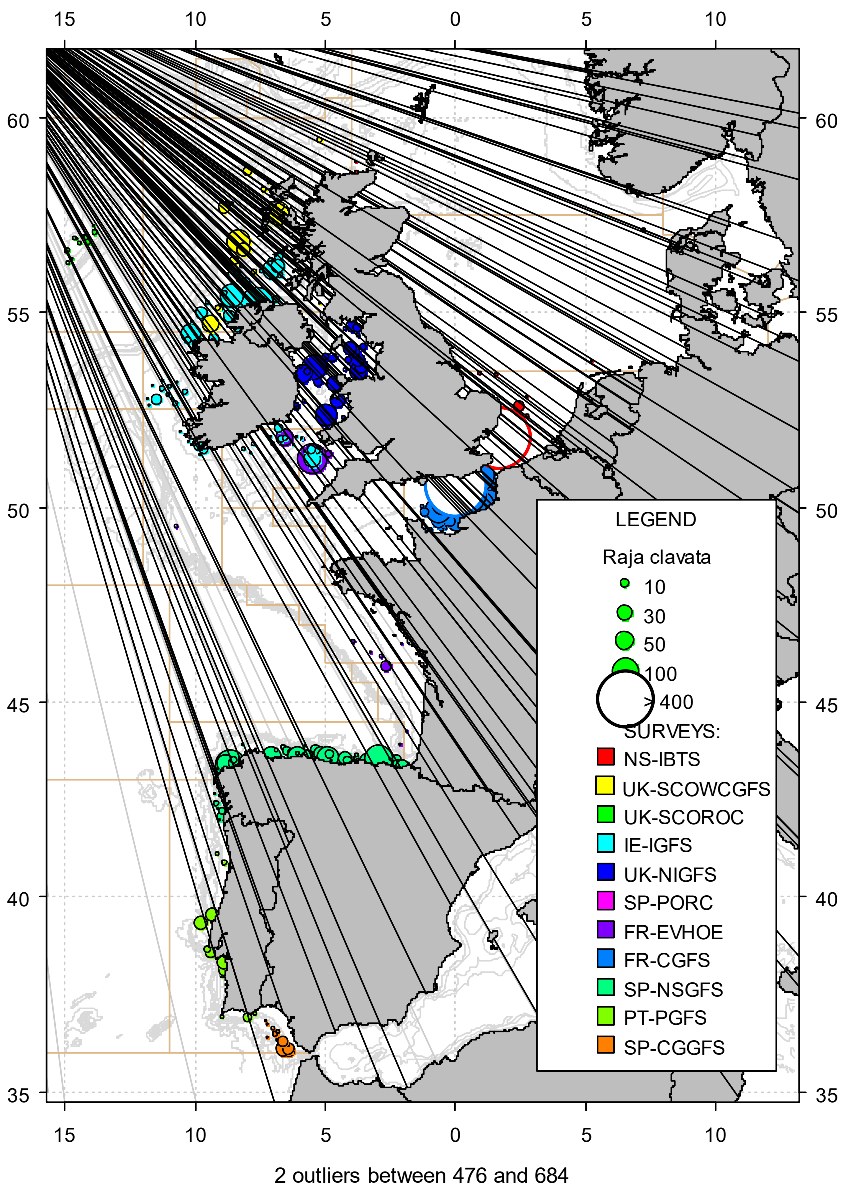

Figure A.5.50. Catches in numbers per hour per hour of thornback ray, *Raja clavata*, in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

Figure A.5.51. Length distribution of thornback ray, *Raja clavata*, per ICES Subarea in the NeAtl surveys (North Sea IBTS not included) during the last six years, each panel presents the surveys occurring. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the lines do not reflect proportional abundance in all the areas but within each survey. The number in each panel corresponds to the sum of the mean stratified number of individuals caught in one hour haul in the surveys carried out in that subdivision.

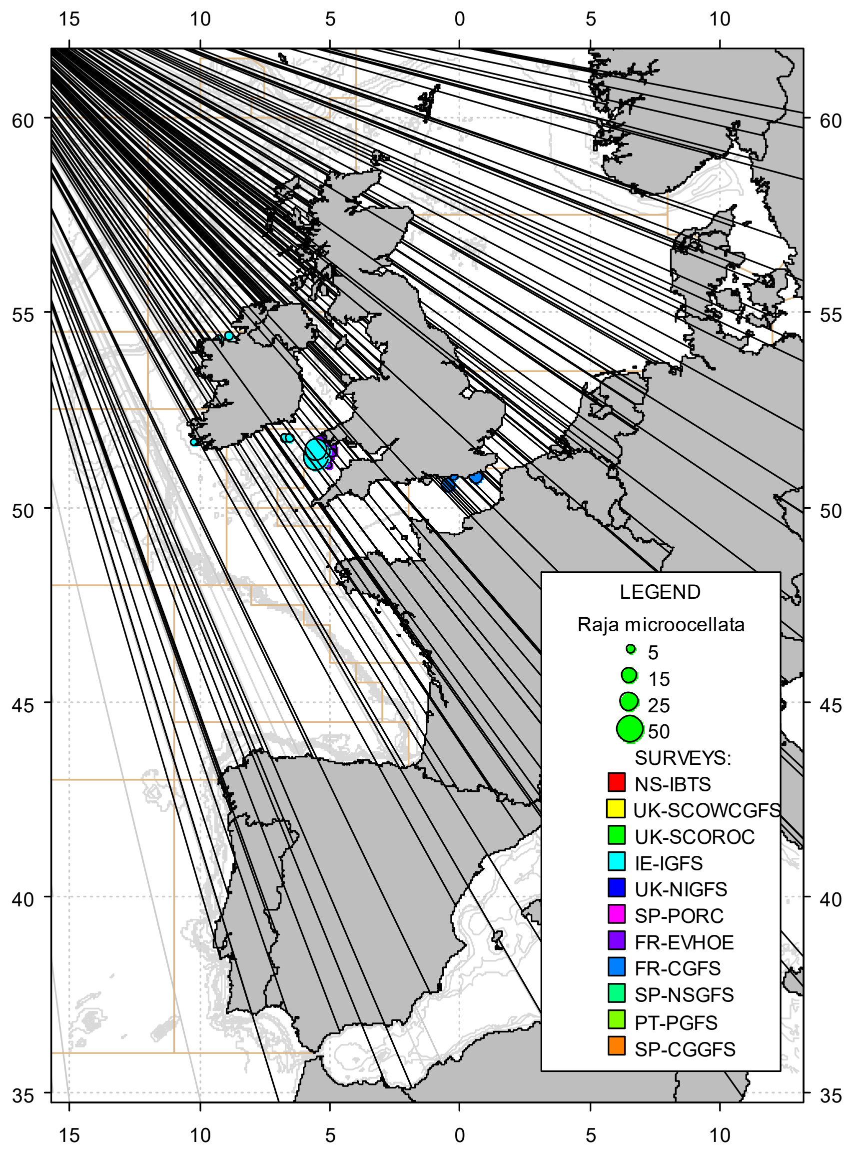

Figure A.5.52. Catches in numbers per hour per hour of small eyed ray, *Raja microocellata*, in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

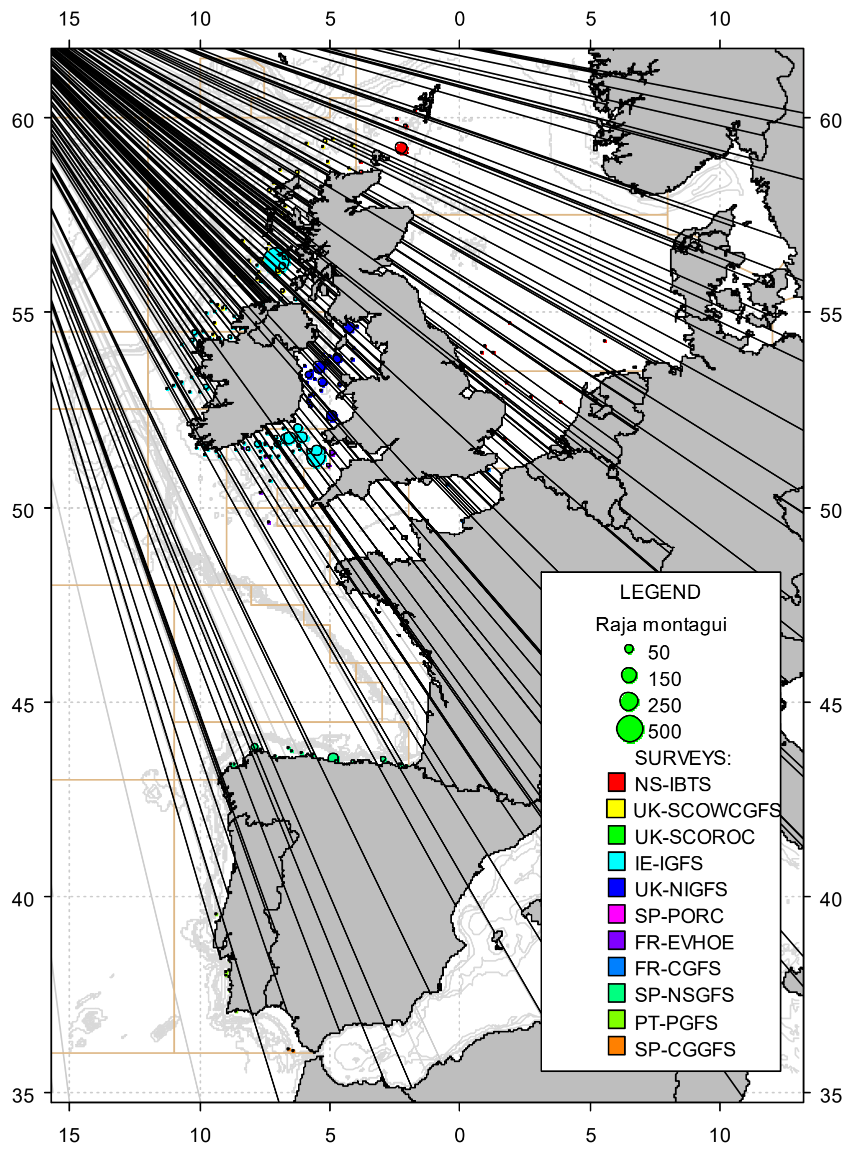

Figure A.5.53. Catches in numbers per hour per hour of spotted ray, *Raja montagui*, in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

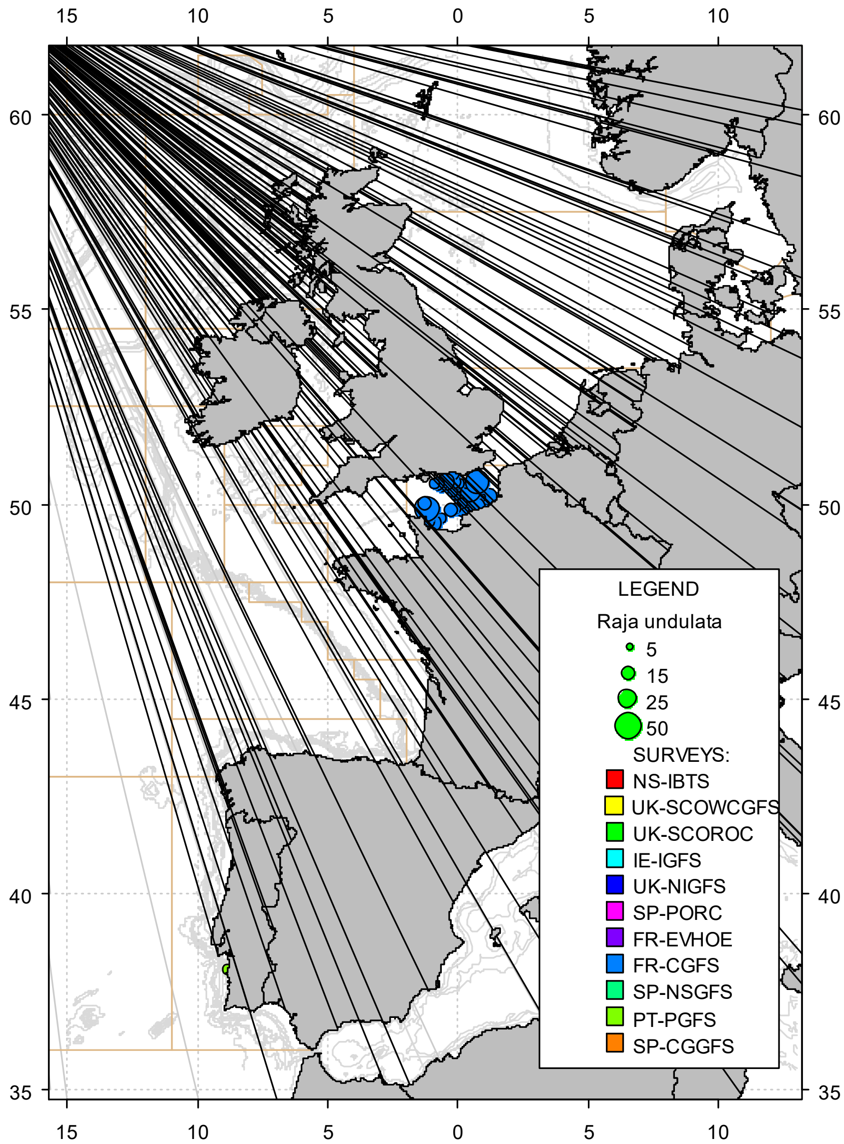

Figure A.5.54. Catches in numbers per hour per hour of undulate ray, *Raja undulata*, in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

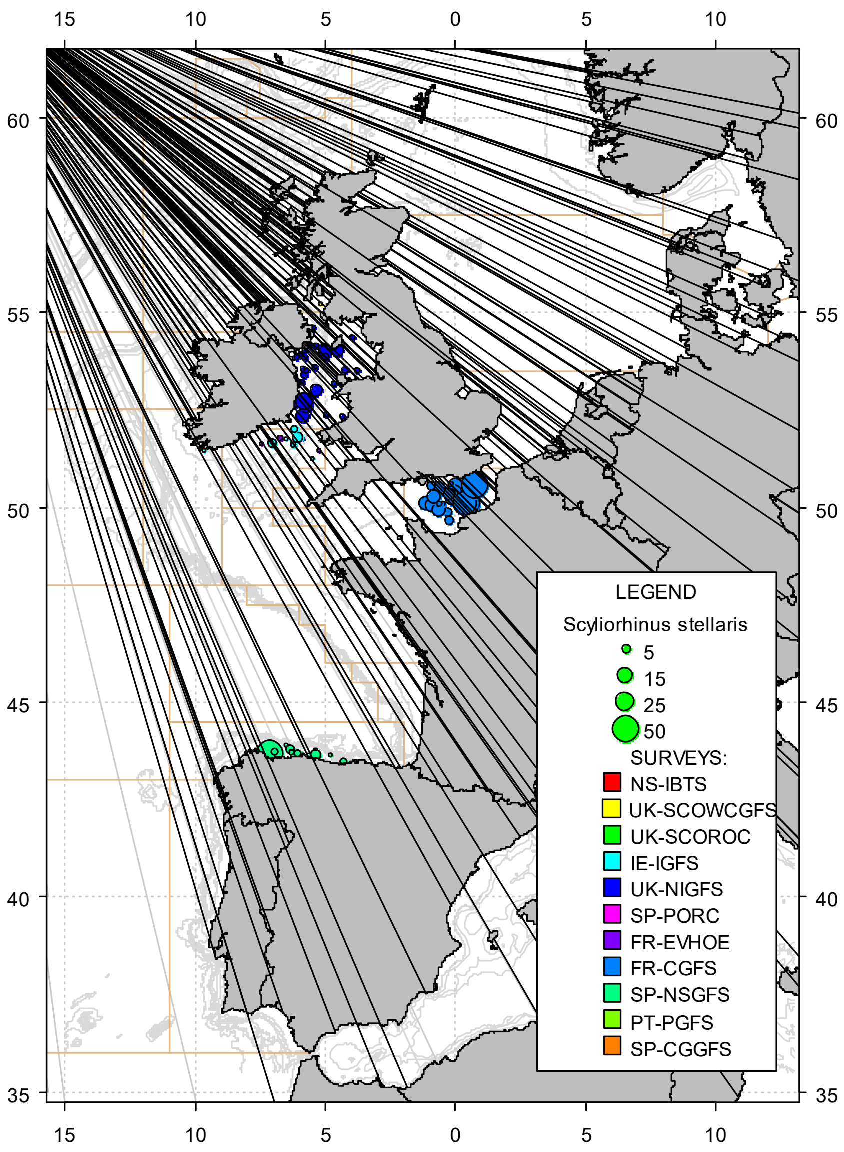

Figure A.5.55. Catches in numbers per hour per hour of nurse hound, *Scyliorhinus stellaris*, in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

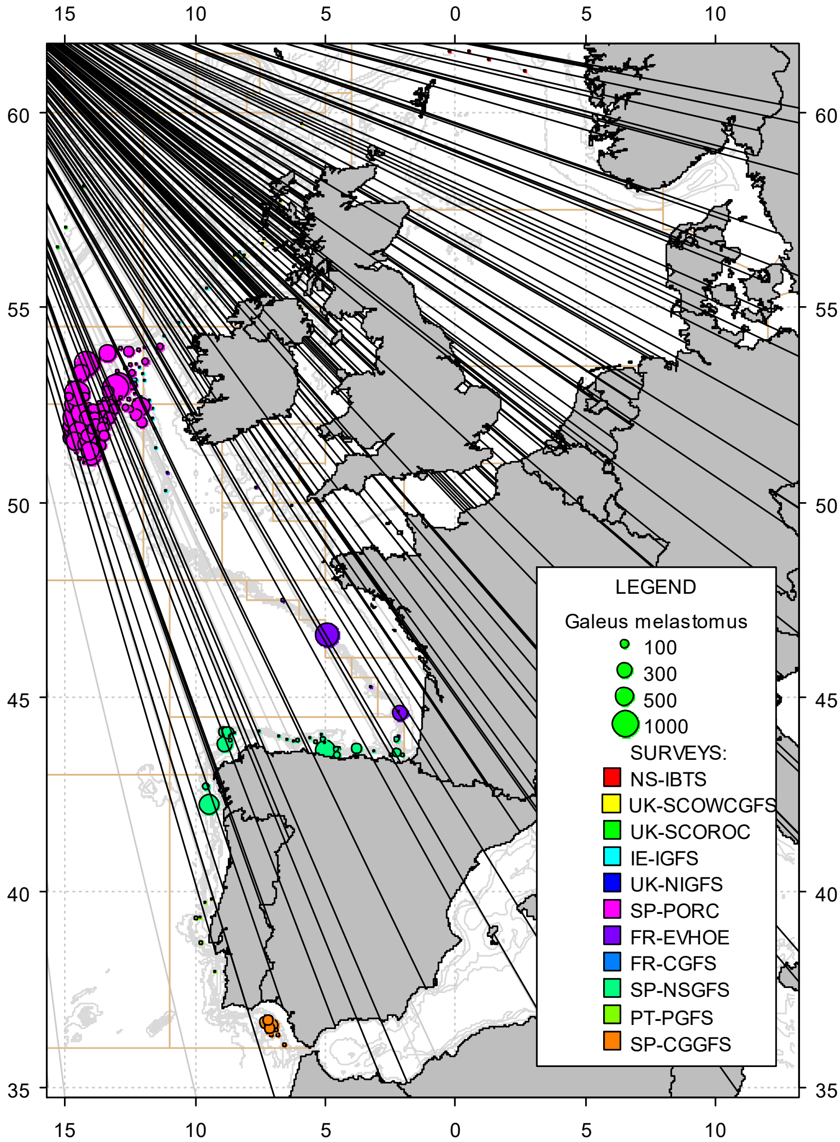

Figure A.5.56. Catches in numbers per hour per hour of Blackmouthed dogfish, *Galeus melastomus*, in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

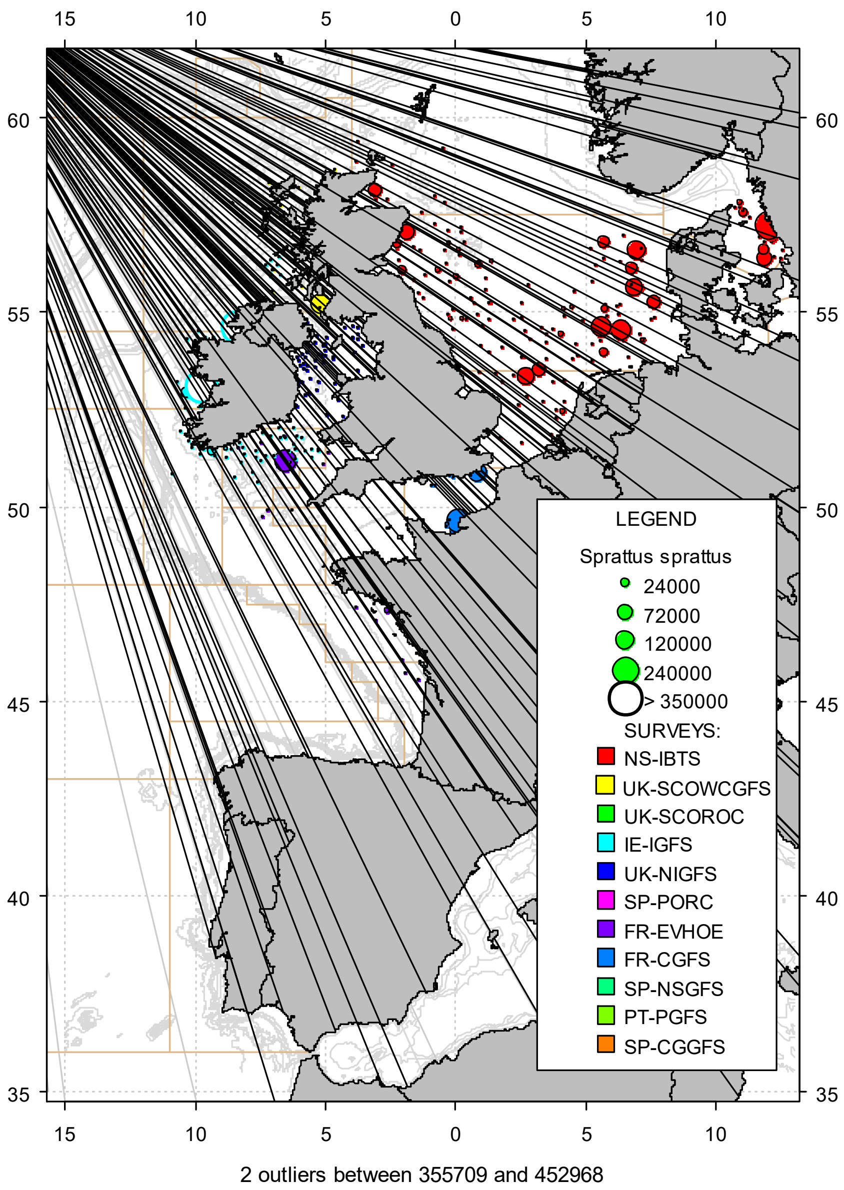

Figure A.5.57. Catches in numbers per hour per hour of European sprat, *Sprattus sprattus*, in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

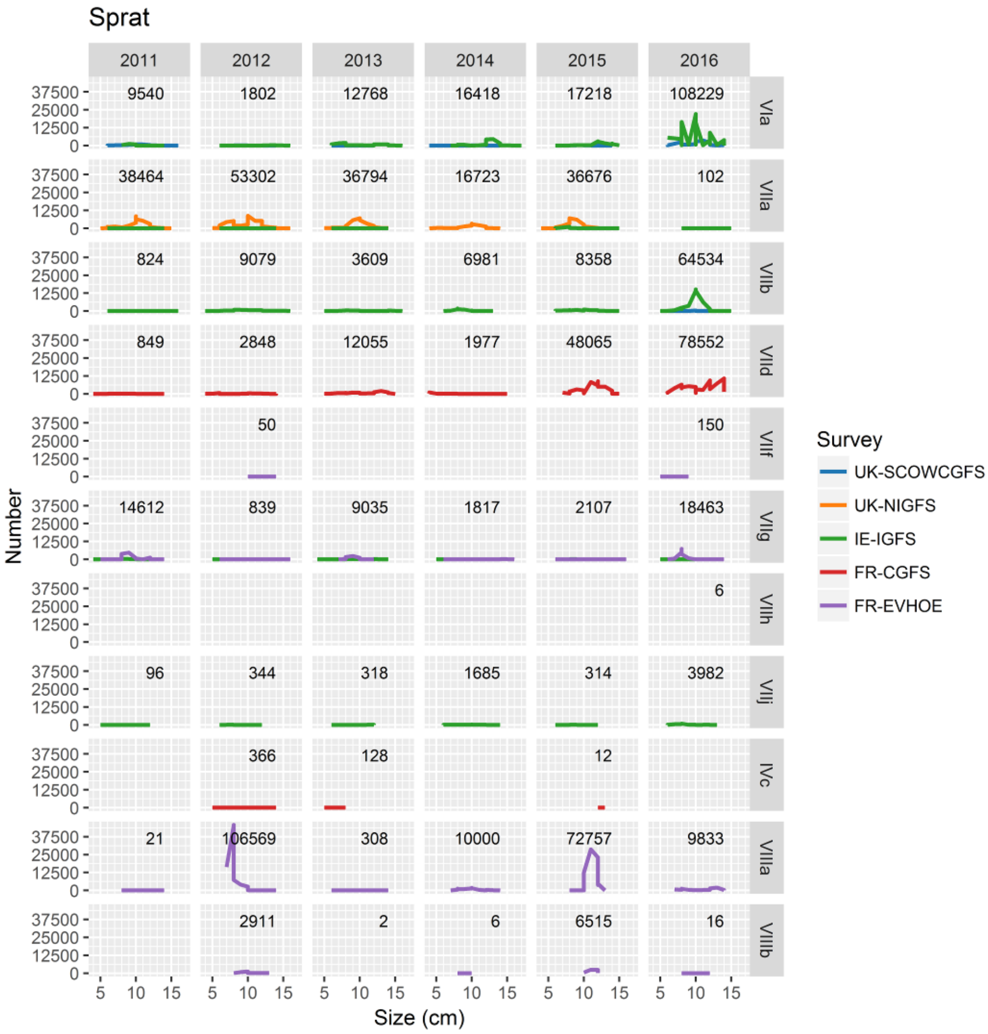

Figure A.5.58. Length distribution of sprat, *Sprattus sprattus*, per ICES Subarea in the NeAtl surveys (North Sea IBTS not included) during the last six years, each panel presents the surveys occurring. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the lines do not reflect proportional abundance in all the areas but within each survey. The number in each panel corresponds to the sum of the mean stratified number of individuals caught in one hour haul in the surveys carried out in that subdivision.

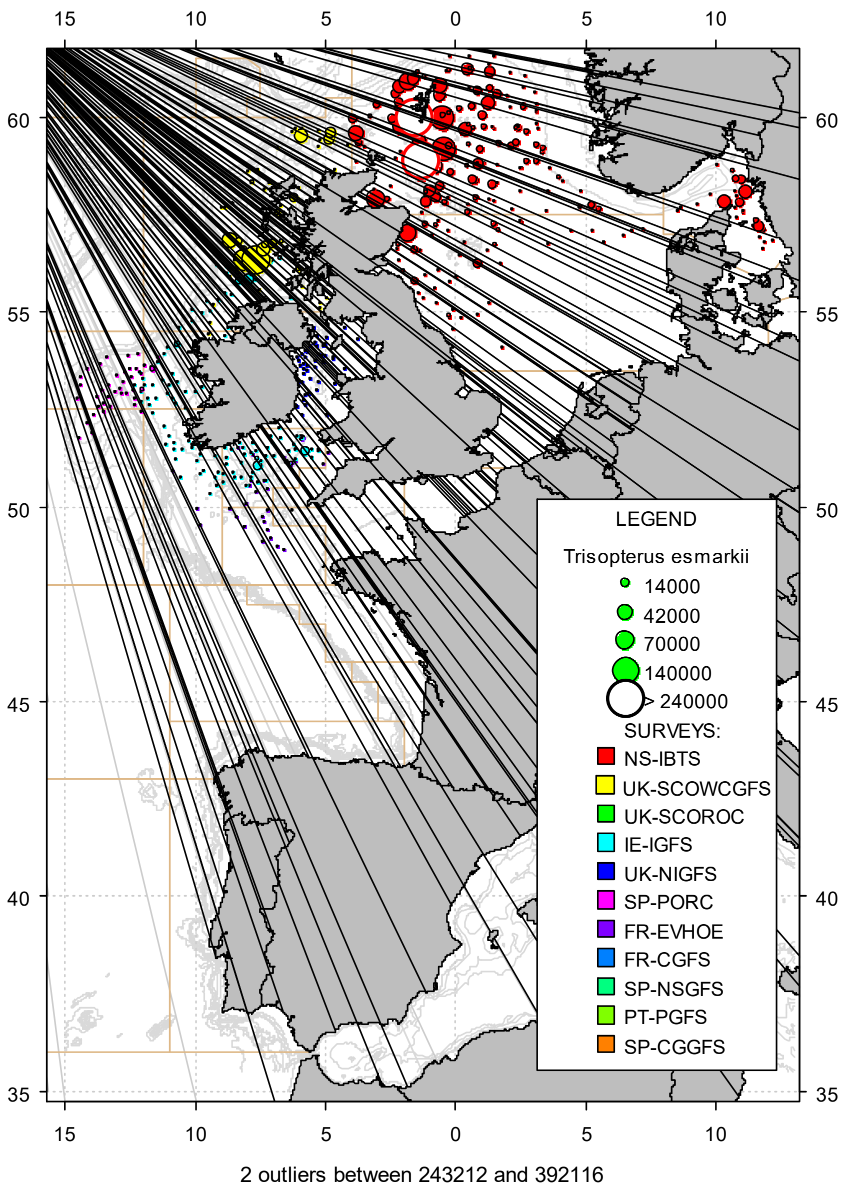

Figure A.5.59. Catches in numbers per hour per hour of Norway pout, *Trisopterus esmarkii*, in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

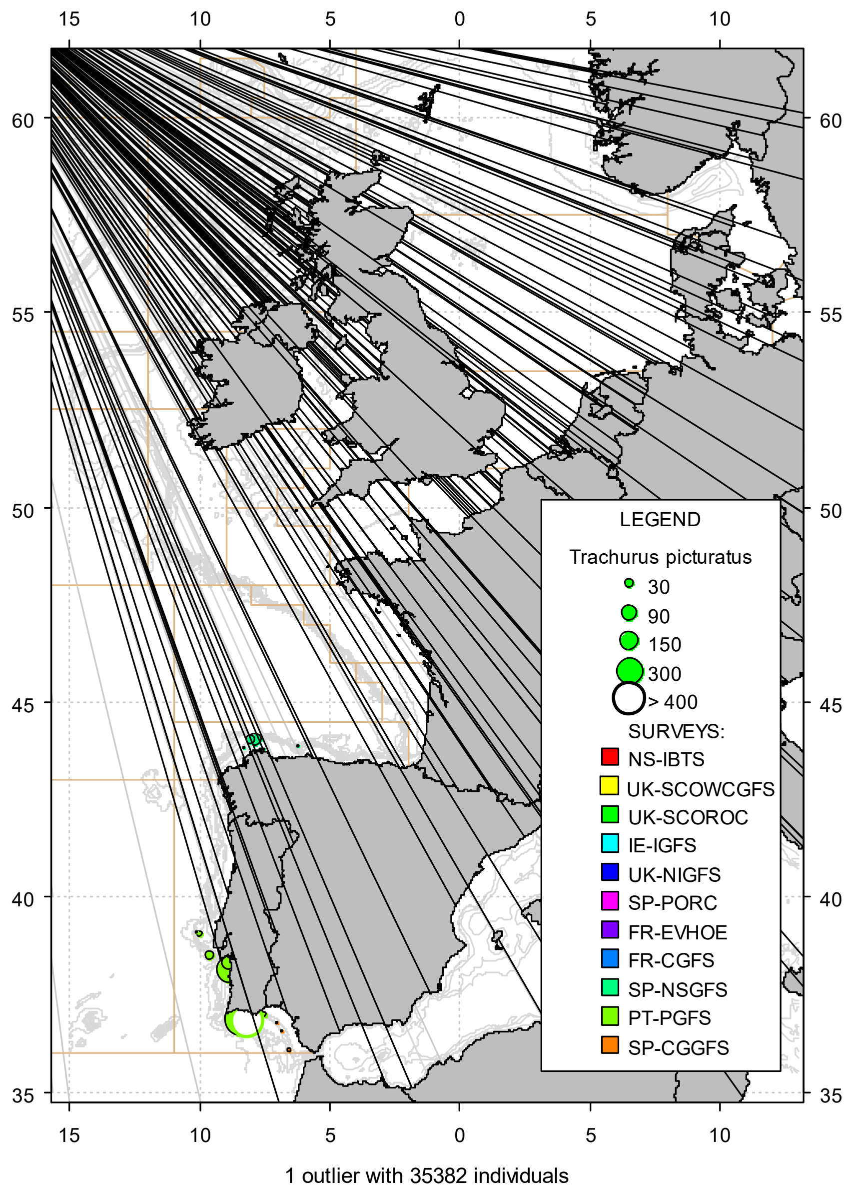

Figure A.5.60. Catches in numbers per hour per hour of blue jack mackerel, *Trachurus picturatus*, in summer/autumn 2016 IBTS. The catchability of the different gears used in the NeAtl surveys is not constant; therefore the map does not reflect proportional abundance in all the areas but within each survey.

Annex 6: Gear plots for the IBTS Northeastern Atlantic

This annex presents the information about gear geometry from the Northeastern Atlantic IBTS area, together with the plots (Figure A.6.1 to A.6.12) that have been developed for two purposes: (1) visualizing gear geometry data, offering a comparison between the gears behaviour in the different surveys, highlighting potential need for correction after initial data upload to DATRAS.; (2) produce a common format for the gear behaviour plots to be included in the Manual for the International Bottom Trawl Surveys in the Northeastern Atlantic to be submitted for its publication in the ICES survey Protocols series, that will replace the Manual for the International Bottom Trawl Surveys in the Western and Southern Areas (ICES, 2010). These figures will be produced by survey responsible after looking at the time-series that better reflects the standard gear behaviour that is considered as optimum for the survey sampling.

The plots presented have been modified from those presented last year in the IBTS report (ICES, 2016), and do not use the Loess model (Jacoby, 2000) but regression models between depth and the gear parameters estimated using the nls R (R Core Team, 2017) function and confidence intervals using the confint.nls method from the MASS R package (Venables and Ripley, 2002).

Comparisons between gear parameters in the different surveys are shown in: relationship wing spread vs. door spread Figure A.6.13; wing spread vs. depth Figure A.6.14; door spread vs. Depth Figure A.6.15 and net vertical opening vs. depth Figure A.6.16.

Table A.6.1. Information on gear geometry available in DATRAS and ongoing revisions

Survey	Figure No.	Years used in Figures	State in DATRAS
UK-SCOSWC-Q1	A.6.1	2014-2016 (new series)	Partial, available from 1990 but different sweep lengths. New series is available
UK-SCOSWC-Q4	A.6.2	2013-2016 (new series)	Partial, available from 1990 but different sweep lengths. New series is available
UK-SCOROC-Q3	A.6.3	2013-2016 (new series)	Partial available from 1999 but different sweep lengths. New series is available
UK-NIGFS-Q1	A.6.4	2008- 2016	Available from 2008 only doorspread data before 2016
UK-NIGFS-Q4	A.6.5	2009- 2016	Available from 2009 only doorspread data before 2016
IE-IGFS-Q3-4	A.6.6	2011- 2016	Available from 2003
SP-PORC-Q3	A.6.7	2003-2016	Only vert+doors available from 2001-2015 Also wings in 2016
FR-CGFS-Q4	A.6.8	2015-2016 (new series change vessel-gear)	Partial available from 1988 but new series from 2015
FR-EVHOE-Q4	A.6.9	1997-2015	Available from 1997
SP-NSGFS-Q4	A.6.10	2014-2016 (change vessel)	Only vert+doors (wings in 2015-6) data available from 2001
SP-GCGFS-Q1	A.6.11	2014-2016 (change	Data from previous years are

		vessel)	uploaded from 2003
SP-GCGFS-Q4	A.6.12	2014-2016 (change vessel)	Data from previous years are uploaded from 2003
PT-GFS-Q4			No data (due to lack of equipment)

References

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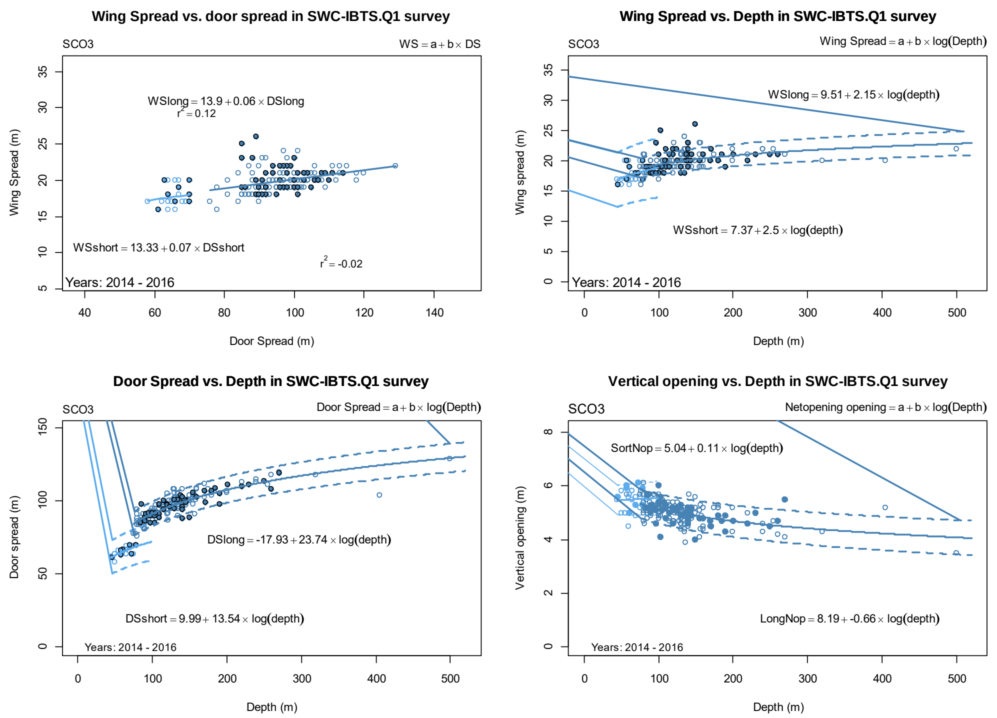


Figure A.6.1. Graphs showing the information available in DATRAS on gear geometry from SCO-SWC-IBTS-Q1 in 2016. Data from 2014-2015 are shown as empty dots on the background. Confidence intervals of door spread, wing spread and vertical opening estimated with the confint.nls procedure.

Table A.6.2. Summary of data used on figure A.6.1

Survey: UK-SWC-Q1	Year		
Sweep length	**2014**	**2015**	**2016**
47 m	9	9	9
97 m	54	55	56
Total hauls	63	64	65

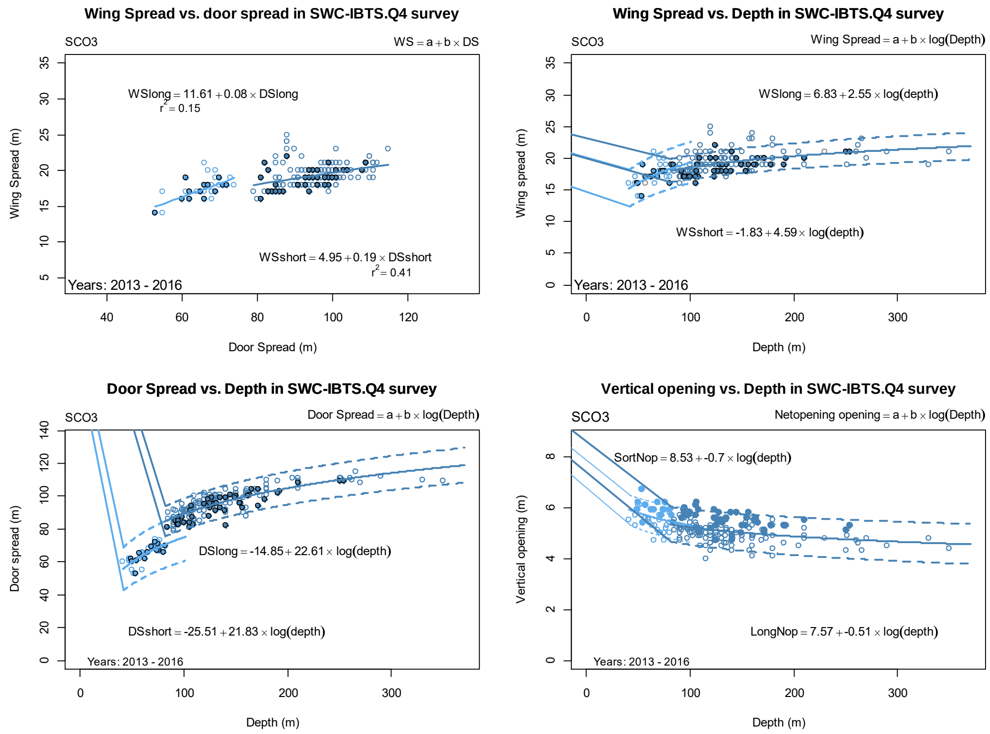


Figure A.6.2. Graphs showing the information available in DATRAS on gear geometry from SCO-SWC-IBTS-Q4 in 2016, data from 2013-2015 are shown as empty dots on the background. Confidence intervals of door spread, wing spread and vertical opening estimated with the confint.nls procedure.

Table A.6.3. Summary of data used on figure A.6.2

Survey: UK-SWC-Q1	Year			
Sweep length	**2013**	**2014**	**2015**	**2016**
47 m	1	11	14	14
97 m	25	50	46	48
Total hauls	26	61	60	62

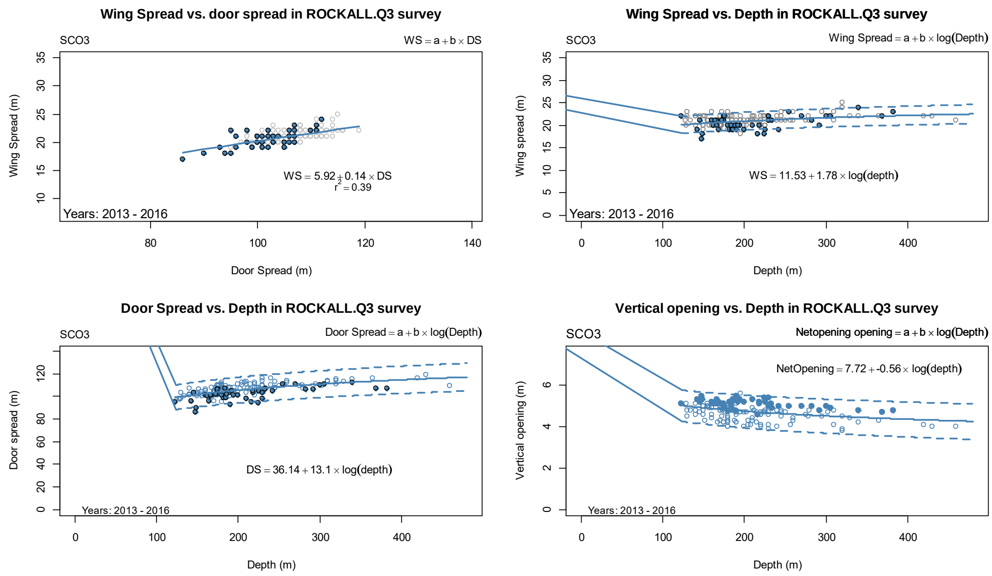


Figure A.6.3. Graphs showing the information available in DATRAS on warp length and gear geometry from UK-SCOROC in 2015, data from 2013-2014 are shown are shown as empty dots on the background. Confidence intervals of door spread, wing spread and vertical opening estimated with the confint.nls procedure.

Table A.6.4. Summary of data used on figure A.6.3

Survey: UK-SCOROCK	Year			
Sweep length	2013	2014	2015	2016
97 m	31	48	43	48
Total hauls	31	48	43	48

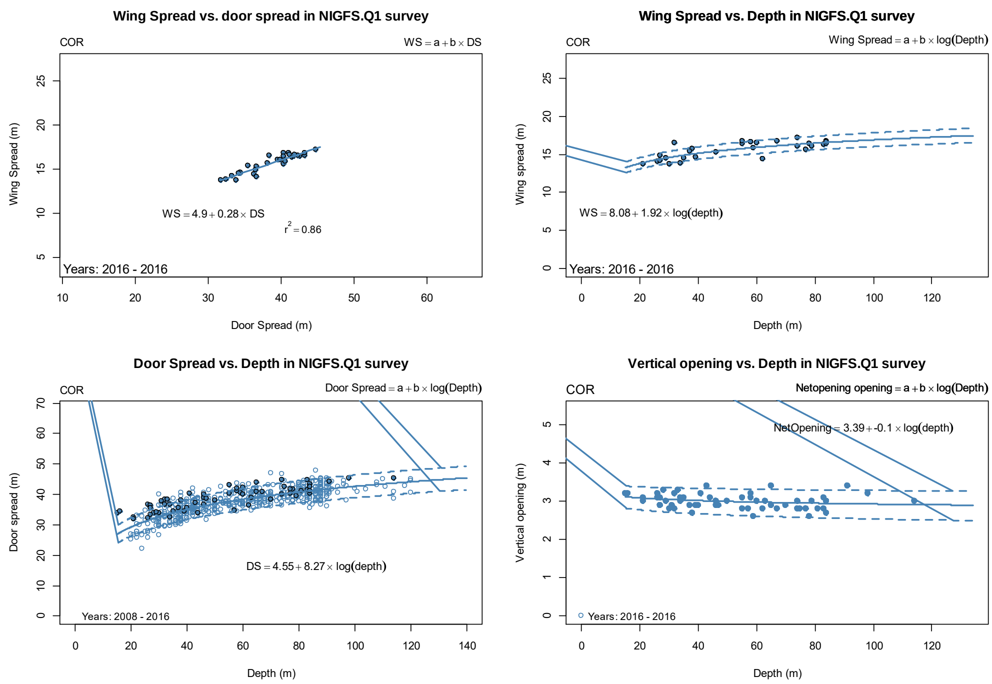


Figure A.6.4. Graphs showing the information available in DATRAS about gear geometry from UK-NIGFS-Q1 in 2016. Figures show different years depending on the information available.

Previous years, when available are shown as empty dots. Confidence interval of door spread, wing spread and net vertical opening estimated with the confint.nls procedure.

Table A.6.5. Summary of data used on figure A.6.4.

UK-NIGFS-Q1	Year								
	2008	2009	2010	2011	2012	2013	2014	2015	2016
Total hauls	54	60	62	61	59	54	55	60	62

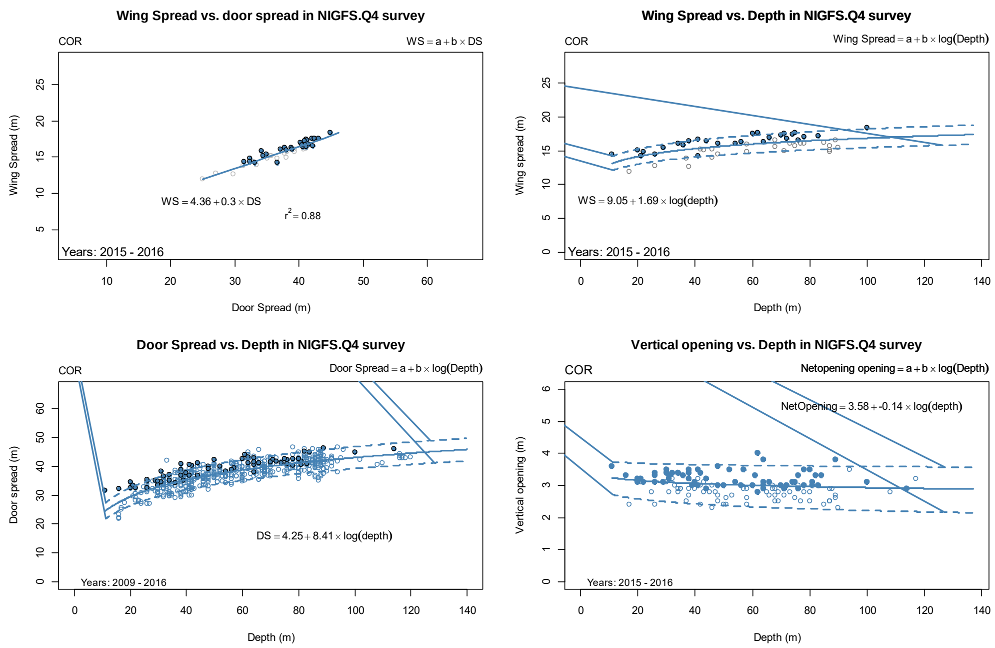


Figure A.6.5. Graphs showing the information available in DATRAS about gear geometry from UK-NIGFS-Q4 in 2016. Figures show different years depending on the information available. Previous years, when available are shown as empty dots. Confidence interval bands of door spread, wing spread and vertical opening were estimated with the confint.nls procedure.

Table A.6.6. Summary of data used on figure A.6.5

UK-NIGFS-Q4	Year							
	2009	2010	2011	2012	2013	2014	2015	2016
Total valid hauls	62	59	58	60	58	58	62	62

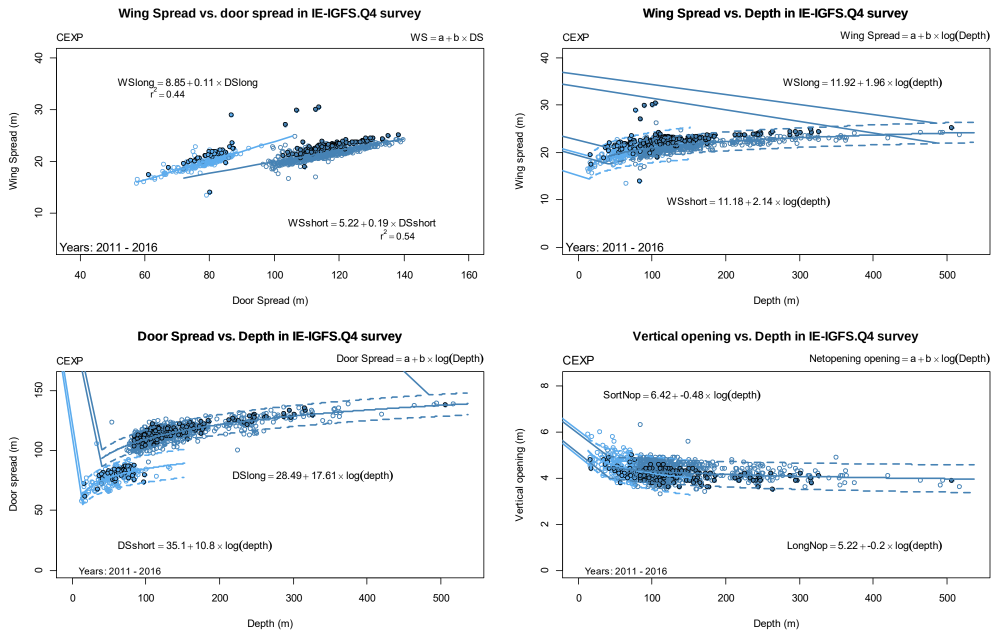


Figure A.6.6. Graphs showing the information available in DATRAS about warp length and gear geometry from IE-IGFS in 2016, showing the change due to the two different sweep lengths used in the survey. Data from previous years are shown as empty symbols on the background. Confidence intervals of door spread, wing spread and vertical opening were estimated using the confint.nls R procedure (see introduction to Annex 7).

Table A.6.7. Summary of data used on figure A.6.6

Survey: IE-IGFS	Year					
Sweep length	2011	2012	2013	2014	2015	2016
55 m	45	46	44	42	36	42
110 m	114	126	132	128	110	130
Total hauls	159	172	176	170	146	172

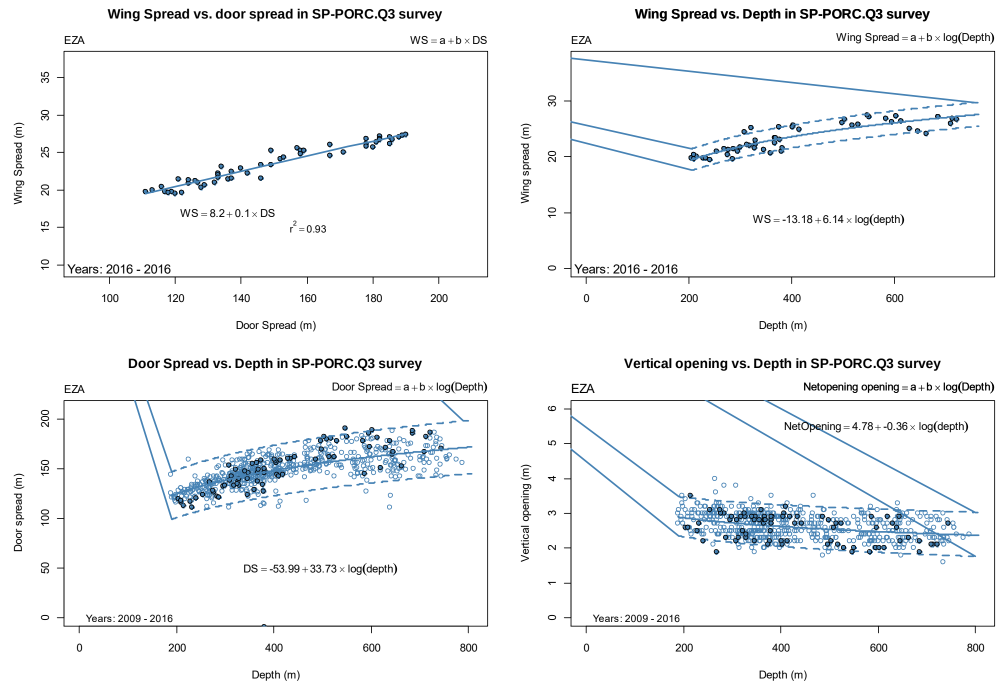
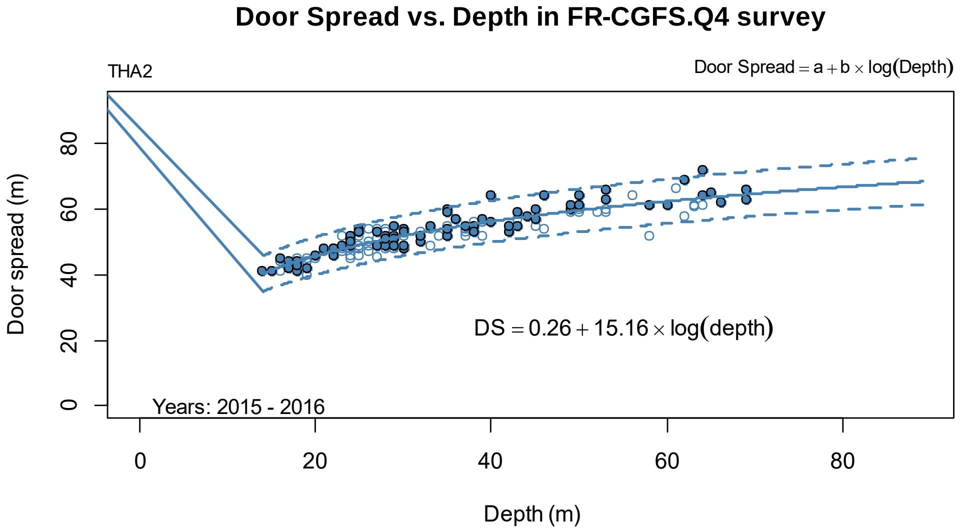


Figure A.6.7. Graphs showing the information available in DATRAS about warp length and gear geometry from SP-Porc-Q3 in 2016 including historical data empty points on the background from 2003-2015, wing spread data only available from 2016. Confidence intervals of door spread, wing spread and vertical opening were estimated using the confint.nls R procedure (see introduction to Annex 7).

Table A.6.8. Summary of data used on figure A.6.7

Survey: SP-Porc	**Year**							
Sweep length	2009	2010	2011	2012	2013	2014	2015	2016
250 m	80	80	80	79	80	80	80	80
Total	80	80	80	79	80	80	80	80



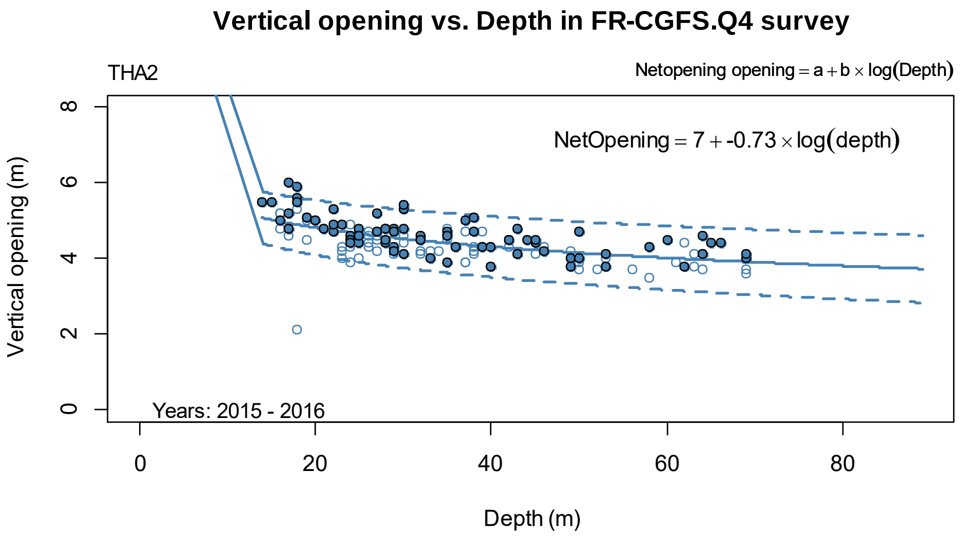


Figure A.6.8. Graphs showing the information about gear geometry from FR-CGFS in 2016. This was the second year FR-CGFS was performed on board the RV *Thalassa*, empty symbols are the points from 2015. Formulae in the figures are the regressions of door and wing spread vs. depth estimated from the results depicted in the graphs. Confidence intervals of door spread, wing spread and vertical opening were estimated using the confint.nls R procedure.

Table A.6.9. Summary of data used on Figure A.6.8

Survey: FR-CGFS	**Year**	
Sweep length	2015	2016
50 m	76	75
Total	76	75

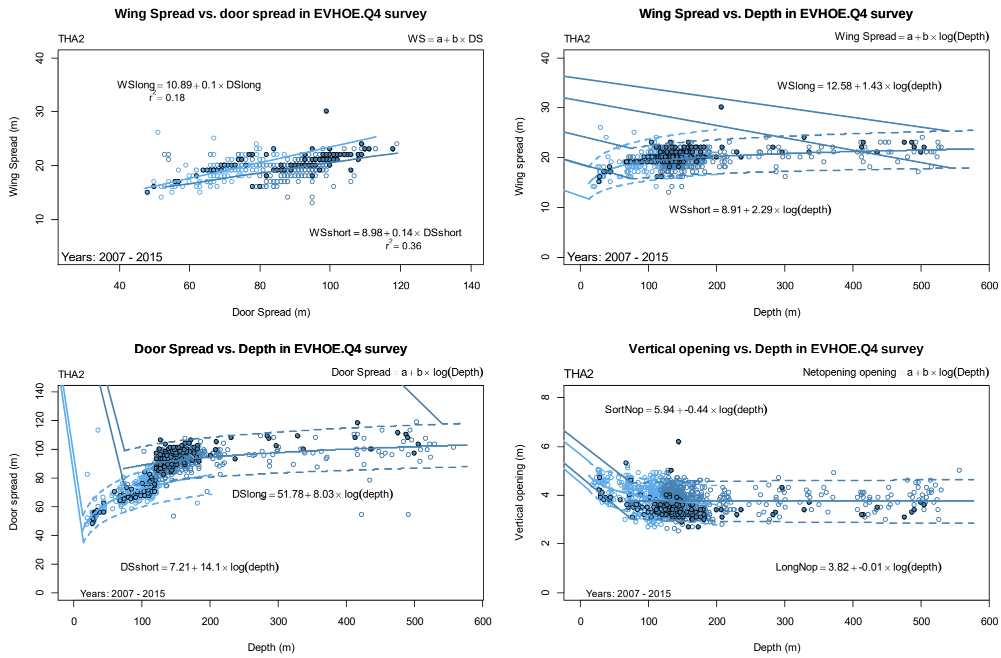


Figure A.6.9. Graphs showing information available in DATRAS about warp length and gear geometry from FR-EVHOE in 2015, (2016 data were not available for these report), marking the difference between the two warp lengths used in the survey. Confidence intervals of door spread, wing spread and vertical opening were estimated using the confint.nls R procedure. Comparison with previous years, in empty points on the background, are from 2007-2013.

Table A.6.10. Summary of data used on figure A.6.9

Survey: FR-EVHOE	**Year**							
Sweep length	2007	2008	2009	2010	2011	2012	2013	2015
50 m	54	51	45	50	57	53	46	49
100 m	91	96	90	89	93	77	92	101
Total	145	147	135	139	150	130	138	150

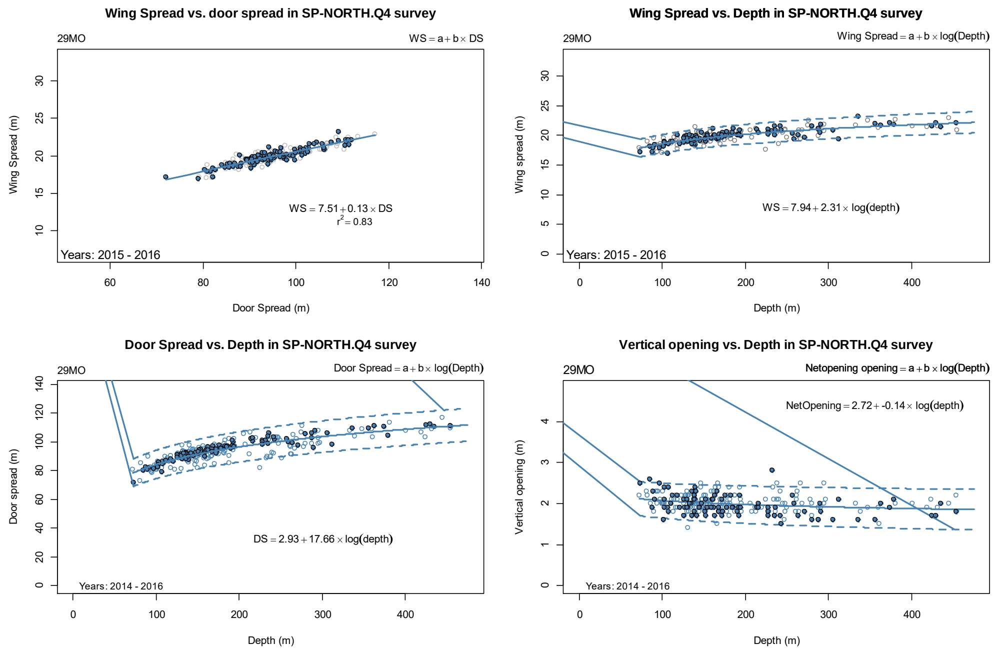


Figure A.6.10. Graphs showing the information available in DATRAS about warp length and gear geometry from SP-NORTH in 2016 including historical data from 2014-2015, the others years the survey had been performed with the RV *Miguel Oliver* and the standard sweeps. Confidence intervals for door spread, wing spread and vertical opening were estimated using the confint.nls R procedure. Wingspread monitored only in 2015 and 2016.

Table A.6.11. Summary of data used on figure A.6.10

Survey: SP-NSGFS	**Year**		
Sweep length	2014	2015	2016
200 m	116	115	113
Total	116	115	113

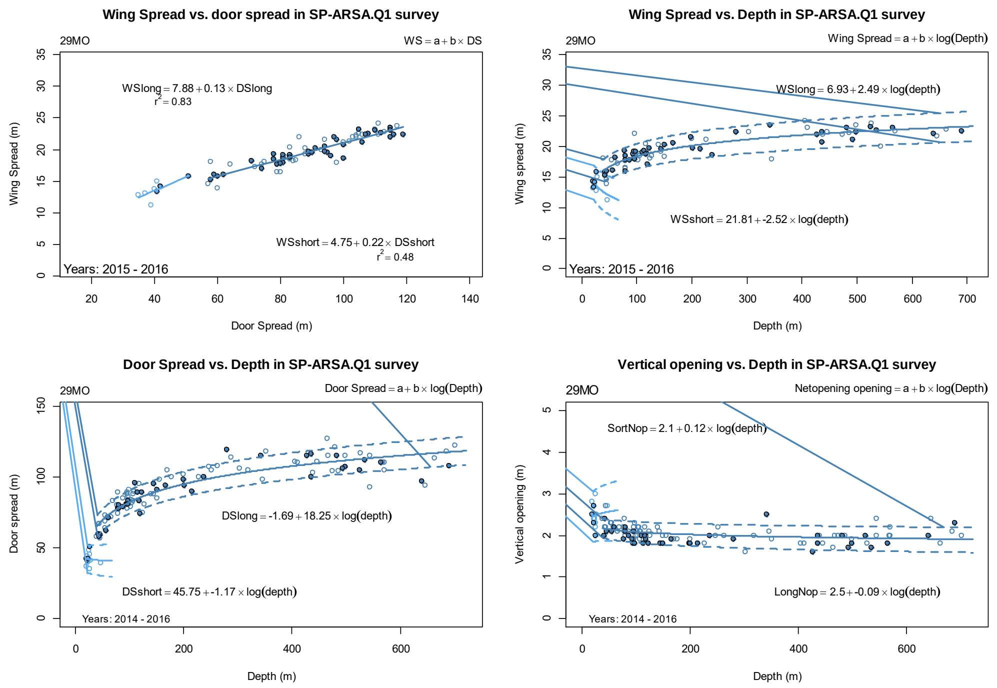


Figure A.6.11. Graphs showing the information available in DATRAS about warp length and gear geometry from SP-GCGFS in 2016 including data from 2014 and 2015 empty points in the background, the other years performed with the RV Miguel Oliver and the standard sweeps. Confidence intervals for door spread, wing spread and vertical opening were estimated using the confint.nls R procedure. Wingspread monitored only in 2015 and 2016.

Table A.6.12. Summary of data used on figure A.6.11

Survey: SP-GCGFSQ1	**Year**		
Sweep length	2014	2015	2016
100 m	4	5	4
200 m	36	38	40
Total	40	43	44

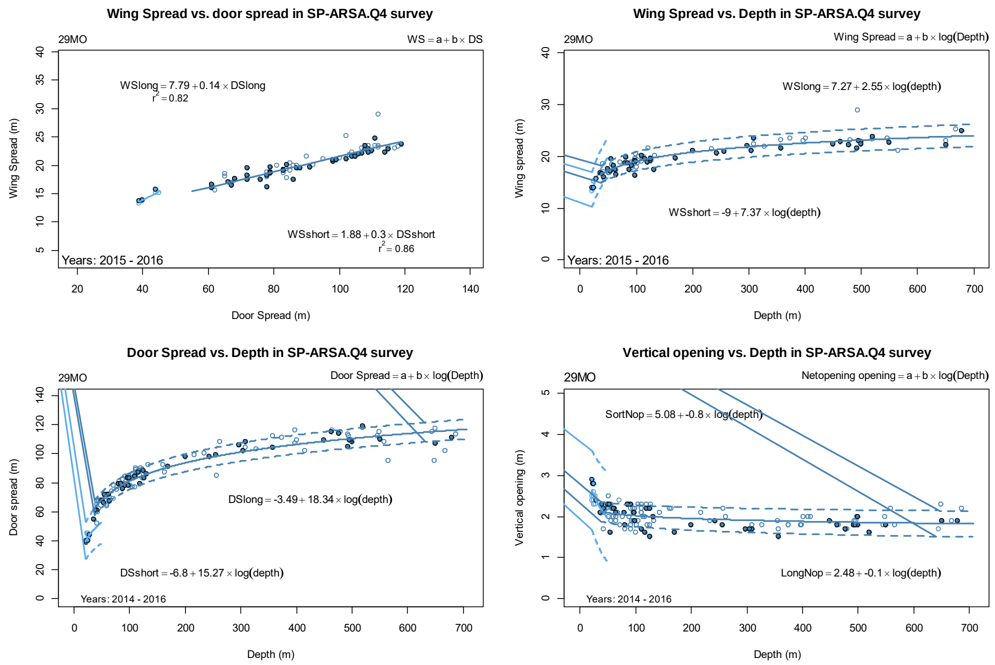


Figure A.6.12. Graphs showing the information available in DATRAS about warp length and gear geometry from SP-GCGFS-Q4 in 2016 including data from 2014 and 2015, the other years performed with the RV Miguel Oliver and the standard sweeps. Confidence intervals for door spread, wing spread and vertical opening were estimated using the confint.nls R procedure. Wingspread monitored only in 2015 and 2016.

Table A.6.13. Summary of data used on figure A.6.12

Survey: SP-GCGFSQ4	Year		
Sweep length	**2014**	**2015**	**2016**
100 m	5	4	4
200 m	40	39	41
Total	45	43	45

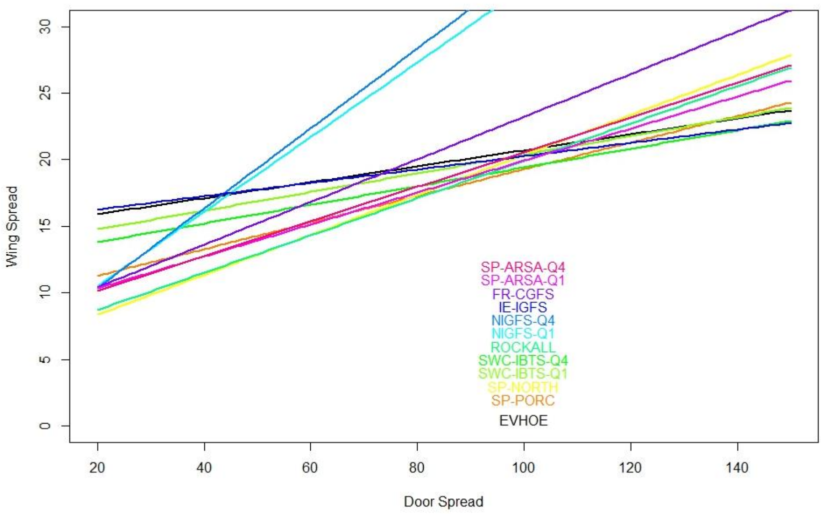


Figure A.6.13. Comparison of wing spread vs. Door spread for all the IBTS surveys in Northeastern Atlantic.

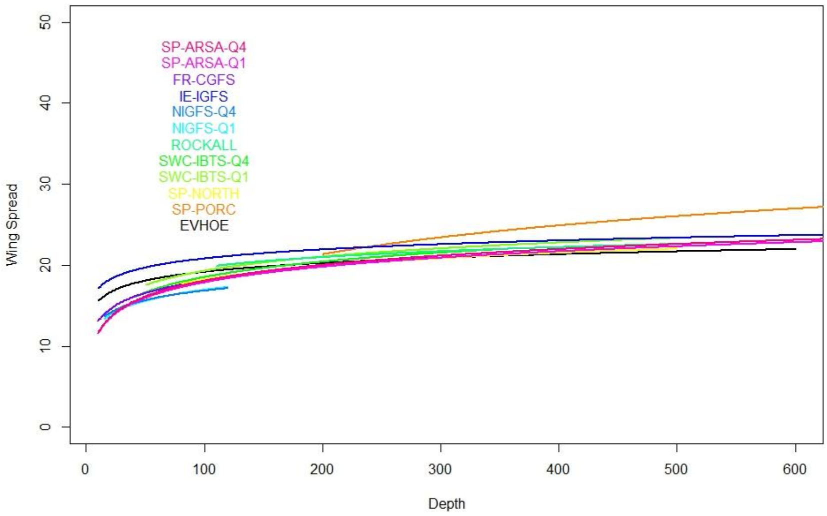


Figure A.6.14. Comparison of regression lines between wing spread and depth for all the IBTS surveys in Northeastern Atlantic.

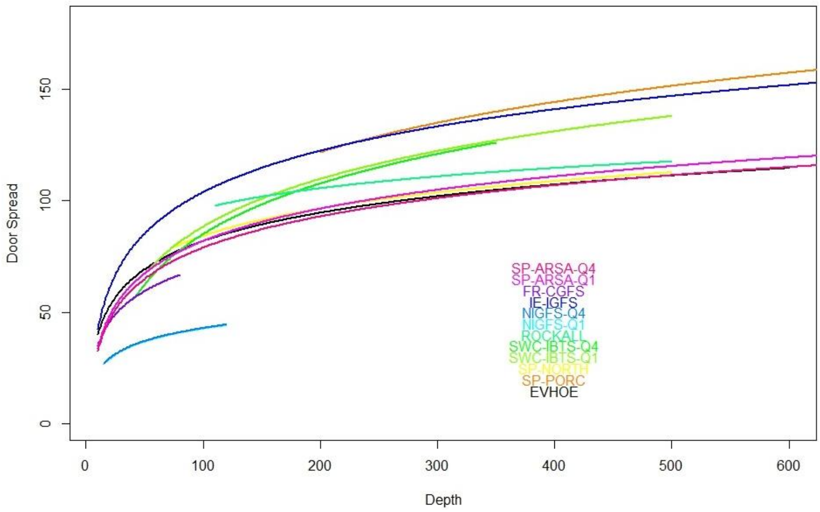


Figure A.6.15. Comparison of regression lines between door spread and depth for all the IBTS surveys in Northeastern Atlantic.

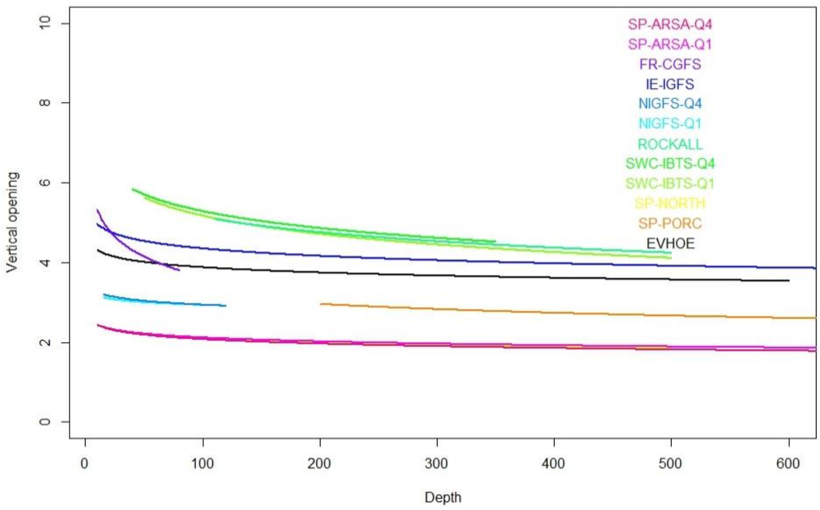


Figure A.6.16. Comparison of regression lines between net vertical opening and depth for all the IBTS surveys in Northeastern Atlantic.

Annex 7: List of working documents and presentations

Working documents:

WD1 - Comparison of theoretical and observed GOV gear geometry in the NS-IBTS for Denmark. K. Wieland

WD2 - Irish Anglerfish and Megrim Survey (Divisions VIa, VIIb,g,j,k) IE-IAMS. H. Gerritsen and E. Kelly

WD3 - Effect of tow duration on whiting and cod cpue in the NS-IBTS 3Q 2015 and 2016. K. Wieland

WD4 - Data analysis for haddock and Norway pout from tow duration experiment NS-IBTS 3rd Quarter 2015–2016. A. Jaworski, L. Clarke and F. Burns

WD5 - The 2016 North Sea IBTS Q3 tow duration experiment. J. Devine and M. Pennington

WD6 - Preliminary observations on the catches of fish in 'zero-minute' hauls. B. Hatton, I. Holmes, J. Ellis, C. Lynam

WD7 - Species diversity and abundance in Q3 experimental tows. M. Moriarty (presented by F. Burns)

WD8 - Within-rectangle variation of species composition and catch rates – Implications for survey design, station allocation and tow duration. K. Wieland.

WD9 - Litter data in the litter assessment output of DATRAS. R. van Hal

Presentations (without corresponding working document):

P10 - DATRAS progress, development and issues and NS-IBTS ALK substitution. Vaishav Soni and Anna Osypchuk

P11 - Plaice maturity issue in NS-IBTS. Ralf Van Hal

P12 - Custom-tailored of fit for multi-purpose? Options for (re)designing North Sea fisheries surveys. Anne Sell

P13 - Proposition of a sampling design for the Western English Channel based on multivariate analysis. Morgane Travers-Trolet

P14 - Survey strata used for OSPAR indicators . Christopher Lynam

P15 - 'ECLIPSE' project Spatio-temporal dynamics of fish communities in the Eastern English Channel and North Sea. Arnaud Auber

P16 - Trials of adding a tickler chain to the GOV 36/49 in the Western English Channel: Comparison of benthic fish catches and underwater video observations. Morgane Travers-Trolet, Fabien Morandeau.

P17 - WGISUR. Ralf van Hal

P18 - Marine Litter IBTS. Ralf van Hal

P19 - Marine litter sampling during the IBTS - MIK survey. Bastian Huwer

P20 - The MIK and IBTS results for 0- and 1-ringer herring. Matthias Kloppmann

P21 - WKSEATEC – ICES Sept 2017. Dave Stokes

Annex 8: Working documents

Comparison of theoretical and observed GOV gear geometry in the NS-IBTS for Denmark

Kai Wieland, DTU Aqua, Section for Monitoring and Data, Hirtshals

Introduction

Data on GOV gear geometry from the North Sea IBTS in recent years have shown that realized vertical net opening and door spread differed from the theoretical values for a standard GOV measure in flume tank experiments (ICES 2015a). The presents study investigates this issue for the Danish 1st and 3rd quarter NS-IBTS.

Material and methods

Data from both the 1st and the 3rd quarter IBTS in 2000 to 2016 were considered. In this period Denmark has always used the same vessel, RV Dana. However, several changes in crew occurred over time and different warp to depth ratios have been applied, in particular during the most recent years. As specified in the survey manual (ICES 2015b), Denmark used long sweeps (110 m) at water depths ≥ 70 m in the 1st quarter until 2015 but abandoned the use of the long sweeps in 2006 like several other countries had done some years earlier (ICES 2015b). In the 3rd quarter always short sweeps (60 m) irrespectively of depth have been used.

The observed raw data (Fig. 1) were group into depth bins, mean ± 1 standard deviation of vertical net opening and door spread were plotted over mean depth of these bins and then regressions of the form $y = a + b * \exp(-c * x)$ to estimates upper and lower limits. The analyses were done separately for short and long sweeps.

Results and Discussion

Observed mean ± 1 standard deviation of vertical net opening and door spread and fitted regressions indicate that this relative simple approach worked fairly well for both the short and the long sweeps (Figs. 3 and 4, see Tab. 1 for the parameter values of the regressions). Due to a lower number of observations for the long sweeps related to the depth distribution of the Danish tows larger depth bins had to be used and all data back to 2000 had to be included. For the short sweeps, the inclusion of the years 2000 to 2003 too much noise and thus this period was excluded.

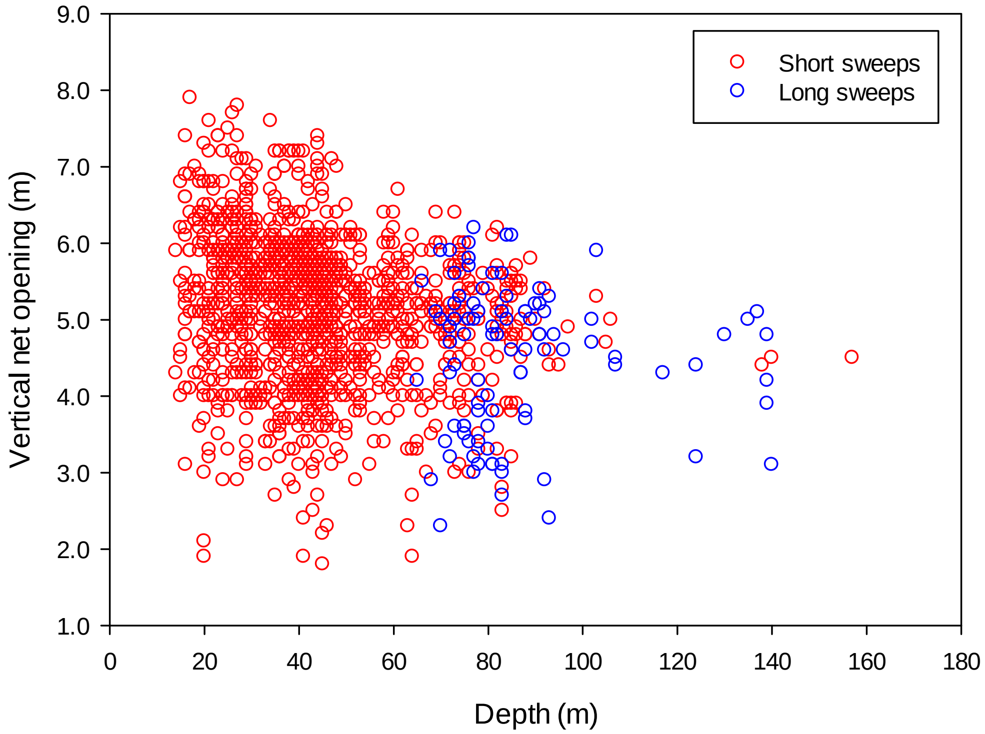
The comparison with the theoretical gear geometry shows that only tows with the short sweeps gave results which are close to the theoretical values whereas for the long sweeps in particular the door spread limits were considerable above the theoretical ones.

Since the deviations from the theoretical values is not that large for the short sweeps in contrast to results obtained with the long sweeps it is suggested not to change back the rigging of the GOV using long sweeps during the Danish 1st quarter surveys.

References

ICES 2015a. Report of the International Bottom Trawl Survey Working Group (IBTSWG). ICES CM 2015/SSGIEOM:24. 278 pp.

ICES 2015b. Manual for the International Bottom Trawl Surveys. SISP 10 – IBTS IX. 86 pp.



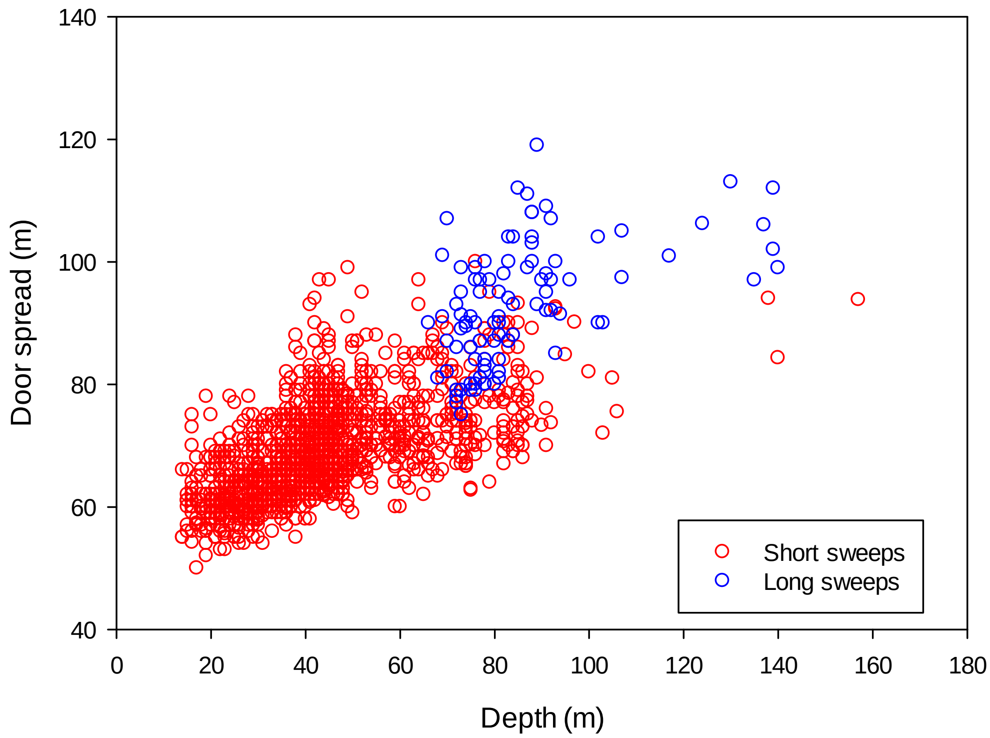


Fig. 1. Observed vertical net opening and door spread, Denmark, 1st and 3rd quarter NS-IBTS 2000 – 2016.

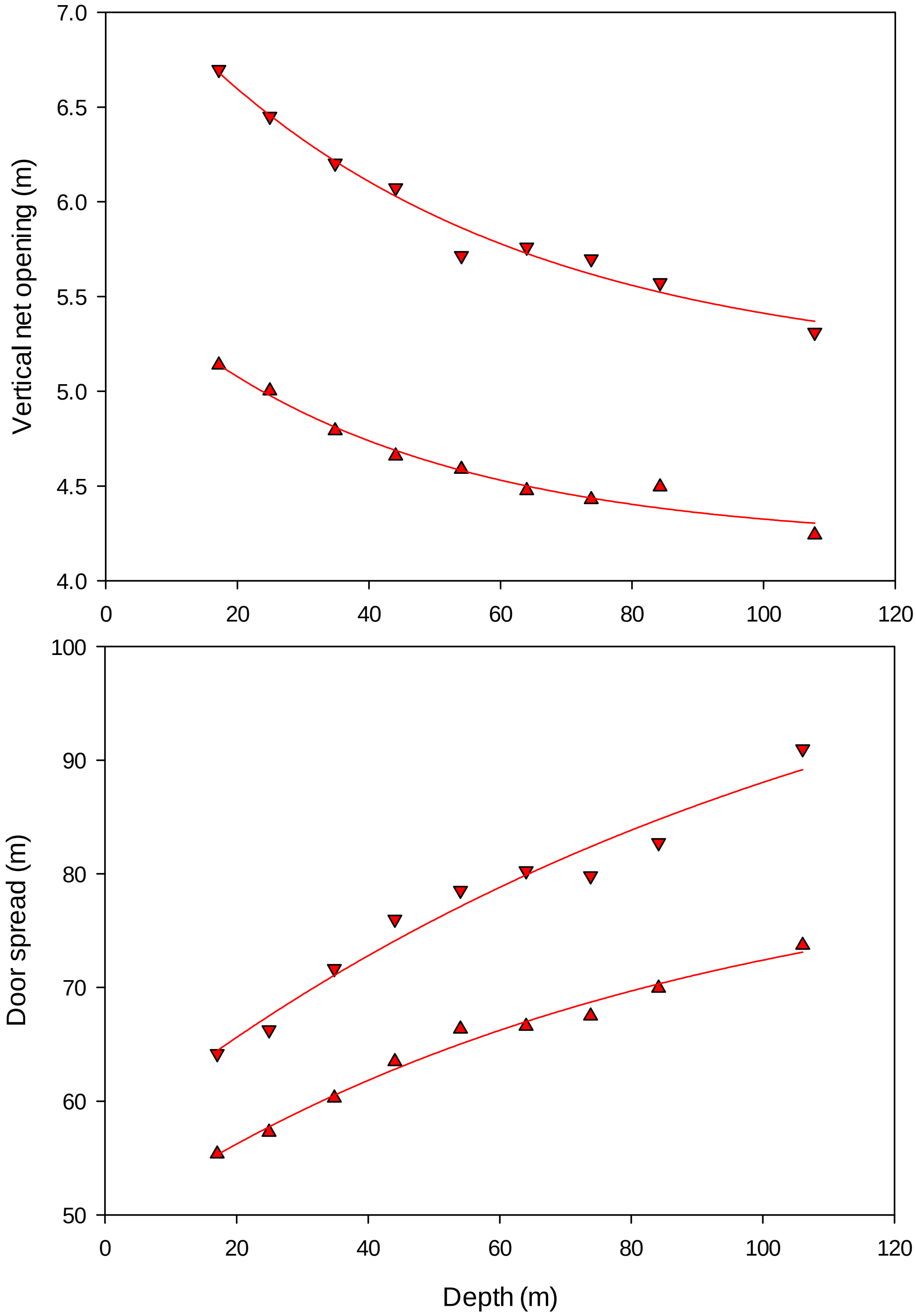


Fig. 2. Vertical net opening and door spread mean ± 1 sd for short sweeps (Denmark, 1st and 3rd quarter NS-IBTS 2000 – 2016) and fitted regressions.

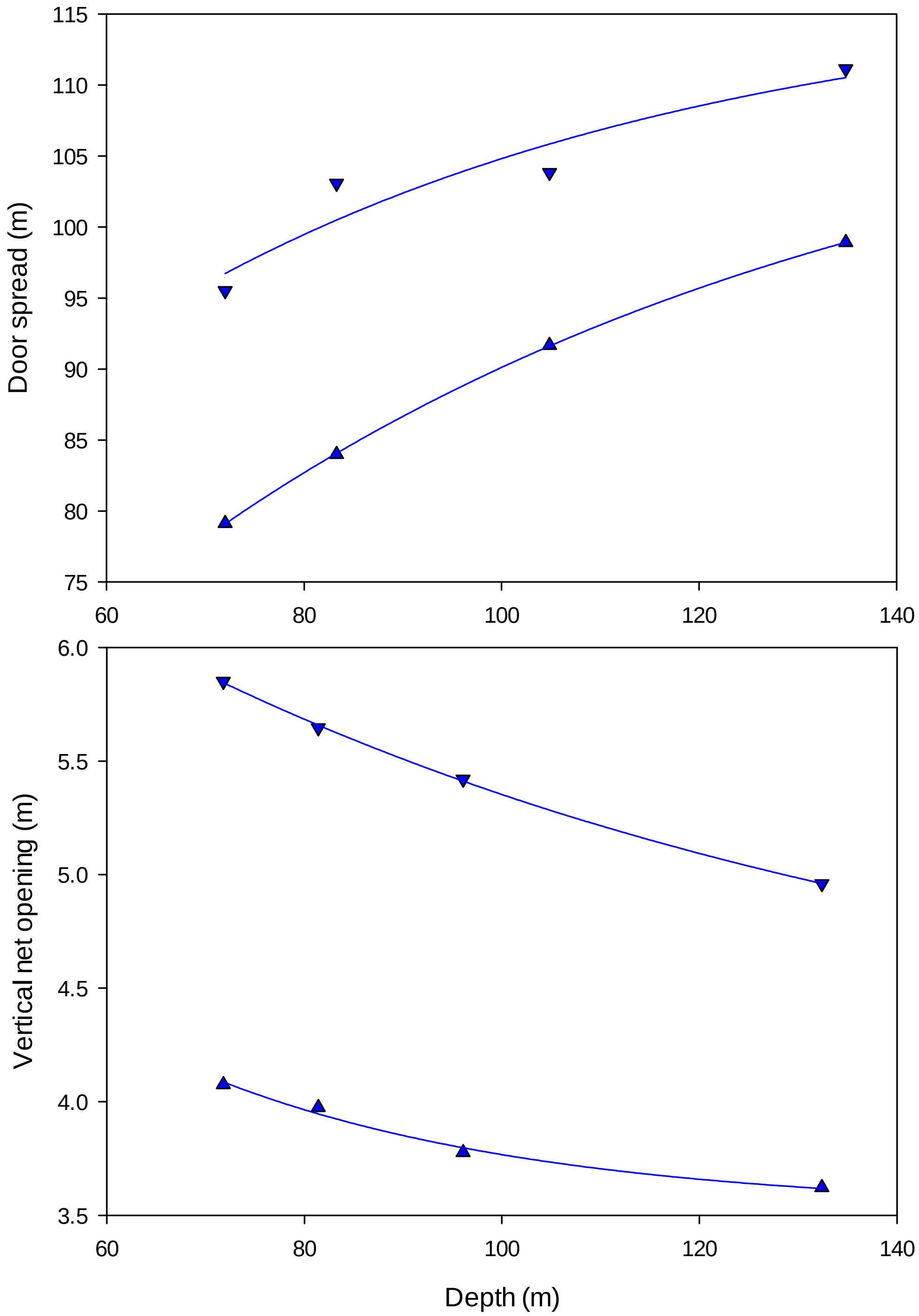


Fig. 3. Vertical net opening and door spread mean ± 1 sd for long sweeps (Denmark, 1st quarter 2000 – 2015) and fitted regressions.

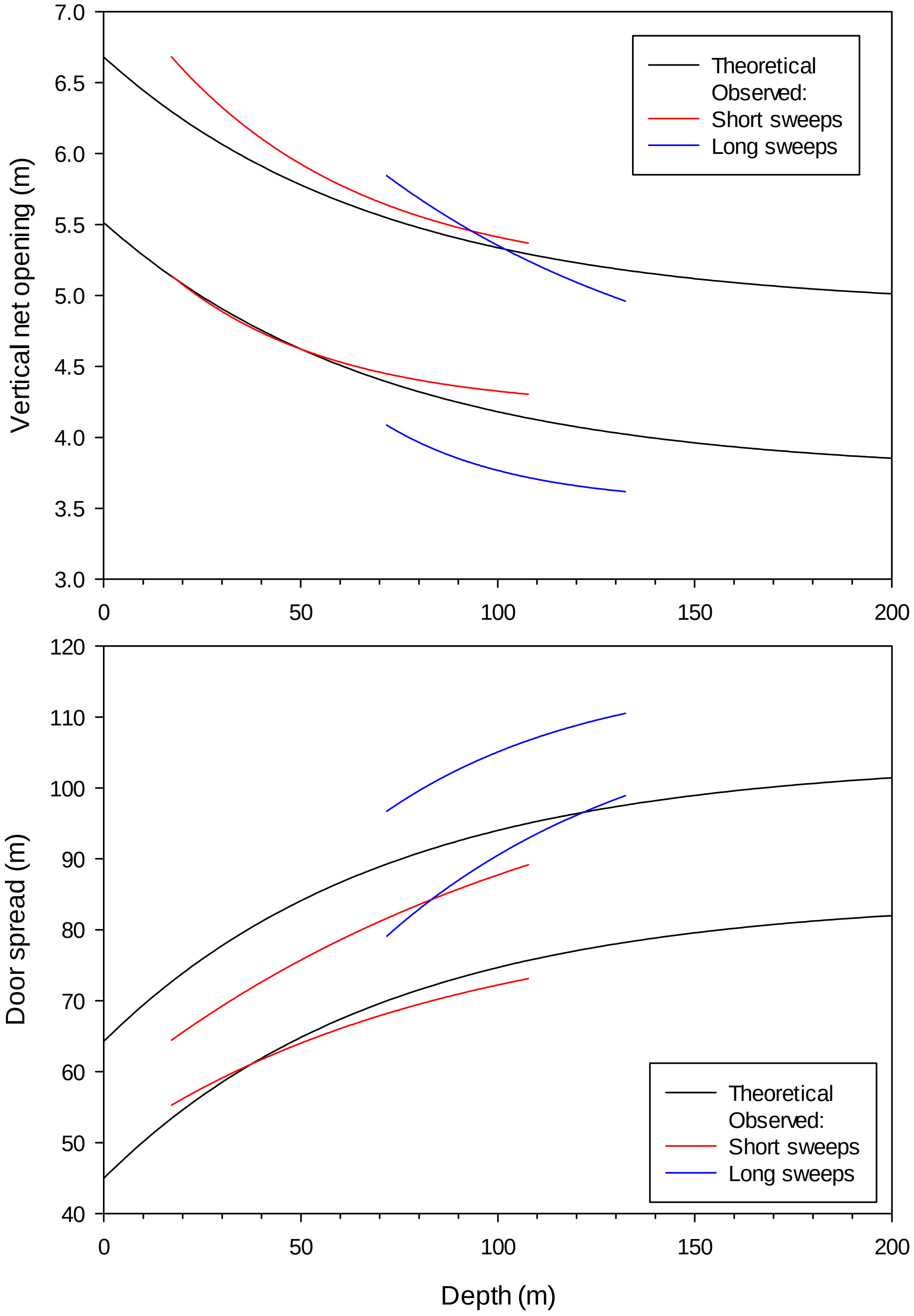


Fig. 4. Comparison of realized upper and lower limits of gear geometry with the theoretical values for the Danish 1st and 3rd quarter NS-IBTS.

Tab. 1. Values for the regressions coefficients.

Theoretical	Vertical net opening		Door Spread	
Coefficient	Upper	Lower	Upper	Lower
a	3.7461	4.9088	103.9178	84.3842
b	1.7689	1.7727	-39.6521	-39.4195
c	0.0140	0.0142	0.0139	0.0140

DK Short sweeps	Vertical net opening		Door Spread	
Coefficient	Upper	Lower	Upper	Lower
a	5.1139	4.2015	109.4745	82.3467
b	2.2234	1.4281	-52.4659	-33.2532
c	0.0200	0.0244	0.0089	0.0121

DK Long sweeps	Vertical net opening		Door Spread	
Coefficient	Upper	Lower	Upper	Lower
a	4.1422	3.5269	116.9395	112.7046
b	4.0572	4.8316	-75.3402	-93.3761
c	0.0121	0.0300	0.0183	0.0142

Irish Anglerfish and Megrim Survey (Divisions VIa, VIIb,g,j,k) IE-IAMS

Hans Gerritsen and Eoghan Kelly, Marine Institute, Ireland

Introduction

IBTSWG 2016 agreed to coordinate the Irish Anglerfish and Megrim Survey (IAMS) (section 5.3.5.4 of the 2016 report). It was also agreed that the IAMS protocols would be provided to IBTSWG in the same format as the IBTS manual revision IV. This document provides a first draft of these protocols.

Sampling design

The Irish Anglerfish and Megrim Survey (EI-IAMS) uses a random stratified survey design.

The survey stratification is based on the following considerations:

- Depth: 0-200m; 200-500m and 500-1000m.
- Clearly defined fishing grounds (from VMS-logbook data: Gerritsen and Lordan, 2011; Gerritsen et al, 2012) were identified as separate strata; an area with high fishing intensity surrounded by low fishing intensity signifies that the ecology on the fishing ground is likely to different from that of the surrounding area. Examples include the *Nephrops* grounds on the Porcupine, west of Aran and Labadie, as well the Stanton Banks and Stags grounds.
- Catch rates of the target species (angerfish and megrim) from VMS-logbook data as well as IBTS and previous Anglerfish & Megrim surveys were also taken into account in determining the boundaries of the strata.
- Rocky bottom types are excluded from the survey area, which implies an assumption that the densities of the target species are zero those areas.
- Regions VIa and VII are treated separately because they are comprise different assessment and TAC areas.

The density of sampling stations in each stratum was either low, medium (twice the low density) or high (four times the low density). These station densities were assigned to each stratum so that the number of stations in each stratum was approximately to be proportional to the expected standard deviation of the biomass estimate of the target species in the stratum.

Three strata with expected low abundance of the target species (Aran and Porcupine *Nephrops* grounds and the area of coarse sediment on the Porcupine Bank) were combined into a single stratum (VII_Shelf_L) despite the differences in depth and bottom type.

The strata are shown in Figure 1. The naming of the strata reflects the region (VIa or VII), area (continental shelf or slope) and density of stations (Low, Medium, High).

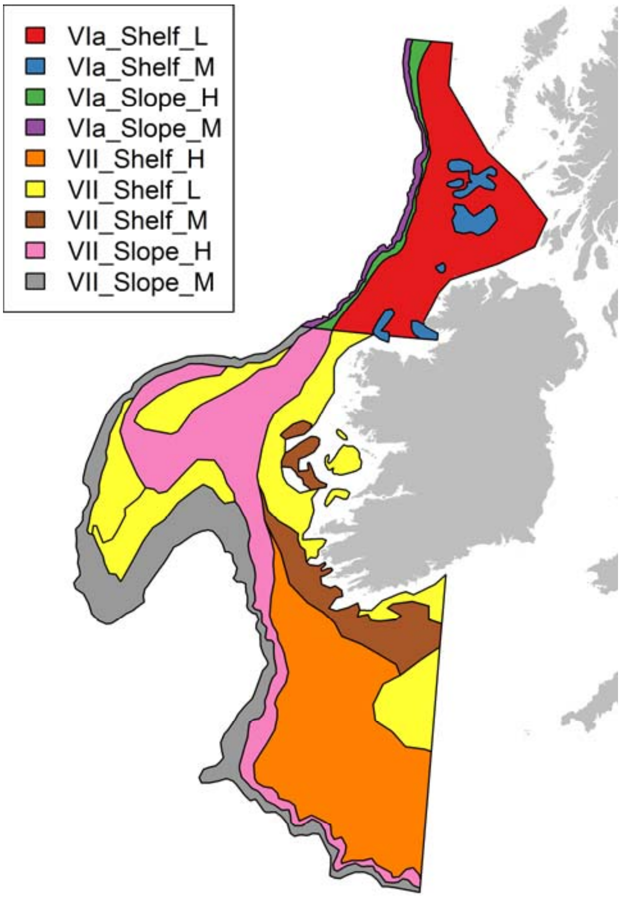


Figure 1. Stratification of the IE-IAMS survey area.

Random sampling stations are selected in the following way to ensure an even spatial distribution within each stratum: First, a 50km buffer is created around the survey area – this avoids edge effects. Next, 10,000 random positions are drawn. The pair of positions with the smallest nearest-neighbour distance is then identified and the point of this pair that is closest to the second-nearest neighbour is then eliminated. This procedure is repeated until there is only one position left. The positions are then assigned a ranking value which is the reverse of the order in which they were eliminated (so the last station to be eliminated gets rank=1).

Next, the stations with the highest rank in each stratum are selected according to the target number of stations in each stratum. This procedure results in evenly spaced stations, regardless of the density of the stations. It also allows for adaptive sampling targets: if targets are unlikely to be met (e.g. due to bad weather), stations with lower ranks can be dropped preferentially.

Finally, a suitable tow track is picked to go through the randomly selected points. Where it was impossible to do so (e.g. underwater cables, passive gear, unsuitable bottom) it will be attempted to find a tow track that came within 1nm of the selected point.

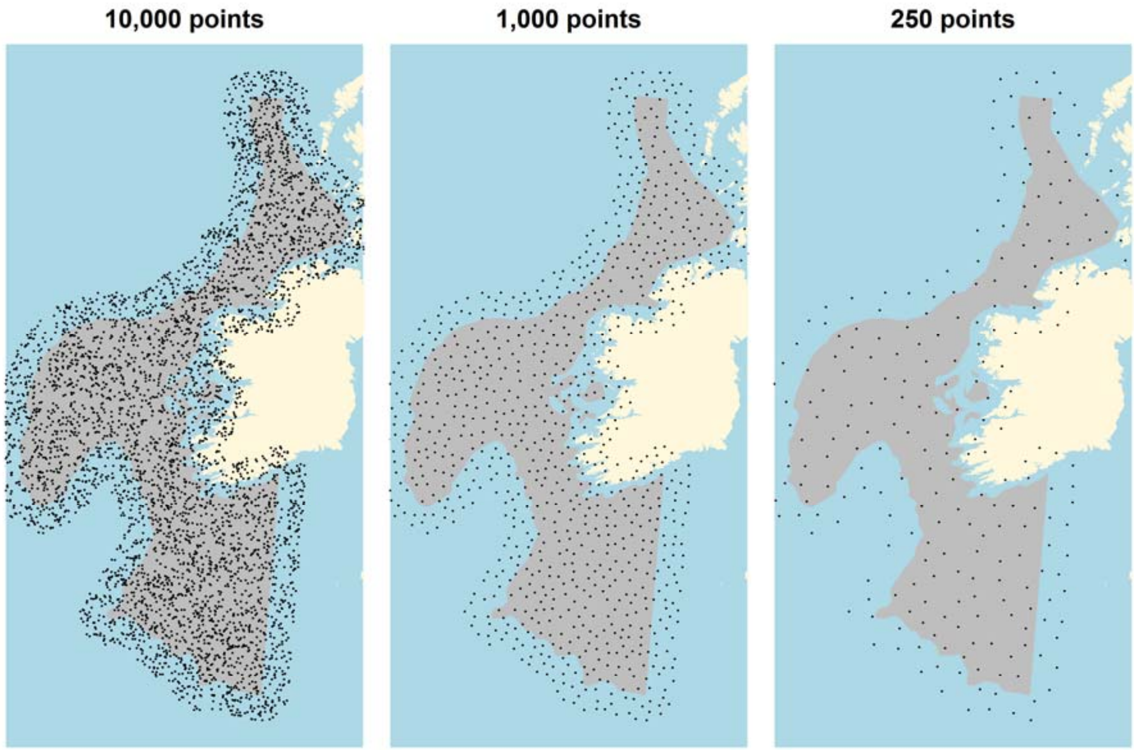


Figure 2. Illustration of the procedure for thinning out random points with the smallest nearest-neighbour distance.

Vessel and gear

The IAMS is carried out on board the R/V *Celtic Explorer*, a 65 m vessel with 4320 KW engine power. The trawl is based on a standard commercial otter trawl used in the anglerfish fishery and is described in detail in Reid *et al*. (2007). The mesh size varies from 200mm in the wings gradually reducing to 100mm in the cod-end. The ground gear is fitted with 16'' rock hopper disks and a 19mm tickler chain is mounted between the wings, rigged to run ahead of the ground gear. The trawl doors were 5.25m^2 Thyboron Type 16 straight oval doors.

Technical description of the hauls

The gear was trawled at 3kn for one hour at each station. The warp to depth ratio was 3/1 for depths up to 200m, and 2/1 plus 200m in deeper water.

Door spread, wing spread, headline height and bottom contact were monitored using Scanmar and Marport trawl sensors (distance sensors in the doors and wing-ends, headline sensor and a trawl-eye sensor positioned on the topsheet directly over the footrope).

All fish and squid species are sorted and weighed. All demersal fish species are sampled for length. Biological data are collected for the species listed in the table 3 in the general section on catch sampling. Occurrence of the following vulnerable or sentinel invertebrate species are noted if present: sea pen, fan mussel and ocean quahog. Otherwise, invertebrate species are not recorded.

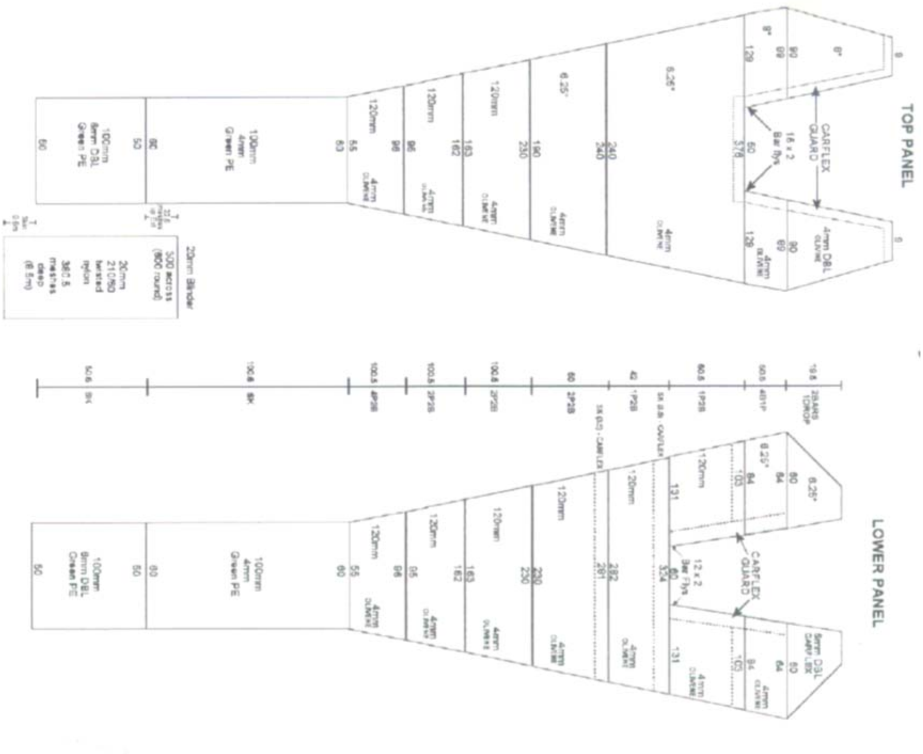


Figure 3. Net diagram of the Jackson trawl used on the IE-IAMS survey

Database storage

Station positions, heading and bottom depth were recorded at the moment the gear settled on the bottom and when the gear was hauled back. Tide and wind direction and speed, barometric pressure, heave, pitch and roll were recorded at the mid-point in the tow. The median values of the door spread, wing spread and headline height were recorded at the end of the tow. These measurement as well as bottom depth and GPS position are recorded in a SQL database at intervals of approximately 1 per second.

Catch weights, length frequency distributions and biological data were captured using the CEFAS Electronic Data Capture (EDC) system and stored into local Access ’97 databases before being imported into a central SQL database. The CEFAS software FSS (Fishing Survey System) was used to enter station data and import catch data. In-house R code was used to quality check the data.

References

Gerritsen, H., & Lordan, C. (2010). Integrating vessel monitoring systems (VMS) data with daily catch data from logbooks to explore the spatial distribution of catch and effort at high resolution. *ICES Journal of Marine Science: Journal du Conseil*, fsq137.

Reid, D. G., V. J. Allen, D. J. Bova, E. G. Jones, R. J. Kynoch, K. J. Peach, P. G. Fernandes, and W. R. Turrell. "Anglerfish catchability for swept-area abundance estimates in a new survey trawl." *ICES Journal of Marine Science: Journal du Conseil* 64, no. 8 (2007): 1503-1511.

Annex 1 – History of the North Eastern Atlantic IBTS Surveys

The Irish Anglerfish and Megrim survey: changes in sampling design and protocols

The Jackson trawl used in the IAMS survey was originally used for three anglerfish/megrim surveys (with various names) carried out on chartered trawlers in 2007, 2008 and 2009 by the Marine Institute in collaboration with Marine Laboratory, Aberdeen, Scotland. In 2007 and 2008 areas 6a, 7bcjk were covered by the Marine Institute but in 2009 only 6a was covered.

In 2016 the IAMS survey series was initiated. This survey takes place on RV Celtic Explorer. The stratification of the IAMS survey is slightly different from the previous charter surveys. The IAMS survey also collects data on more species. Otherwise the survey design and data collection protocols are comparable.

For the 2017 survey, the trawl doors were slightly modified to increase their area and spreading power; this resulted in 5-8m additional door spread, bringing it closer to the doorspread achieved by the commercial trawlers (which used their own trawl doors).

In 2017 the headline was also replaced and the floats tidied up. This resulted in an increase in the mean headline height from 4.8m to 5.4m.

Tables in the current IBTS manual with updated information on IE-IAMS:

Table 1. Summary of surveys in the Northeastern Atlantic IBTS area

Survey	Division	Acronym
…		
Irish surveys		
Irish Groundfish Surveys- Quarter 4	VIa - VIIbgj	EI-IGFS-Q4
Irish Angerfish and Megrim Survey - Quarter 1	VIa - VIIbcgk	EI-IAMS-Q1
…		

Table 2. Sampling materials used in the groundfish surveys (see surveys acronyms in Table 1)

Country/Survey	EI-IGFS	EI-IAMS	…
Research Institute	MI	MI	
Equipment			
Research vessel	Celtic Explorer	Celtic Explorer	
Type	Stern trawler	Stern trawler	
GRT	2425	2425	
KW	4320	4320	
Overall length (m)	65.5	65.5	
Gear Type	GOV 36/47	Jackson trawl	
Depth range (m)	20-600	20-1000	
Trawling speed (knots)	4	3	
Doors weight (kg)	1450	1700	
Doors surface (m^2)	5.3	5.3	
Sweep length (m)	55/110	66	
Diameter of Lower Bridle (mm)	22	19mm chain	
Diameter of Upper Bridle (mm)	16	18 mm wire	
Diameter of Middle Bridle (mm)	16	none	

Exocet Kite	No	No	
Floats in Headline	10x280mm	180x200m heavy duty	
Floats in Winglines	66x200mm		
Mean vertical opening (m)	4.3	5.0	
Mean doorspread (m)	78/115	91	
Mean horizontal opening (m)	19.5/21	28	
Groundgear	Rubber disks	Rubber disks (and tickler chain)	

Table 3 - Summary of species for which biological information is routinely collected per survey (see Surveys acronyms in Table 1)

Species	UK-SCOWCGFS	UK-SCOROC	UK-NIGFS	SP-PORC	EI-IGFS	IE-IAMS	FR-CGFS	FR-EVHOE	SP-NSGFS	PT-PGFS	SP-GCGFS
Clupea harengus	X	X			X						
Conger conger			X	X							
Dicentrarchus labrax			X		X		X				
Gadus morhua	X	X	X	X	X	X	X	X			
Glyptocephalus cynoglossus						X		X			
Helicolenus datylopterus				X							
Lepidorhombus boscii				X	X	X			X	X *	
Lepidorhombus whiffiagonis				X	X	X		X	X	X *	
Lophius budegassa				X	X	X		X	X	X *	
Lophius piscatorius				X	X	X		X	X	X *	
Melanogrammus aeglefinus	X	X	X	X	X	X		X			
Merlangius merlangus	X	X	X	X	X	X	X	X			
Merluccius merluccius	X		X	X	X	X		X	X	X	X
Micromessistius poutassou					X				X	X	
Microstomus kitt					X	X		X			
Molva molva			X	X		X		X			
Mullus surmuletus							X	X			
Pleuronectes platessa			X		X	X	X	X			
Pollachius pollachius			X		X	X		X			
Pollachius virens	X	X				X					
Psetta maxima	X		X			X					
Scomber colias										X	
Scomber scombrus	X			X	X				X	X	
Scophthalmus rhombus	X		X		X						
Solea solea					X	X	X	X			
Sprattus sprattus	X				X						
Trachurus picturatus										X	
Trachurus trachurus					X				X	X	
Trisopterus esmarki	X				X						
Leucoraja naevus	X	X	X		X	X		X		X	
Raja montagui	X	X	X		X	X		X		X	
Raja clavata	X	X	X		X	X		X		X	
Raja microocellata								X		X	
Raja brachyura	X	X	X		X	X		X		X	

Dipturus batis[(1)]	X	X	X		X	X				
Mustelus mustelus	X	X			X					
Mustelus asterias	X	X			X					
Squalus acanthias			X		X	X				
Nephrops norvegicus				X	X	X	X	X	X *	X
Parapenaeus longirostris									X *	X
Melicertus kerathurus										X
Loligo vulgaris					X				X	X
Sepia officinalis					X			X	X	X
Octopus vulgaris								X	X	X
Eledone cirrhosa								X	X	X
Eledone moschata									X	X

*** not well sampled due to bottom trawl net with rollers in the groundrope**

(1) including *Dipturus batis* complex at the moment

Table 7.1. Area of the geographic sectors used in the IBTS SW Areas – See Annex 6 for a complete table of strata and sampling areas.

Country	Survey	Geographic sector	
		Name	Area (square km)
UK - Scotland	UK-SCOWCGFS UK-SCOROC	Overall area[(1)]	99 949 – 102 316 21 694
UK - Northern Ireland	UK-NIGFS	Overall area [(1)]	44 952
Ireland	IE-IGFS	North West (VIa) West (VIIb) Celtic Sea (VIIfgj)	167 673 105 065 280 742
Ireland	IE-IAMS	VIa VIIbcjk	49 023 172 593
…	…	**…**	…

Annex 2

		IE-IAMS				IE-IAMS
Staffing	Number available for catch processing	5/6		**By sex**	anglers	N
Catch	Retention in hopper bin	Y			Cod	N
	Codend cleaned	Y			Dab	N
	Net cleaned	Y			Elasmo	Y
	Cleanings added to catch	Y			Had	N
	Total weight*	N			Hke	N
Sorting	Deckmaster	Y			Lem	Y
	Bench or conveyor	B			meg	Y
	Complete sort up to x	NA			Nep	Y
	Small fish mix	y			Ple	Y
	Part of catch discarded	n			Sol	Y
Categories	By sex	Y			whg	n
	L / S	Y		**0.5cm**	Anchovy	NA
	Multi-modal	y			Her	NA
Subsample	Re-mix before selection	Y			Pil	NA
	Selection random	y			spr	NA
weighing	All catch components	Y		**1mm**	Benthos	na
	All sub samples	y			nephrops	d
measuring	All fish species	n		**Prescribed spp**	Anglers	Y
	Minimum sample size	*			Whb	N

	Commercial benthos	n			Cod	Y
	cephalopods	n			Had	Y
	Other benthos	v			Hke	y-o
Biological	Prescribed spp	Y			Her	N
	Other spp	Y			Hom	N
	Weight	Y			Lem	D,y-o
	Sex	Y			Mac	N
	Maturity	Y			Meg	Y
	Age material	Y			Nep	D,y-o
	Ageing sea/ashore	a			Ple	Y
Data	Station	e/p			Pok	Y
	Catch	E			Sol	D,Y
	Length	E			Dgs	D,y-o
	Biological	E			whg	Y
	Error check	Y		**others**	Bll	D,y-o
	backup	y			Elasmo	D,Y-o
					Spr	N
* the number of size classes in the sample times 10					tur	D,y-o

Effect of tow duration on catch rates of whiting and cod in the NS-IBTS 3Q 2015 and 2016

Kai Wieland, DTU AQUA, Section for Monitoring and Data Hirtshals

Introduction

IBTSWG 2015 agreed to conduct an experiment on tow duration in NS-IBTS Q3 2015, because evidence exists for other surveys that benefits arose from changing to shorter tow duration (ICES IBTSWG Report 2015 section 10.3. for a thorough discussion on the pros and cons). The results were presented at the IBTSWG meeting in 2016 and it was agreed to continue with short (15 min) and long (30 min) tows in NS-IBTS Q3 2016.

The analysis of the Q3 2015 data for cod and whiting has also been presented and discussed during the WGISDAA meeting in 2016. WGISDAA recommended that an update of the analysis with the NS-IBTS Q3 2016 results included in the data set should consider some modifications of the analysis set up (ICES WGISDAA Report 2016). The suggested modifications include an extension of the analysis using tow duration as a categorical variable, considering a Poisson error distribution for the count data as this may be more appropriate for non-schooling species, the use of AICc (Akaike Information Criterion corrected), which is more appropriate than AIC for low sample sizes and converges to AIC values as the number of observations increases, and to model presence/absence for rare age groups rather than modelling low catch rates explicitly.

Material and Methods

An almost geographically balanced distribution of nominal 15 and 30 min tows have available from the NS-IBTS 3Q 2015 and 2016 in the North Sea (Fig. 1). This data set includes tows from 5 different vessels and usually 2 hauls per rectangle, one 30 min and one 15 min tow, were done by two different countries while in some rectangles the same country did a long and a short tow (IBTS WG 2016, 2017). The analysis has been based on DATRAS CPUE per age per haul and HH records (download 25 January 2017 with DATRAS date of calculation 10 May 2016), and the dataset comprises 629 hauls in total for roundfish areas 1 to 7 (North Sea without Skagerrak). Tow duration was categorized in short (< 17 min) and long (≥ 18 min) tows (Fig. 1).

Catch at age and effort by haul was analysed using GAM's with the following setups (subscript for haul omitted):

1) All values (count data including zero observations)

$$g(\mu) = s(\text{Depth}) + s(\text{Time of day}) + s(\text{X\_utm}, \text{Y\_utm}) + f(\text{Haul category}) + f(\text{Vessel}) + f(\text{Year}) + \text{offset}(\log(\text{Swept area}))$$

log(Swept area) was used as an offset assuming proportionality between catch in numbers and effort. Negative binominal and Poisson error distributions was used with a log link reflecting that the data are counts which include zero observations, and the expected response μ is N_{Age} per haul for the different age groups (0, 1, 2, 3, 4, 5, and 6+).

2) Presence/absence

g(μ) = s(Depth) + s(Time of day) + s(X_utm, Y_utm) + f(Haul category) + f(Vessel) + f(Year)

with a binomial error distribution and a logit link, and where the expected response μ is 1 for presence and 0 for absence for the different age groups.

3) Positive values (numerical densities, i.e. catch in number per km^2, log transformed)

g(μ) = s(Depth) + s(Time of day) + s(X_utm, Y_utm) + f(Haul Category) + f(Vessel) + f(Year)

with a gamma error distribution and a log link, and where the expected response μ is log(CPUE) in number per km^2 for the different age groups.

Vessel, year and haul category were considered as factors whereas the other covarites were considered as continuous variables. X_utm and Y_utm denote geographical position for which latitude and longitude were converted to UTM coordinates to ensure equal distances in North –South and East-West direction.

Restrictions of the number of knots (k) determining the “wiggliness” of the curve for the non-linear smoothers were applied (k = 3 for Depth, k = 4 for Time of day and k = 25 for the 2D smoother on geographical position) to avoid overfitting and biologically unreasonable fits.

Results

Count data including zero observations

The negative binominal GAMs work better than the Poisson Gam’s for almost all age groups of cod and whiting except for Cod age 5 (Tab. 1) based on the AICc values. This is also supported by the QQ (deviance versus theoretical quantiles) plots and the histograms of the residuals (Fig. 3, Fig. 4). Except for cod age 5, the Theta values were far below 10 indicating that there is no indication for overdispersion in the negative binominal GAM’s. Plots of response versus fitted values indicated that extreme high values were better fitted by the Poisson GAM’s than in the negative binominal GAM’s (Fig. 3, Fig. 4). However, all of the best models for a given age group clearly indicated that haul category had no effect on the catches of neither cod nor whiting (Tab. 3).

Presence/absence models

The binominal GAM’s for cod suggested a significant effect of haul category for age groups 2 and older and for whiting for age 2 and 6+ (Tab. 2). However, all models without haul category had a higher AICc values than the full models, and the model diagnostic plots showed poor results in several cases (Fig. 5, Fig. 6). Furthermore, the high number of zeroes observations for occurring throughout the entire range of the values of the covariates makes it difficult to find appropriate models.

Positive catches in numbers per km^2

The Gamma GAM's with log transformed numerical densities indicated a significant effect of all cod age groups except for age 0 but showed no significant effect of haul category for all age groups of whiting (Tab. 3). However, strange model diagnostic and response plots were found for cod, in particular for age 5 and age 6+ but not for age 0, whereas these plots indicated no severe problems of the model fits for whiting (Fig. 7, Fig. 8). These finding are presumable related to the number of observations which were in particular low for cod at age 0, 5 and 6+ (Tab.3).

Conclusions

The different model types and approaches produced some conflicting results in respect to the effect of the various covariates considered. For cod, the best results were obtained when count data including the zero observations were used applying a negative binominal distribution. The same was found whiting but here also the presence/absence models and the GAMs for the positive catch rates yielded satisfactory results.

In summary, no clear indication is obvious that the experimental 15 min tows are less representative than the standard 30 min for the catch rates at age for whiting and cod. However, it appears worthwhile to continue with a balanced distribution of nominal 15 and 30 min tows in the future 3Q NS-IBTS surveys in order to increase the data set suitable for the analysis of the tow duration effect.

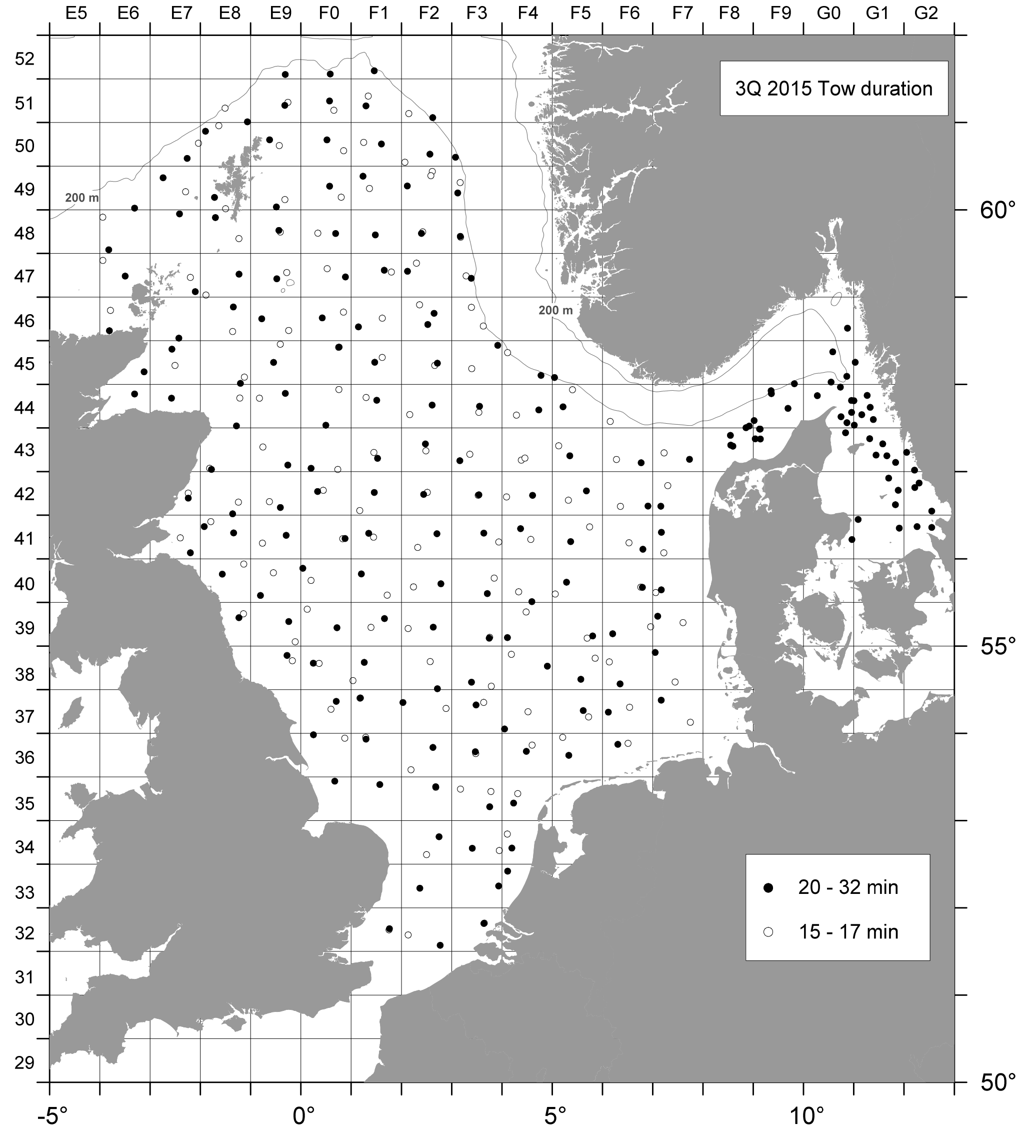


Fig. 1a. Geographical distribution of tows by duration, NS-IBTS 3Q 2015.

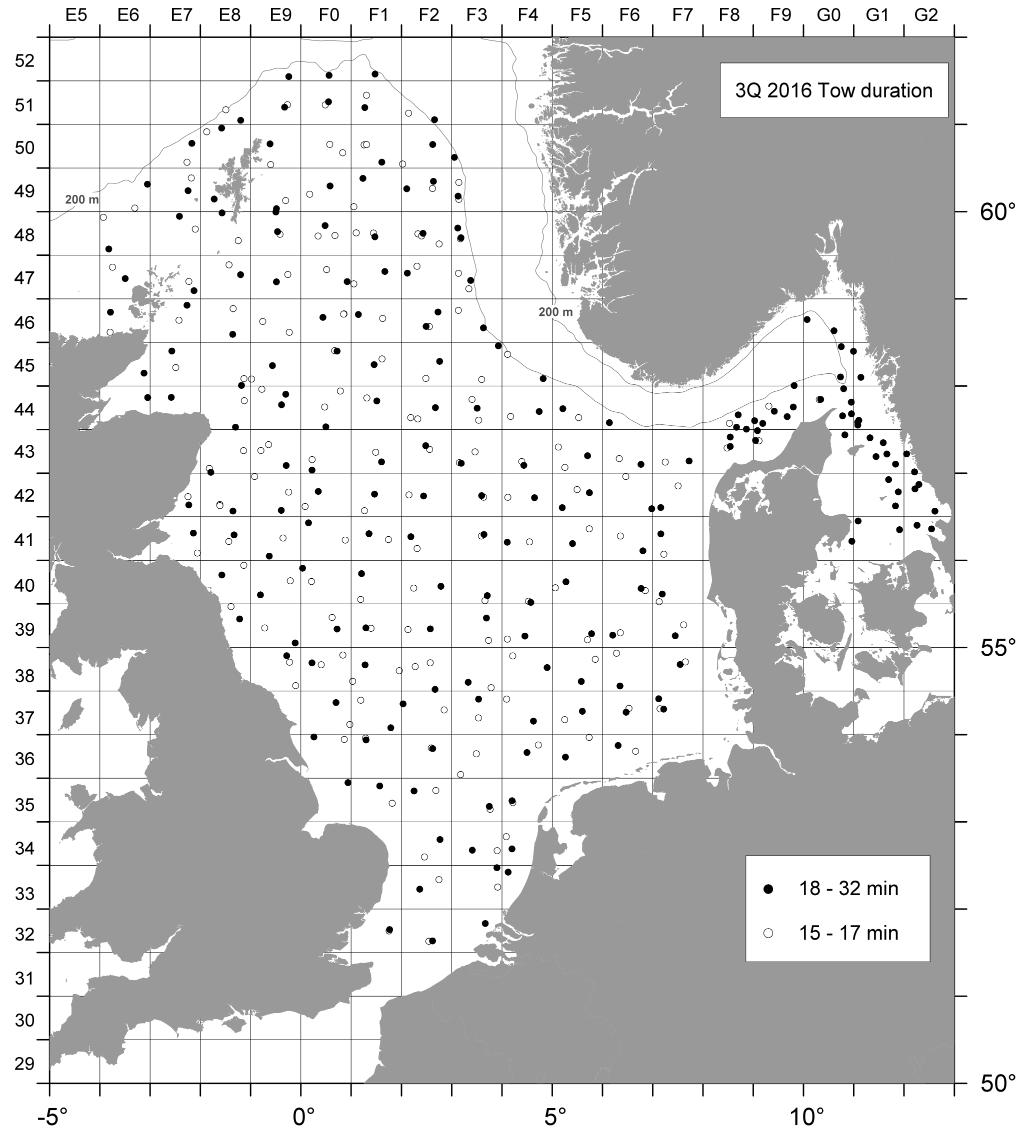


Fig. 1b. Geographical distribution of tows by duration, NS-IBTS 3Q 2016.

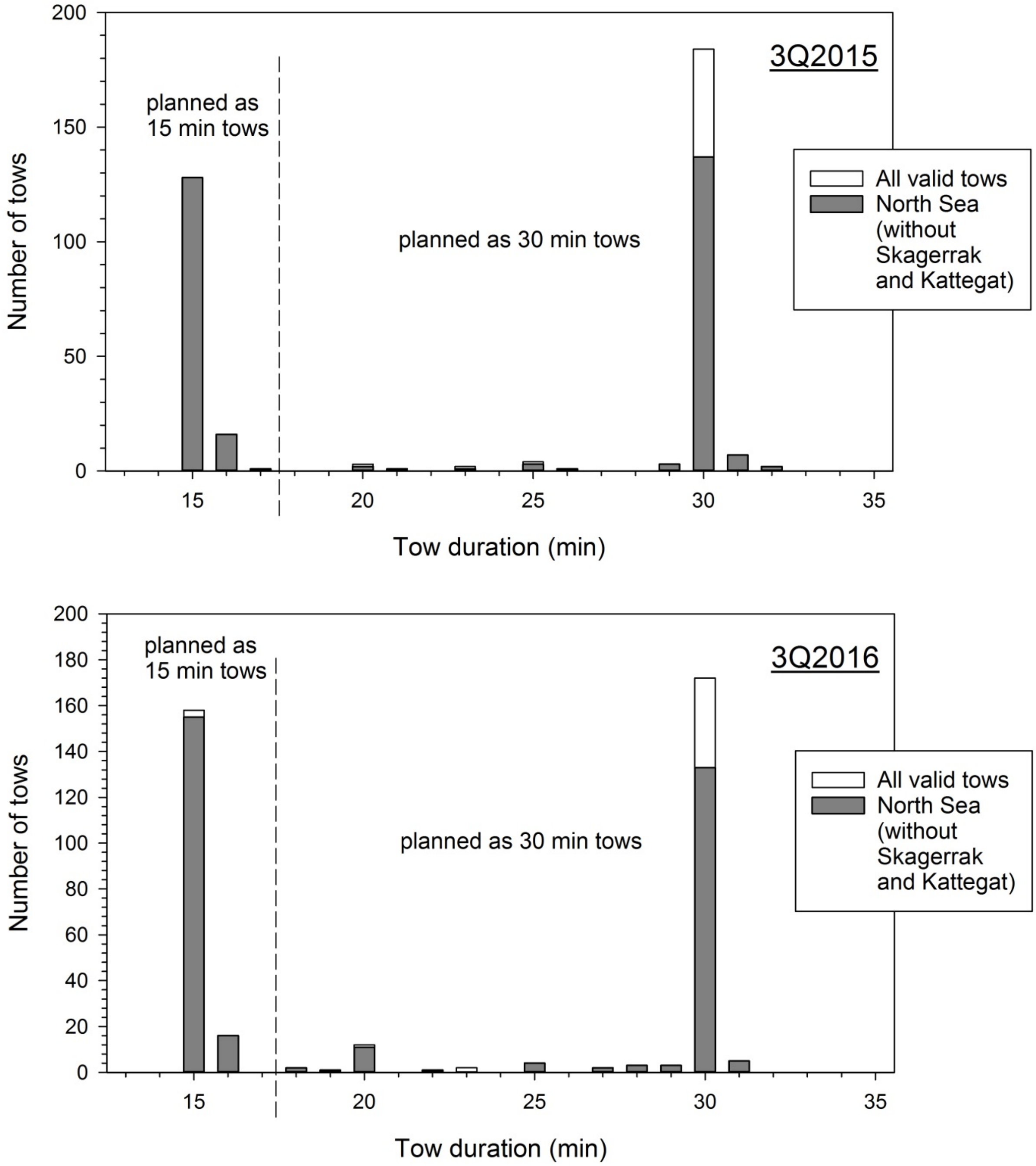
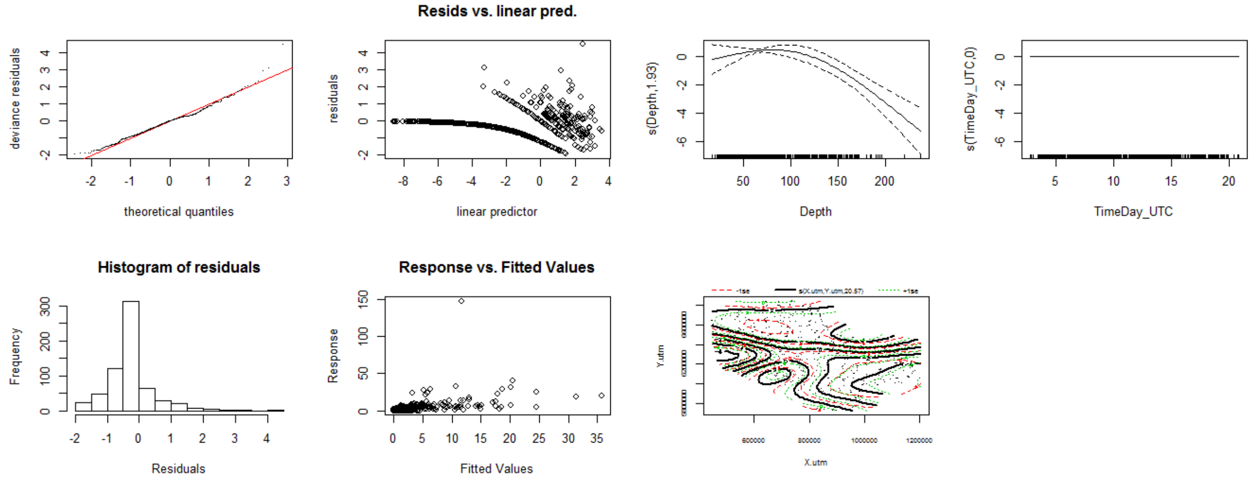


Fig. 2. Frequency distribution of tow duration, NS-IBTS 3Q 2015 and 2016.



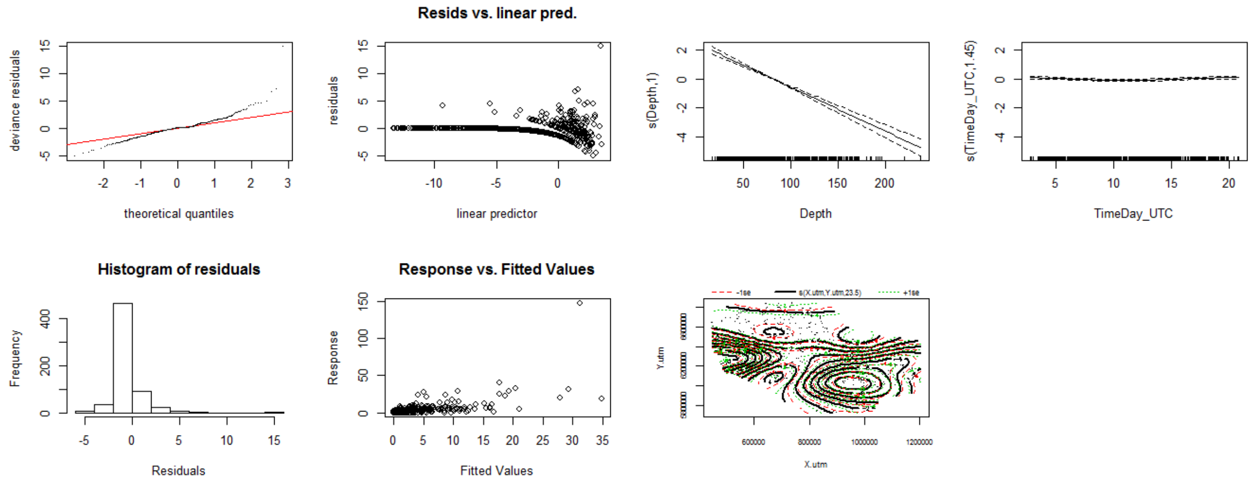


Fig. 3. Model diagnostic and response plots for cod age 2. Upper panel: Negative binominal GAM, Lower panel: Poisson GAM.

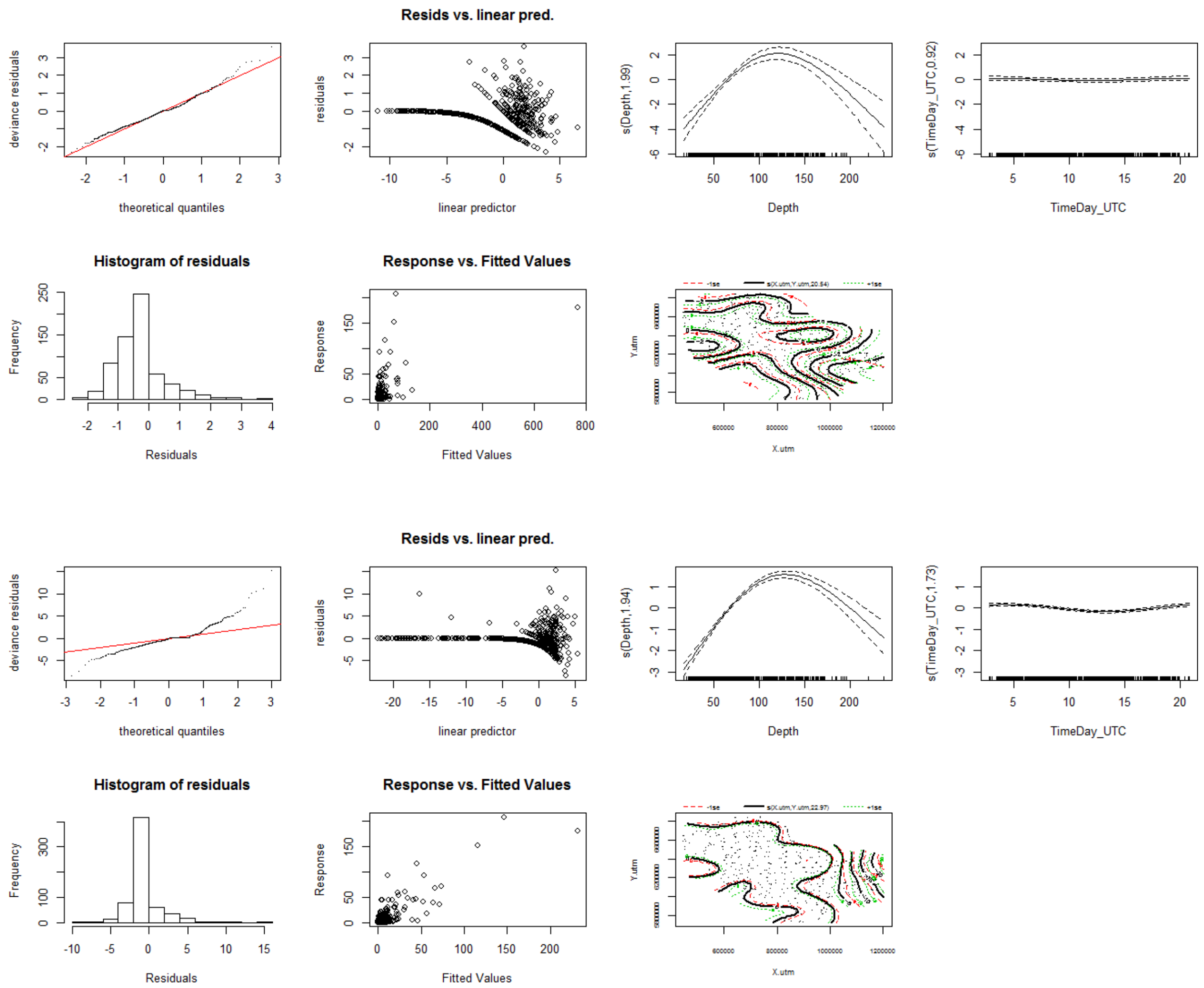


Fig. 4. Model diagnostic and response plots for whiting age 5. Upper panel: Negative binominal GAM, Lower panel: Poisson GAM.

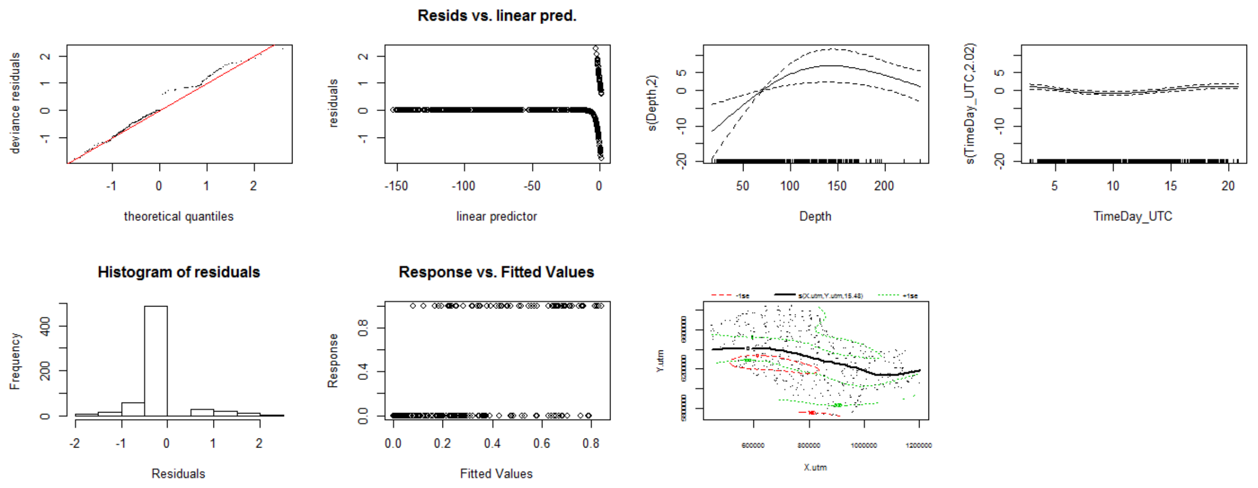


Fig. 5. Model diagnostic and response plots for cod age 6+ (presence/absence GAM).

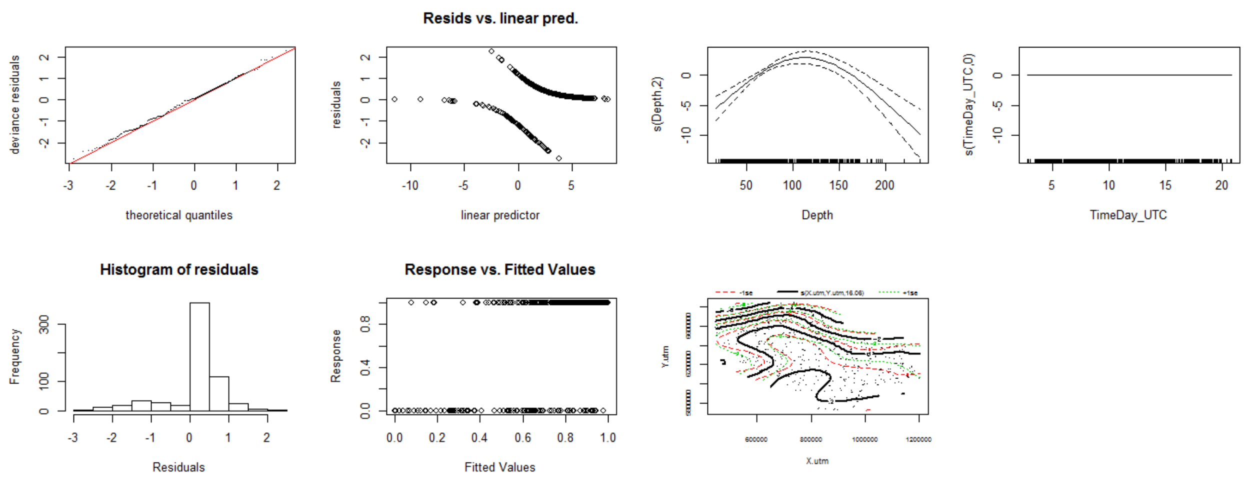


Fig. 6. Model diagnostic and response plots for whiting age 2 (presence/absence GAM).

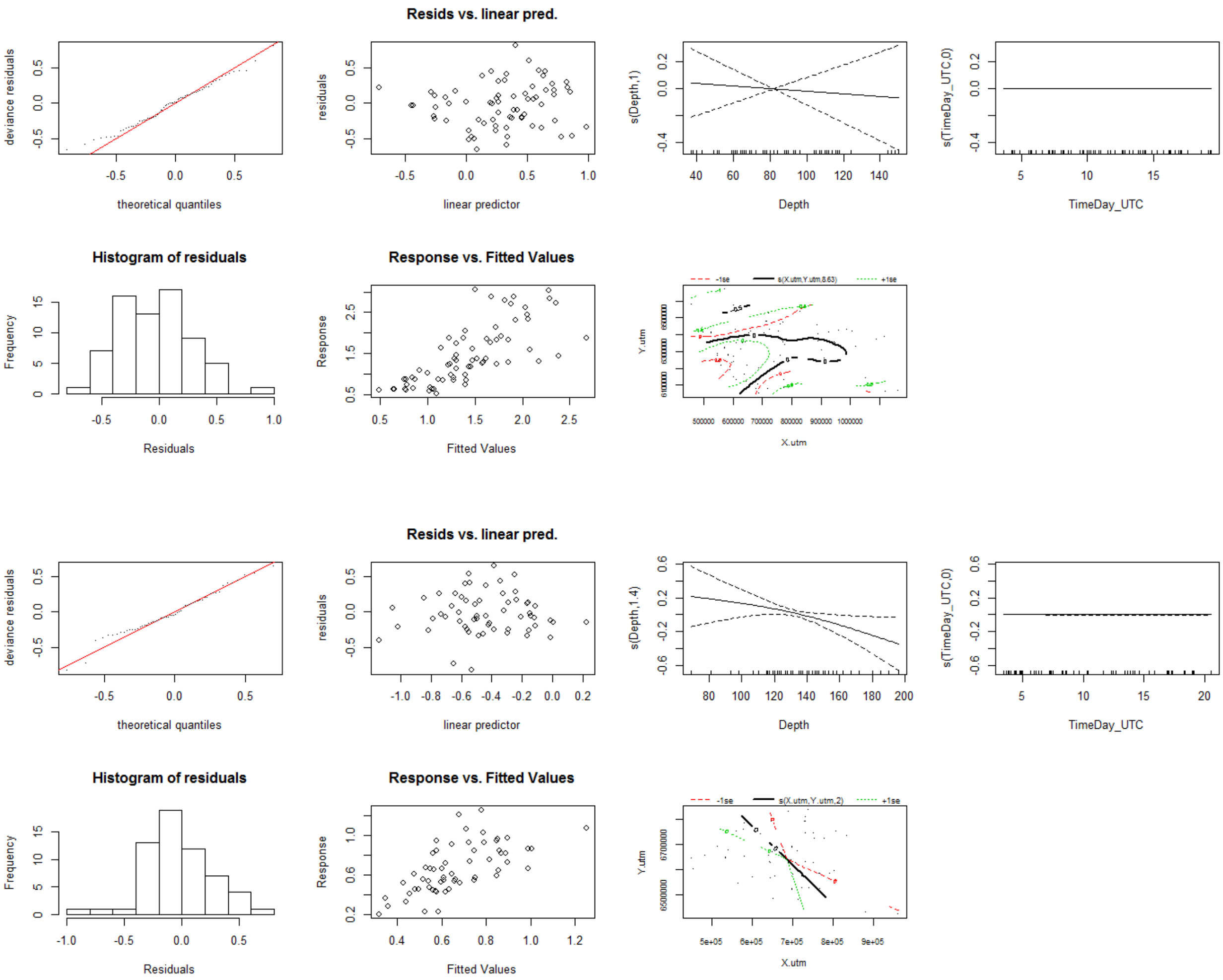
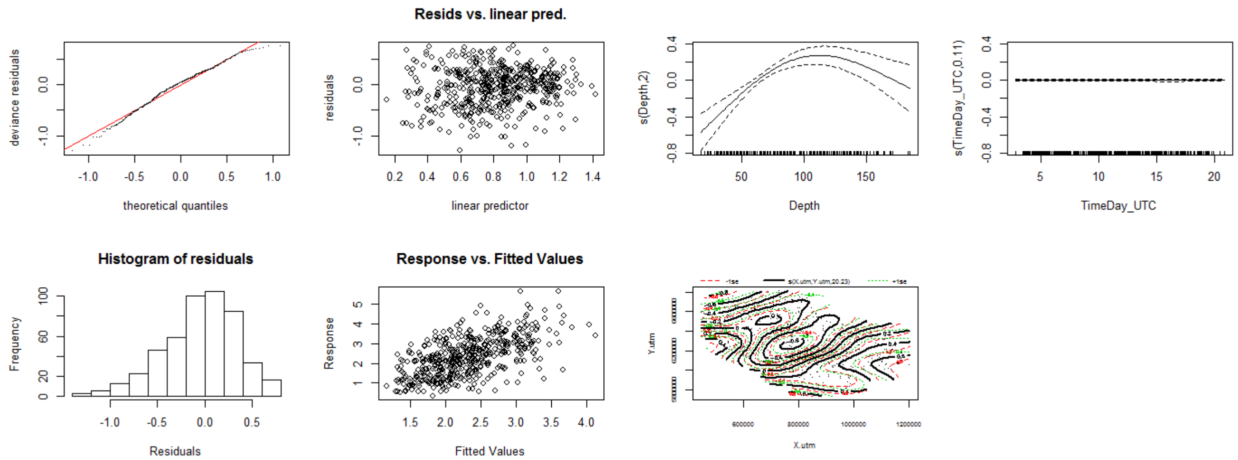


Fig. 7. Model diagnostic and response plots for cod age 0 (upper panel) and cod age 5 (lower panel) (GAMs for positive values).



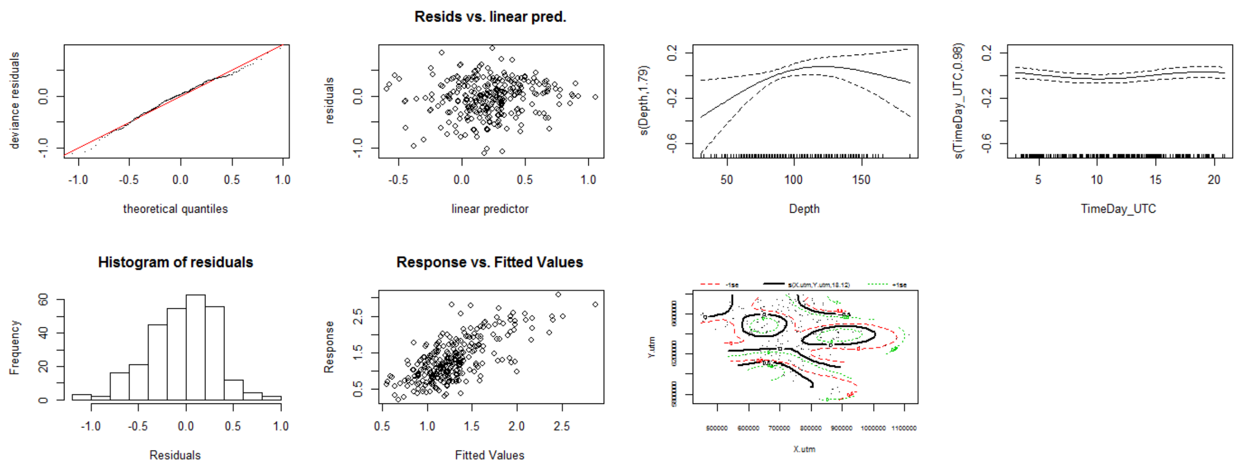


Fig. 8. Model diagnostic and response plots for whiting age 0 (upper panel) and whiting age 5 (lower panel) (GAMs for positive values).

Tab. 1. Summary of the GAM analysis using catch in numbers per tow by age (NB: negative binominal, P: Poisson; *: best model for a given age group based on AICc and residual plots).

			Significance level									
Species	Age	Error distribution	Depth	Time of day	Position (utm)	Vessel	Year	Haul category	AIC_c	Deviance explained (%)	Theta	
Cod	0	NB	n.s.	0.0079	< 0.001	n.s.	< 0.001	n.s.	729.38	77.4	0.1668	*
		P	n.s.	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	1938.29	84.9	-	
	1	NB	< 0.001	n.s.	< 0.001	n.s.	n.s.	n.s.	1136.32	53.1	0.4940	*
		P	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	n.s.	1486.30	53.3	-	
	2	NB	< 0.001	n.s.	< 0.001	n.s.	< 0.001	n.s.	1408.99	76.1	1.1847	*
		P	< 0.001	0.0346	< 0.001	< 0.001	< 0.001	0.0013	2030.32	70.0	-	
	3	NB	< 0.001	n.s.	< 0.001	n.s.	< 0.001	n.s.	1161.92	74.3	1.4594	*
		P	< 0.001	0.0104	< 0.001	n.s.	< 0.001	n.s.	1339.02	71.5	-	
	4	NB	n.s.	n.s.	< 0.001	n.s.	< 0.001	n.s.	748.35	73.5	2.8559	*
		P	0.0341	n.s.	< 0.001	n.s.	< 0.001	n.s.	769.33	70.6	-	
	5	NB	n.s.	n.s.	< 0.001	n.s.	n.s.	n.s.	307.45	58.6	82541.36	
		P	n.s.	n.s.	< 0.001	n.s.	n.s.	n.s.	306.54	58.0	-	*
	6+	NB	0.0122	0.0417	0.0066	n.s.	n.s.	n.s.	374.77	63.8	1.0260	*
		P	0.0078	0.0014	< 0.001	n.s.	n.s.	n.s.	380.12	62.5	-	
Whiting	0	NB	< 0.001	n.s.	< 0.001	0.017	n.s.	n.s.	6107.79	46.5	0.2643	*
		P	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	583195.50	71.5	-	
	1	NB	< 0.001	n.s.	< 0.001	n.s.	< 0.001	n.s.	5174.09	57.5	0.4667	*
		P	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	86741.43	64.5	-	
	2	NB	< 0.001	n.s.	< 0.001	0.0153	0.0134	n.s.	4983.32	55.5	0.5033	*
		P	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	60525.10	66.6	-	
	3	NB	< 0.001	n.s.	< 0.001	0.0142	< 0.001	n.s.	3605.30	58.2	0.4937	*
		P	< 0.001	n.s.	<0.001	< 0.001	< 0.001	0.0060	15785.97	70.3	-	
	4	NB	< 0.001	n.s.	< 0.001	0.0174	n.s.	n.s.	2434.27	64.4	0.5941	*
		P	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	n.s.	5872.77	63.5	-	
	5	NB	< 0.001	n.s.	< 0.001	0.0128	< 0.001	n.s.	2030.58	70.2	0.6284	*
		P	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.0414	3848.25	73.6	-	
	6+	NB	< 0.001	n.s.	< 0.001	0.0483	n.s.	n.s.	1748.03	71.2	0.6080	*
		P	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.0469	3042.15	74.5	-	

Tab. 2. Summary of the GAM analysis using presence/absence by age (Probability: Chi-square test comparing models with and without haul category).

		Significance level								
Species	Age	Depth	Time of day	Position (utm)	Vessel	Year	Haul category	AIC_c	Deviance explained (%)	Probalility
Cod	0	n.s.	n.s.	< 0.001	n.s.	< 0.001	n.s.	291.62	43.5	0.1701
	1	< 0.001	n.s.	< 0.001	n.s.	n.s.	n.s.	504.95	38.5	0.0477
	2	< 0.001	0.0440	< 0.001	n.s.	< 0.001	0.0121	411.29	56.8	0.0092
	3	n.s.	n.s.	< 0.001	n.s.	n.s.	0.0292	431.93	52.5	0.0243
	4	n.s.	n.s.	< 0.001	n.s.	< 0.001	0.0082	327.50	60.3	0.0064
	5	n.s.	n.s.	0.0027	n.s.	n.s.	0.0303	241.81	50.0	0.0305
	6+	0.0099	< 0.001	n.s.	n.s.	n.s.	0.0385	233.01	56.6	0.0295
Whiting	0	0.0093	n.s.	< 0.001	0.0068	0.0014	n.s.	560.60	25.7	0.4054
	1	< 0.001	n.s.	< 0.001	n.s.	n.s.	n.s.	391.20	46.3	0.7325
	2	< 0.001	n.s.	< 0.001	n.s.	n.s.	0.0094	387.73	42.8	0.0058
	3	< 0.001	n.s.	< 0.001	0.0240	0.0054	n.s.	439.26	55.0	0.0493
	4	< 0.001	n.s.	< 0.001	n.s.	n.s.	n.s.	389.29	62.9	0.1549
	5	< 0.001	n.s.	< 0.001	n.s.	< 0.001	n.s.	376.84	64.4	0.0807
	6+	< 0.001	n.s.	< 0.001	n.s.	n.s.	0.0101	387.83	60.8	0.0073

Tab. 3. Summary of the GAM analysis using CPUE in numbers per km2 (positive values only).

		Significance level									
Species	Age	Depth	Time of day	Position (utm)	Vessel	Year	Haul category	AIC_c	Deviance explained (%)	Number of observations	Probalility
Cod	0	n.s.	n.s.	0.0046	n.s.	< 0.001	n.s.	113.75	60.9	69	0.2720
	1	0.014	n.s.	n.s	< 0.001	n.s.	0.0075	117.12	28.9	169	0.0072
	2	< 0.001	n.s.	< 0.001	n.s.	< 0.001	0.0027	170.25	51.2	218	0.0028
	3	0.0017	n.s.	< 0.001	n.s.	< 0.001	0.0286	135.93	46.8	192	0.0285
	4	n.s.	n.s.	0.0021	n.s.	0.0012	0.0344	72.38	43.6	143	0.0384
	5	0.0458	n.s.	0.0186	n.s.	n.s.	< 0.001	-16.12	44.9	59	< 0.001
	6+	n.s.	n.s.	n.s	n.s.	n.s.	0.0144	18.85	30.1	63	0.0186
Whiting	0	< 0.001	n.s.	< 0.001	0.0150	n.s.	n.s.	1224.45	31.5	485	0.6218
	1	< 0.001	n.s.	< 0.001	n.s.	n.s.	n.s.	985.07	45.9	489	0.6908
	2	< 0.001	n.s.	< 0.001	n.s.	n.s.	n.s.	975.39	45.9	518	0.0830
	3	< 0.001	n.s.	< 0.001	n.s.	0.0096	n.s.	651.35	45.6	395	0.1836
	4	n.s.	n.s.	< 0.001	0.0040	n.s.	n.s.	440.85	37.5	317	0.3470
	5	n.s.	n.s.	< 0.001	n.s.	0.0123	n.s.	358.19	42.1	279	0.0321
	6+	n.s.	n.s.	< 0.001	n.s.	n.s.	n.s.	314.88	41.2	245	0.1856

Data Analysis For Haddock and Norway Pout From Tow Duration Experiment NS-IBTS 3rd Quarter 2015–2016

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Introduction

During the meeting of the IBTSWG in 2015, it was proposed that a tow duration experiment be conducted during the Q3 survey in the North Sea in 2015 (NS-IBTS Q3 2015). This was subsequent to several discussions on survey design where the issue of tow duration on IBTS surveys was raised and whether, in fact, 30 minutes was the optimal duration for this survey. Obvious benefits of shorter tows include potentially increasing the total number of hauls undertaken during the survey as well as reducing the probability of gear damage and a reduction in the level of subsampling required. Several studies were discussed that examined the effects of reducing tow duration and on balance, it was decided to proceed with a similar study during the NS-IBTS Q3 2015.

The experiment was conducted during the NS-IBTS Q3 2015 according to the agreed plan. The results of preliminary analyses were presented during the meeting of the IBTSWG in 2016 (ICES, 2016). During IBTSWG in 2016 it was decided to proceed with and repeat this experiment during the NS-IBTS Q3 2016 with a similar set-up. The present analysis is an update and is based on combined data from the two surveys.

Data and Analysis

For all the North Sea rectangles within the Q3 survey area that were sampled twice, it was proposed that, within each rectangle, one trawl of a typical 30 minute duration would be completed with another being undertaken with a trawl duration of 15 minutes. The resultant dataset provided an almost 50/50 split across the entire survey area of both haul duration categories. In most instances, haul duration was of either 15 or 30 minutes, although several hauls were found to be of an intermediate duration and so the hauls were grouped in two categories, "short" (15–17 minutes) and "long" (18–32 minutes). A combined total of 733 valid hauls were completed during the both years of the survey. Removal of the Skagerrak and Kattegat hauls reduced the number to 629 hauls (in 2015, 300 hauls, 157 "long" and 143 "short" ones; in 2016, 329 hauls, 160 "long" and 169 "short" ones). These 629 hauls were subject to analysis. MSS was tasked with analysing and comparing the catch rates for haddock (*Melanogrammus aeglefinus*) and Norway pout (*Trisopterus esmarkii*) from both haul duration categories and report the results to the IBTSWG in 2017.

For the analysis, the haul data included, amongst others, year, vessel, geographical position (longitude, latitude), depth (m), day (ordinal day of the year), hour (Coordinated Universal Time, UTC), haul number, statistical rectangle, tow duration (in minutes) and swept area (in km^2). Five vessels took part in the experiment: "Dana" (Denmark and Sweden), Cefas "Endeavour" (England), "Johan Hjort" (Norway), "Scotia" (Scotland) and "Walther Herwig III" (Germany). The catch data for each age group of the two species were expressed as recorded numbers per haul or numbers per km^2.

First, the observed numbers of fish, standardised to 1 km^2, were viewed. They varied mainly with year, haul geographical position and depth. As regards the latter, the highest numbers were typically observed at intermediate depths (Figure 1). With no account given to the other factors (year, vessel, haul position, day or hour), no obvious differences could be seen along the depth gradient (apart from high variation) between the two haul categories at this stage of the analysis.

Further investigation of the data clearly demonstrated a non-linear relationship with respect to depth and geographical position and, consequently, additive modelling was deemed to be a suitable alternative to linear regression (Zuur et al., 2007). Similarly, a non-linear relationship was considered for the other continous variables (day and hour), at least for some age groups of the two species. The two remaining variables, year and vessel, were treated as categorical variables.

A statistical model (a negative binomial GAM for counts with a log link function) was used to estimate catch. The dispersion parameter, theta, for the negative binomial was found during the model optimisation within the supplied range of likely values for this parameter (0.15–5.00). This was run separately for age groups, as well as for an additional aggregate age group, ages 1–6 for haddock or ages 1–5 for Norway pout (the age-0 group were omitted in this aggregation as they usually show distinguishing characteristics before the settling transition). The recorded numbers were the response variable in the model. The log of door swept area was used as an offset. First, a full model was considered that included year, vessel, the interaction between longitude and latitude, depth, day and hour:

```
NumberAtAge ~ offset(log(SweptArea)) + Year + Ship + s(Long, Lat) + s(Depth)
+ s(Day) + s(Hour)
```

The variables in the full model were deemed to have a potential effect on catch rate. Since their effect was likely to vary in magnitude and importance, an automated AIC-based backward-forward selection of terms was used (as it turned out during in the runs, only backward selection was the case). As a result of the step selection, only important variables were included in the model for the given age group. Smoothing parameter estimation for the model maximised likelihood (maximum likelihood, ML; Wood, 2006).

In the final phase of the analysis, the selected model was compared with the respective model augmented with a haul category effect (which was a categorical variable). The null hypothesis of this test (chi-square test) was that there was no haul category effect. In addition to the test, a bootstrap procedure provided 95 % confidence intervals for the difference in catch rate between the two hauls categories.

All the analyses were conducted using the statistical package R (R Development Core Team, 2013). The package `mgcv` provided functions for generalised additive modelling.

Results

The dispersion parameter in the negative binomial distribution varied within a wide range from 0.41 to 5 for haddock and from 0.15 to 5 for Norway pout (Table 1). The lower limit had to be set in one case to prevent an error in the fit with lower parameter values. The upper limit had to be set in two cases to prevent an unbounded increase of the parameter.

Depth, geographical position and year effect explained a significant proportion of the variation in catch rate (except the very sparse 5-year-old Norway pout, Figure 2 and 3). The effect of vessel, day and hour was less pronounced among the age groups.

The haul category (“long” vs. “short”) hardly had an effect on catch rate of haddock (Figure 2, see the last row of plots for the partial effect of the haul category). Although the difference between “short” and “long” hauls in the model had positive values in all age groups (Table 1), the chi-square test showed no significant difference (at the 0.05 significance level). In relative terms, the catch rate was by 3–32 % higher in “short” hauls. Consistently with the test results, the confidence intervals for the difference between the two haul categories did contain zero in most cases. Only at age 0 and 4, the confidence intervals did not include zero, but the lower bounds were very close to it (Figure 4).

For Norway pout, the effect of haul category varied among the age groups to a greater extent compared to haddock (Figure 3, see the last row of plots for the partial effect of the haul category). The difference in catch rate between “short” and “long” appeared to be positive in age groups 1–3 and also in the aggregate age group 1–5, while in age goups 0, 4 and 5, it was negative (Table 1). These differences among the age groups followed a smooth J-shaped curve (where a curve initially falls and then steeply rises above the starting point). The chi-square test showed no significant difference between the two haul categories for any age group. In relative terms, the catch rate in “short” hauls in age groups 0–4 varied between 0.72 and 1.42 of that in “long” hauls. The confidence bands were slightly wider for Norway pout compared to haddock. For ages 0, 1 and 3, they included zero. For ages 2 and 4, they (or more specifically, their closest bounds) approached zero. At age 5, the confidence bounds were found relatively far from zero with a low confidence level of a difference.

The previous analysis was based on data from the 2015 experiment only (ICES, 2016). It showed roughly similar results to those presented here (more for haddock than for Norway pout). However, the present analysis has an advantage of being based on more data (2015 and 2016 data combined), of including more explanatory variables (where justified) and of using more rigorous methods (step selection of the model terms). Details of the present GAM analysis and diagnostic plots are shown in Annex 1 and Annex 2.

Conclusions

In conclusion, whilst the available data for haddock and Norway pout from the experiment conducted over the last two years show some age-specific differences in catch rate between the two haul categories (mainly for Norway pout), these were not deemed significant. Consequently, there is no clear evidence that the short duration hauls are any less representative than the long hauls when estimating the catch rates at age for haddock and Norway pout.

However absence of evidence is not evidence of absence and there could still be an affect which is not being picked up by the model. There are several reasons why there could be an effect that is not significant. For example, given the unbalanced nature of the experimental design, the effect could be being attributed in part to a vessel affect. Similarly, the effect of the large haddock year-classes could have on the model parameters is unclear. The approach assumes complete independence between ages (by the use of separate models for each age) but we know that abundances of different age-classes are correlated. Information is being lost by not including all species and ages in one model. In addition, the confidence intervals (Fig 4) show some evidence of an effect at some ages, in contradiction to the hypothesis tests. To test for lack of an effect (or more precisely, an effect smaller than a predetermined threshold), an equivalence test should be used. However, power is still an issue with equivalence tests. All in all, we cannot conclude there is no effect from these results and a decision to move to 15 minute hauls on the basis of these results could be erroneous.

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Wood, S. N. 2006. Generalized Additive Models: An Introduction with R. Chapman and Hall/CRC, Boca Raton, Florida, 382 pp.

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Table 1. Summary of the GAM analysis for the difference in catch rate (log numbers) between long and short hauls, by age group, for haddock and Norway pout.

Species	Age group	Theta para-meter, θ	Modelled difference between "short" and "long", d (with 95 % CI)	exp(d)	Proba-bility, p, in χ^2 test	Deviance explained (%)
haddock	0	0.412	0.277 [0.015, 0.540]	1.32	0.102	74.4
	1	0.759	0.080 [–0.200, 0.361]	1.08	0.695	84.7
	2	1.068	0.146 [–0.051, 0.343]	1.16	0.280	87.8
	3	2.111	0.028 [–0.159, 0.216]	1.03	0.724	81.9
	4	4.506	0.215 [0.054, 0.376]	1.24	0.067	73.6
	5	4.999*	0.265 [–0.083, 0.613]	1.30	0.108	65.1
	6	1.714	0.141 [–0.051, 0.333]	1.15	0.300	83.2
	1–6	0.906	0.064 [–0.138, 0.266]	1.07	0.711	86.1
Norway pout	0	0.151**	0.196 [–0.121, 0.513]	1.22	0.595	99.4
	1	0.278	–0.204 [–0.642, 0.235]	0.82	0.567	91.0
	2	0.487	–0.323 [–0.566, –0.079]	0.72	0.147	85.1
	3	0.729	–0.119 [–0.339, 0.101]	0.89	0.454	87.1
	4	0.222	0.352 [0.094, 0.609]	1.42	0.742	71.8
	5	4.999*	2.114 [1.117, 3.110]	8.28	0.086	17.2
	1–5	0.276	–0.250 [–0.703, 0.203]	0.78	0.367	91.3

*** The upper limit for this parameter was set to 5.**

**** The lower limit for this parameter was set to 0.15..**

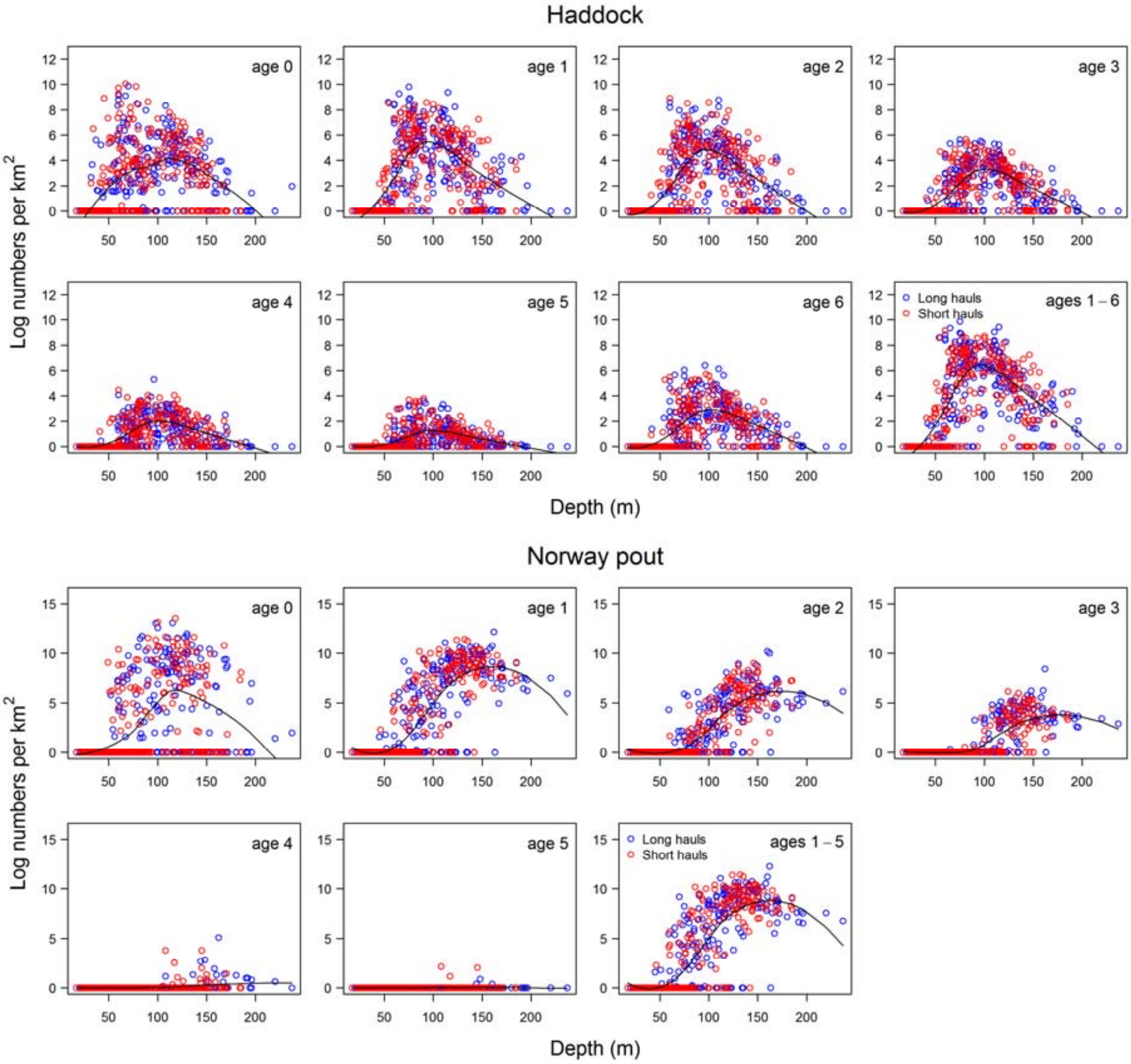


Figure 1. Scatterplots of log numbers at age for haddock (upper panel) and Norway pout (lower panel). The points show observations in the two haul categories. The line represents a loess smoother (with a span of 0.75).

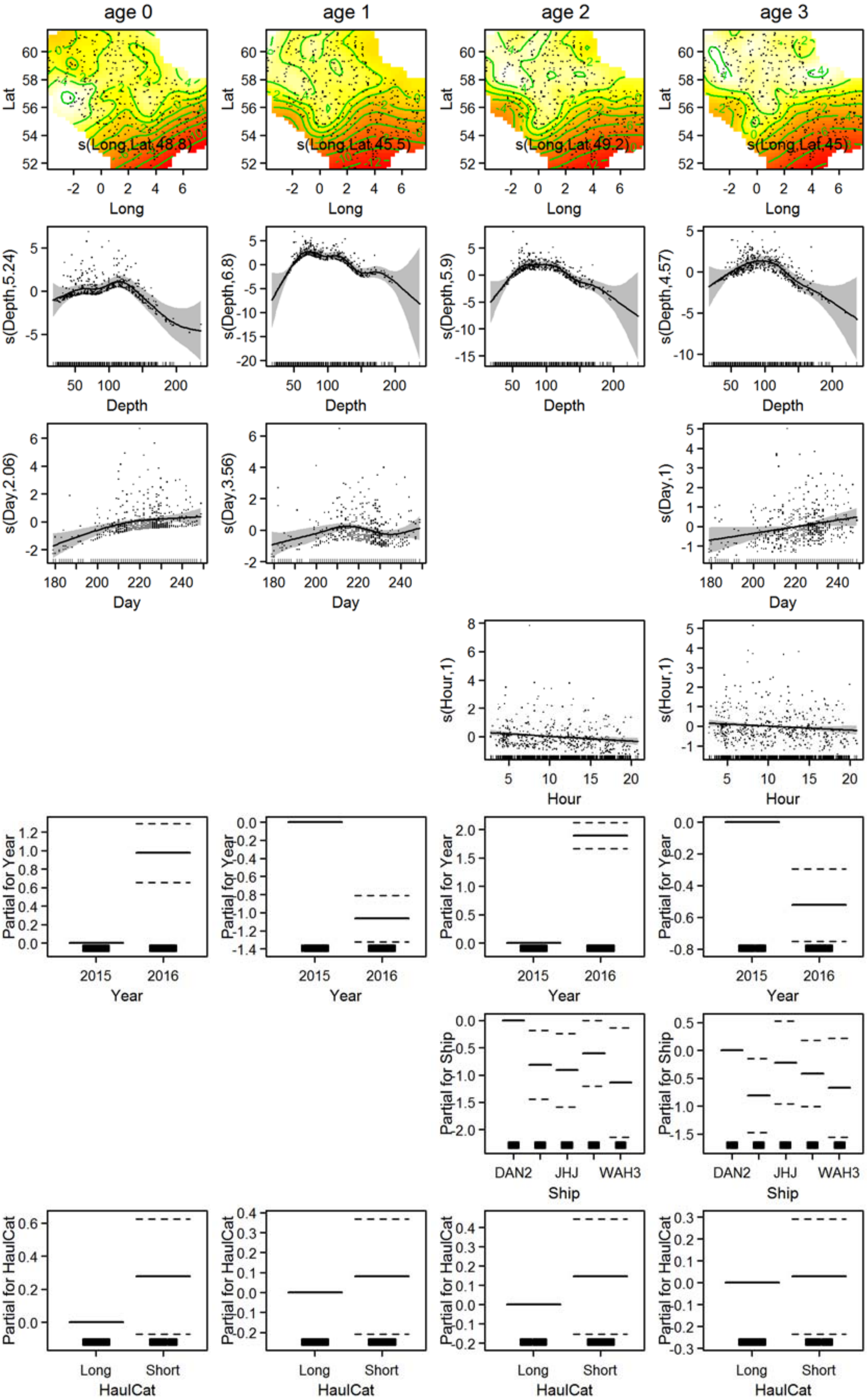


Figure 2. GAM model for haddock by age group with variables found in the step model selection. Row 1 shows smoothing curves for the interaction of longitude and latitude (with no confidence limits and with dots showing the locations). Rows 2–4 show other smoothing curves (with 95 % confidence limits in grey and partial residuals shown as dots). Rows 5–7 show partial residuals of categorical covarates.

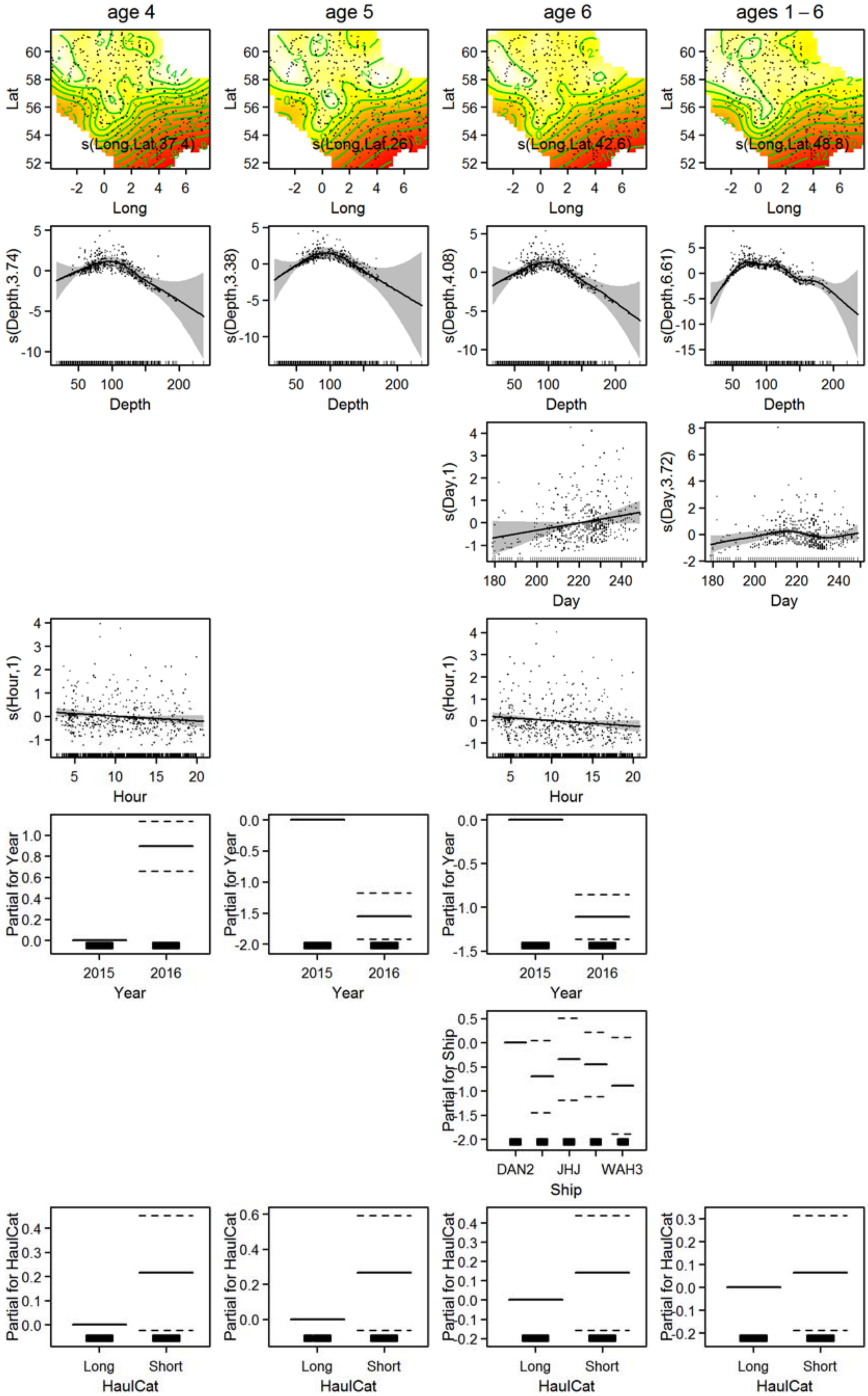


Figure 2. (continued)

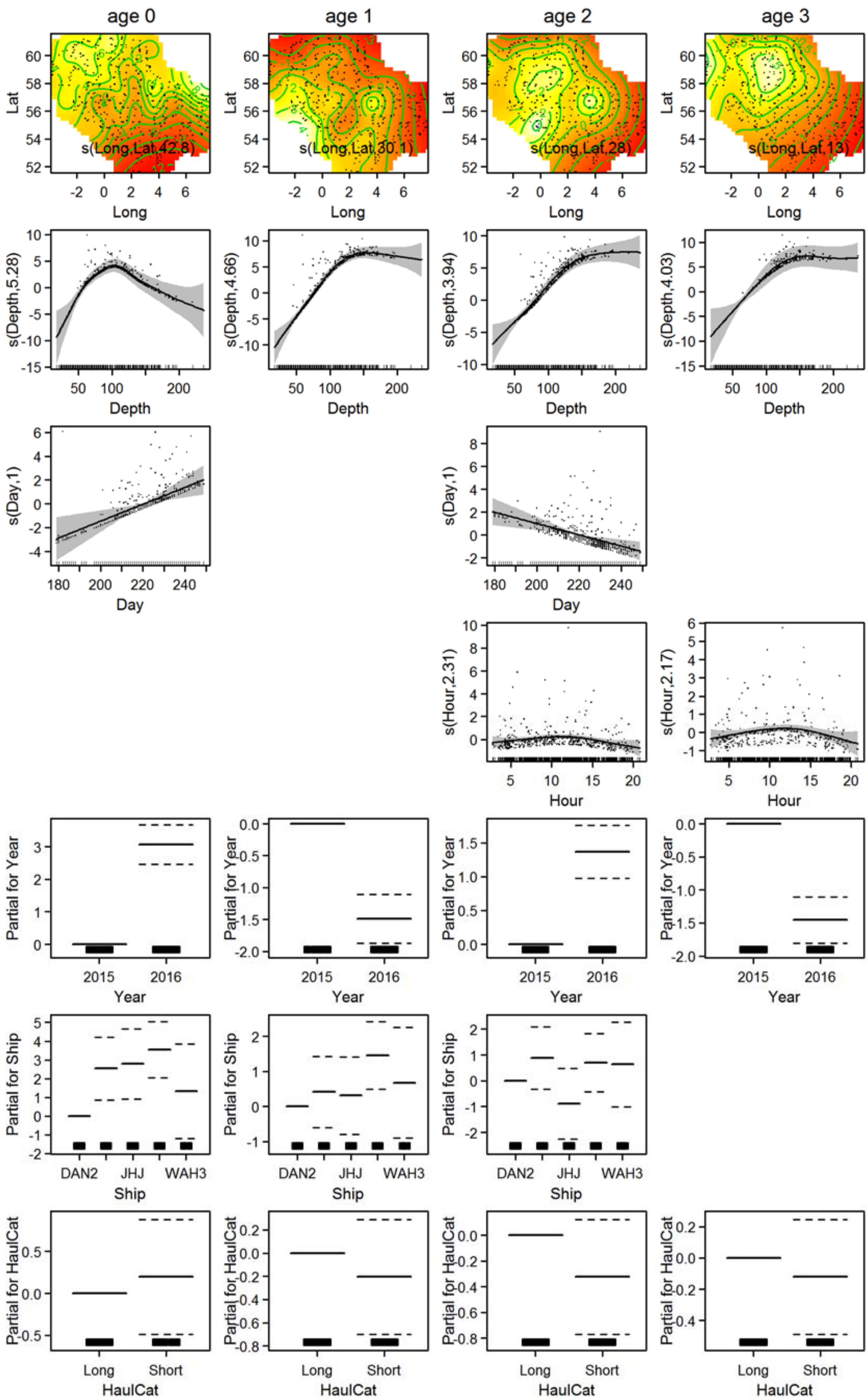


Figure 3. GAM model for Norway pout by age group with variables found in the step model selection. Row 1 shows smoothing curves for the interaction of longitude and latitude (with no confidence limits and with dots showing the locations). Rows 2–4 show other smoothing curves (with 95 % confidence limits in grey and partial residuals shown as dots). Rows 5–7 show partial residuals of categorical covarates.

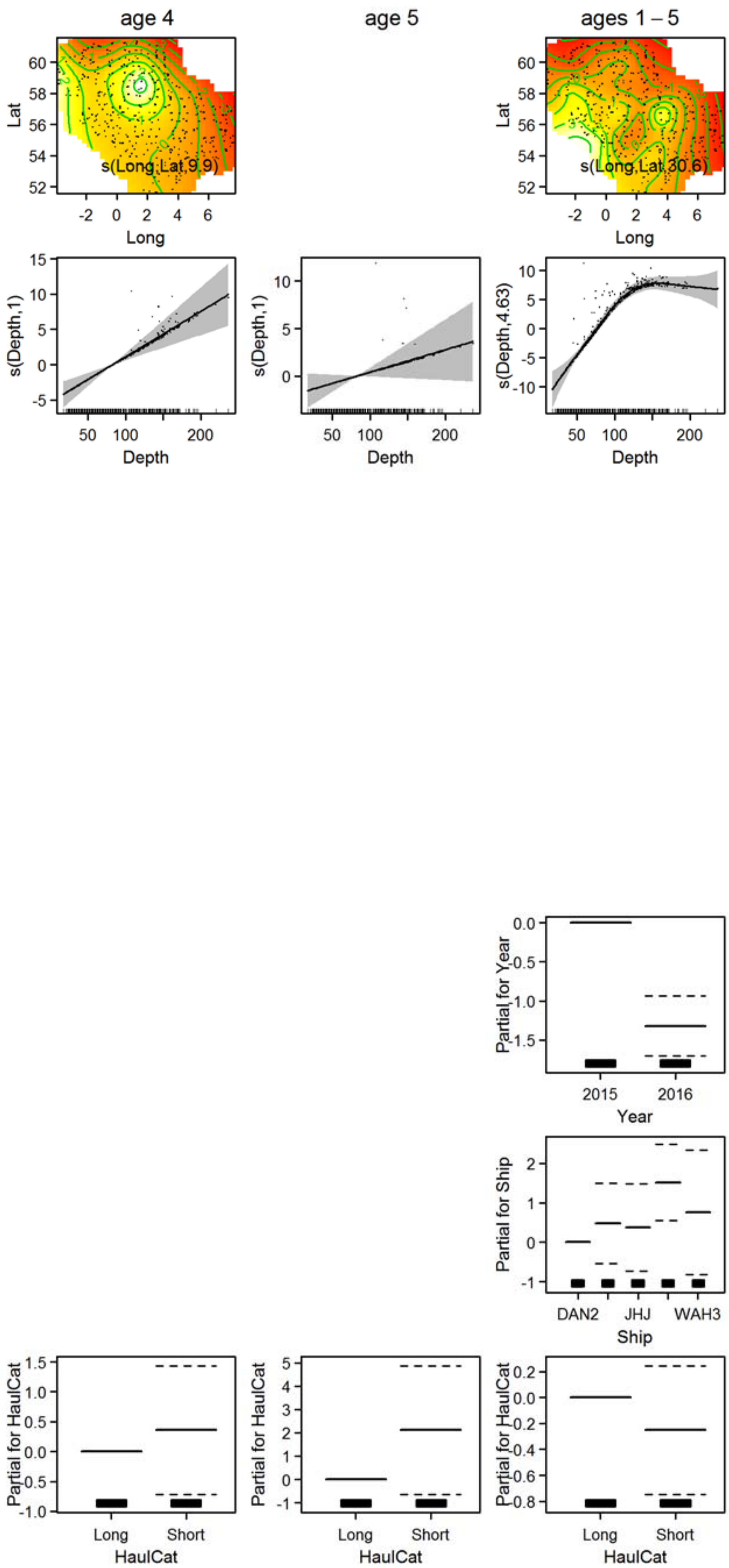


Figure 3. (continued)

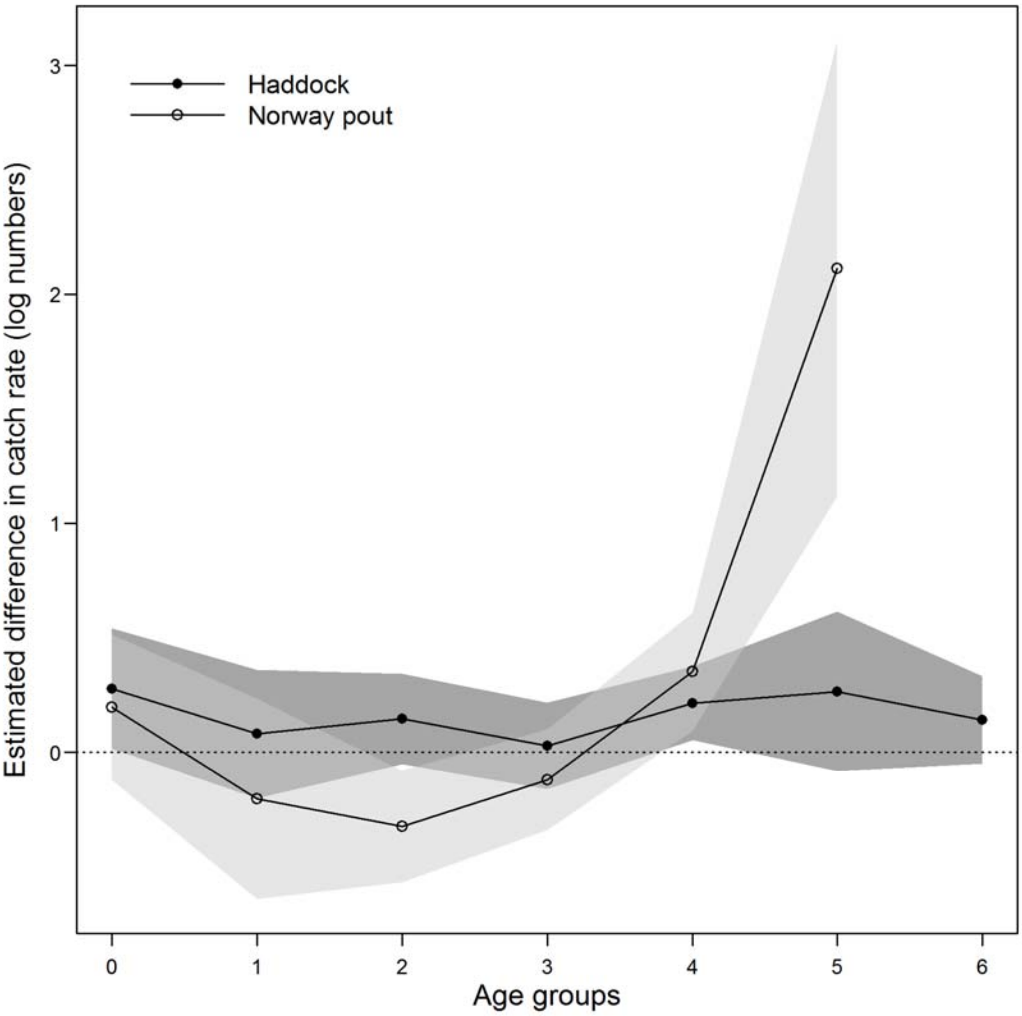


Figure 4. Estimated difference in catch rate between short and long hauls by age group (with 95 % confidence bands) for haddock and Norway pout.

Annex 1

GAM analysis

Haddock

```
####### Age 0

Family: Negative Binomial(0.412)
Link function: log

Formula:
NumberAtAge ~ Year + s(Long, Lat, k = 100) + s(Depth) + s(Day) +
    HaulCat + offset(log(SweptArea))

Estimated degrees of freedom:
48.83  5.24  2.06  total = 59.13

ML score: 1779.343

Parametric coefficients:
             Estimate Std. Error z value Pr(>|z|)
(Intercept)    1.3673     0.3743   3.653  0.00026 ***
Year2016       0.9743     0.1588   6.135 8.49e-10 ***
HaulCatShort   0.2773     0.1740   1.593  0.11106

Approximate significance of smooth terms:
               edf Ref.df Chi.sq  p-value
s(Long,Lat) 48.828 62.739 441.79  < 2e-16 ***
s(Depth)     5.239  6.319  40.93 5.03e-07 ***
s(Day)       2.061  2.556  19.45 0.000172 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  -0.0901   Deviance explained = 74.4%
ML score = 1779.3  Scale est. = 1         n = 629

Analysis of Deviance Table

Model 1: NumberAtAge ~ Year + s(Long, Lat, k = 100) + s(Depth) + s(Day) +
    offset(log(SweptArea))
Model 2: NumberAtAge ~ Year + s(Long, Lat, k = 100) + s(Depth) + s(Day) +
    HaulCat + offset(log(SweptArea))
  Resid. Df Resid. Dev      Df Deviance Pr(>Chi)
1    570.80     477.80
2    569.87     475.28 0.92623   2.5181   0.1018
                 df      AIC
model1.gam 58.20205 3476.214
model2.gam 59.12828 3475.548

####### Age 1

Family: Negative Binomial(0.759)
Link function: log

Formula:
NumberAtAge ~ Year + s(Long, Lat, k = 100) + s(Depth) + s(Day) +
    HaulCat + offset(log(SweptArea))

Estimated degrees of freedom:
45.53  6.80  3.56  total = 58.88

ML score: 1818.024

Parametric coefficients:
             Estimate Std. Error z value Pr(>|z|)
(Intercept)   1.17929    0.57514   2.050   0.0403 *
Year2016     -1.06648    0.12795  -8.335   <2e-16 ***
HaulCatShort  0.08029    0.14409   0.557   0.5774

Approximate significance of smooth terms:
               edf Ref.df Chi.sq p-value
s(Long,Lat) 45.529 57.893 564.90 < 2e-16 ***
s(Depth)     6.795  7.495 140.66 < 2e-16 ***
s(Day)       3.559  4.393  14.42 0.00873 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.592   Deviance explained = 84.7%
ML score =   1818  Scale est. = 1         n = 629

Analysis of Deviance Table
```

```
Model 1: NumberAtAge ~ Year + s(Long, Lat, k = 100) + s(Depth) + s(Day) +
    offset(log(SweptArea))
Model 2: NumberAtAge ~ Year + s(Long, Lat, k = 100) + s(Depth) + s(Day) +
    HaulCat + offset(log(SweptArea))
  Resid. Df Resid. Dev      Df Deviance Pr(>Chi)
1    571.08     447.32
2    570.12     447.18 0.95824   0.1366   0.6947
                 df      AIC
model1.gam 57.92449 3518.439
model2.gam 58.88273 3520.219

####### Age 2

Family: Negative Binomial(1.068)
Link function: log

Formula:
NumberAtAge ~ Year + Ship + s(Long, Lat, k = 100) + s(Depth) +
    s(Hour) + HaulCat + offset(log(SweptArea))

Estimated degrees of freedom:
49.2  5.9  1.0  total = 63.09

ML score: 1494.822

Parametric coefficients:
             Estimate Std. Error z value Pr(>|z|)
(Intercept)   -0.2652     0.6171  -0.430  0.66740
Year2016       1.8910     0.1131  16.721  < 2e-16 ***
ShipEND       -0.8144     0.3155  -2.582  0.00983 **
ShipJHJ       -0.9106     0.3363  -2.708  0.00677 **
ShipSCO3      -0.6060     0.3005  -2.017  0.04370 *
ShipWAH3      -1.1380     0.5002  -2.275  0.02289 *
HaulCatShort   0.1459     0.1490   0.979  0.32758

Approximate significance of smooth terms:
               edf Ref.df  Chi.sq p-value
s(Long,Lat) 49.193 61.172 505.705 < 2e-16 ***
s(Depth)     5.898  6.769 112.223 < 2e-16 ***
s(Hour)      1.000  1.001   7.336 0.00677 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.584   Deviance explained = 87.8%
ML score = 1494.8  Scale est. = 1         n = 629

Analysis of Deviance Table

Model 1: NumberAtAge ~ Year + Ship + s(Long, Lat, k = 100) + s(Depth) +
    s(Hour) + offset(log(SweptArea))
Model 2: NumberAtAge ~ Year + Ship + s(Long, Lat, k = 100) + s(Depth) +
    s(Hour) + HaulCat + offset(log(SweptArea))
  Resid. Df Resid. Dev      Df Deviance Pr(>Chi)
1    566.87     425.75
2    565.91     424.64 0.95999    1.109     0.28
                 df      AIC
model1.gam 62.13120 2873.258
model2.gam 63.09119 2874.069

####### Age 3

Family: Negative Binomial(2.111)
Link function: log

Formula:
NumberAtAge ~ Year + Ship + s(Long, Lat, k = 100) + s(Depth) +
    s(Day) + s(Hour) + HaulCat + offset(log(SweptArea))

Estimated degrees of freedom:
45.01  4.57  1.00  1.00  total = 58.58

ML score: 952.3553

Parametric coefficients:
             Estimate Std. Error z value Pr(>|z|)
(Intercept)   0.40715    0.57510   0.708   0.4790
Year2016     -0.52357    0.11358  -4.610 4.03e-06 ***
ShipEND      -0.80863    0.33168  -2.438   0.0148 *
ShipJHJ      -0.21851    0.37046  -0.590   0.5553
ShipSCO3     -0.41456    0.29810  -1.391   0.1643
ShipWAH3     -0.67457    0.44379  -1.520   0.1285
HaulCatShort  0.02847    0.13162   0.216   0.8288

Approximate significance of smooth terms:
              edf Ref.df  Chi.sq p-value
s(Long,Lat) 45.01 56.671 315.121  <2e-16 ***
s(Depth)     4.57  5.537  99.125  <2e-16 ***
s(Day)       1.00  1.000   4.613  0.0317 *
```

```
s(Hour)      1.00  1.000   3.595  0.0580 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =   0.62   Deviance explained = 81.9%
ML score = 952.36  Scale est. = 1         n = 629

Analysis of Deviance Table

Model 1: NumberAtAge ~ offset(log(SweptArea)) + Year + Ship + s(Long, 
    Lat, k = 100) + s(Depth) + s(Day) + s(Hour)
Model 2: NumberAtAge ~ Year + Ship + s(Long, Lat, k = 100) + s(Depth) + 
    s(Day) + s(Hour) + HaulCat + offset(log(SweptArea))
  Resid. Df Resid. Dev      Df Deviance Pr(>Chi)
1    571.40     394.42                          
2    570.42     394.31 0.97717  0.11643   0.7239
                 df      AIC
model1.gam 57.59879 1787.222
model2.gam 58.57596 1789.060

####### Age 4

Family: Negative Binomial(4.506) 
Link function: log 

Formula:
NumberAtAge ~ Year + s(Long, Lat, k = 100) + s(Depth) + s(Hour) + 
    HaulCat + offset(log(SweptArea))

Estimated degrees of freedom:
37.38  3.74  1.00  total = 45.13 

ML score: 575.3697     

Parametric coefficients:
             Estimate Std. Error z value Pr(>|z|)    
(Intercept)   -1.6428     0.5391  -3.047  0.00231 ** 
Year2016       0.8974     0.1191   7.533 4.96e-14 ***
HaulCatShort   0.2150     0.1186   1.813  0.06979 .  

Approximate significance of smooth terms:
               edf Ref.df  Chi.sq  p-value    
s(Long,Lat) 37.384  48.65 187.996  < 2e-16 ***
s(Depth)     3.745   4.60  66.145 8.35e-13 ***
s(Hour)      1.000   1.00   2.779   0.0955 .  
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.523   Deviance explained = 73.6%
ML score = 575.37  Scale est. = 1         n = 629

Analysis of Deviance Table

Model 1: NumberAtAge ~ Year + s(Long, Lat, k = 100) + s(Depth) + s(Hour) + 
    offset(log(SweptArea))
Model 2: NumberAtAge ~ Year + s(Long, Lat, k = 100) + s(Depth) + s(Hour) + 
    HaulCat + offset(log(SweptArea))
  Resid. Df Resid. Dev     Df Deviance Pr(>Chi)  
1    584.88     331.36                           
2    583.87     327.98 1.0102   3.3765   0.0671 .
                 df      AIC
model1.gam 44.11849 1010.481
model2.gam 45.12870 1009.125

####### Age 5

Family: Negative Binomial(4.999) 
Link function: log 

Formula:
NumberAtAge ~ Year + s(Long, Lat, k = 100) + s(Depth) + HaulCat + 
    offset(log(SweptArea))

Estimated degrees of freedom:
25.96  3.38  total = 32.33 

ML score: 383.615     

Parametric coefficients:
             Estimate Std. Error z value Pr(>|z|)    
(Intercept)   -1.0478     0.5003  -2.094   0.0362 *  
Year2016      -1.5511     0.1847  -8.399   <2e-16 ***
HaulCatShort   0.2651     0.1639   1.617   0.1058    

Approximate significance of smooth terms:
               edf Ref.df Chi.sq  p-value    
s(Long,Lat) 25.956 35.476  79.80 2.98e-05 ***
s(Depth)     3.376  4.164  38.57 1.27e-07 ***
```

```
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.616   Deviance explained = 65.1%
ML score = 383.61  Scale est. = 1         n = 629

Analysis of Deviance Table

Model 1: NumberAtAge ~ Year + s(Long, Lat, k = 100) + s(Depth) + offset(log(SweptArea))
Model 2: NumberAtAge ~ Year + s(Long, Lat, k = 100) + s(Depth) + HaulCat +
    offset(log(SweptArea))
  Resid. Df Resid. Dev      Df Deviance Pr(>Chi)
1    597.66     264.57
2    596.67     262.00 0.99096   2.5708   0.1076
                 df      AIC
model1.gam 31.34114 619.5951
model2.gam 32.33210 619.0062

####### Age 6

Family: Negative Binomial(1.714)
Link function: log

Formula:
NumberAtAge ~ Year + Ship + s(Long, Lat, k = 100) + s(Depth) +
    s(Day) + s(Hour) + HaulCat + offset(log(SweptArea))

Estimated degrees of freedom:
42.64  4.08  1.00  1.00  total = 55.72

ML score: 880.4864

Parametric coefficients:
             Estimate Std. Error z value Pr(>|z|)
(Intercept)   0.05412    0.71154   0.076   0.9394
Year2016     -1.10899    0.12810  -8.657   <2e-16 ***
ShipEND      -0.70236    0.37381  -1.879   0.0603 .
ShipJHJ      -0.34113    0.42270  -0.807   0.4197
ShipSCO3     -0.44943    0.33337  -1.348   0.1776
ShipWAH3     -0.89578    0.49973  -1.793   0.0731 .
HaulCatShort  0.14084    0.14899   0.945   0.3445

Approximate significance of smooth terms:
               edf Ref.df  Chi.sq  p-value
s(Long,Lat) 42.645 54.002 334.012  < 2e-16 ***
s(Depth)     4.076  4.976  75.899 6.52e-15 ***
s(Day)       1.000  1.000   3.269   0.0706 .
s(Hour)      1.000  1.000   4.046   0.0443 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =    0.5   Deviance explained = 83.2%
ML score = 880.49  Scale est. = 1         n = 629

Analysis of Deviance Table

Model 1: NumberAtAge ~ offset(log(SweptArea)) + Year + Ship + s(Long,
    Lat, k = 100) + s(Depth) + s(Day) + s(Hour)
Model 2: NumberAtAge ~ Year + Ship + s(Long, Lat, k = 100) + s(Depth) +
    s(Day) + s(Hour) + HaulCat + offset(log(SweptArea))
  Resid. Df Resid. Dev      Df Deviance Pr(>Chi)
1    574.25     371.37
2    573.28     370.34 0.97219   1.0355      0.3
                 df      AIC
model1.gam 54.74801 1647.240
model2.gam 55.72020 1648.149

####### Ages 1-6

Family: Negative Binomial(0.906)
Link function: log

Formula:
NumberAtAge ~ s(Long, Lat, k = 100) + s(Depth) + s(Day) + HaulCat +
    offset(log(SweptArea))

Estimated degrees of freedom:
48.81  6.61  3.72  total = 61.14

ML score: 2131.314

Parametric coefficients:
             Estimate Std. Error z value Pr(>|z|)
(Intercept)   1.49112    0.49959   2.985  0.00284 **
HaulCatShort  0.06381    0.12558   0.508  0.61136

Approximate significance of smooth terms:
               edf Ref.df Chi.sq p-value
```

```
s(Long,Lat) 48.807 61.194 694.44  <2e-16 ***
s(Depth)     6.612  7.398 140.24  <2e-16 ***
s(Day)       3.717  4.584  14.11  0.0115 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.658   Deviance explained = 86.1%
ML score = 2131.3  Scale est. = 1         n = 629
Analysis of Deviance Table

Model 1: NumberAtAge ~ s(Long, Lat, k = 100) + s(Depth) + s(Day) + offset(log(SweptArea))
Model 2: NumberAtAge ~ s(Long, Lat, k = 100) + s(Depth) + s(Day) + HaulCat +
    offset(log(SweptArea))
  Resid. Df Resid. Dev      Df Deviance Pr(>Chi)
1    568.84     460.73
2    567.86     460.60 0.97257  0.12671   0.7109
                 df      AIC
model1.gam 60.16454 4147.442
model2.gam 61.13711 4149.261
```

Norway pout

```
####### Age 0

Family: Negative Binomial(0.151)
Link function: log

Formula:
NumberAtAge ~ Year + Ship + s(Long, Lat, k = 100) + s(Depth) +
    s(Day) + HaulCat + offset(log(SweptArea))

Estimated degrees of freedom:
42.84  5.27  1.00  total = 56.11

ML score: 2053.095

Parametric coefficients:
             Estimate Std. Error z value Pr(>|z|)
(Intercept)   -3.1182     1.2080  -2.581  0.00985 **
Year2016       3.0637     0.3054  10.033  < 2e-16 ***
ShipEND        2.5336     0.8378   3.024  0.00249 **
ShipJHJ        2.7842     0.9404   2.961  0.00307 **
ShipSCO3       3.5397     0.7518   4.708  2.5e-06 ***
ShipWAH3       1.3274     1.2582   1.055  0.29144
HaulCatShort   0.1962     0.3420   0.574  0.56610

Approximate significance of smooth terms:
               edf Ref.df Chi.sq  p-value
s(Long,Lat) 42.844 55.351 322.24  < 2e-16 ***
s(Depth)     5.266  6.343  68.17 2.34e-12 ***
s(Day)       1.000  1.000  10.64   0.0011 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  -38.2   Deviance explained = 99.4%
ML score = 2053.1  Scale est. = 1         n = 629

Analysis of Deviance Table

Model 1: NumberAtAge ~ offset(log(SweptArea)) + Year + Ship + s(Long,
    Lat, k = 100) + s(Depth) + s(Day)
Model 2: NumberAtAge ~ Year + Ship + s(Long, Lat, k = 100) + s(Depth) +
    s(Day) + HaulCat + offset(log(SweptArea))
  Resid. Df Resid. Dev      Df Deviance Pr(>Chi)
1    573.87     392.19
2    572.89     391.92 0.98551  0.27403   0.5946
                 df      AIC
model1.gam 55.12515 4044.203
model2.gam 56.11066 4045.900

####### Age 1

Family: Negative Binomial(0.278)
Link function: log

Formula:
NumberAtAge ~ Year + Ship + s(Long, Lat, k = 100) + s(Depth) +
    HaulCat + offset(log(SweptArea))

Estimated degrees of freedom:
30.49  4.66  total = 42.15

ML score: 2309.49

Parametric coefficients:
             Estimate Std. Error z value Pr(>|z|)
```

```
(Intercept)    2.9360     0.5511   5.327 9.97e-08 ***
Year2016      -1.4886     0.1918  -7.760 8.52e-15 ***
ShipEND        0.4036     0.5060   0.798  0.42512
ShipJHJ        0.3078     0.5515   0.558  0.57681
ShipSCO3       1.4476     0.4811   3.009  0.00262 **
ShipWAH3       0.6757     0.7879   0.858  0.39110
HaulCatShort  -0.2035     0.2471  -0.824  0.41013

Approximate significance of smooth terms:
               edf Ref.df Chi.sq  p-value
s(Long,Lat) 30.492 41.931  142.9 6.32e-13 ***
s(Depth)     4.657  5.669  276.9  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  -1.31   Deviance explained =   91%
ML score = 2309.5  Scale est. = 1         n = 629

Analysis of Deviance Table

Model 1: NumberAtAge ~ offset(log(SweptArea)) + Year + Ship + s(Long,
    Lat, k = 100) + s(Depth)
Model 2: NumberAtAge ~ Year + Ship + s(Long, Lat, k = 100) + s(Depth) +
    HaulCat + offset(log(SweptArea))
  Resid. Df Resid. Dev      Df Deviance Pr(>Chi)
1    587.80     432.49
2    586.85     432.20 0.95184   0.2945   0.5669
                 df      AIC
model1.gam 41.19702 4580.864
model2.gam 42.14886 4582.473

####### Age 2

Family: Negative Binomial(0.487)
Link function: log

Formula:
NumberAtAge ~ Year + Ship + s(Long, Lat, k = 100) + s(Depth) +
    s(Day) + s(Hour) + HaulCat + offset(log(SweptArea))

Estimated degrees of freedom:
27.89  3.91  1.00  2.34  total = 42.13

ML score: 1343.032

Parametric coefficients:
             Estimate Std. Error z value Pr(>|z|)
(Intercept)   -0.7195     0.7345  -0.980    0.327
Year2016       1.3701     0.1972   6.948  3.7e-12 ***
ShipEND        0.8780     0.6002   1.463    0.144
ShipJHJ       -0.8908     0.6817  -1.307    0.191
ShipSCO3       0.6978     0.5612   1.243    0.214
ShipWAH3       0.6261     0.8165   0.767    0.443
HaulCatShort  -0.3233     0.2229  -1.450    0.147

Approximate significance of smooth terms:
               edf Ref.df  Chi.sq  p-value
s(Long,Lat) 27.888 38.049 138.515 2.46e-13 ***
s(Depth)     3.907  4.810 193.330  < 2e-16 ***
s(Day)       1.000  1.000  11.838 0.000581 ***
s(Hour)      2.339  2.909   8.826 0.029717 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.459   Deviance explained = 85.1%
ML score =   1343  Scale est. = 1         n = 629

Analysis of Deviance Table

Model 1: NumberAtAge ~ offset(log(SweptArea)) + Year + Ship + s(Long,
    Lat, k = 100) + s(Depth) + s(Day) + s(Hour)
Model 2: NumberAtAge ~ Year + Ship + s(Long, Lat, k = 100) + s(Depth) +
    s(Day) + s(Hour) + HaulCat + offset(log(SweptArea))
  Resid. Df Resid. Dev      Df Deviance Pr(>Chi)
1    587.78     357.51
2    586.87     355.56 0.91847   1.9482   0.1466
                 df      AIC
model1.gam 41.21522 2638.519
model2.gam 42.13369 2638.408

####### Age 3

Family: Negative Binomial(0.729)
Link function: log

Formula:
NumberAtAge ~ Year + s(Long, Lat, k = 100) + s(Depth) + s(Hour) +
    HaulCat + offset(log(SweptArea))
```

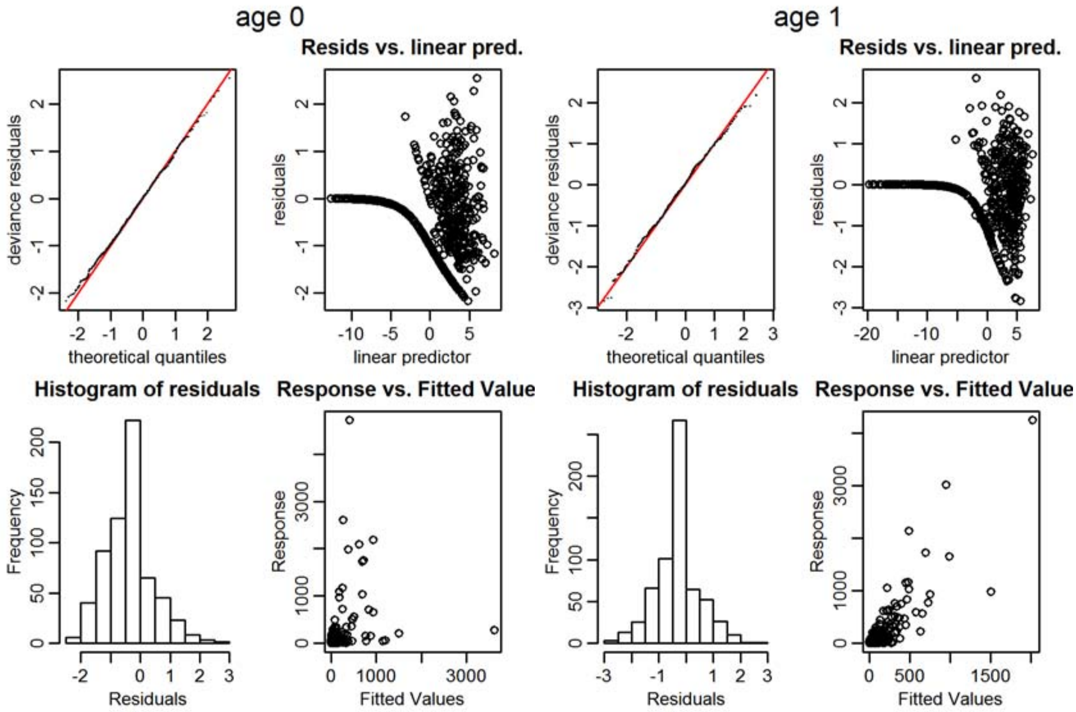
```
Estimated degrees of freedom:
12.85  4.03  2.21  total = 22.09

ML score: 680.6512

Parametric coefficients:
             Estimate Std. Error z value Pr(>|z|)
(Intercept)   -2.7298     1.0951  -2.493   0.0127 *
Year2016      -1.4529     0.1752  -8.292   <2e-16 ***
HaulCatShort  -0.1191     0.1834  -0.649   0.5162

Approximate significance of smooth terms:
               edf Ref.df Chi.sq  p-value
s(Long,Lat) 12.852 17.904  54.69 1.38e-05 ***
s(Depth)     4.028  4.873 118.34  < 2e-16 ***
s(Hour)      2.214  2.759   6.23   0.0847 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.311   Deviance explained = 87.1%
ML score = 680.65  Scale est. = 1         n = 629

Analysis of Deviance Table

Model 1: NumberAtAge ~ offset(log(SweptArea)) + Year + s(Long, Lat, k = 100) +
    s(Depth) + s(Hour)
Model 2: NumberAtAge ~ Year + s(Long, Lat, k = 100) + s(Depth) + s(Hour) +
    HaulCat + offset(log(SweptArea))
  Resid. Df Resid. Dev      Df Deviance Pr(>Chi)
1    607.87     242.86
2    606.91     242.33 0.96452  0.52533   0.4544
                df      AIC
model1.gam 21.12994 1326.159
model2.gam 22.09446 1327.562

####### Age 4

Family: Negative Binomial(0.222)
Link function: log

Formula:
NumberAtAge ~ s(Long, Lat, k = 100) + s(Depth) + HaulCat + offset(log(SweptArea))

Estimated degrees of freedom:
10.1  1.0  total = 13.08

ML score: 103.6016

Parametric coefficients:
             Estimate Std. Error z value Pr(>|z|)
(Intercept)   -4.8626     1.5106  -3.219  0.00129 **
HaulCatShort   0.3518     0.5398   0.652  0.51463

Approximate significance of smooth terms:
              edf Ref.df Chi.sq  p-value
s(Long,Lat) 10.09  14.25  30.25  0.00798 **
s(Depth)     1.00   1.00  19.96 7.91e-06 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.131   Deviance explained = 71.8%
ML score =  103.6  Scale est. = 1         n = 629

Analysis of Deviance Table

Model 1: NumberAtAge ~ offset(log(SweptArea)) + s(Long, Lat, k = 100) +
    s(Depth)
Model 2: NumberAtAge ~ s(Long, Lat, k = 100) + s(Depth) + HaulCat + offset(log(SweptArea))
  Resid. Df Resid. Dev      Df Deviance Pr(>Chi)
1    616.90     69.339
2    615.92     69.237 0.98056  0.10231   0.7416
                df      AIC
model1.gam 12.10420 188.2905
model2.gam 13.08476 190.1493

####### Age 5

Family: Negative Binomial(4.999)
Link function: log

Formula:
NumberAtAge ~ s(Depth) + HaulCat + offset(log(SweptArea))

Estimated degrees of freedom:
1  total = 3

ML score: 17.99918
```

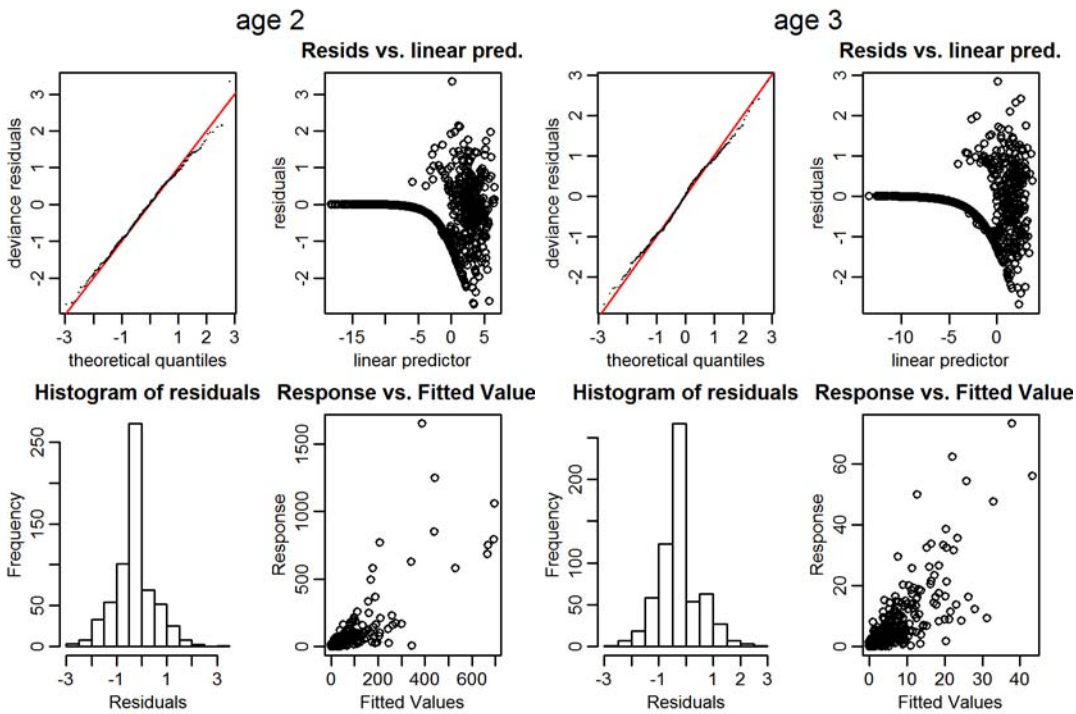
```
Parametric coefficients:
             Estimate Std. Error z value Pr(>|z|)
(Intercept)    -5.510      1.463  -3.765 0.000166 ***
HaulCatShort    2.114      1.377   1.535 0.124858

Approximate significance of smooth terms:
         edf Ref.df Chi.sq p-value
s(Depth)   1      1   2.98  0.0843 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.000415   Deviance explained = 17.2%
ML score = 17.999  Scale est. = 1         n = 629

Analysis of Deviance Table

Model 1: NumberAtAge ~ offset(log(SweptArea)) + s(Depth)
Model 2: NumberAtAge ~ s(Depth) + HaulCat + offset(log(SweptArea))
  Resid. Df Resid. Dev Df Deviance Pr(>Chi)
1       627     30.415
2       626     27.471  1   2.9441  0.08619 .
                 df      AIC
model1.gam 2.000004 40.37404
model2.gam 3.000003 39.42993

####### Ages 1-5

Family: Negative Binomial(0.276)
Link function: log

Formula:
NumberAtAge ~ Year + Ship + s(Long, Lat, k = 100) + s(Depth) +
    HaulCat + offset(log(SweptArea))

Estimated degrees of freedom:
31.08  4.62  total = 42.7

ML score: 2345.724

Parametric coefficients:
             Estimate Std. Error z value Pr(>|z|)
(Intercept)    2.8903     0.5583   5.177 2.25e-07 ***
Year2016      -1.3214     0.1920  -6.883 5.88e-12 ***
ShipEND        0.4660     0.5073   0.919  0.35830
ShipJHJ        0.3624     0.5534   0.655  0.51261
ShipSCO3       1.5088     0.4824   3.128  0.00176 **
ShipWAH3       0.7602     0.7902   0.962  0.33605
HaulCatShort  -0.2501     0.2476  -1.010  0.31256

Approximate significance of smooth terms:
               edf Ref.df Chi.sq  p-value
s(Long,Lat) 31.080 42.655  143.4 8.45e-13 ***
s(Depth)     4.621  5.629  269.9  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  -0.861   Deviance explained = 91.3%
ML score = 2345.7  Scale est. = 1         n = 629

Analysis of Deviance Table

Model 1: NumberAtAge ~ offset(log(SweptArea)) + Year + Ship + s(Long,
    Lat, k = 100) + s(Depth)
Model 2: NumberAtAge ~ Year + Ship + s(Long, Lat, k = 100) + s(Depth) +
    HaulCat + offset(log(SweptArea))
  Resid. Df Resid. Dev     Df Deviance Pr(>Chi)
1    587.34     432.37
2    586.30     431.50 1.0452  0.86648   0.3674
                 df      AIC
model1.gam 41.65521 4654.466
model2.gam 42.70046 4655.690
```

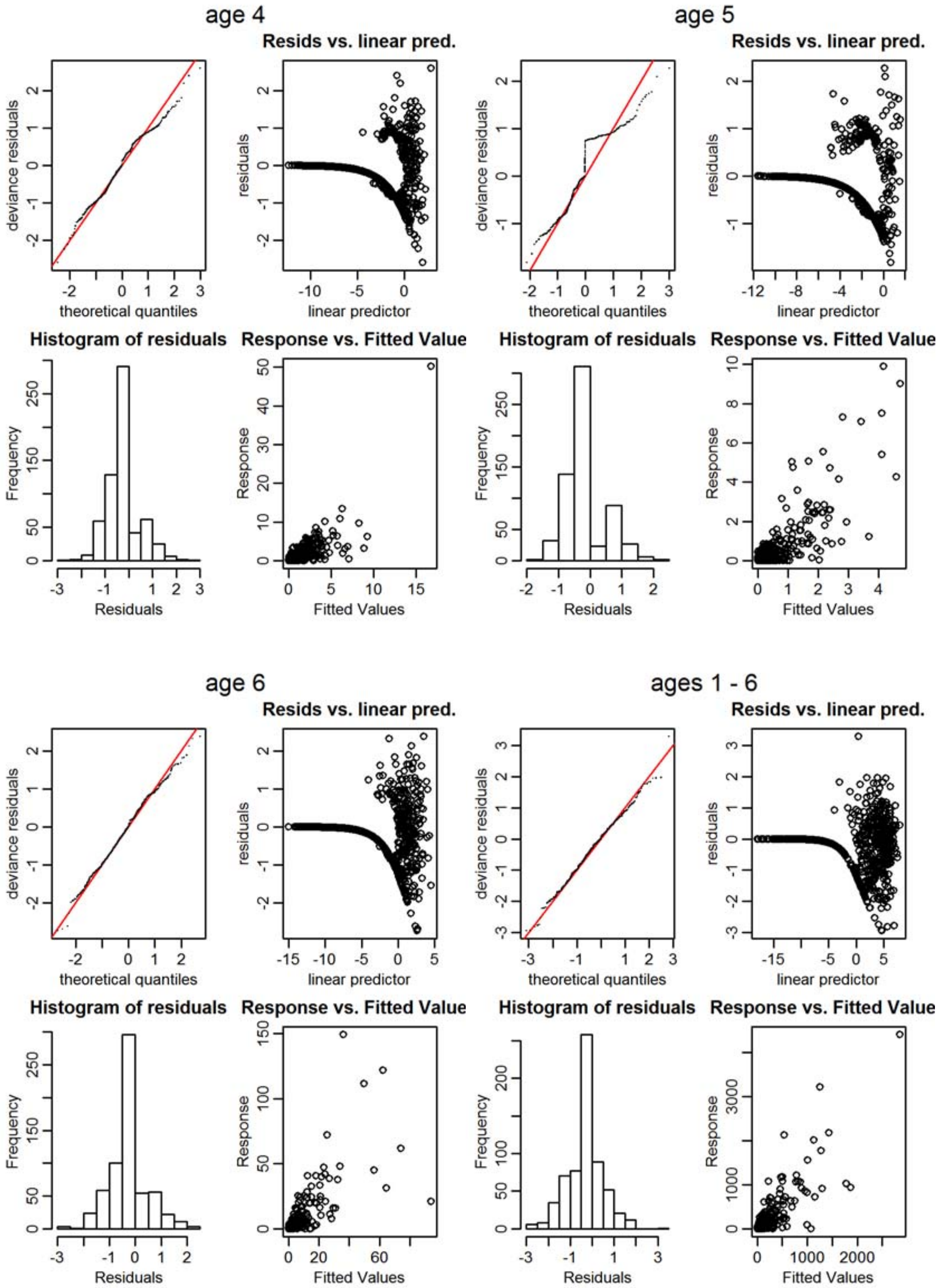
Annex 2

GAM-check plots

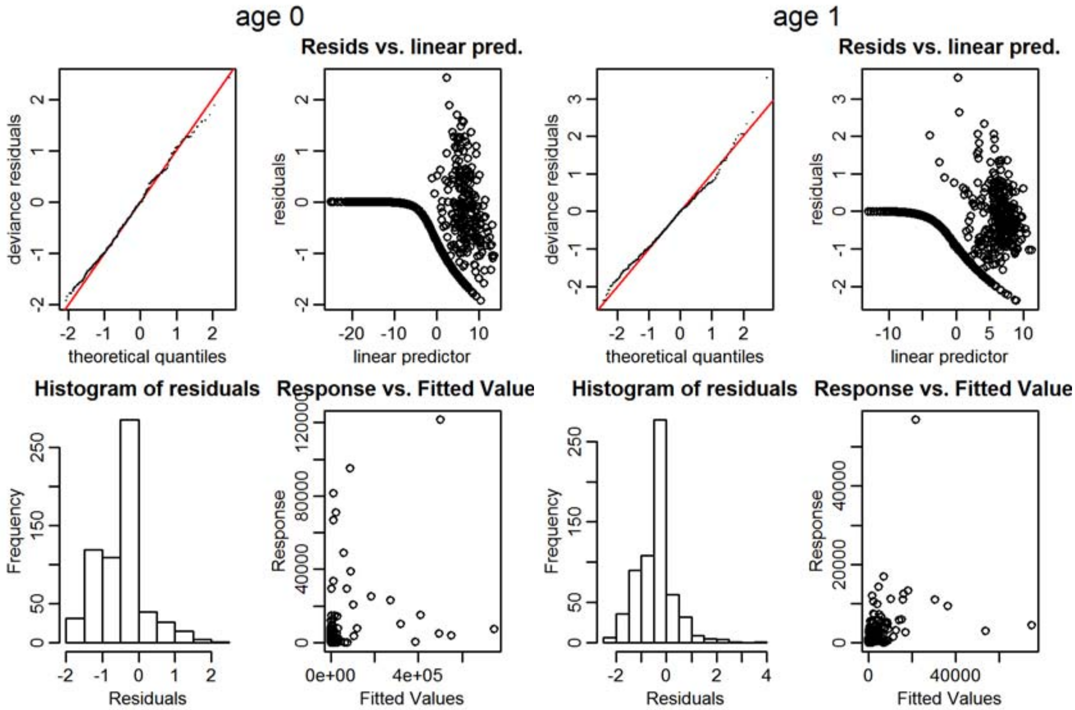
Haddock

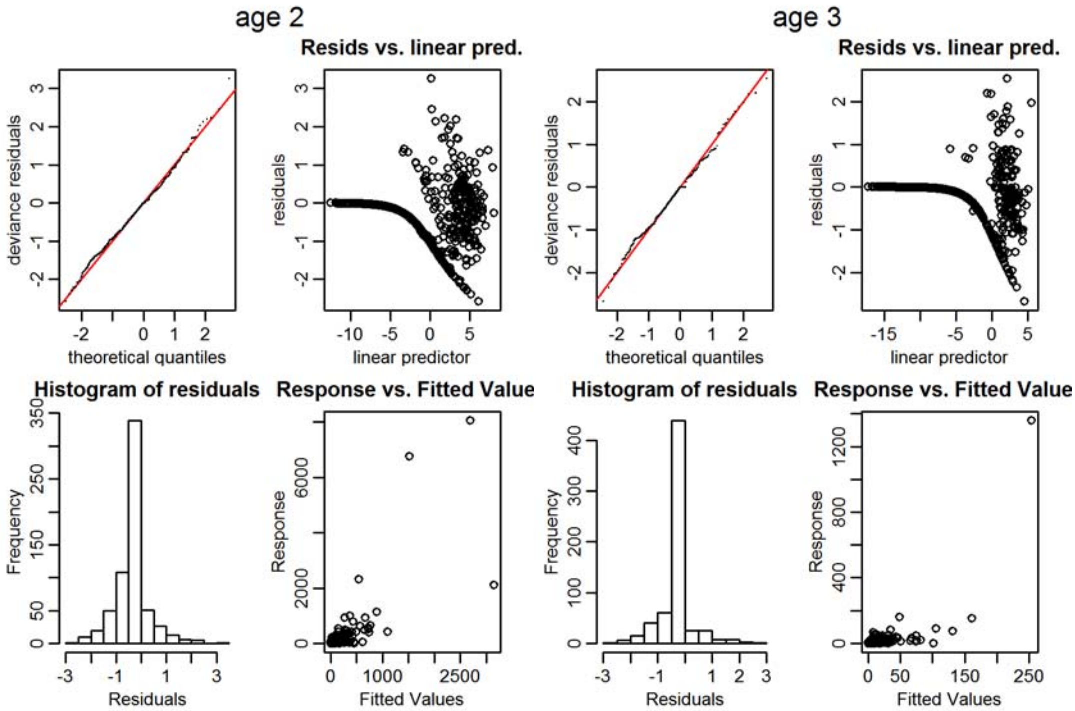


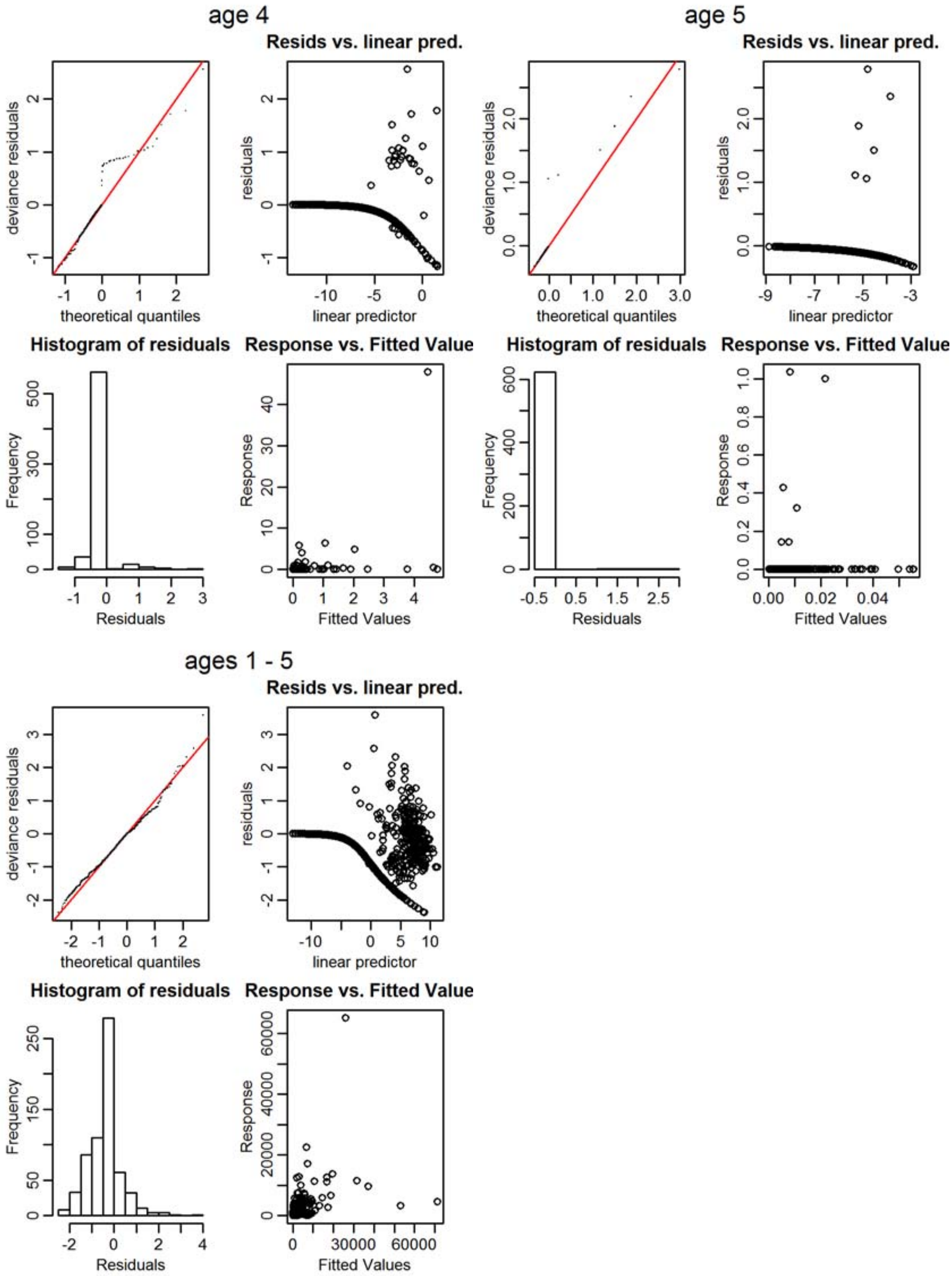


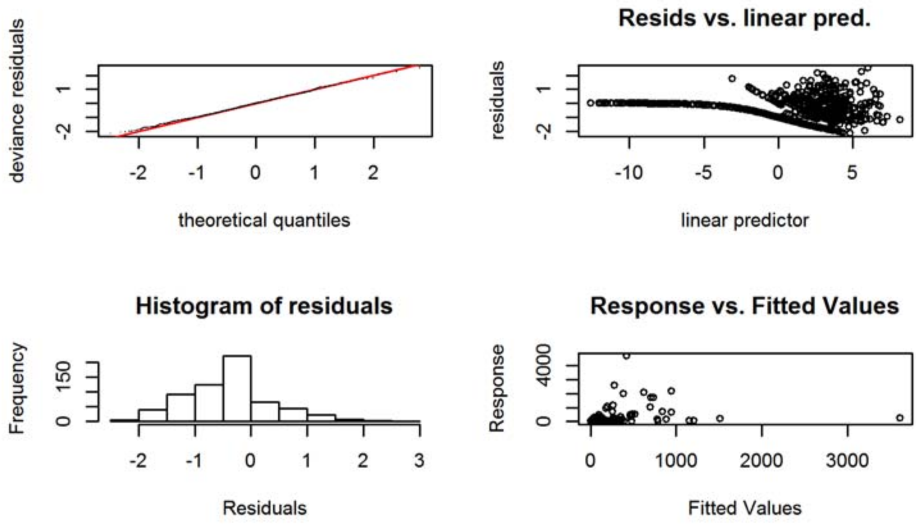

age 4
Resids vs. linear pred.
deviance residuals
theoretical quantiles
residuals
linear predictor
Histogram of residuals
Response vs. Fitted Value
Frequency
Residuals
Response
Fitted Values
age 5
Resids vs. linear pred.
deviance residuals
theoretical quantiles
residuals
linear predictor
Histogram of residuals
Response vs. Fitted Value
Frequency
Residuals
Response
Fitted Values
age 6
Resids vs. linear pred.
deviance residuals
theoretical quantiles
residuals
linear predictor
Histogram of residuals
Response vs. Fitted Value
Frequency
Residuals
Response
Fitted Values
ages 1 - 6
Resids vs. linear pred.
deviance residuals
theoretical quantiles
residuals
linear predictor
Histogram of residuals
Response vs. Fitted Value
Frequency
Residuals
Response
Fitted Values

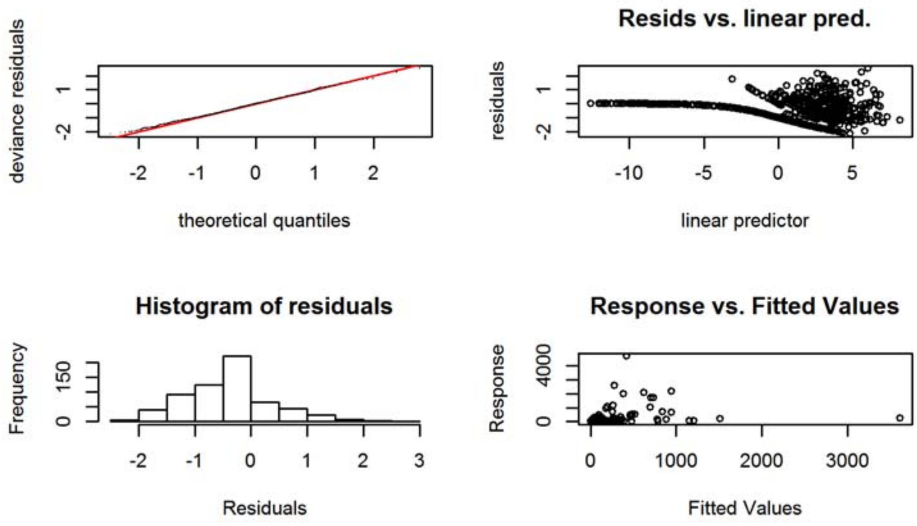
Norway pout

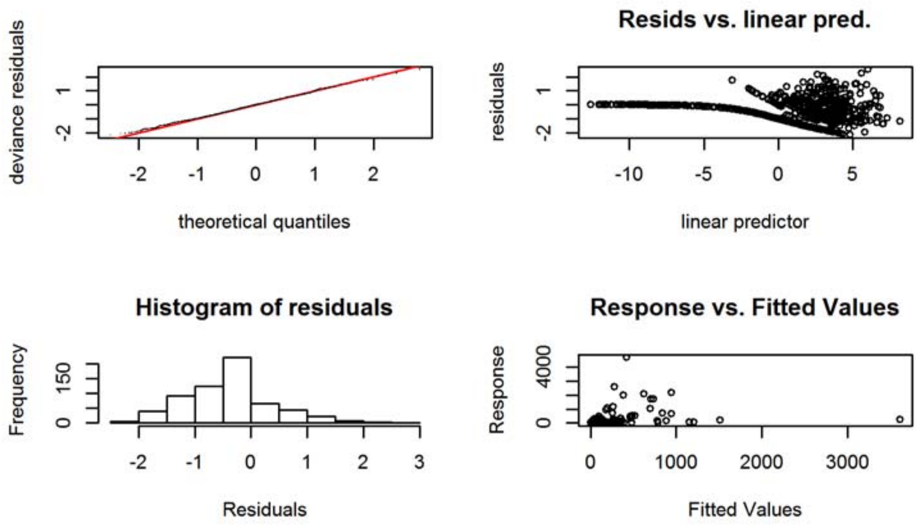

age 0
age 1
Resids vs. linear pred.
deviance residuals
theoretical quantiles
residuals
linear predictor
Histogram of residuals
Response vs. Fitted Value
Frequency
Residuals
Response
Fitted Values

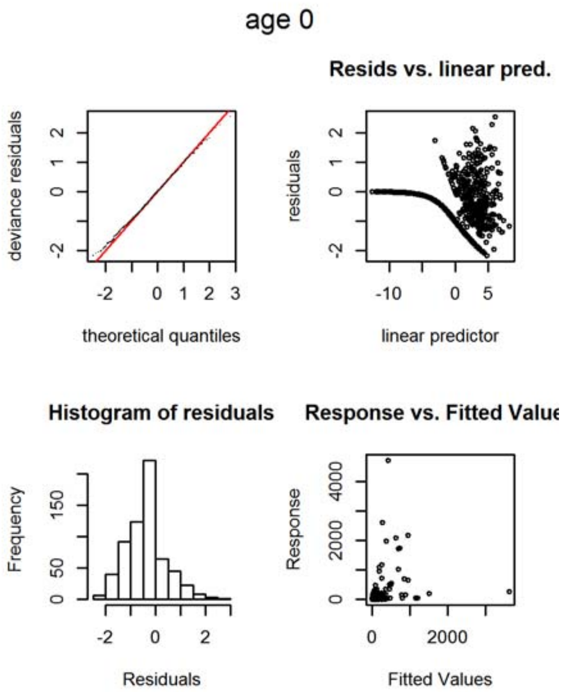

age 2
age 3
Resids vs. linear pred.
deviance residuals
theoretical quantiles
residuals
linear predictor
Histogram of residuals
Response vs. Fitted Value
Frequency
Residuals
Response
Fitted Values

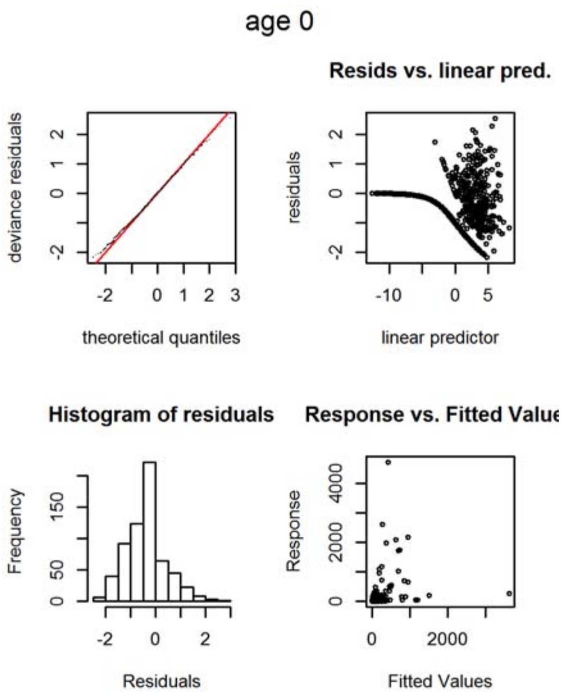

age 4
Resids vs. linear pred.
Histogram of residuals
Response vs. Fitted Value
age 5
Resids vs. linear pred.
Histogram of residuals
Response vs. Fitted Value
ages 1 - 5
Resids vs. linear pred.
Histogram of residuals
Response vs. Fitted Value
deviance residuals
theoretical quantiles
residuals
linear predictor
Frequency
Residuals
Response
Fitted Values


deviance residuals
theoretical quantiles
Resids vs. linear pred.
residuals
linear predictor
Histogram of residuals
Frequency
Residuals
Response vs. Fitted Values
Response
Fitted Values


deviance residuals
theoretical quantiles
Resids vs. linear pred.
residuals
linear predictor
Histogram of residuals
Frequency
Residuals
Response vs. Fitted Values
Response
Fitted Values


deviance residuals
theoretical quantiles
Resids vs. linear pred.
residuals
linear predictor
Histogram of residuals
Frequency
Residuals
Response vs. Fitted Values
Response
Fitted Values


age 0
Resids vs. linear pred.
deviance residuals
theoretical quantiles
residuals
linear predictor
Histogram of residuals
Response vs. Fitted Value
Frequency
Residuals
Response
Fitted Values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Working document: The 2016 North Sea IBTS Q3 tow duration experiment

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Abstract

There have been many experiments that have shown that for marine scientific surveys, little is gained by towing more than 15-minutes. One reason is because for trawl surveys, a cluster of fish is caught at each station; fish caught together tend to have more similar characteristics, such as length, age, stomach contents, than those in the entire population. When this is the case, the effective sample size for estimates, e.g., of the frequency distribution of a population characteristic can, therefore, be much smaller than the number of fish sampled during the survey. For trawl surveys the effective sample size is often approximately one fish, on average, per tow. Thus, many more fish than necessary are usually sampled at each station (location). Based on the IBTS Q1 and Q3 tow duration experiments, it appears that 15-minute tows are as efficient as the 30-minute tows for conducting the IBT surveys, and that the effective sample sizes are similar to those found for other marine surveys, about one fish per tow. It is apparent that reducing tow duration from 30-minutes to 15-minutes would make the IBT survey more efficient and produce more precise estimates of population characteristics because the time saved could be used to increase the number of stations in the survey and to collect more biological measurements at each station.

Introduction

The North Sea IBT surveys currently take place twice a year, Q1 (Jan-Mar) and Q3 (typically late Jul-Sept, but Norway begins in late June), with seven and six nations taking part in the surveys, respectively. Typically, two nations survey each statistical rectangle although there are a few exceptions, e.g., Sweden in the Skagerrak, Scotland west of Shetland, and several other isolated rectangles throughout the survey area (Figure 1; see the latest IBTSWG manual, ICES 2015).

Based on numerous experiments, it has been observed that little is gained in terms of the precision of estimates of relative abundance or estimates of biological characteristics, by towing longer than about 15 minutes at a station (Godø et al., 1990; Pennington and Vølstad, 1991, 1994; Gunderson, 1993; Goddard, 1997; Folmer and Pennington, 2000; Wieland and Storr-Paulsen, 2006). Therefore, a tow duration experiment embedded in the standard IBTS was planned for Q3 in 2015 and repeated in 2016, which were detailed in the last two IBTSWG report (ICES-IBTSWG 2015, 2016). An excerpt included here:

> "In order to warrant a thorough comparison with the current methodology, it has been planned that in each ICES rectangle, one of the two assigned hauls will remain at 30-min haul duration, whereas the second will be reduced to 15 min. Any freed-up survey time will, where logistically possible, be utilized to conduct additional hauls and to increase coverage of the fringe areas highlighted with the proposed extended index areas for assessed species (ICES-IBTSWG 2015)."

The nation that was assigned the 30-min tow in each rectangle was the country that was listed first on map in the manual; however, there was some modification (Figure 1). Sweden and England did not participate in the tow duration experiment. This means that there are no 15 min tows in the Skagerrak and all of England's stations were 30-minutes in duration (Figure 2). Because England surveys the entire North Sea (every other row of statistical rectangles), nations sharing those rectangles mainly had 15-min tows; tows of varying duration were not evenly distributed amongst the nations (Table 1). Scotland and Denmark were able to conduct true paired tows in several rectangles (5 stations for Denmark and 15 for Scotland) in 2015. In 2016, most nations conducted additional tows throughout the survey area, not as true pairs, but as an agreement to increase their sampling (stations) to compensate for the potential loss of biodiversity as a result for decreased tow time (see ICES-IBTSWG 2016 for discussion on this)

Data and Methods

Data were pulled from the DATRAS database and the *DATRAS* R-package (Kristensen & Berg 2010) was used to prepare the data. Stations within a statistical rectangle were considered ‘paired tows’ and consisted of 177 stations. Data were also screened to prepare two other data sets, which were tows within 5-km and 10-km of each other (Figure 3).

Tows of duration 15–17 minutes were considered 15-minute tows, while those between 29 and 31 minutes were considered 30-min tows (Table 1). Average tow time for tows classified as 15-min was 15.1 minutes (+/- 0.09), while for 30-min tows, average tow time was 30.01 minutes (+/- 0.05 minutes).

Data were first converted to raw data; DATRAS data contains a combination of raw and standardized to 60-minutes tow duration. Only mandatory species were retained in the data because the identification of benthos is country-dependent. This included all all fish, sharks, skates, rays, and cephalopods and a few species of crustaceans and mollusks (see ICES 2015). Counts and weights were then standardized to either 30-min or 15-min, depending on tow duration classification.

Analyses compared mean catch per tow in numbers and weights of all species. Norway was also tasked with comparing 5 of the 8 fish species that have age sampling conducted: herring, sprat, mackerel, plaice, and saithe. Analyses for these five species included comparisons of mean catch per tow (in weight and numbers) and mean length per tow. Methods are those used in Pennington et al. (2002).

The significance of the difference between the estimated mean catch (in numbers or weight) by 15-minute tows and 30-minute tows were calculated in two ways; assuming the two catch series were independent and by pairing the 15-minute tow and the 30-minute tow in each stratum.

A ratio estimator $\hat{R}$, was used to estimate the mean length:

$$\hat{R} = \frac{\sum_{i=1}^{n} M_i \hat{\mu}_i}{\sum_{i=1}^{n} M_i},$$

where M_i is the number of fish caught (either actual or estimated) at station *i* and $\hat{\mu}_i$ denotes an estimate of the average length of fish at station *i*. The variance of $\hat{R}$ is approximately given by

$$\mathrm{var}(\hat{R}) = \sum_{i=1}^{n} \frac{(M_i / \overline{M})^2 (\hat{\mu}_i - \hat{R})^2}{n(n-1)}, \qquad (1)$$

where $\overline{M} = \sum_{i=1}^{n} M_i / n$.

The sample of fish measured during a survey is not a random sample of individual fish from the entire population but a sample of *n* clusters, one cluster from each station. Since fish caught together are usually more similar than those in the general population, a total of *M* fish collected in *n* clusters will contain usually much less information about, say, the population length distribution than *M* fish randomly sampled (Pennington and Vølstad, 1994; Pennington et al., 2001; Francis, 2014; Nelson, 2014). One way to measure the information contained in a sample of length measurements is to estimate the number of fish that one would need to sample at random (the effective sample size) to obtain the same information on length contained in the cluster samples.

Now if it were possible to sample *m* fish at random from the population then the variance of the sample mean would be equal to σ_x^2 / m, where σ_x^2 is the population variance, e.g., for length. The effective sample, m_{eff}, is defined as the number of fish that would need to be sampled at random so that the sample mean would have the same precision as an estimate based on a sample of *n* clusters.

The estimated length distributions for the IBT surveys are stored in *L* length bins, therefore

$$\hat{\sigma}_x^2 = \frac{\sum_{k=1}^{L} f_k (y'_k - \hat{R})^2}{M-1} \qquad (2)$$

was used to estimate σ_x^2, where f_k is the frequency, that is the number of fish in the k^{th} length bin and y'_k is the bin's midpoint and *M* is the total number of fish in the bins.

An estimate of the effective sample size for a cluster sample can be derived by substituting the estimates from (1) and (2) into the equation

$$\frac{\hat{\sigma}_x^2}{\hat{m}_{eff}} = \text{var}(\hat{R}) \cdot$$

A relatively small effective sample size implies that it is best to take small samples at as many locations as possible, which is the only way to increase the effective sample sizes for estimating population attributes.

Results

The catch rates for numbers and weight for 15-minutes tows and 30-minute tows were not significantly different, except for mackerel (Tables 3-4). The estimates of mean length were not significantly different for the two tow durations (Table 5). The effective sample sizes for estimating length distributions were rather small when compared to the number of fish measured, less than one fish-per-tow on average (Table 6).

Conclusions and Discussion

The only significant differences in catch rates was for mackerel, both for numbers and weight (Tables 3 and 4). When statistically testing many comparisons, it is not surprising to get a few "significant" results, which are actually false positives. In last year's tow duration experiment, there were no significant differences in the catch rates for mackerel (Appendix 1). Also, the Q3 30-minute tows for mackerel had three rather large catches and by removing these three catches, the catch rates were not significantly different.

The estimates of mean length were just as precise for 15-minute tows as for 30-tows (Table 5). The very small effective sample sizes for the IBT survey (on average less than one fish per tow) are like those reported for other surveys (Pennington and Vølstad, 1994; Pennington et al., 2001; Francis, 2014; Nelson, 2014). This implies that it is not necessary or efficient to sample many fish at a station for estimating population characteristics, which is another reason for reducing tow duration for the IBT surveys. Usually, it is sufficient to sample approximately 20 fish at a station for estimating population characteristics.

Tows of 15-min duration were deemed as representative as those of 30-min duration. Variation in duration of the standard tow causes little bias and adds little to the variance because typically around 97% of the variance is due to station to station variability and the remaining 3% is due to within station variation. In addition to increasing survey precision, additional benefits from reducing tow duration include:

- Less gear and equipment wear and less fuel consumption.
- One can tow in more places (cover more habitat).
- Fewer large catches must be subsampled. It is very difficult to collect a representative subsample from a catch.
- Shorter tows can be made at more locations in the survey area, which would increase the effective sample sizes for estimating population characteristics.
- The problem of gear saturation will be reduced.
- Because of intra-cluster correlation (i.e. small effective sizes), the amount of knowledge gained by sampling more fish at a station for estimating biological characteristics is low.

- Why kill twice as many fish for no increase in survey precision or accuracy? (approximately 92 tons versus 184 tons for the Q1 survey in 2016)
- Perhaps the most important reason is the increased capability to obtain more biological information. That is, short tows require less sorting time, which will provide more time for taking other biological measurements.

Many marine trawl surveys have reduced tow duration based on sound scientific studies. These include: the US Bering Sea groundfish survey, 30-minutes to 15-minutes; the US groundfish survey off the northeast coast, 30-minutes to 20-minutes; the shrimp survey off the west coast of Greenland, one hour to 15-minutes; the Norwegian winter survey and the summer eco-system survey in the Barents Sea, 30-minutes to 15-minutes; the Canadian groundfish survey off the east coast of Canada, 30 minutes to 15-minutes; etc. None of these surveys, to our knowledge, have reported any problems resulting from reducing tow duration.

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Table 1. Number of stations by haul duration (in minutes) that were classified to either 15-min or 30-min in duration.

	Classification	
Haul duration	15-min	30-min
15	158	0
16	16	0
17	0	0
18	0	0
19	0	0
20	0	0
21	0	0
22	0	0
23	0	0
24	0	0
25	0	0
26	0	0
27	0	0
28	0	0
29	0	3
30	0	172
31	0	5

Table 2. Number of stations by country and hauls duration. Grey shaded cells indicate data that was used to specify 15-min or 30-min hauls.

Duration	DEN	ENG	GFR	NOR	SCO	SWE
15	33	1	21	39	64	0
16	0	1	1	12	2	0
17	0	0	0	0	0	0
18	0	1	0	1	0	0
19	0	1	0	0	0	0
20	0	11	0	0	0	1
21	0	0	0	0	0	0
22	0	0	0	1	0	0
23	0	0	0	0	0	2
24	0	0	0	0	0	0
25	1	2	0	1	0	0
26	0	0	0	0	0	0
27	0	2	0	0	0	0
28	0	2	0	1	0	0
29	1	2	0	0	0	0
30	24	54	11	10	31	42
31	0	1	0	2	2	0

Table 3. Comparison of mean catch per tow (in weight), by the *n* 15 and 30 minute tows. Tows in a statistical rectangle where both catches were zero are not included. N.S and S.D. denote not significant and significant difference, respectively. The category "All" is the total catch of all the mandatory species, and All* denotes all mandatory species except sprat.

Species	*n*	$2 \times \bar{x}_{15wt.}$ (Kg / tow)	$s.e.(2 \times \bar{x}_{15wt.})$	$\bar{x}_{30.wt.}$ (Kg / tow)	$s.e.(\bar{x}_{30wt.})$	Significance (Pr. value, not paired)	Significance (Pr. value, paired)
All	154	439.6	47.2	501.9	54.3	N.S. (0.39)	N.S. (0.34)
Mackerel	125	16.2	3.7	42.4	11.7	S.D. (0.03)	S.D. (0.03)
Sprat	71	37.0	11.7	36.7	14.1	N.S. (0.99)	N.S. (0.99)
Herring	137	145.9	40.6	209.2	50.4	N.S. (0.36)	N.S. (0.31)
Plaice	137	12.9	1.1	11.1	1.0	N.S. (0.11)	S.D. (0.06)
Saithe	99	33.7	8.2	40.7	8.3	N.S. (0.55)	N.S. (0.39)

Table 4. Comparison of mean catch per tow (in numbers) by the *n* 15 and 30 minute tows. The tows in a statistical rectangle where both catches were zero are not included. N.S and S.D. denote not significant and significant difference, respectively. The "All" is the total catch of all the mandatory species, and All* denotes all mandatory species except sprat.

Species	*n*	$2 \times \bar{x}_{15no.}$ (No./tow)	$s.e.(2 \times \bar{x}_{15no.})$	$\bar{x}_{30.no.}$ (No./tow)	$s.e.(\bar{x}_{30no.})$	Significance (Pr. value, not paired)	Significance (Pr. value, paired)
All	154	12,209	2,493	9,651	1,467	N.S. (0.40)	N.S. (0.38)
Mackerel	125	53.4	13.0	88.7	13.0	S.D. (0.03)	S.D. (0.02)
Sprat	71	4,370	1,310	3,364	1,354	N.S. (0.61)	N.S. (0.61)
Herring	137	2075	570	2347	769	N.S. (0.78)	N.S. (0.78)
Plaice	137	44.1	5.0	39.4	5.1	N.S. (0.51)	N.S. (0.41)
Saithe	66	22.9	6.5	40.7	8.3	N.S. (0.55)	N.S. (0.39)

Table 5. Estimates of the mean length of fish caught in the 15 or the 30 minute tows. A ratio estimator, $\hat{R}$ was used to estimate mean length. The difference in the estimated means, $\hat{R}_{30} - \hat{R}_{15}$, was considered significant if the difference was greater than 2 times the standard error (Col 9).

Species	n_{15}	$\hat{R}_{15}$ (cm)	$s.e.(\hat{R}_{15})$	n_{30}	$\hat{R}_{30}$ (cm)	$s.e.(\hat{R}_{30})$	$\hat{R}_{30} - \hat{R}_{15}$ (cm)	$s.e.(\hat{R}_{30} - \hat{R}_{15})$	Significance
Mackerel	81	31.7	0.49	115	30.2	3.08	-1.54	3.12	N.S.
Sprat	48	9.6	0.39	64	10.5	0.32	0.92	0.50	N.S.
Herring	117	18.4	1.84	128	19.9	1.72	1.44	2.52	N.S.
Plaice	125	27.1	0.73	122	26.1	0.47	-1.01	0.87	N.S.
Saithe	54	48.6	1.98	50	47.1	1.19	-1.50	2.31	N.S.

Table 6. Estimated effective sample sizes for estimating length for the 15-minute and 30-minute tows. The total number of fish caught is denoted by *M,* the estimated variance of the length distribution by $\hat{\sigma}^2$, the number of fish measured by *m* and the effective size by m_{eff}.

Species	15-minute tows				30-minute tows			
	M_{15}	$\hat{\sigma}^2_{15}$	m_{15}	m_{eff}	M_{30}	$\hat{\sigma}^2_{30}$	m_{30}	m_{eff}
Mackerel	489	28.2	153	118	1846	34.6	336	4
Sprat	1771	18.5	756	29	3097	29.6	1015	53
Herring	2183	57.8	899	18	4181	59.5	1284	21
Plaice	802	18.5	375	35	1638	13.5	427	61
Saithe	327	173.9	164	45	369	47.6	163	34

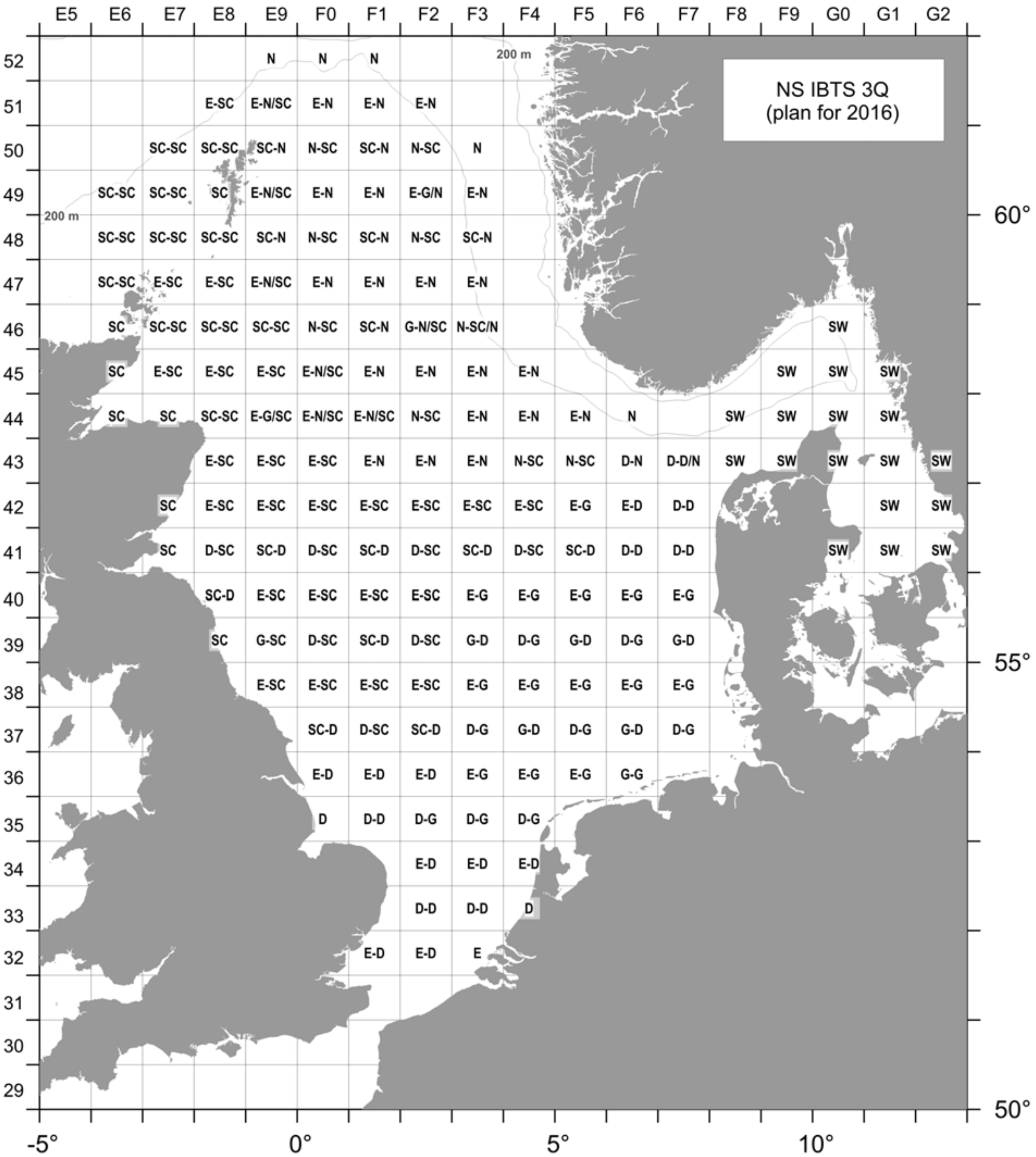

Figure 1. 2015 IBTS Q3 proposed survey grid for all participants: D: Denmark, E: England, G: Germany, N: Norway, SC: Scotland, SW: Sweden. The country named first in the rectangle was to take the standard 30-min tow, whereas the second country could take the 15-min tow. England took only 30-min tows, therefore all countries sharing rectangles with England took the 15-min tow.

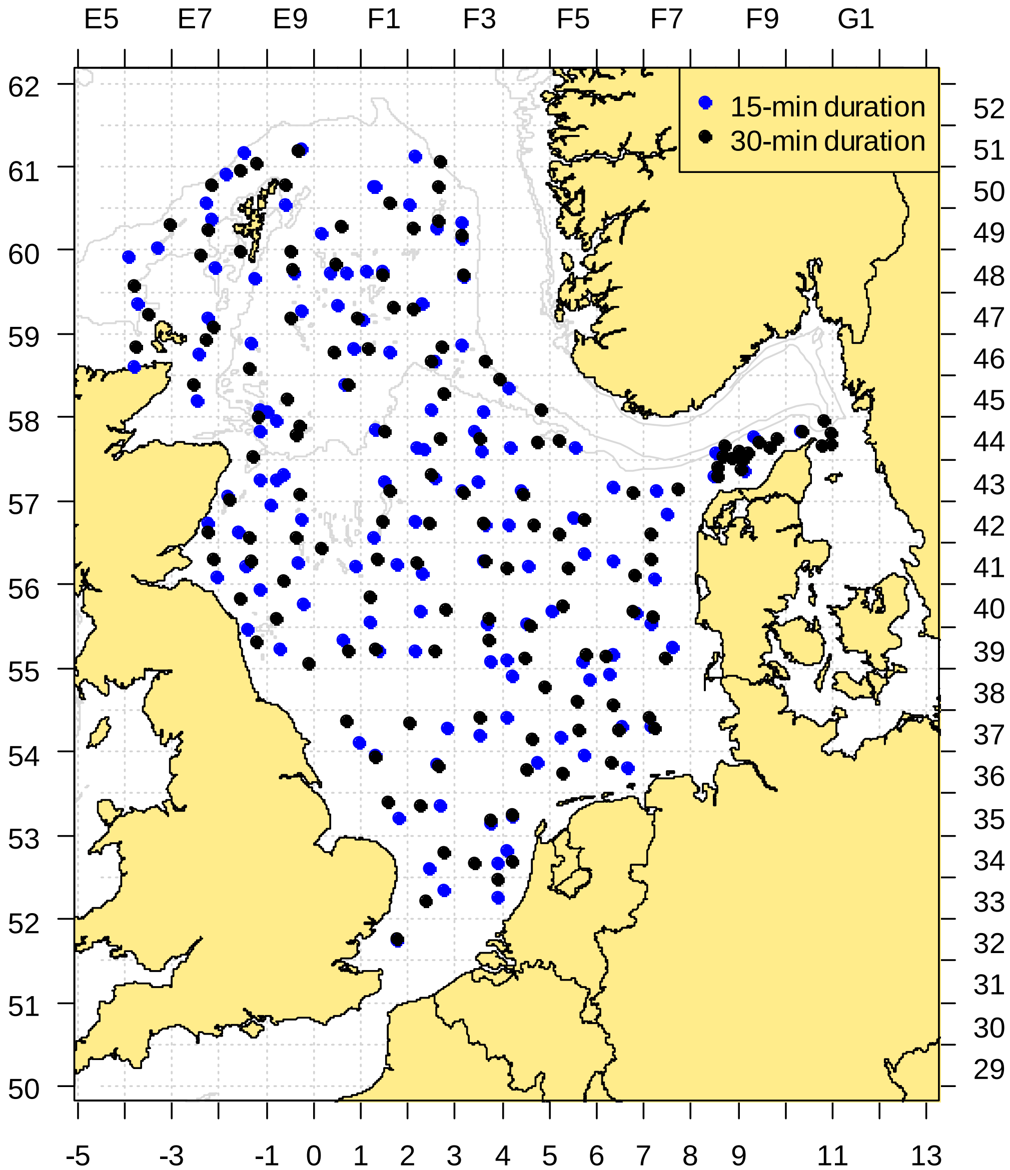

Figure 2. Distribution of 15- and 30-min tows during tow duration experiment, IBTS Q3 2015. Black circles were classified as 30-min tow duration (between 29-31 minutes), blue circles are 15-min tows (between 15-17 minutes duration). Circles were omitted from rectangles that had only 30-min or only 15-min tows (i.e., no pairs).

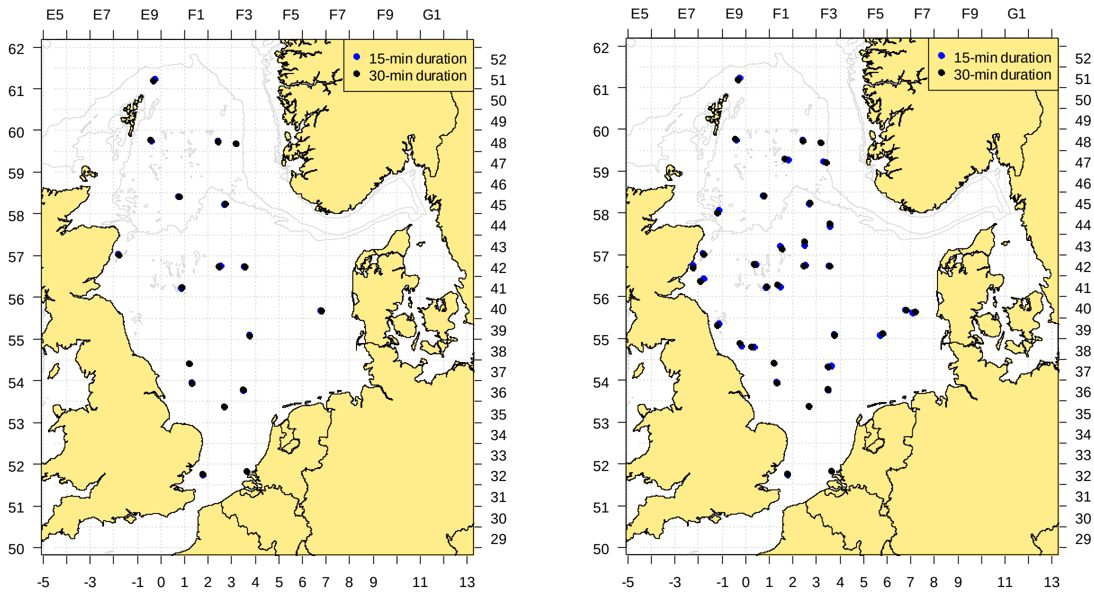

Figure 3. (left) Location of the tows within 5 km and (right) 10 km of each other.

Appendix A. North Sea IBTS Q3 tow duration experiment 2015

Abstract

In trawl surveys, a cluster of fish is caught at each station; fish caught together tend to have more similar characteristics, such as length, age, stomach contents, than those in the entire population. When this is the case, the effective sample size for estimates of the frequency distribution of a population characteristic can, therefore, be much smaller than the number of fish sampled during a survey. On average for trawl surveys the effective sample size is approximately one fish per tow. Thus, many more fish than necessary are measured at each station (location). One way to increase the effective sample size for these surveys and, hence, increase the precision of the length-frequency estimates, is to reduce tow duration and use the time saved to collect samples at more stations.

Introduction

The North Sea IBTS surveys currently take place twice a year, Q1 (Jan-Mar) and Q3 (typically late Jul-Sept, but Norway begins in late June), with seven and six nations taking part in the surveys, respectively. Typically, two nations survey each statistical rectangle although there are a few exceptions, e.g., Sweden in the Skagerrak, Scotland west of Shetland, and several other isolated rectangles throughout the survey area (Figure 1; see the latest IBTSWG manual, ICES 2015).

Based on numerous experiments, it has been observed that little is gained in terms of the precision of estimates of relative abundance or estimates of biological characteristics, by towing longer than about 15 minutes at a station (Godø et al., 1990; Pennington and Vølstad, 1991, 1994; Gunderson, 1993; Goddard, 1997; Folmer and Pennington, 2000; Wieland and Storr-Paulsen, 2006). Therefore, a tow duration experiment embedded in the standard IBTS was planned for Q3 in 2015, which is detailed in the latest IBTSWG report (ICES-IBTSWG 2015). An excerpt included here:

> In order to warrant a thorough comparison with the current methodology, it has been planned that in each ICES rectangle, one of the two assigned hauls will remain at 30-min haul duration, whereas the second will be reduced to 15 min. Any freed-up survey time will, where logistically possible, be utilized to conduct additional hauls and to increase coverage of the fringe areas highlighted with the proposed extended index areas for assessed species (ICES-IBTSWG 2015).

The nation that was assigned the 30-min tow in each rectangle was the country that was listed first on map in the manual; however, there was some modification (Figure 1). Sweden and England did not participate in the tow duration experiment. This means that there are no 15 min tows in the Skagerrak and all of England's stations were 30-minutes in duration. Because England surveys the entire North Sea (every other row of statistical rectangles), nations sharing those rectangles mainly had 15-min tows; tows of varying duration were not evenly distributed amongst the nations (Table 1). Scotland and Denmark were able to conduct true paired tows in several rectangles (5 stations for Denmark and 15 for Scotland).

Methods

Data were pulled from the DATRAS database and the *DATRAS* R-package (Kristensen & Berg 2010) was used to prepare the data. Stations within a statistical rectangle were considered 'paired tows', however, data was also screened to prepare a second data set; 128 stations within the same statistical rectangle and 20 n mi of each other (and 17 stations between 22-30 n mi from each other) were chosen (Figure 2).

Tows of duration 15–20 minutes were considered 15 minute tows, while those >= 20 min were considered 30 min tows (Table 1). Average tow time for tows classified as 15-min was 15.2 minutes (+/- 0.74), while for 30-min tows, average tow time was 29.8 minutes (+/- 1.4 minutes).

Data were first converted to raw data; DATRAS data contains a combination of raw and standardized to 60-minutes tow duration. Only mandatory species were retained in the data. This included all fish, sharks, skates, rays, and cephalopods and a few species of crustaceans and mollusks (see ICES 2015). Counts and weights were then standardized to either 30-min or 15-min, depending on tow duration classification.

Analyses compared mean catch per tow in numbers and weights of all species, where 'All' included all IBTS mandatory species. Norway was also tasked with comparing 5 of the 8 fish species that have age sampling conducted: herring, sprat, mackerel, plaice, and saithe. Analyses for these five species included comparisons of mean catch per tow (in weight and numbers) and mean length per tow. Methods are those of Pennington et al. (2002).

Results

Tables 3-5 show the results of the analyses. Tow duration was not significant for any of the analysis except for plaice (mean catch weight only), but only when using stations that were more closely paired (Table 3). Tow duration did not have a significant effect on the length distribution of fish caught and sampled (Table 5). The number of species caught average 15.8 species in 15 min tows and in the 30 min tows, 18.9 per tow.

Conclusions

Tows of 15-min duration were deemed as representative as those of 30-min duration. Variation in duration of the standard tow causes little bias and adds little to the variance because typically around 97% of the variance is due to station to station variability and the remaining 3% is due to within station variation. In addition to increasing survey precision, additional benefits from reducing tow duration include:

- Less gear and equipment wear and less fuel consumption.
- One can tow in more places (cover more habitat).
- Fewer large catches will have to be subsampled. It is very difficult to collect a representative subsample from a catch.
- Shorter tows can be made at more locations in the survey area.
- The problem of gear saturation will be reduced.
- Because of intra-cluster correlation (i.e. small effective sizes), the amount of knowledge gained by sampling more fish at a station for estimating biological characteristics is low.
- Why kill twice as many fish for no increase in survey precision or accuracy? (approximately 92 tons versus 184 tons for the Q3 survey in 2015)
- Perhaps the most important reason is the increased capability to obtain more biological information. That is, short tows require less sorting time, which will provide more time for taking other biological measurements.

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Table 1. Number of stations by haul duration (in minutes) that were classified to either 15-min or 30-min in duration.

	Classification	
Haul duration	**15-min**	**30-min**
15	128	0
16	16	0
17	1	0
20	3	0
21	0	1
23	0	2
25	0	4
26	0	1
29	0	3
30	0	184
31	0	7
32	0	2

Table 2. Number of stations by country and hauls duration. Grey line in the table denotes the cut-off in duration between the 15-min and 30-min classification of tow duration.

Haul duration	DEN	ENG	GFR	NOR	SCO	SWE
15	29	0	23	20	56	0
16	0	0	2	14	0	0
17	0	0	0	1	0	0
20	0	2	0	0	0	1
21	0	0	0	0	1	0
23	0	0	0	1	0	1
25	1	2	0	0	0	1
26	0	1	0	0	0	0
29	0	0	0	3	0	0
30	28	69	7	4	34	42
31	1	2	1	3	0	0
32	0	0	0	2	0	0

Table 3. Comparison of mean catch per tow (in weight), by the *n* 15 and 30 minute tows. Tows in a statistical rectangle where both catches were zero are not included. N.S and S.D. denote not significant and significant difference, respectively. The category "All" is the total catch of all the mandatory species, and All* denotes all mandatory species except sprat.

Species	*n*	$2\times\bar{x}_{15wt.}$ (Kg / tow)	$s.e.(2\times\bar{x}_{15wt.})$	$\bar{x}_{30.wt.}$ (Kg / tow)	$s.e.(\bar{x}_{30wt.})$	Significance (Pr. value, not paired)	Significance (Pr. value, paired)
All	140	492.8	81.4	574.5	58.9	N.S. (0.42)	N.S. (0.41)
Mackerel	128	32.8	7.9	43.1	10.9	N.S. (0.45)	N.S. (0.43)
Sprat	77	148.1	64.8	90.7	33.6	S.D. (0.43)	N.S. (0.44)
Herring	133	137.6	76.4	177.2	50.4	N.S. (0.67)	N.S. (0.67)
Plaice	125	11.4	1.2	8.5	0.9	N.S. (0.07)	S.D. (0.02)
Saithe	58	32.0	6.9	41.4	9.1	N.S. (0.40)	N.S. (0.30)

Table 4. Comparison of mean catch per tow (in numbers) by the *n* 15 and 30 minute tows. The tows in a statistical rectangle where both catches were zero are not included. N.S and S.D. denote not significant and significant difference, respectively. The "All" is the total catch of all the mandatory species, and All* denotes all mandatory species except sprat.

Species	*n*	$2\times\bar{x}_{15no..}$ (No./tow)	$s.e.(2\times\bar{x}_{15no.})$	$\bar{x}_{30.no.}$ (No./tow)	$s.e.(\bar{x}_{30no.})$	Significance (Pr. value, not paired)	Significance (Pr. value, paired)
All	140	15,160	3,719	13,520	2,664	N.S. (0.72)	N.S. (0.71)
Mackerel	128	201.0	60.6	251.1	79.9	N.S. (0.62)	N.S. (0.60)
Sprat	77	13,520	5,826	9,073	3,952	N.S. (0.53)	N.S. (0.54)
Herring	133	1,690	712.8	1,765	403.6	N.S. (0.93)	N.S. (0.93)
Plaice	125	51.4	6.2	40.4	5.3	N.S. (0.18)	N.S. (0.08)
Saithe	58	22.4	5.0	36.0	9.5	N.S. (0.21)	N.S. (0.17)

Table 5. Estimates of the mean length of fish caught in the 15 or the 30 minute tows. A ratio estimator, $\hat{R}$ was used to estimate mean length. The difference in the estimated means, $\hat{R}_{30} - \hat{R}_{15}$ was considered significant if the difference was greater than 2 times the standard error (Col 9).

Species	n_{15}	$\hat{R}_{15}$ (cm)	$s.e.(\hat{R}_{15})$	n_{30}	$\hat{R}_{30}$ (cm)	$s.e.(\hat{R}_{30})$	$\hat{R}_{30} - \hat{R}_{15}$ (cm)	$s.e.(\hat{R}_{30} - \hat{R}_{15})$	Significance
Mackerel	92	26.29	0.63	116	26.85	0.60	0.56	0.87	N.S.
Sprat	64	10.86	0.25	74	10.38	0.25	-0.48	0.34	N.S.
Herring	105	18.85	3.34	119	21.87	0.98	3.02	3.48	N.S.
Plaice	114	26.38	0.34	122	26.2	0.33	-0.18	0.47	N.S.
Saithe	47	51.69	0.81	50	48.6	1.37	-3.09	1.59	N.S.

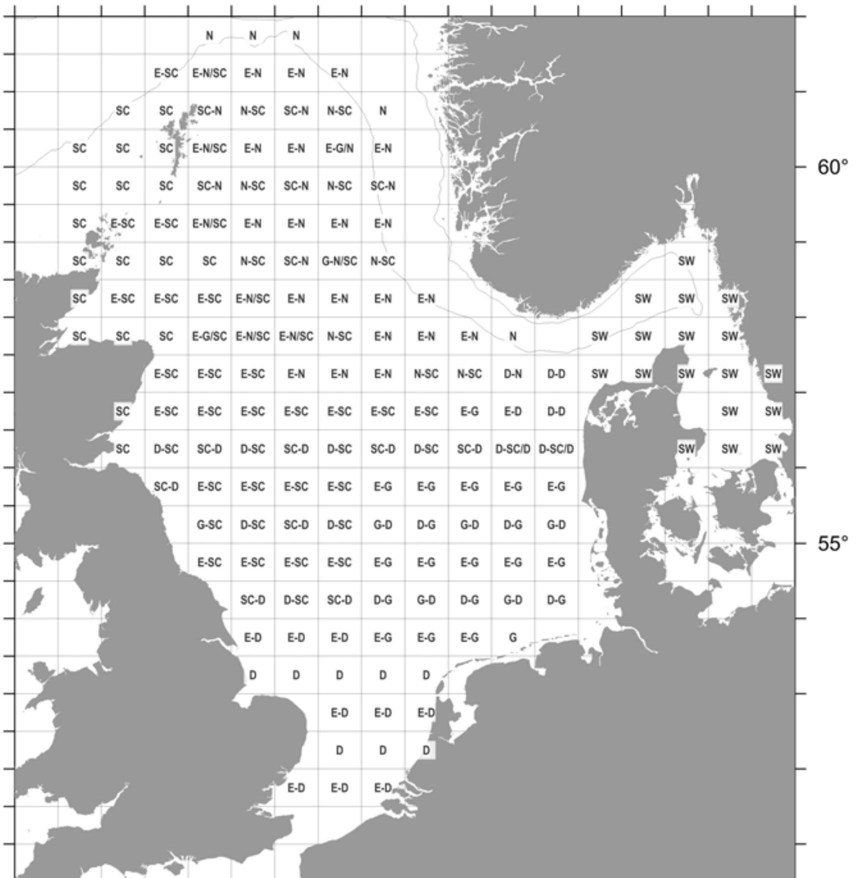

Figure 1. 2015 IBTS Q3 proposed survey grid for all participants: D: Denmark, E: England, G: Germany, N: Norway, SC: Scotland, SW: Sweden. The country named first in the rectangle was to take the standard 30-min tow, whereas the second country could take the 15-min tow. England took only 30-min tows, therefore all countries sharing rectangles with England took the 15-min tow.

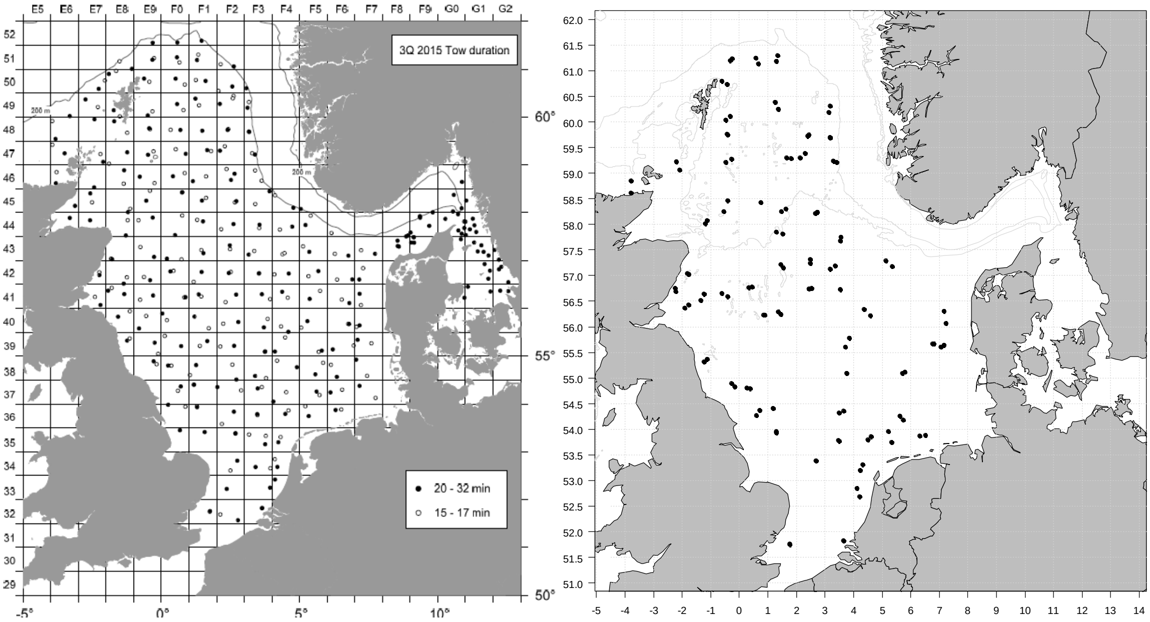

Figure 2. (left) Distribution of 15- and 30-min tows during tow duration experiment, IBTS Q3 2015. (Right) Location of the tows within 15 n mi of each other.

Appendix B. Results of Norway Q1 2015 tow duration “experiment”

Time did not allow for a truly paired tow experiment, i.e., tows conducted side-by-side. Tows were approximately randomly allocated to either 30- or 15-minute duration; because time was limited due to weather, gear trials, or other reasons, some rectangles were sampled at 15-minutes out of necessity. Figure 1A shows the location of the tows, where all tows less than 20 minutes were called 15-min for the analysis, and those that were 25-31 in duration were allocated to 30-minutes. Areas in the north and south of the survey area (Figure 1A) were analyzed separately because the fish communities differed greatly; this was to not introduce a spurious significant result when using a limited area of the North Sea. Fish communities to the south are dominated by a few flatfish species and sporadic high catches of herring, sprat, and anchovy; the overall number of species caught is relatively low. To the north, roundfish (cod, haddock, whiting, saithe, Norway pout) dominate the catches, small pelagic species are seldom captured, and the number of species caught is generally high.

Table 1A. Average, mean, and CV comparing 15-min and 30-min tows in the Norwegian survey area, IBTS Q1 2015.

South	**15-min tows (*n*= 8)**			**30-min tows (*n*=10)**		
Total number per tow	$\overline{X}_{no}$ = 1012	*s.e.* = 350	*cv* = 98%	$\overline{X}_{no}$ = 4222	*s.e.* = 2537	*cv* = 190%
Total weight per tow	$\overline{X}_{wt}$ = 69	*s.e.*=16	*cv* =66%	$\overline{X}_{wt}$ =130	*s.e.* = 37	*cv*=89%
North	**15-min tows (*n* = 6)**			**30-min tows (*n* = 11)**		
Total number per tow	$\overline{X}_{no}$ =5589	*s.e.*=2096	*cv*=92%	$\overline{X}_{no}$ =12,190	*s.e.*=2314	*cv* = 63%
Total weight per tow	$\overline{X}_{wt}$ =174	*s.e.*=61	*cv* = 86%	$\overline{X}_{wt}$ =480	*s.e.*= 92	*cv* = 64%

Table 2A. Average CV’s north (upper) and south (lower).

	15-min tow	**30-min tows**
Number	95%	127%
Weight	76%	77%

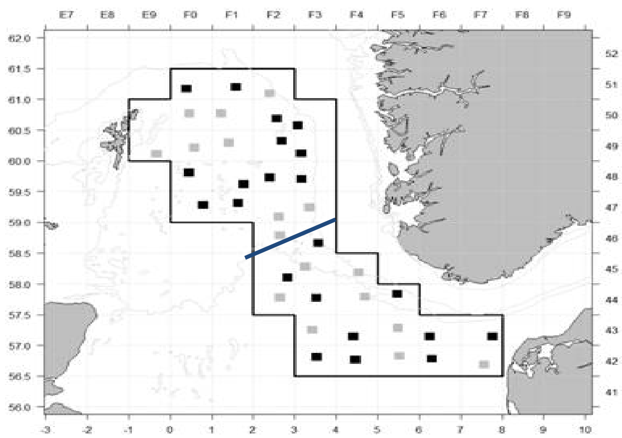

Figure 1A. Norwegian survey area and stations; grey squares indicate <20 minutes in duration, black are 25-31 minutes. Stations called ‘south’ in the analysis are south of the blue line; these are stations that capture a different community (flatfish dominated, includes sprat and anchovy) than the northern stations (mainly roundfish, no sprat or anchovy).

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Preliminary observations on the catches of fish in 'zero-minute' hauls

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Summary

During the 2016 North Sea Q3 IBTS, six experimental hauls of 'zero-minute' duration were undertaken. The catches from these hauls ranged from 16.5–251 kg (biomass of fish, shellfish and benthic bycatch) and included from 6–20 taxa. Further studies are required to better understand the potential catches during deployment and retrieval of hauls, as these catches are potentially independent of tow duration.

Introduction

There have been various discussions at IBTSWG as to the advantages and disadvantages of reducing haul duration in trawl surveys from 30 min to 15 min (ICES, 2016). The potential advantages are that more trawl stations should then be achievable and/or that additional field sampling could be accommodated during the survey. The potential disadvantages are that the total area of seabed sampled is reduced, which has potential implications for 'biodiversity monitoring', and the uncertainty of whether or not the reduced haul durations would impact on indices of stock abundance.

A further aspect that should be considered is in relation to the 'undocumented fishing time'. When otter trawls are being deployed, there will be an unknown period of time from when the trawl is on the sea floor until the desired length of warp is paid out and the net geometry readings have stabilised. It is at this latter point that the start time of the trawl is recorded. Additionally, the end time of the haul is recoded when the haul back of the warps starts, but there is a period of time at the end of the haul when the gear may still be fishing. Consequently, hauls with towed gears will generally comprise the 'documented fishing time' as well as the 'undocumented fishing times' immediately prior and subsequent to the recorded tow duration.

Given these issues, there is the potential that various fish are caught outside the documented fishing time. If this occurs, there is the potential that changes in fishing time could not only affect the consistency of longer-term CPUE data, but also that the undocumented fishing time becomes proportionally greater, relative to the documented fishing time.

It should also be noted that the original selection and design of the GOV trawl was to allow for the sampling of herring (ICES, 2015), a pelagic species. The high headline of the trawl (including the behaviour of the kite) is designed to maximise the sampling of pelagic fish. Furthermore, as the middle bridle of the GOV takes much of the strain when hauling (as evidenced from observations in flume tanks), there is the potential for the distance between the headline and ground rope to be maintained when the net is being hauled through the water column, which could then allow pelagic fish to be captured during hauling. Indeed, on-board observations indicate that catches of pelagic fish once on deck can be moribund (presumably when caught at the start of the tow) or very lively (presumably when caught either at the end of the tow or when hauling).

Whilst numerous studies have examined the catch rates and size ranges of fish caught under different haul durations (Ehrich & Stransky, 2001; Godø *et al.*, 1990; Somerton *et al.*, 2002; Wieland & Storr-Paulsen, 2006), there are fewer studies that have examined the catches of fish in 'zero-minute' hauls (Battaglia *et al.*, 2006), equating with those that may be captured during the 'undocumented fishing time'.

Methods

During the English Q3 North Sea IBTS, six additional hauls were undertaken that were of 'zero-minute' duration (Table 1, Figure 1). Essentially, the trawl was deployed normally, and electronic net sensors monitored. Shot time was recorded as the headline entered the water, then, at the point when the net had settled (equating with when the start time would normally be recorded), the net was then immediately hauled and haul time recorded upon the headline coming out of the water. On retrieval of the trawl, the catch weights and length composition of fish and shellfish were recorded, using the same procedures as used in valid hauls.

Results

The following results are only based on six tows (Table 2), and so only a summary of these data are given.

Herring could be caught in high numbers in 'zero-minute' hauls. Herring dominated the catches at prime stations 54 and 55, in terms of biomass, with ca. 191 kg caught at prime station 54 alone. Catches of other pelagic species (e.g. sprat, horse mackerel and mackerel) were low in the current data.

Norway pout was also seen in considerable numbers, especially in some of the more northerly stations, with the largest catches comprising many juveniles. While prime 54 showed a broad length range (7–19 cm), the catch at prime 55 was exclusively small (5–9 cm) fish, with a total catch of 1 068 fish (ca. 3 kg biomass). Other bentho-pelagic species (e.g. argentines and silvery pout) were caught in lower numbers.

Smaller gadoids (including whiting and haddock) could be found in relatively high numbers. Whiting was seen in high numbers at both northern and southern stations, with the largest catch (ca. 38 kg) caught at prime 9. Overall, whiting was caught over a wide length range (6–43 cm), with both adults and juveniles caught together. Larger gadiforms could also be captured in 'zero-minute' hauls. For example, cod (2—4 in number) were present in three of the six experimental hauls, including individuals up to 81 cm in length. Hake (7–8 in number; 12–13 kg in biomass; 32—82 cm) were present in two hauls and saithe (overall length range of 44—65 cm) occurred in three hauls.

Other demersal species, such as flatfish and rocklings, were generally in lower numbers, but noting that 121 dab were caught at prime station 26, where dab was the main species caught. Some larger-bodied demersal species were also caught, including anglerfish (two stations, each at *ca.* 3 kg biomass), wolf-fish (one station; 3.9 kg biomass) and starry ray (two stations, up to five in numbers).

By station, the more northerly (and deeper) stations saw much more biomass caught in 'zero-minute' hauls. Prime stations 70 and 62 (118–132 m deep) both had total catch weights of *ca.* 61 kg, whist prime stations 54 and 55 (depths of 106–148 m) had a total biomass of *ca.* 247 kg and 199 kg, respectively. Compared to this, the two most southerly stations (prime stations 9 and 26) yielded catches of *ca.* 16 kg each.

The number of taxa recorded in each haul ranged from 6—20 across the six 'zero-minute' hauls. The four most northerly stations yielded the largest number of taxa seen (13–20), whilst only six different species were caught at prime 26.

Three of the stations fished for 'zero-minutes' were also sampled for the standard tow duration (25–30 mins) and 15 minutes. The low number of replicates (plus the potential for temporal affects, in relation to time of day, state of tide, trawl disturbance etc.) prevents quantitative comparisons, but data (Table 2) highlight that herring, and even gadoids, can be caught in greater quantities in a 'zero-minute' haul than in a 30-minute haul.

Discussion

In the light of the discussions regarding proposed reductions in haul duration from 30 minutes to 15 minutes, the potential catch during deployment and retrieval of the GOV should be better assessed, as these unavoidable catches are potentially unaffected by tow duration but may affect the total catch. As discussed by Battaglia *et al*. (2006), the catch in a 'zero-minute' haul may relate to the 'surprise effect' on fish species during deployment and/or the 'end effect' of gear retrieval.

It is logical to suggest that some pelagic species, such as herring, could be caught during the retrieval of the net, considering their usual distribution in the water column and the design of the GOV trawl. Given the number of herring seen in these six experimental tows, and catch weights of up to 191 kg, this hypothesis has some credence. Even some groundfish, including whiting, haddock and Norway pout, may be caught in notable quantities, and even larger bodied gadiforms (cod, saithe and hake) can be captured.

It is also noticeable that, of the six 'zero-minute' hauls, those in the more northerly stations (especially prime stations 54 and 55, at depths of 106–148 m) had the higher total catch weights. This would support the earlier suggestions of Battaglia *et al*. (2006), given that deployment and retrieval times are dependent on water depth, that surveys covering a larger depth range may see more influence from the 'surprise effect' or 'end effect'. Whilst such catches may be affected by depth (although further data are required to better demonstrate this), they should be mostly independent of tow duration. Consequently, reductions in tow duration have the capacity to affect reported catch rates to an unknown degree. This may be particularly important for small pelagic and benthopelagic fish, although even relatively high numbers of commercial gadoids can be captured when the gear is only deployed and retrieved.

Whilst the present observations are only based on six ‘zero-minute’ hauls, there was sufficient indication that there can be large catches (up to 250 kg), and that catches of some species in a ‘zero-minute’ haul can even be greater than in a 30-minute tow. Given this, further work should be undertaken to better understand the potential catches associated with the ‘undocumented fishing time’ (equating with ‘surprise effect’ and/or ‘end effect’) to help inform future discussions on tow duration. Such additional work could usefully be undertaken on surveys coordinated by IBTSWG and would neither compromise existing survey protocols nor time series data.

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Table 1: Summary details of 'zero-minute' hauls

Date	Time	Station number	Prime station	Latitude	Longitude	Depth (m)	Shot time (hours)	Haul time (hours)
01-Sep-16	14:31	140	70	60°N, 11.92'	3°, 7.31' E	130	00:15	00:24
02-Sep-16	13:45	148	62	59°N, 13.28'	0°, 54.29' E	118	00:15	00:17
04-Sep-16	07:32	156	54	58°N, 24.50'	0°, 43.81' E	148	00:19	00:16
04-Sep-16	13:03	158	55	58°N, 14.31'	1°, 27.54' E	106	00:14	00:22
05-Sep-16	15:17	165	26	55°N, 34.58'	3°, 43.84' E	37	00:07	00:10
06-Sep-16	09:17	167	9	53°N, 50.06'	2°, 38.21' E	70	00:10	00:14

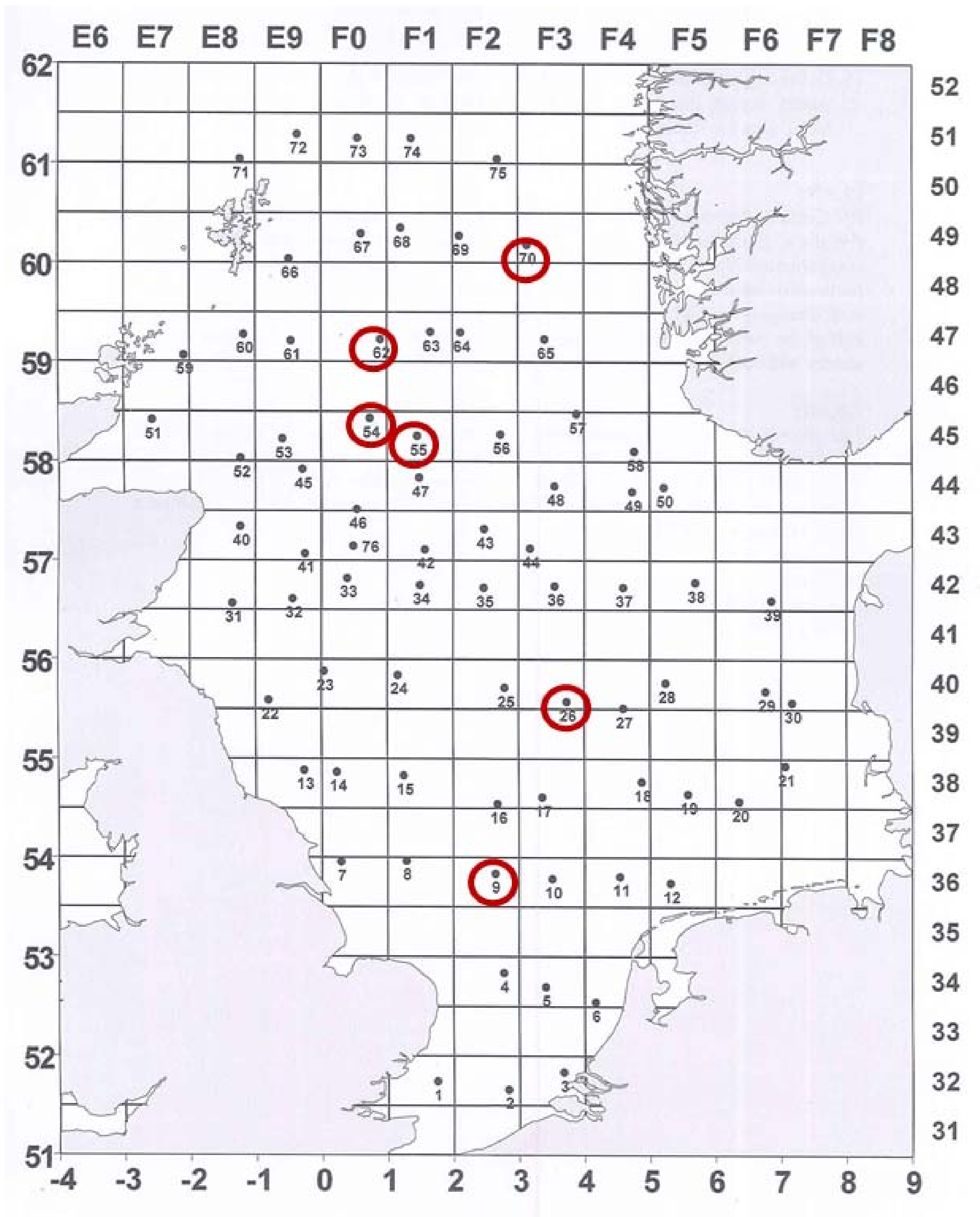

Figure 1: English Q3 IBTS stations indicating stations where 'zero-minute' hauls were undertaken

Table 2: Summary details on the catch weight (kg), abundance and length range (cm) of fish and shellfish caught in four 'zero-minute' hauls

	Species	Prime station 70			Prime station 62		
		Wt.	No.	L_T	Wt.	No.	L_T
Pelagic fish	*Clupea harengus*	0.23	1	30	24.16	125	22.5-33
	Sprattus sprattus	–	–	–	–	–	–
	Trachurus trachurus	6.54	22	27-36	–	–	–
	Scomber scombrus	0.94	3	29-37	2.09	8	30-35
Bentho-pelagic fish	*Argentina* spp.	0.62	15	11-23	0.4	7	15-23
	Gadiculus argenteus	–	–	–	–	–	–
	Trisopterus esmarkii	0.01	2	8-9	7.23	601	7-17
Demersal gadiforms	*Gadus morhua*	–	–	–	1.57	2	8-55
	Melanogrammus aeglefinus	0.06	5	9-13	5.05	17	10-42
	Merlangius merlangus	–	–	–	0.89	32	7-34
	Pollachius virens	25.44	20	44-59	0.74	1	46-46
	Enchelyopus cimbrius	–	–	–	–	–	–
	Molva molva	–	–	–	0.73	1	53-53
	Merluccius merluccius	12.36	7	52-82	–	–	–
Flatfish	*Lepidorhombus whiffiagonis*	1.28	2	24-52	0.13	1	25-25
	Glyptocephalus cynoglossus	–	–	–	0.25	1	35-35
	Hippoglossoides platessoides	0.02	2	9-12	0.90	24	9-24
	Limanda limanda	–	–	–	–	–	–
	Microstomus kitt	–	–	–	1.32	5	19-37
	Pleuronectes platessa	–	–	–	1.22	1	46-46
	Buglossidium luteum	–	–	–	–	–	–
Other demersal fish	*Myxine glutinosa*	–	–	–	–	–	–
	Amblyraja radiata	0.16	1	29-29	1.86	5	16-44
	Lophius piscatorius	2.97	2	34-55	3.09	1	58
	Eutrigla gurnardus	2.09	5	35-38			-
	Anarhichas lupus	–	–	–	3.93	2	57-59
Crustaceans	*Lithodes maja*	–	–	–	0.5	1	11.1
	Nephrops norvegicus	–	–	–	–	–	–
Molluscs	*Rossia macrosoma*	–	–	–	0.02	2	
	Sepiola spp.	0.02	1		–	–	–
	Alloteuthis subulata	–	–	–	–	–	–
	Loligo forbesi	–	–	–	–	–	–
	Eledone cirrhosa	0.02	1		–	–	–
	Arctica islandica	–	–	–	0.05	1	–
Biomass of benthic bycatch		8.03	–	–	5.17	–	–
Total biomass (abundance)		60.75	89	–	61.26	838	–
Total no. of taxa		**15**			**20**		

Table 2 (continued): Summary details on the catch weight (kg), abundance and length range (cm) of fish and shellfish caught in four 'zero-minute' hauls

	Species	**Prime station 54**			**Prime station 55**		
		Wt.	No.	L_T	Wt.	No.	L_T
Pelagic fish	*Clupea harengus*	190.96	919	24.5—31.5	91.35	447	23.5—32
	Sprattus sprattus	–	–	–	–	–	–
	Trachurus trachurus	–	–	–	–	–	–
	Scomber scombrus	0.63	2	31—36	1.20	3	34—37
Bentho-pelagic fish	*Argentina* spp.	0.83	15	16—24	0.15	5	11—21
	Gadiculus argenteus	0.10	9	9—11	–	–	–
	Trisopterus esmarkii	35.70	1531	7—19	2.99	1068	5—9
Demersal gadiforms	*Gadus morhua*	7.14	4	9—81	6.88	2	30—80
	Melanogrammus aeglefinus	0.03	3	10—10	33.00	218	8—47
	Merlangius merlangus	4.43	131	7—40	38.61	263	8—43
	Pollachius virens	5.06	3	54—65	–	–	–
	Enchelyopus cimbrius	–	–	–	–	–	–
	Molva molva	–	–	–	–	–	–
	Merluccius merluccius	–	–	–	13.28	8	32—75
Flatfish	*Lepidorhombus whiffiagonis*	–	–	–	–	–	–
	Glyptocephalus cynoglossus	–	–	–	0.94	4	27—40
	Hippoglossoides platessoides	0.81	22	9—22	1.48	40	10—23
	Limanda limanda	–	–	–	–	–	–
	Microstomus kitt	–	–	–	1.13	4	19—35
	Pleuronectes platessa	–	–	–	2.90	4	37—43
	Buglossidium luteum	–	–	–	–	–	–
Other demersal fish	*Myxine glutinosa*	0.12	2	33—35	–	–	–
	Amblyraja radiata	–	–	–	–	–	–
	Lophius piscatorius	–	–	–	–	–	–
	Eutrigla gurnardus	0.22	1	31	4.93	28	21—36
	Anarhichas lupus	–	–	–	–	–	–
Crustacean s	*Lithodes maja*	0.82	2	10.7—11.6	–	–	–
	Nephrops norvegicus	–	–	–	–	–	–
Molluscs	*Rossia macrosoma*	0.05	1	–	–	–	–
	Sepiola spp.	–	–	–	–	–	–
	Alloteuthis subulata	–	–	–	–	–	–
	Loligo forbesi	–	–	–	–	–	–
	Eledone cirrhosa	–	–	–	–	–	–
	Arctica islandica	–	–	–	–	–	–
Biomass of benthic bycatch		4.96	–	–	–		–
Total biomass (abundance)		**251.84**	**2645**	–	–	**2094**	–
Total no. of taxa		**14**			**13**		

Table 2 (continued): Summary details on the catch weight (kg), abundance and length range (cm) of fish and shellfish caught in four 'zero-minute' hauls

	Species	Prime station 26			Prime station 9		
		Wt.	No.	L_T	Wt.	No.	L_T
Pelagic fish	*Clupea harengus*	–	–	–	2.43	477	7—15
	Sprattus sprattus	–	–	–	1.51	133	9—13
	Trachurus trachurus	–	–	–	–	–	–
	Scomber scombrus	–	–	–	–	–	–
Bentho-pelagic fish	*Argentina* spp.	–	–	–	–	–	–
	Gadiculus argenteus	–	–	–	–	–	–
	Trisopterus esmarkii	–	–	–	0.01	1	10
Demersal gadiforms	*Gadus morhua*	–	–	–	–	–	–
	Melanogrammus aeglefinus	–	–	–	–	–	–
	Merlangius merlangus	0.07	1	20	4.25	127	6—29
	Pollachius virens	–	–	–	–	–	–
	Enchelyopus cimbrius	–	–	–	0.24	7	16—20
	Molva molva	–	–	–	–	–	–
	Merluccius merluccius	–	–	–	–	–	–
Flatfish	*Lepidorhombus whiffiagonis*	–	–	–	–	–	–
	Glyptocephalus cynoglossus	–	–	–	–	–	–
	Hippoglossoides platessoides	–	–	–	–	–	–
	Limanda limanda	7.08	121	13—25	3.71	72	12—25
	Microstomus kitt	0.34	3	17—25	–	–	–
	Pleuronectes platessa	1.41	5	24—35	0.65	3	20—32
	Buglossidium luteum	–	–	–	0.11	9	8—11
Other demersal fish	*Myxine glutinosa*	–	–	–	–	–	–
	Amblyraja radiata	–	–	–	–	–	–
	Lophius piscatorius	–	–	–	–	–	–
	Eutrigla gurnardus	6.75	75	15—32	2.56	21	16—33
	Anarhichas lupus	–	–	–	–	–	–
Crustaceans	*Lithodes maja*	–	–	–	–	–	–
	Nephrops norvegicus	–	–	–	0.08	2	3.1—3.9
Molluscs	*Rossia macrosoma*	–	–	–	0.02	3	–
	Sepiola spp.	–	–	–	–	–	–
	Alloteuthis subulata	–	–	–	0.15	82	1—8
	Loligo forbesi	0.36	3	14—18	0.02	1	50
	Eledone cirrhosa	–	–	–	–	–	–
	Arctica islandica	–	–	–	–	–	–
Biomass of benthic bycatch		1.22	–	–	0.85	–	–
Total biomass (abundance)		**17.23**	**208**		**16.54**	**938**	
Total no. of taxa		**6**			**13**		

Table 3: Summary details on the catch weight (kg) of cod, haddock, herring, hake, Norway pout, saithe and whiting, at sites fished with different tow durations, including 'zero-minute' hauls.

Prime station	**54**				**55**			**26**		
Haul duration (mins)	**0**	**15**	**30**	**30**	**0**	**15**	**25**	**0**	**15**	**30**
Cod	7.14	2.18	21.68	20.9	6.88	3.64	2.28	–	–	–
Haddock	0.03	7.86	14.05	7.74	33.00	51.82	69.17	–	0.72	1.30
Herring	190.96	675.68	42.89	19.63	91.35	106.44	642.45	–	1.56	0.23
Hake	–	1.15	24.63	1.72	13.28	19.38	32.83	–	–	–
Norway pout	35.70	87.90	159.69	69.96	2.99	40.92	24.62	–	–	–
Saithe	5.06	8.98	16.90	3.22	–	–	1.12	–	–	–
Whiting	4.43	11.23	9.99	17.17	38.61	52.79	30.07	0.07	0.27	1.66

Working Document: Species diversity and abundance in Q3 experimental tows

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In order to test if sampling effort could be reduced without a significant loss in data quality an experiment was performed within the ICES International Bottom Trawl Survey conducted in the North Sea. The variation in species richness, abundance, biomass and body size caused by differences due to experimental tow durations is studied (30 minutes vs 15 minutes). This within survey sampling variation is examined looking at the quarter three international bottom trawl survey as a case study. Results show significant differences in biomass and abundances between the two haul categories, generally "short" hauls have higher relative biomasses and abundances than long hauls. The large fish indicator (LFI) recorded in "short" hauls is significantly higher than in "long" hauls. Species richness estimates are lower in the "short" haul category. The results presented here lead the authors to the conclusion that reducing tow duration in this survey would not optimise the survey in aspects of biodiversity.

Data and Analysis

For all the North Sea rectangles within the Q3 survey area that were sampled twice, it was proposed that within each rectangle one trawl of a typical 30 minute duration would be completed with the second perscribed haul being shortened to 15 minutes. The resultant dataset provided an almost 50/50 split across the entire survey area of both haul duration categories. In most instances haul duration was of either 15 or 30 minutes although a few hauls were found to be of an intermediate duration and so the hauls were grouped in two categories, "short" (12–18 minutes) and "long" (24–36 minutes), this allowed for a 20% error around the haul time. A total of 352 valid hauls were completed during the 2015 survey while 381 hauls where completed in the 2016 survey. Onlystatistical rectangles that contained both a short haul and a long were included, providing a total of 499 hauls that were available for this analyses. This gives a a suite of hauls covering 118 ICES rectangles, consisting of 120 "long" and 120 "short" hauls in 2015 and 124 "long" and 135 "short" in 2016**.** For this analysis, the haul data included geographical position (longitude, latitude), depth (m), haul number, vessel, statistical rectangle, tow duration (minutes) and swept area (in km^2) and year.

The catch data for all species was expressed as recorded numbers, numbers per km^2 or biomass per km^2. The data set used was the quality assured monitoring and assessment data set for the "Greater North Sea International otter trawl survey quarter 3" (GNSIntOT3) (MS-S, 2017). All data was quality assured using the criteria set out in Moriarty and Greenstreet (2016). All the analyses were conducted using the statistical package R (R Development Core Team, 2013). A Welch two sample t-test was performed to test the null hypothesis, "there is no difference in the mean species richness of short hauls and long hauls". The power of the t-test was also calculated, to assess the power associated with the level of sampling which has occurred. Species richness curves with confidence intervals were plotted against number of hauls for both "long" and "short" tows categories using a randomised method. Number of hauls required to sample 50 species using both "short" and "long" tows was calculated. A Gleason semi-log function was fitted to the data for both "short" and "long" tows to predict the effect of shorter tows on species richness in the North Sea over 300 and 600 tows.

For the Gleason semi – log plot;

$$s=c+z(\log A)$$

where "s" is the species richness count, "A" is the area sampled (number of hauls) and "c" (for "long" haul category is 16.27, "short" is 21.37) and "z" ("long" is 0.32, "short" is 0.25) are constants.

The body size (length cm) of fish was investigated to test if there were significant differences in the body size of fish between the two haul duration categories. The abundance of (numbers per km^2) of fish in the two categories was plotted to see if there was a difference in abundance estimates between long and short tows. To test if there is a significent difference between the "short" and "long" tows in estimates of MSFD indicators being derived from this survey the LFI, Mean Max Length (MML) and Total Length (TyL) were calculated for a suite of species in the samples.

Results

The haul category ("long" vs. "short") had an effect on species richenss (i.e. the number of fish species caught per km^2). The species richness was consistently lower in the short hauls compared to the long hauls. The box plot in figure 1 shows the number of species found in the short and long hauls. The mean in the long haul group was 20.17 species per haul, while in the short haul group the mean number of species per haul was 18.2. Using a Welch two sample t-test to test the null hypothesis of no difference in the means, ie that the species richness is not effected by haul duration, is rejected with a p-value of <0.001. The t-test power calculation suggested this test had a power of 0.95 given the sample sizes in each haul group. The overall richness within the "long" tow category was 90 species while in the "short" tow category the overall species richness was 81 species. This suggests that reducing the haul duration to 15 minutes as standard without increasing the number of hauls has the potential to effect the overall biodiversity within the survey timeseries. In 2015 the "long" category recorded 80 species while the short category recorded 73 species. In 2016 the "long" category recorded 81 species while the short category recorded 79 species. There was 15 additional "short" hauls and 4 additional "long" hauls in 2016 when compared to the same survey in 2015. The 12.5% increase in "short" hauls from 2015 to 2016 was reflected in the increased species richness.

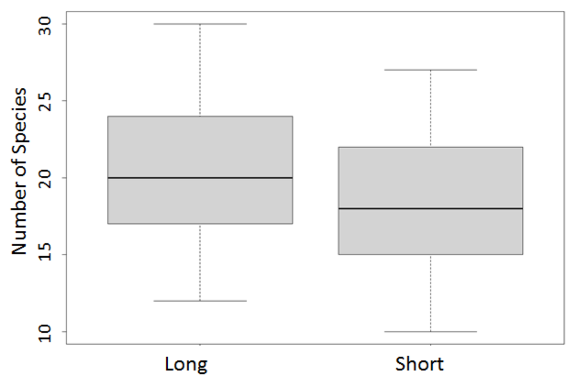

Figure 1. Box plot showing spread of the number of species recorded in the long hauls beside the spread of species recorded in the short hauls. The mean number of species recorded in the long hauls was 20.17 while in the short hauls the mean is 18.2 species per haul. The whiskers show the range of values 12-30 in "long" hauls and 10-27 in "short" hauls.

Figure 2 highlights the difference in potential species richness within the two tow categories. The "long" tow category was 33% more effective at sampling species richness, this suggests that a 33% increase in the "short" tows would provide a similar species richness estimate. When increased to a species richness of 75 species this gap widens and a 67% increase in "short" hauls to "long" hauls would be needed.

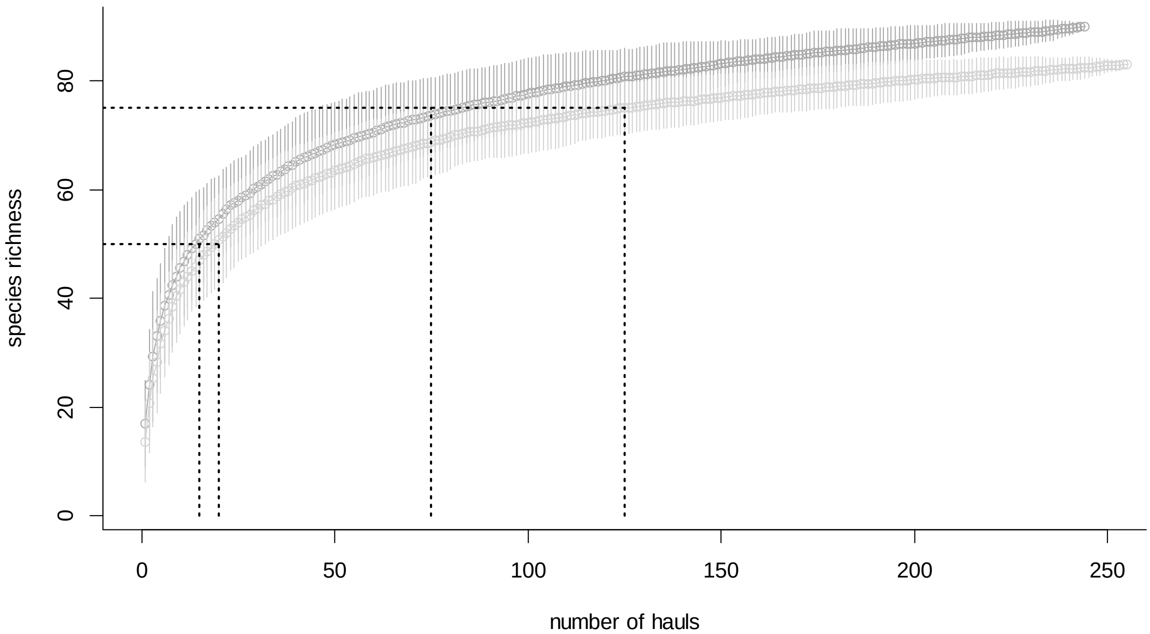

Figure 2: Cumulative species richness curves for "long" tows in dark grey and "short" tows in light grey.

The Gleason-semi log function was used to predict potential species richness across the total survey area (Figure 3), and looks at the added effort which would be required if the "short" tow duration was made operational. The curve plotted in figure 3 can be interperted to mean that to reach a species richness of 100 species using a "long" tow, 300 stations will need to be sampled. To get the same species richness with the "short" tow 480 stations would need to be sampled. To reach a species richness of 110 species using a "long" tow, about 400 stations will need to be sampled. To get the same species richness with the "short" tow about 600 stations would need to be sampled. This would infer approximetely a minimum of a 50% increase in sampling to retain species diversity. The extrapolation of this function beyond the data is quite high, but with the addition of the 2016 data the variance increased in the "short" haul samples.

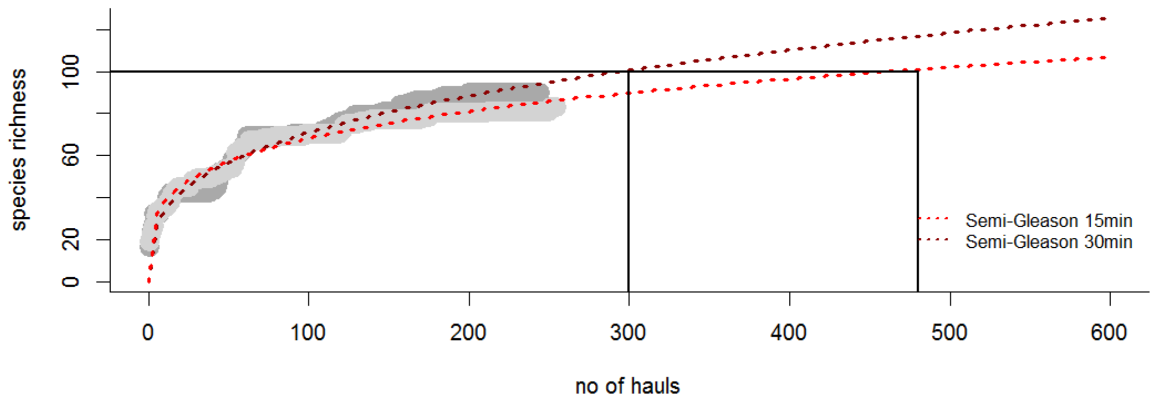

Figure 3: "Long" tow (in dark grey) and "short" tow (in light grey) cumulative species richness (collected) plotted by haul. A Gleason-semi log function is plotted in dark red for "long" hauls light red for "short" hauls.

To investigate any differences in body size of fish between the two haul duration categories the abundance of (numbers per km^2) and biomass (kg/km^2) of fish in 10-cm length classes in the two categories was plotted. Figure 4 shows the results of this on a logged scale. The logged mean biomass (kg/km^2) was 4.6 for the "short" haul group and the logged mean biomass at length was 4.3 for the "long" haul group. To test if there was a significant difference between the "short" and "long" haul groups the average logged biomass (kg/km^2) at each length was tested using a Welch two sample t-test, the average differences between the two haul groups was significant with a p-value 0.009. The average logged abundance at length was 5.1 for the "short" haul group and the logged mean abundance at length was 4.6 for the "long" haul group. This is not a significant difference.

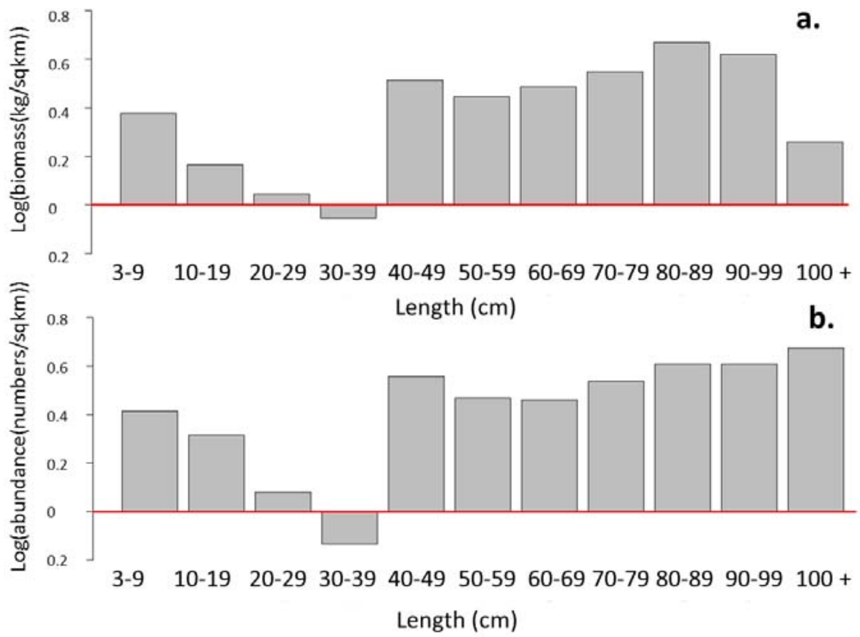

Figure 4 a. Bar charts showing the difference between logged mean biomass (kg/km^2) in "short" and "long" haul categories for groups of length of all fish over the two years. (b.) Showing the difference between logged mean abundance (numbers/km^2) in "short" and "long" haul categories for groups of length of all fish over the two years.

In 2015 the LFI for "short" hauls was 0.086, and for "long" hauls in the same year the LFI was 0.093. In 2016 the mean LFI for "short" hauls was 0.141 and the LFI for "long" hauls was 0.097. There was no significant difference in the mean LFI results for long and short hauls. Figure 5 shows the range of values of the LFI across all of the sampled rectangles in the North Sea over the two years for both "short" and "long" hauls. The mean LFI in the "long" group was 0.12 and in the "short" group was 0.18. This result was found to be significant with a p-value of 0.04.

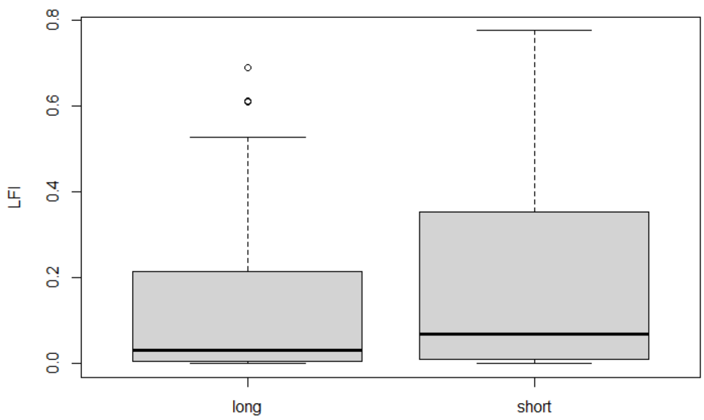

Figure 5 Boxplot shows the variation in the LFI indicator across the ICES Statistical Squares in the North Sea for 2015 and 2016. The mean LFI in the "long" tow duration group was 0.12 and in the "short" tow duration group was 0.18 (p-value 0.1 and power of .4) at an LFI large fish value of 50 cm and above.

Estimates of MML and TyL were calculated for each subdivision and haul category to test if there is a significent difference between the “short” and “long” tows in estimates of these MSFD indicators being derived from this survey. The MML and TyL were calculated for pelagic and demersal species caught in these hauls in both years by rectangle to test for a significant difference in the estimated results for long and for short hauls. No significant differences were found between the “short” and “long” haul categories for MML or TyL of the pelagic or demersal species.

Discussion

The results show a clear effect on species richness that could be attributed to the haul category (“long” vs. “short”). Even with an increased number on “short” hauls there was a significant difference between the two means, 20 species per haul for the “long” category and 18 for the “short” category (figure 1). This coupled with the overall difference in potential species richness within the two tow categories, survey richness of the “long” haul category was more efficent at reaching a higher species diversity that the shorter hauls (figure 2). The 12.5% increase in shorter hauls in 2016 did help to increase the richness estimate from 73 in 2015 to 79 in 2016, which was very close to the 80 in 2015 and 81 in 2016 recorded in the “long” haul category. The individual species recorded did differ in each category, with rarer species not consistently present across years. Figure 3 uses a Gleason-semi log function to predict potential species richness across the total survey area, if “short” tows were adopted, to get a mean species richness of 100 species aproximetly 480 stations would need to be sampled, this is an additional 60% more hauls than the 300 required for the same species richness in “long” hauls. On balance in terms of the species richness estimates staying with the longer 30 minute hauls is more effective, and will give better estimates of species richness. However it should be noted that subsampling the 30 minute tows has been found to limit the species richness in a similar manner to the shortened tow duration (Ehrich and Stransky, 2001).

In general the trend in Figure 4 shows the biomass and abundance in the “short” haul category is higher than in the “long” haul, with the exception of fish in the 30-39 cm class. This class is dominated by pelagic species Atlantic horse mackerel (*Trachurus trachurus),* herring (*Clupea harengusI),* argentines (*Argentina sphyraena*), mackerel (*Scomber scombrus*) and blue whiting (*M. poutassou*). The results investigating differences in the body size of the community sampled by the two different haul duration categories showed significant differences in the logged mean biomass. In both the logged mean abundance at length and the logged mean biomass at length the “short” haul group was higher than the “long” haul group. This trend was evident in the mean LFI results (when both years are combined), the “long” group was 0.12 and in the “short” group was 0.18. However the MML and the TyL showed no significant difference in the two categories. The LFI with a 50 cm limit was dominated by common skate (*Dipturus batis)*, followed by cod (*Gadus morhua*), monkfish (*Lophius piscatorius)*, pollack (*Pollachius virens*), and hake (*Merluccius merluccius*). Other species which made up the community of larger fish included sensitive rays and sharks (*Squalus acanthias, Raja clavata, R. montagui, Mustelus asterias*), and commercially important species such as haddock (*Melanogrammus aeglefinus*). While there was no significant difference in the mean LFI results for long and short hauls in each year, it is important to note that the individual results for the LFI in each category drastically underestimate the results found in each year when all the data is combined. For the given subset of rectangles the combined data gives an LFI ratio of 0.224 in 2015 and 0.216 in 2016. If the 15 minutes hauls became the accepted practise the, given the trends seen here there is the potential for the LFI to be overinflated in these years, this must be considered, and accounted for in future assessments.

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Within-rectangle variation of species composition and catch rates – Implications for survey design, station allocation and tow duration

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Introduction

Actually, the NS-IBTS is stratified by statistical rectangles which have little or no biological meaning and the sampling locations are pragmatically chosen by the different countries on their own premises along as a minimum distance of 10 nautical miles between subsequent tows is achieved according to the manual (ICES 2015a). Discussion on survey design of the 3rd quarter North Sea IBTS has been initiated the IBTSWG itself (ICES 2015b), and by WGISUR in 2015 (ICES 2015c) and continued thereafter during WKPIMP in 2016 (ICES 2016a). Building upon results from the EU project "JMP – Towards a Joint Monitoring Programme for the North Sea and the Celtic Sea" where the stratification of the ecosystem model 'Atlantis' was applied (Hufnagl et al. 2014), WKPIMP suggested a stratification of the NS-IBTS into 11 geographical strata but without any sub-stratification e.g. in respect to depth. The outcomes of WKPIMP were presented to the IBTSWG during its meeting in 2016, and the IBTSWG decided to wait with the implementation of changes of the NS-IBTS survey design until more information have become available, partly from own analyses but also based on advice from other IBTS Expert Groups (ICES 2016b).

The present analysis show examples for within-rectangle variability of species composition and catch rates in respect to depth and provides results which may be considered for a change of the NS-IBTS survey stratification, station allocation procedure as well as tow duration.

Material and methods

The analysis used data from the Danish 3rd quarter NS-IBTS in the period 2011-2016 from 5 rectangles in the southwestern North Sea where two trawl tracks which differed considerably in depth within a distance of 5, 8, 10, 14 or 20 nautical miles have been fished (Fig. 1). Decision on which of the two tracks in a given rectangle was covered differed between years depending on a pragmatic approach by the cruise leader but were always in accordance with the rules as specified in the NS-IBTS manual. Only the most recent years were considered in this preliminary analysis although some of the locations have been more frequently than one or two times since 2007.

Results

The total catch of fish was higher at the deep than at the shallow station in 4 out of the 5 rectangles, both in terms of weight and in numbers (Tab. 1). The largest fish had been caught on the deep tracks in the most cases but average L_{max} was higher for the shallow then for the deep tracks which was mainly related to the presence of large sharks at the shallow stations (Tab. 1). The total number of different fish species was always lower on the shallow tracks than on the deep ones (Tab. 1) and on average 13 different fish species were found on the shallow stations whereas 21 different fish species occurred on the deep stations (Fig. 2).

Species composition differed considerably between the shallow and the deep station in a rectangle but showed also large variation between years for the same track (Figs. 3a-e). Sharks and rays amounted to about 30 % of the catch of the deep track in rectangle 36F1 whereas they were almost completely missing on the shallow track in this rectangle (Fig. 3a). Clear differences of the species composition between the years for the same trawl tracks were found in rectangles 35F0, 35F1 and 35F2 which was most pronounced for the catches of mackerel, whiting and Greater as well as Lesser sandeel (Figs. 3b-d). Tope and lobster was caught on the shallow track in rectangle 35F0 in both years (Fig. 3b) whereas the occurrence of other shark and ray species and crustaceans was more variable. Species composition differed also between the shallow and the deep track in rectangle 36F2 (Fig 3e) and here the presence of Norway lobster on the deep track, which was not found on any other station in the study area, may suggest an influence of sediment type in addition to depth.

Conclusions

The high fish and shell fish diversity makes a representative sampling of this relative small but heterogeneous area difficult, and appears that track selection, i.e. either deep or shallow, is much more important for the number of species recorded than whether tow duration is 30 or 15 min.
Denmark is the only country covering rectangles 35F0-F2 in the 3rd quarter and thus usually only either the deep or the shallow in a rectangle can be done in particular when tow duration of 30 min is requested. And even for rectangles 36F0-F2 where England is the other country coverage of both shallow and deep tracks is not ensured because coordination in this respect is currently quite limited.
It is therefore suggested that or the area studied here future changes in survey stratification should consider a sub-stratification into at least two depth strata (e.g. < 25 m and ≥ 25 m), a random selection of clear tow positions within these substrata replacing the existing minimum distance rule of 10 nautical miles which may then also include a random allocation of short (15 min) and long (30 min) tows.

Acknowledgements

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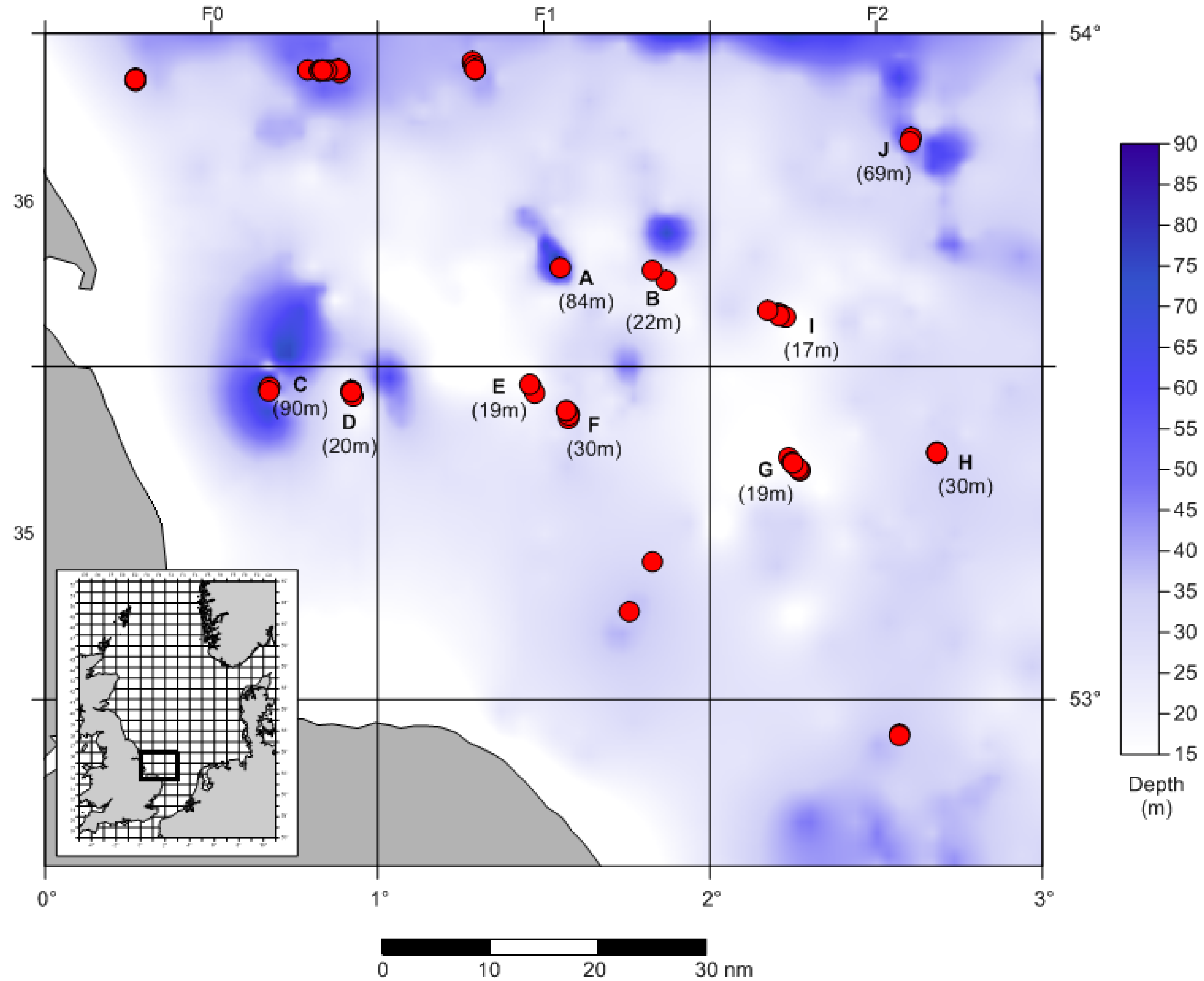
Tab. 1. Station information and catch results for the various locations in 2011 - 2016.

Rectangle	Location	Year	Depth (m)	Tow duration (min)	Fish catch: Weight (kg)	Fish catch: Number	Number of species: bony fish	Number of species: sharks and rays	Number of species: total	Fish length (cm): L_{max}	Fish length (cm): Species
36F1	A	2013	84	30	350	14205	19	6	25	111	Spurdog
	B	2011	22	30	202	2527	7	2	9	57	Lesser-spotted dogfish
35F0	C	2013	90	30	294	1118	18	2	20	65	Lesser-spotted dogfish
		2015		30	538	5078	20	2	22	98	Starry smoothhound
	D	2014	20	30	316	5599	15	4	19	163	Tope
		2016		30	55	268	15	3	18	163	Tope
35F1	E	2012	19	31	688	11634	10	1	11	63	Lesser-spotted dogfish
		2013		30	480	28265	12	1	13	62	Lesser-spotted dogfish
	F	2015	30	30	147	1961	20	4	24	83	Thornback ray
		2016		30	151	2916	17	4	21	88	Smoothhound
35F2	G	2013	19	30	197	1856	12	2	14	68	Thornback ray
		2016		30	36	1215	10	0	10	40	Tub gurnard
	H	2014	30	28	545	40967	17	3	20	56	Spotted ray
		2015		30	236	31576	16	1	19	59	Lesser-spotted dogfish
36F2	I	2015	17	15	59	1419	8	3	11	85	Smoothhound
	J	2016	69	15	88	3245	13	1	14	41	Blonde ray
				Average shallow:	254	6598	11	2	13	88	
				Average deep:	294	12633	18	3	21	75	



A: 2013
B: 2007, 2011
C: 2008, 2012, 2013, 2015
D: 2007, 2009, 2011, 2014, 2016
E: 2011, 2012, 2013
F: 2008, 2009, 2010, 2014, 2015, 2016
G: 2008, 2009, 2010, 2011, 2012, 2013, 2016
H: 2007, 2014, 2015
I: 2007, 2008, 2010, 2011, 2012, 2013, 2014, 2015
J: 2009, 2016

Fig. 1. Sampling locations in the Danish 3Q NS-IBTS, 2007-2016.

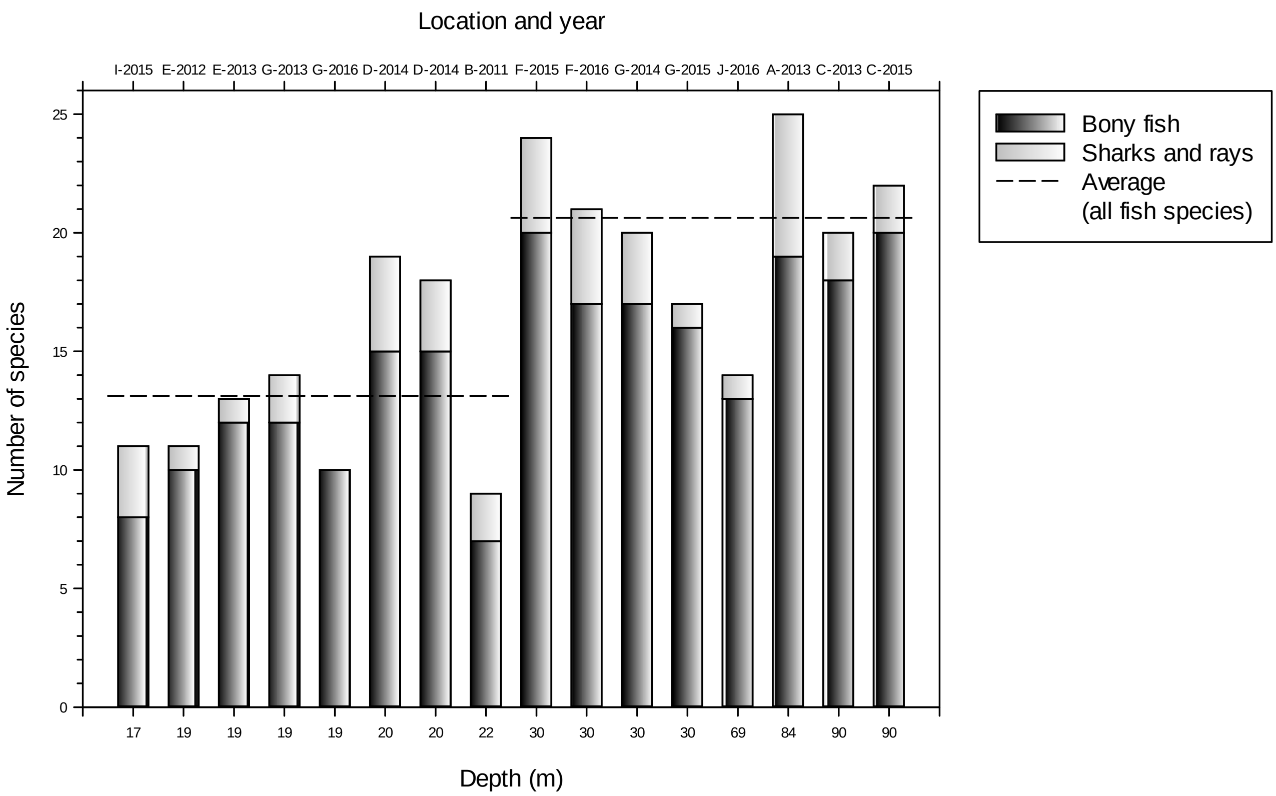


Fig. 2. Number of different fish species recorded at the various locations in the study area in respect to depth, 2011-2016.

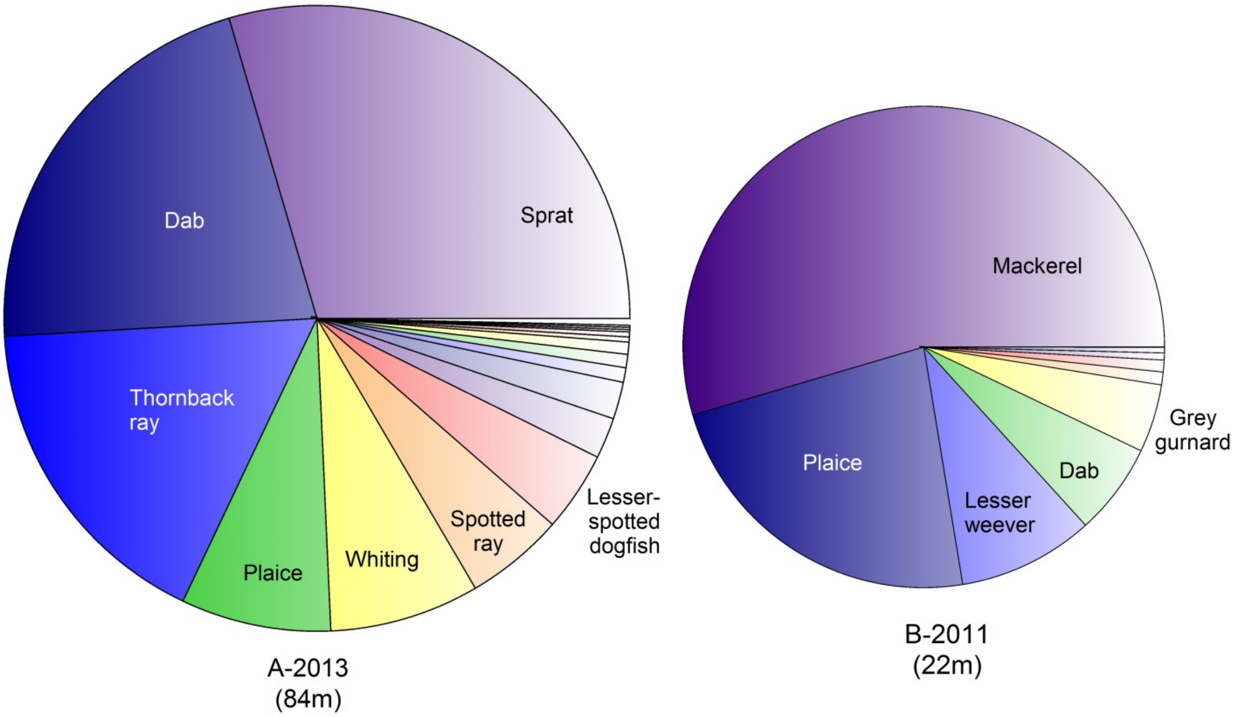


Fig. 3a. Species composition on two different trawl tracks with a distance of 10 nautical miles in rectangle 36F1 (size of the pies reflects total catch in weight).

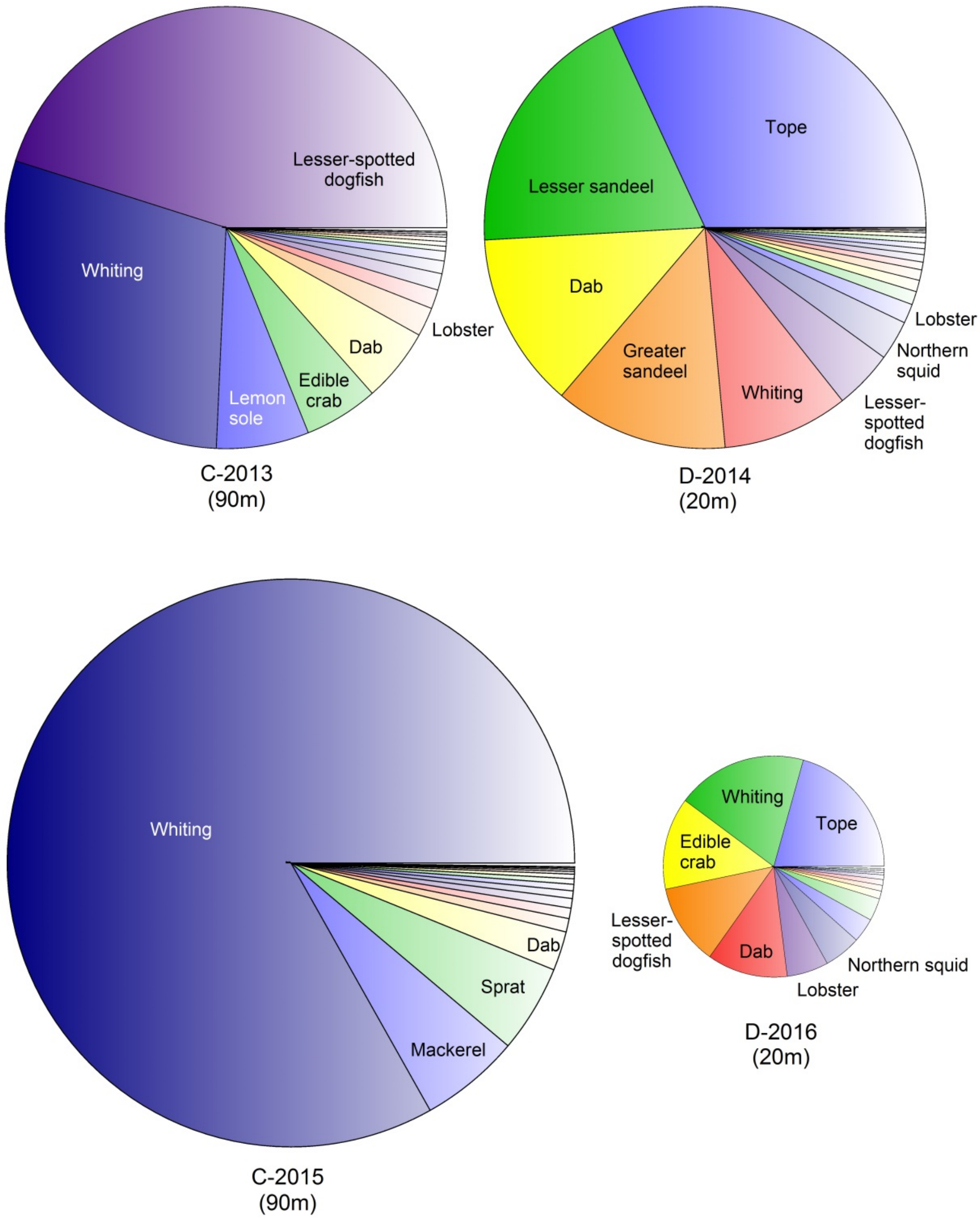


Fig. 3b. Species composition on two different trawl tracks with a distance of 8 nautical miles in rectangle 35F0 (size of the pies reflects total catch in weight).

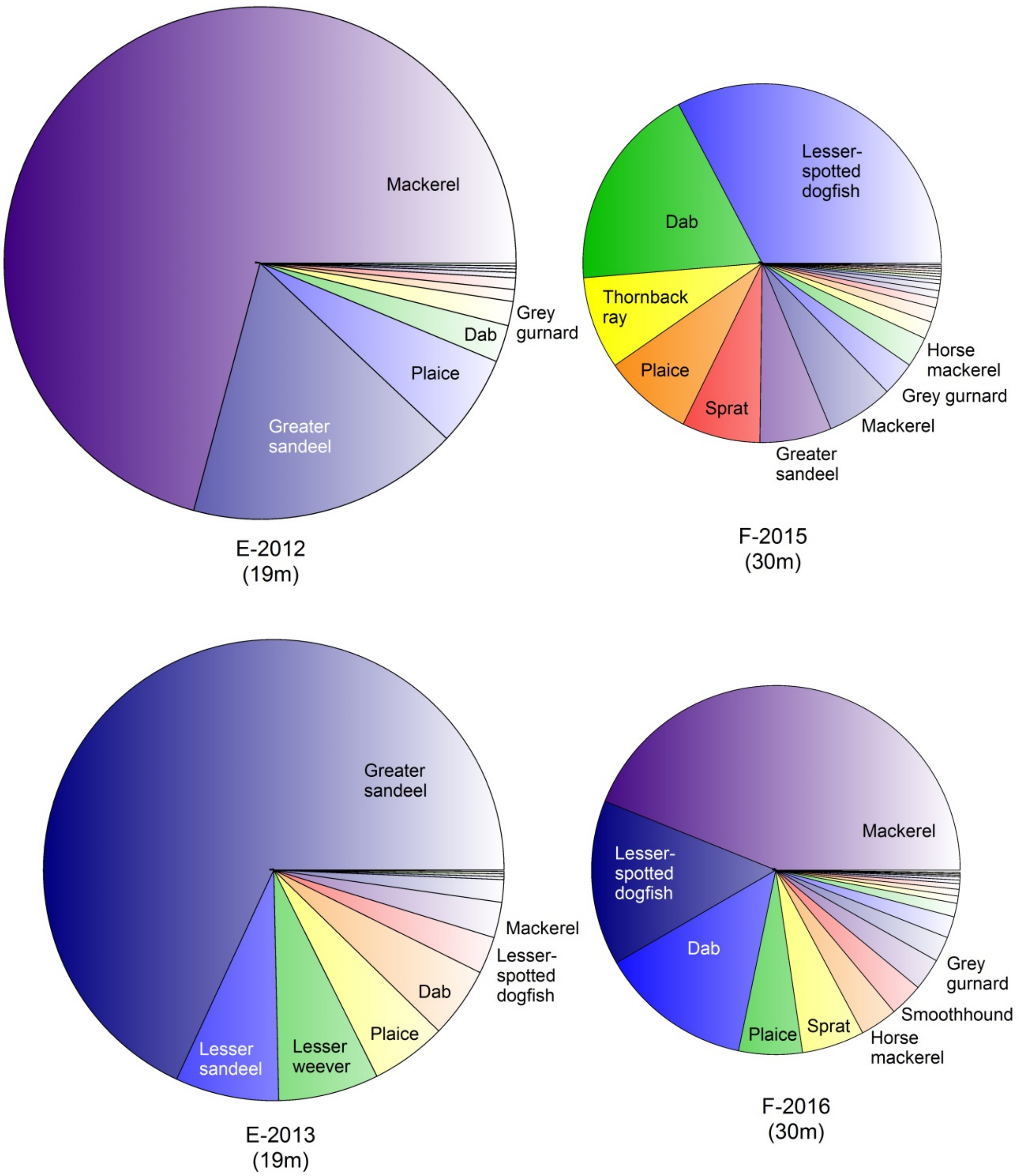


Fig. 3c. Species composition on two different trawl tracks with a distance of 5 nautical miles in rectangle 35F1 (size of the pies reflects total catch in weight).

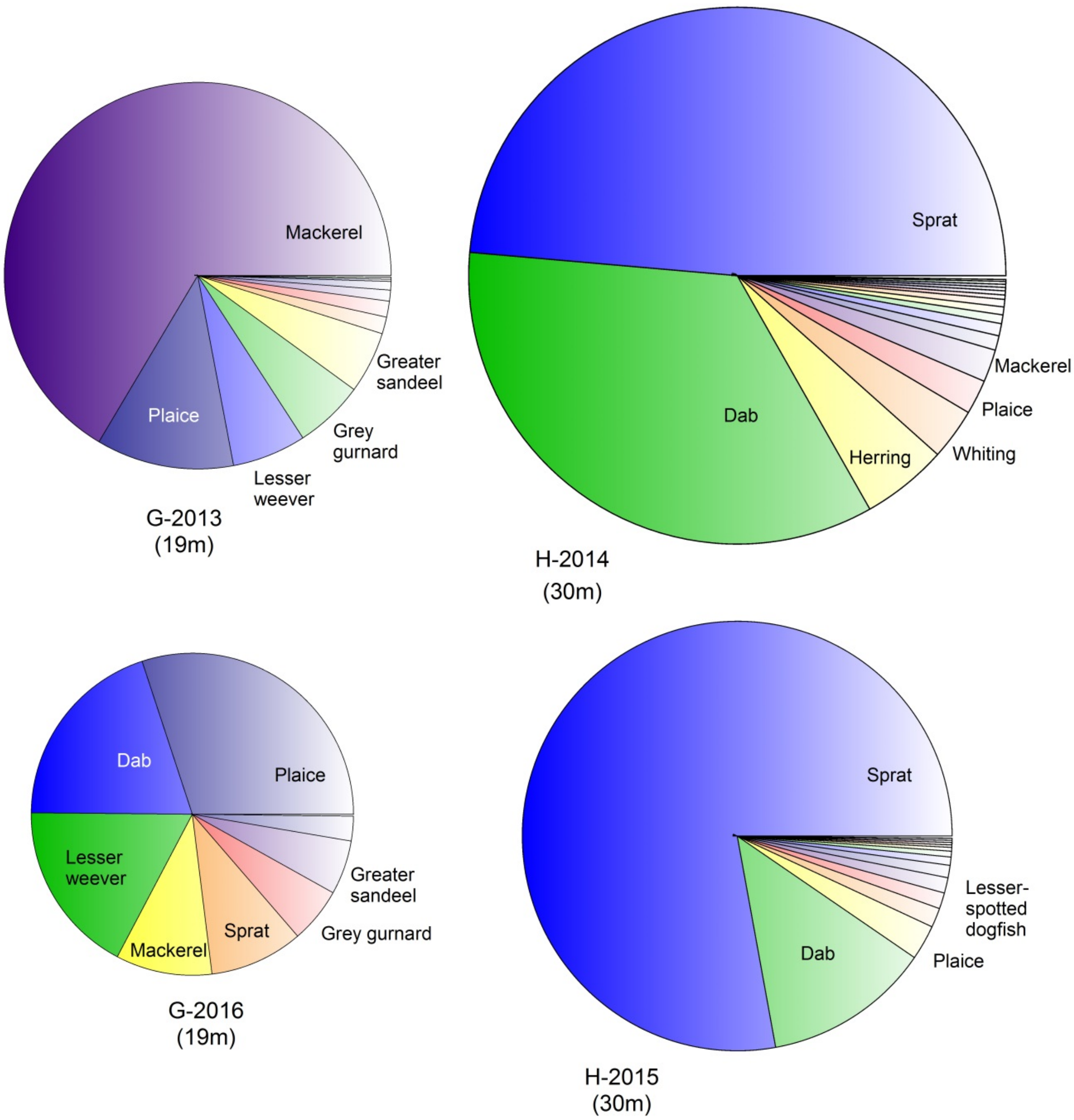


Fig. 3d. Species composition on two different trawl tracks with a distance of 14 nautical miles in rectangle 35F2 (size of the pies reflects total catch in weight).

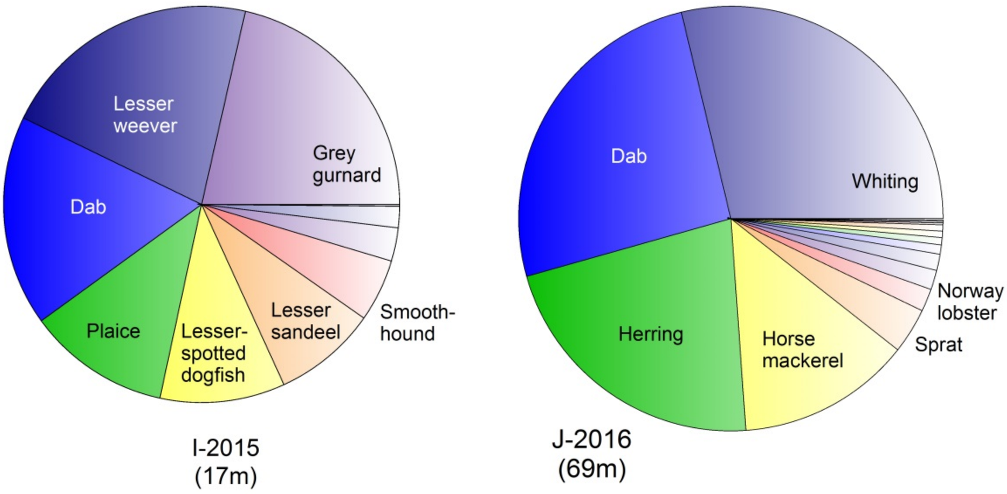


Fig. 3e. Species composition on two different trawl tracks with a distance of 20 nautical miles in rectangle 36F2 (size of the pies reflects total catch in weight).

Litter data in the Litter assessment output of Datras – Ralf van Hal

On 6 March 2017 the Litter assessment output of Datras was downloaded to assess the amount and composition of the litter caught on the Dutch continental plate. There happened to be some merging error, which resulted in a multiplication of the number of hauls and with that the amount of litter. In communication with the ICES-datacentre (Vaishav Soni) this error was corrected and a new dataset was provided: Trawl_Litter_OSPAR_V5_20170807.csv and later Trawl_Litter_OSPAR_V6_20170310.csv. Following information is based on the data in this datasets. (However, there is still a mistake in these datasets as the information on subcategory (PARAM) was missing for some countries. This is filled based on information from the raw data that can be downloaded from the Datras database as well).

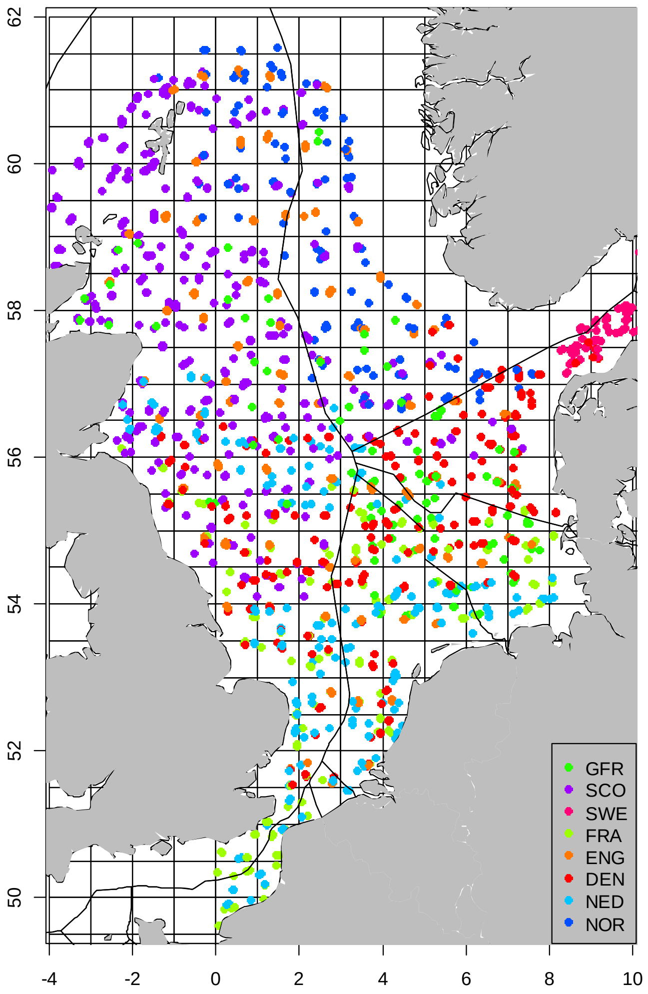
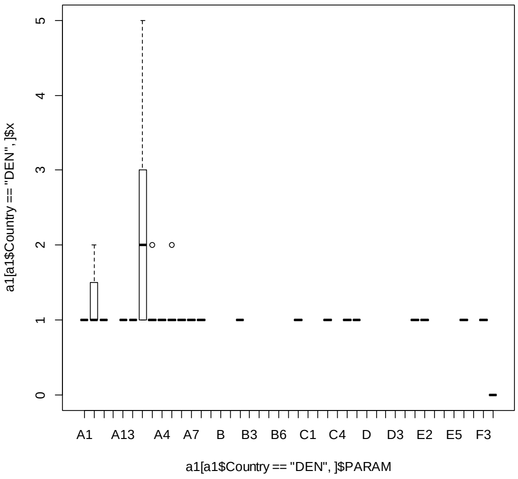


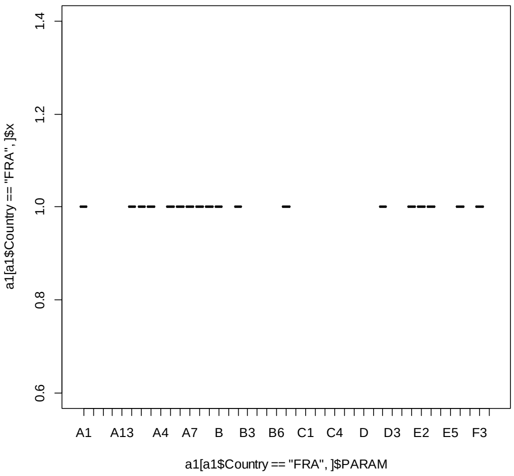
Fig 1: The complete data set

Zooming in on only the Dutch NCP shows that the Netherlands, Germany, Denmark, France and England fish there. The intention was to combine the data of these countries to estimate the number of items per km2 in the Dutch waters and to assess the composition of this litter. However, looking at each countries data separately raised the question of the same method of registering litter was actually used. Below the number of litter items per subcategory by haul are shown for Denmark, France and the Netherlands. Denmark (based on 57 hauls) report in 1 haul two items A10 in 1 haul two items A3, and in 1 haul two items A5, furthermore it report in a larger number of hauls multiple (up to 5) items A2. In contrast France how provided data on 61 hauls in the Dutch zone never reported more than 1 item per subcategory. The Netherlands (53 hauls) regularly reports multiple items (up to 18 items) for a number of subcategories. Below the figures there are three photos of all the items caught in the first haul of the Dutch IBTS Q1 2017, while this was a larger catch in number of items it is not that exceptional to see this.

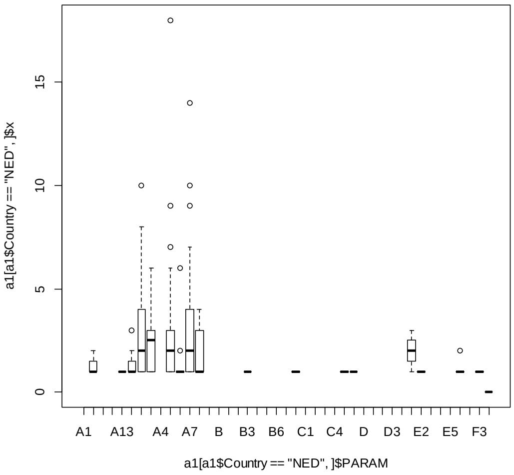
This contrast is large and makes us wonder if especially France is not reporting on weight by subcategory, and to fill the LT_items column in the database report they reported a 1, while actually the number of items is not counted.



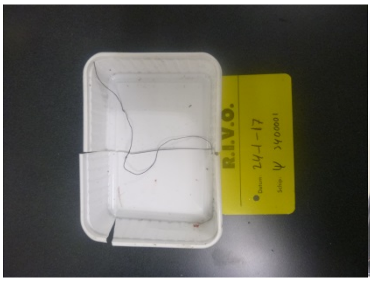
Denmark: Total of 57 hauls in the Dutch waters



France: Total of 61 hauls in the Dutch waters



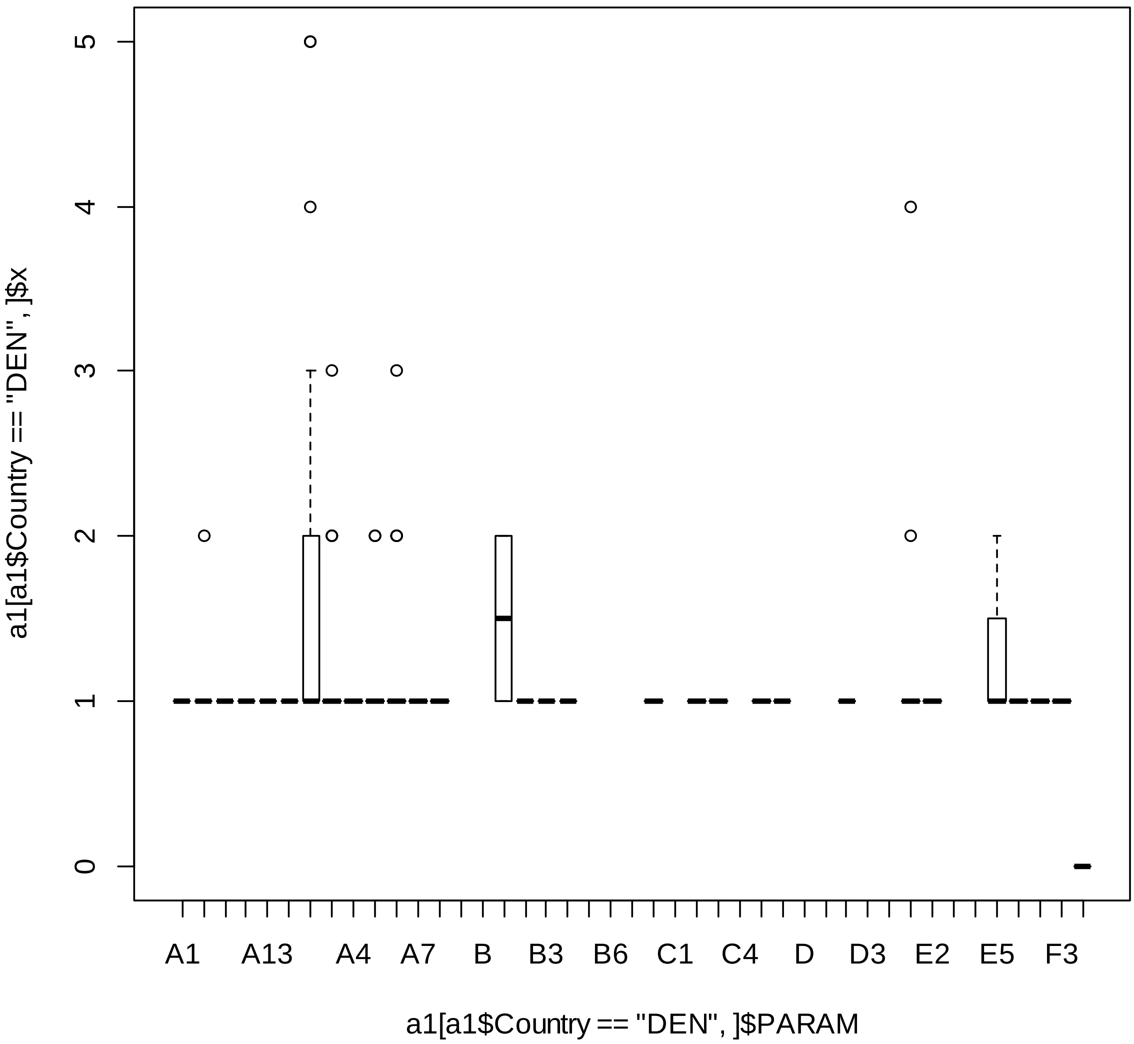
The Netherlands: Total of 53 hauls in the Dutch waters



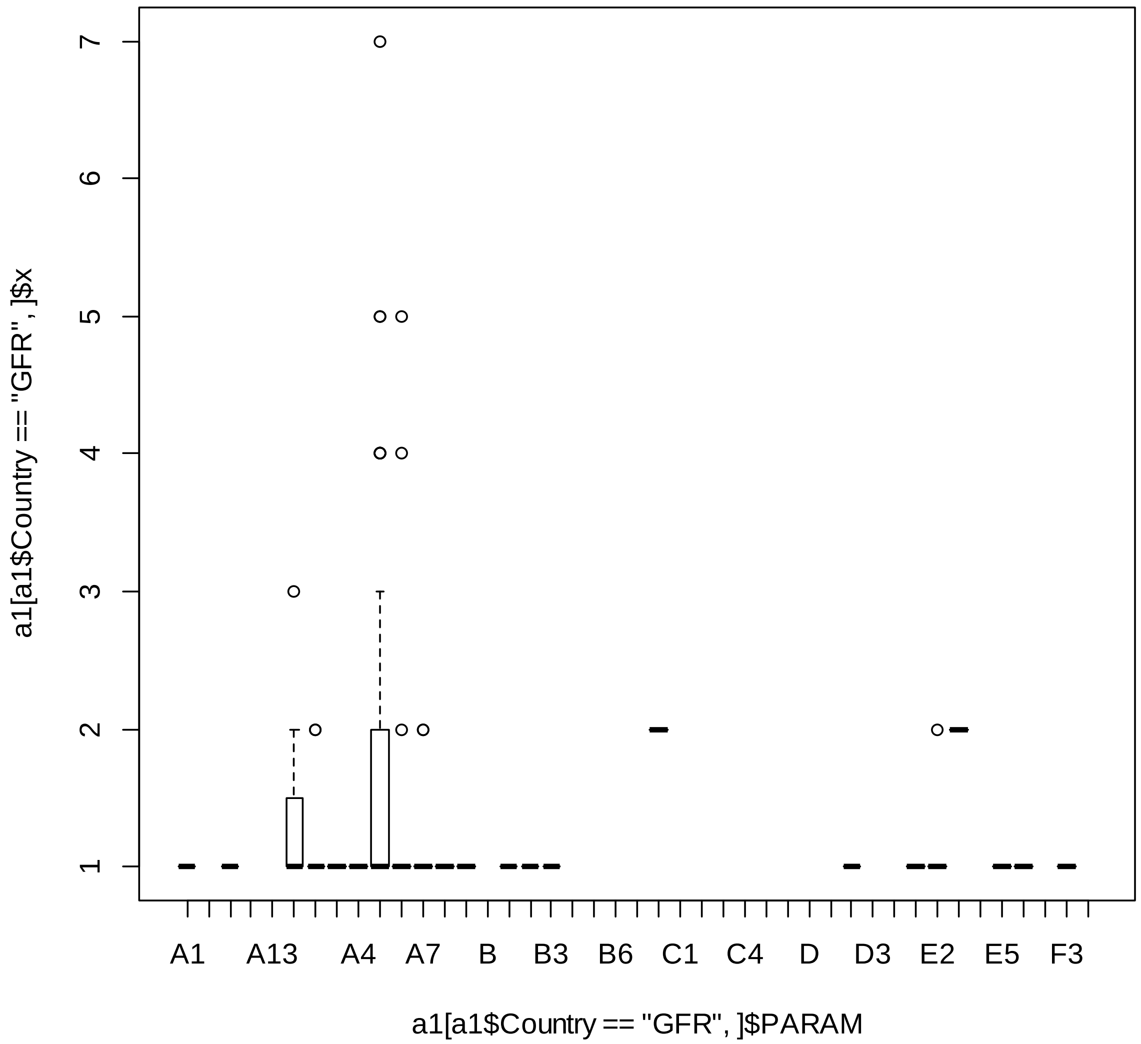

As we wondered if the countries are actually reporting the same, we made the boxplot based on the complete North Sea IBTS dataset for all countries. It is clear from these figures that France is an exception and only reported more than a single item per category in three or four occasions. The other exceptions are the Netherlands and Sweden that regularly report multiple items per subcategory up to in the Swedish case 30 items. All other countries only rarely report multiple items, this might be real especially in the more northern area where the amount of litter seems to be lower. However, some of the countries overlap for a part with the area fished by the Netherlands making this large difference questionable. For example England reported only in a small number of hauls more than a single A2. And had only in three out of the 290 hauls more than 3 items per category. Scotland had this only once, while a part of the Scottish area overlaps with the Dutch area.

When the reporting of number of items has not been consistent over the years and between countries, the analysis on number of items/km^2 and the power analyses based on these numbers as presented in CEMP/JAMP cannot be used.

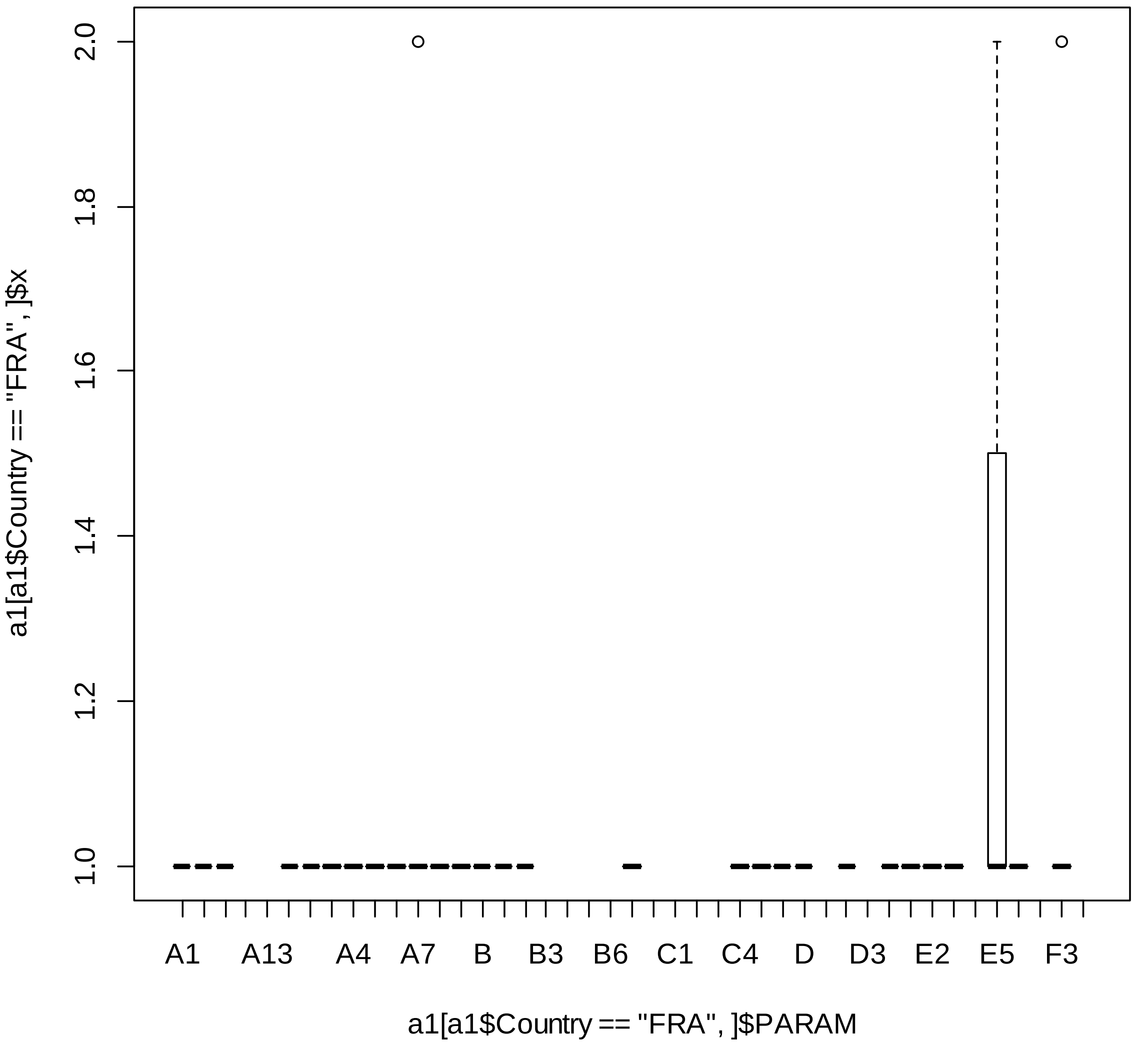
To show a possible effect of this, on the last page the data of EVHOE survey are presented in the same way. Here, even up to a 100 items per subcategory is caught. And on a regular basis multiple items per subcategory are reported. When these data are combined with the French IBTS data in a single spatial map the difference between the two areas will be very large, however might not be true as the French IBTS only reports the presence of a subcategory not the amount of items in that subcategory.


5
4
3
2
1
0
a1[a1$Country == "DEN",]$x
A1
A13
A4
A7
B
B3
B6
C1
C4
D
D3
E2
E5
F3
a1[a1$Country == "DEN",]$PARAM

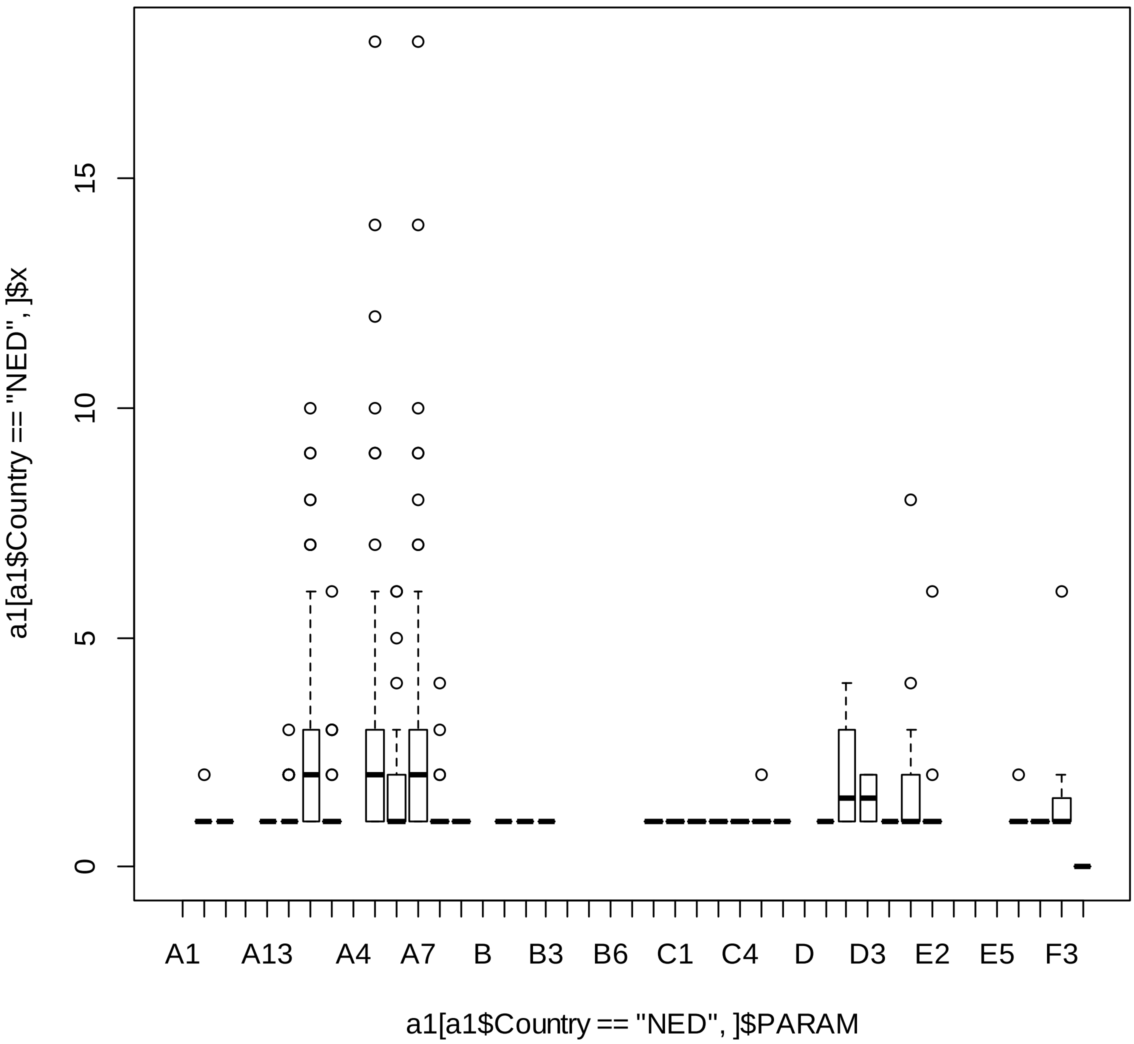
Denmark


a1[a1$Country == "GFR",]$x
1
2
3
4
5
6
7
A1
A13
A4
A7
B
B3
B6
C1
C4
D
D3
E2
E5
F3
a1[a1$Country == "GFR",]$PARAM

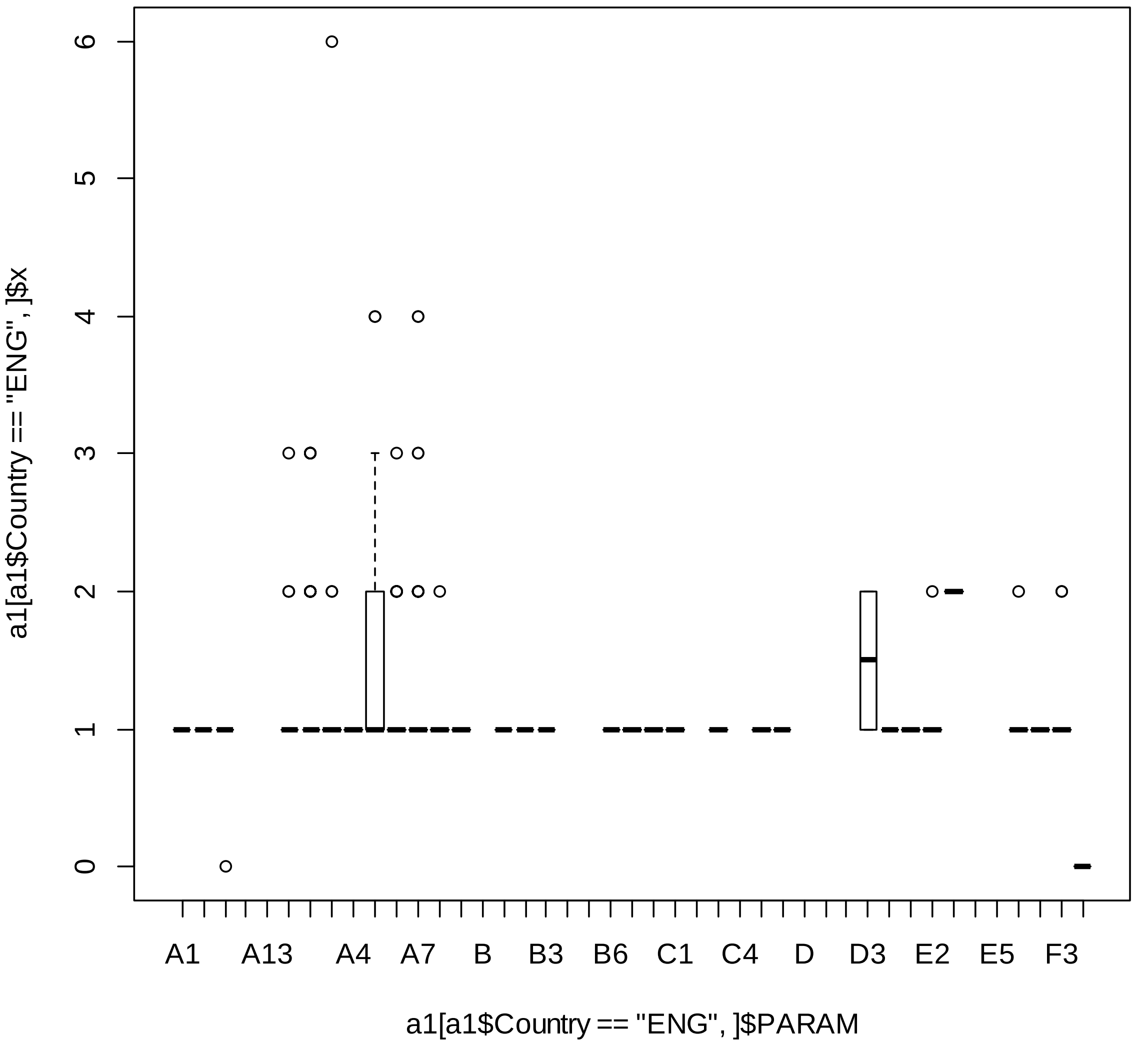
Germany


2.0
1.8
1.6
1.4
1.2
1.0
a1[a1$Country == "FRA",]$x
A1
A13
A4
A7
B
B3
B6
C1
C4
D
D3
E2
E5
F3
a1[a1$Country == "FRA",]$PARAM

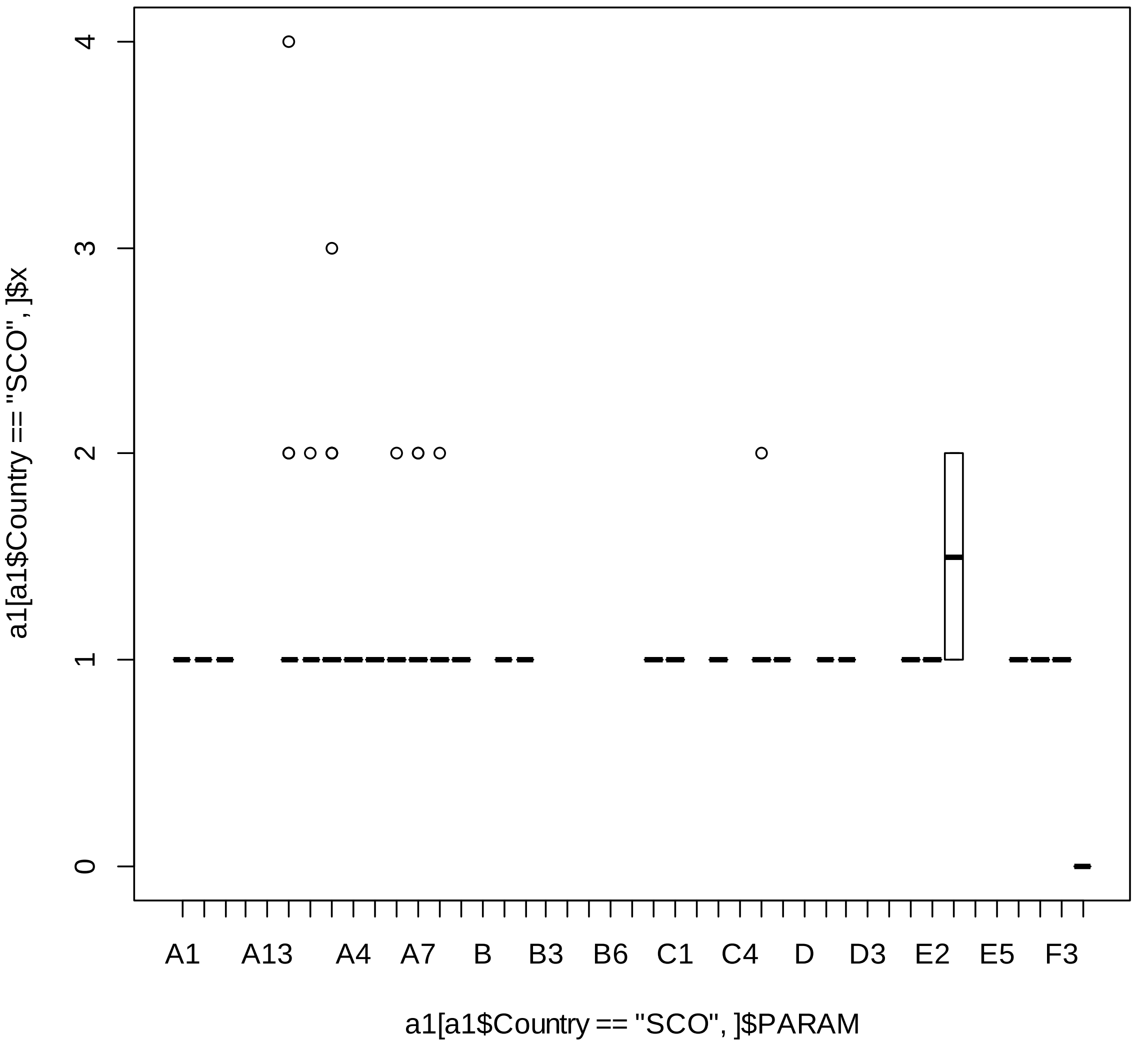
France



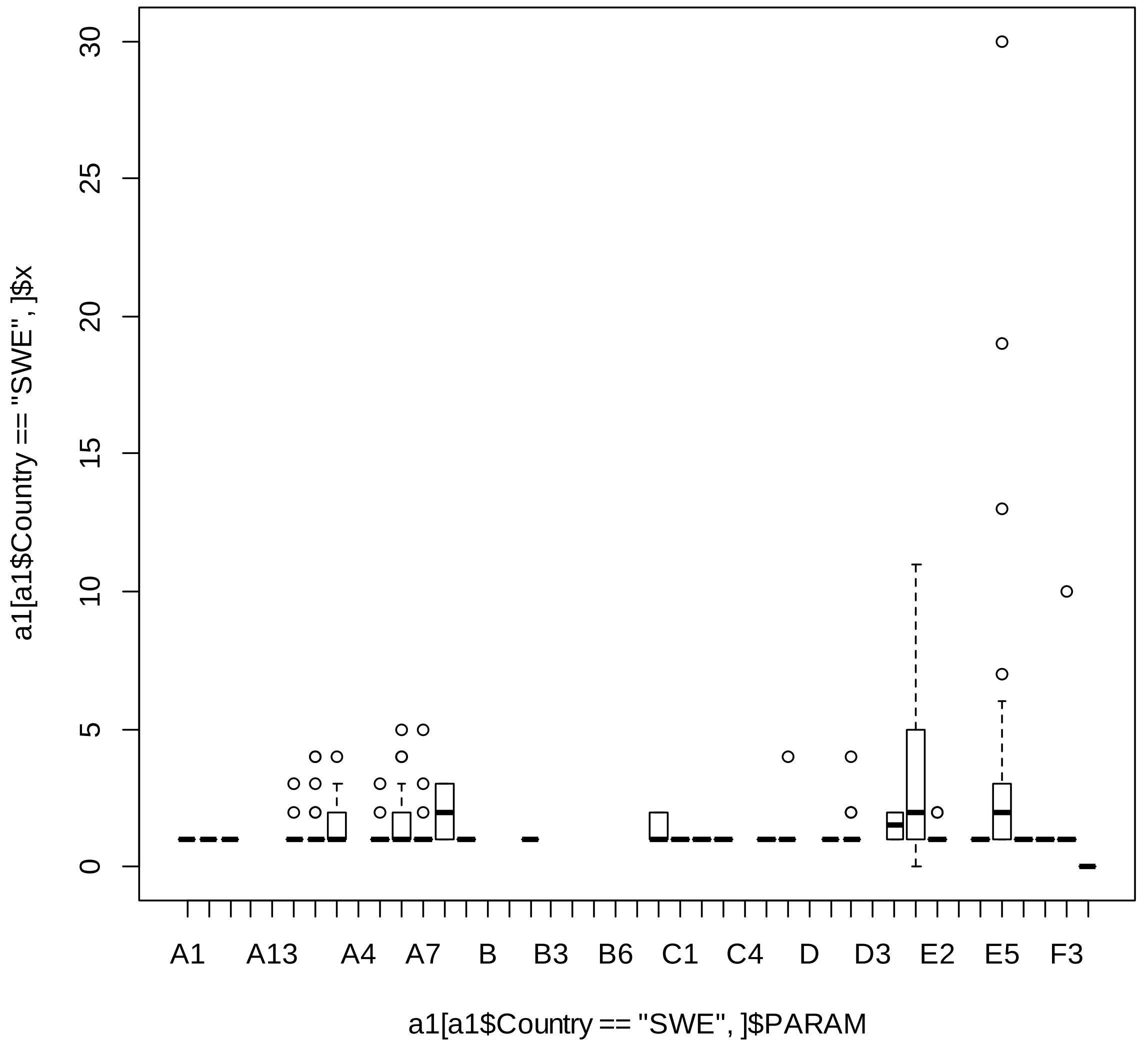
the Netherlands


0
1
2
3
4
5
6
a1[a1$Country == "ENG",]$x
A1
A13
A4
A7
B
B3
B6
C1
C4
D
D3
E2
E5
F3
a1[a1$Country == "ENG",]$PARAM

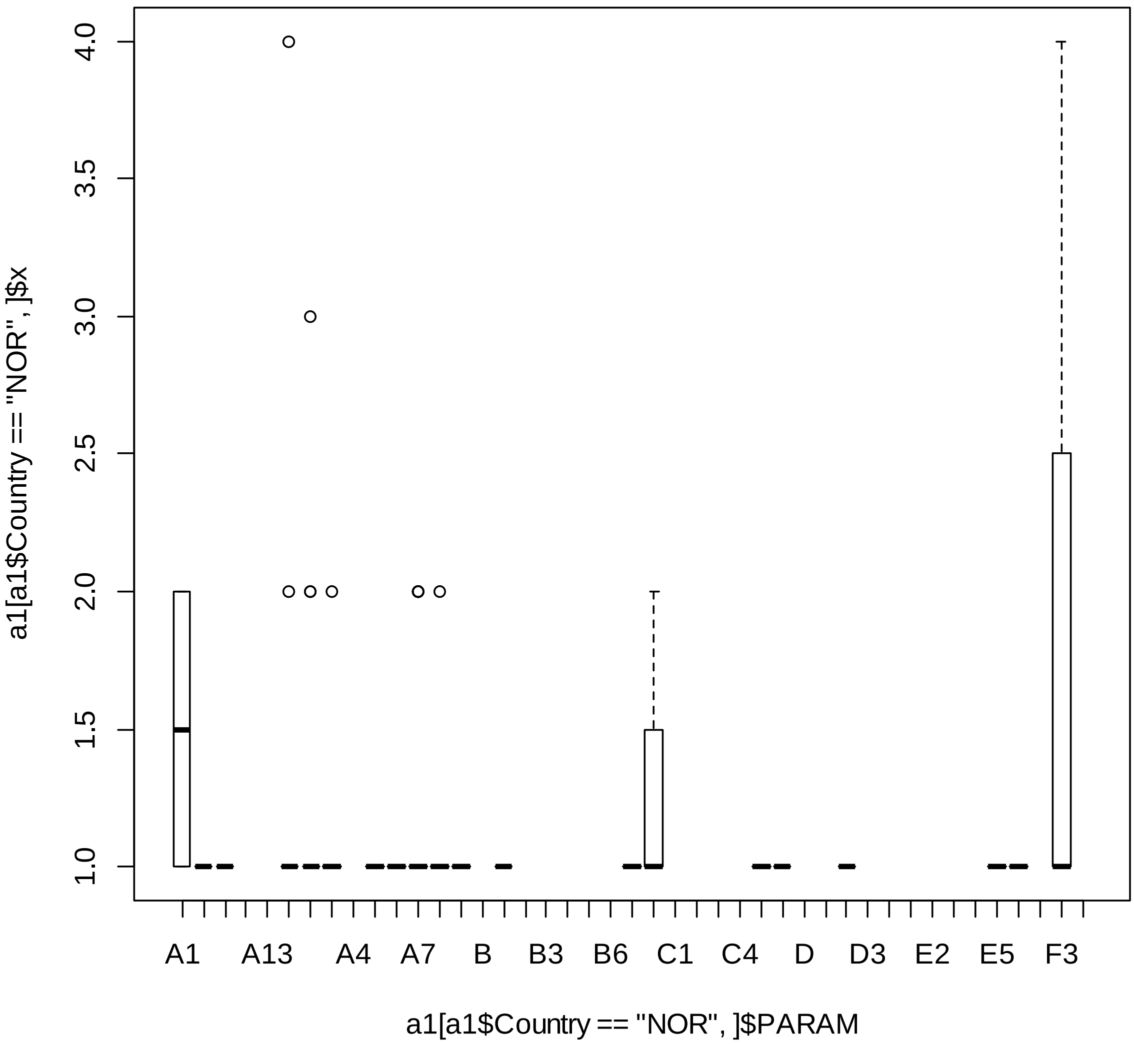
England


4
3
2
1
0
a1[a1$Country == "SCO",]$x
A1
A13
A4
A7
B
B3
B6
C1
C4
D
D3
E2
E5
F3
a1[a1$Country == "SCO",]$PARAM

Scotland


a1[a1$Country == "SWE",]$x
0
5
10
15
20
25
30
A1
A13
A4
A7
B
B3
B6
C1
C4
D
D3
E2
E5
F3
a1[a1$Country == "SWE",]$PARAM

Sweden


a1[a1$Country == "NOR",]$x
4.0
3.5
3.0
2.5
2.0
1.5
1.0
A1
A13
A4
A7
B
B3
B6
C1
C4
D
D3
E2
E5
F3
a1[a1$Country == "NOR",]$PARAM

Norway

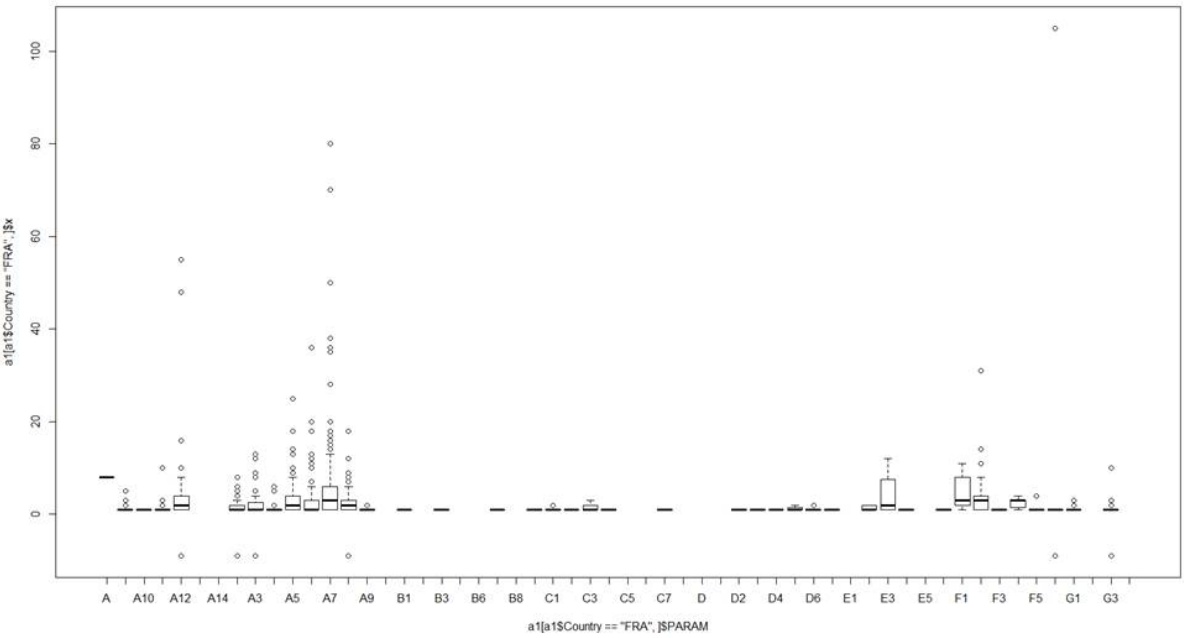


Fig: data on the EVHOE survey.