International Bottom Trawl Survey Working Group (IBTSWG)

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INTERNATIONAL BOTTOM TRAWL SURVEY WORKING GROUP (IBTSWG)

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Contents

i Executive summary

The International Bottom Trawl Survey Working Group (IBTSWG) coordinates fishery-independent bottom trawl surveys in the ICES area in the Northeast Atlantic and the North Sea. These long-term monitoring surveys provide data for stock assessments and facilitate examination of changes in fish distribution and relative abundance. The group also promotes the standardization of fishing gears and methods as well as survey coordination. This report summarizes the national contributions in 2021–2022 and plans for the 2022–2023 surveys coordinated by IBTSWG.

In the North Sea, the surveys are performed in quarters (Q) Q1 and Q3, while in the Northeast Atlantic the surveys are conducted in Q1, Q3, and Q4 with a suite of 14 national surveys covering a large area of continental shelf that extends from the north of Scotland to the Gulf of Cádiz.

North Sea surveys in 2022-Q1 were affected severely by mechanical and COVID-related issues, as well as the number of storms experienced during the survey period. Some of the ICES rectangles in the survey area could not be sampled and a larger number of the rectangles were only sampled with a single tow.

North Sea surveys in 2021-Q3 were broadly complete, with the wider area surveyed and comparable number of hauls. However, some rectangles close to shore or with obstructions may not have had full coverage.

Most of the surveys in the Northeast Atlantic were completed successfully. However, the two Spanish groundfish surveys in the Gulf of Cádiz could not be undertaken in 2021. Vessel-related problems also affected the Spanish survey of the Cantabrian Sea, although this survey was completed using two vessels over a more protracted survey window. The IBTSWG welcomed the return of the Portuguese groundfish survey (Q4) after a two-year absence, with the survey being undertaken by the new research vessel, the “Mario Ruivo”.

IBTSWG discussed the roadmap for the new survey trawl, following on from the Workshop on the Further Development of the New IBTS Gear (WKFDN). IBTSWG agreed the main aspects of the new trawl, and will meet intersessionally to discuss and agree the final net plans. Trials are planned to start in late 2022 with the subsequent introduction of the trawl in the North Sea over the next few years.

IBTSWG met with members of various assessment groups, including the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK) and the Working Group for the Bay of Biscay and the Iberian Waters Ecoregion (WGBIE) to discuss how closer cooperation could enhance the use of data outcomes. IBTSWG members subsequently gave presentations to some of the assessment working groups using the data collected under the auspices of IBTSWG and intends to incorporate feedback into the its work.

The trawl surveys coordinated by IBTSWG also provide an important platform for the collection of additional data, including the sampling of sprat larvae, fish stomachs and fish parasites.

ii Expert group information

Expert group name	International Bottom Trawl Survey (IBTSWG)
Expert group cycle	Multiannual fixed term
Year cycle started	2022
Reporting year in cycle	1/3
Chair(s)	Pia Schuchert, Northern Ireland (UK)
	Jim Ellis, UK
Meeting venue(s) and dates	4–8 April 2022, Online meeting (47 participants)
	To be confirmed
	To be confirmed

1 Introduction

1.1 Background

ICES International Bottom Trawl Survey Working Group (IBTSWG) has its origins in the North Sea (Subarea 4), and the Skagerrak and Kattegat (Division 3.a), where coordinated surveys have occurred since 1965. Although there have been surveys in various quarters, the coordinated surveys in the North Sea are currently conducted in Q1 (NS-IBTS-Q1) and Q3 (NS-IBTS-Q3), and these provide the best time-series data. The Q1 survey also extends into the eastern parts of the eastern Channel (Division 7.d; roundfish area 10). For more details of the history of the survey, see Heessen *et al.* (1997) and ICES (2020).

The IBTSWG assumed responsibility for coordinating trawl surveys in North-eastern Atlantic European seas (ICES Subareas 6–9) in 1994. The different ground types sampled in these areas has resulted in survey-specific trawl gears.

In addition to survey coordination and the annual meetings of IBTSWG, the group also edits the relevant survey manuals, which provide further information on the surveys, sampling protocols and history of the surveys. These manuals cover the North Sea IBTS (ICES, 2020) and the North-eastern Atlantic (ICES, 2017).

1.2 Terms of Reference (ToRs)

The ToRs for IBTSWG for the period 2022–2025 were:

a) Coordination and reporting of North Sea and North-eastern Atlantic bottom trawl surveys, including appropriate field sampling in accordance to the EU Data Collection Framework. Review and update (where necessary) IBTS survey manuals in order to achieve additional updates and improvements in survey design and standardization. (ACOM).

b) Address DATRAS-related topics in cooperation with DGG: data quality checks and the progress in re-uploading corrected datasets, quality checks of indices calculated, and prioritizing further developments in DATRAS. (ACOM).

c) Develop a new survey trawl gear package to replace the existing standard survey trawl GOV. (SCICOM)

d) Evaluate the current survey design and explore modifications or alternative survey designs, identifying any potential benefits and drawbacks with respect to spatial distribution and frequency of sampling. Consider the effects of enforced changes in the distribution of survey stations (e.g. in relation to MPAs and offshore industries). Explore potential additional data collection, e.g. stomach sampling and tagging (SCICOM) and engage with the Workshop on Pilot North Sea Fisheries Independent Regional Observation (WKPilot NS-FIRMOG).

e) Making data from IBTS available to be used by different ICES end-users, such as assessment groups, OSPAR and others. Establish a communication with end-user groups as to the needs of the users and the data available within DATRAS. Collate a user document that outlines the important caveats in the data with regards to non-target species (e.g. when a non-target species was first recorded as a species, the confidence in sampling). Establish a continued working relationship between user groups and survey group.

The participants list in provided in Annex 1, with full details of the resolutions provided in Annex 2. ICES have recently developed alpha-numeric codes for the various surveys used in ICES assessments and advice, and the relevant codes for those surveys conducted under the auspices of IBTSWG are provided in Annex 3.

1.3 Format of the report

The survey summaries and planning coordination (ToR a) are provided in Section 2, with more details on the surveys also provided for the North Sea IBTS Q1 (Annex 4), North Sea IBTS Q3 (Annex 5) and North-eastern Atlantic surveys (Annex 6).

DATRAS-related topics, including data quality (ToR b), are addressed in Section 3. Following on from the previous Workshop on the Further Development of the New IBTS Gear (WKFDNG), which was held in November 2021 (see ICES, 2022), further considerations on the new survey trawl are provided in Section 4 (Tor c).

Relevant aspects of survey design, including additional data collection (ToR d), are addressed in Section 5, with the communication with user groups (ToR e) summarized in Section 6.

1.4 References

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ICES. 2020. Manual for the North Sea International Bottom Trawl Surveys. Series of ICES Survey Protocols SISP 10-IBTS 10, Revision 11. 102 pp. http://doi.org/10.17895/ices.pub.7562

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ICES. 2022. Workshop on the Further Development of the New IBTS Gear (WKFDNG). ICES Scientific Reports. 4:18. 46 pp. http://doi.org/10.17895/ices.pub.10094

2 Coordination of North Sea and North-eastern Atlantic surveys

2.1 Introduction

This section of the report provides short summaries on the most recent surveys coordinated by IBTSWG, with more detailed information provided in the Annexes 4–6. The observed distributions and catch rates of selected species are shown in Annex 7. This report section addresses ToR (a).

2.2 Summary report of the North Sea IBTS Q1

(Coordinator: Ralf van Hal)

2.2.1 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 Subarea 4 and Divisions 3.a and 7.d. During daytime, the GOV (Grand Ouverture Verticale) bottom trawl with standard ground gear A for normal bottom conditions or ground gear B for rough ground (Scotland in Division 4.a only) was used to sample fish, with age data collected for the target species (cod, haddock, whiting, saithe, Norway pout, herring, mackerel, and sprat) and a number of additional species. A CTD was deployed at most trawl stations to collect temperature and salinity profiles. Herring larvae were sampled with a MIK-net (Methot Isaac Kitt) during the night.

In 2022, there were seven participating vessels in the Q1 survey, namely “Dana” (26D4, Denmark), “GO Sars” (58G2, Norway), “Scotia” (748S, Scotland), “Thalassa” (35HT, France), “Walther Herwig III” (06NI, Germany) , “Tridens II” (64T2, Netherlands) and “Svea” (77SE, Sweden). The survey covered the period 18 January to 24 February 2022.

A total of 248 GOV hauls (11 of which were invalid) were uploaded to DATRAS and 433 valid MIK hauls were deployed and uploaded to the eggs and larvae database. Due to mechanical and COVID-related issues, and the number of storms during the survey period, some of the ICES rectangles could not be sampled and a larger number of the rectangles were only sampled with a single tow. This affected the northern and, to a lesser extent, the central North Sea (see Figure A4.1). Given the lower survey coverage, IBTSWG decided not to calculate the preliminary indices. More details of the 2022 surveys are given in Annex 4.

2.2.2 Highlights and issues

- Scotland had mechanical issues on “Scotia”, forcing them to cancel their survey after 14 of the 57 planned GOV-stations. Germany had COVID-related issues and were then affected by the storms which resulted in only 10 of the 67 planned GOV-stations being completed. Denmark was affected by the severe weather and did 26 of their 42 planned GOV-stations. Sweden, France and the Netherlands missed fewer of their planned GOV-stations. Norway was able to do an additional three stations. In total, only 237 valid hauls out of 371 planned stations were completed, and 26 rectangles were not sampled (see Figure A4.1).

- Due to the incomplete survey coverage, it was decided not to calculate the preliminary indices, as a result there are no highlights on the comparison of this years' catches of the target species with those in previous years.
- The countries (FR) covering the southern part of the area reported unusual numbers of blue whiting *Micromesistius poutassou* in their catches.
- In contrast to the last couple of years (Oesterwind *et al.*, 2020), very few young *Illex coindetii* were caught in 2022.
- The Dutch had to declare a single haul invalid in rectangle 35F4 owing to the large amounts of bryozoans, similar to the Danish and English experiences in the 2021-Q3 survey (see below). The French encountered large amounts of bryozoans in the same area but were able to handle these catches.
- For a second year in a row the German vertical net opening was unexpectedly high, especially in shallow waters. The reasons for this are unclear. It may be the short warp length used in the shallow waters, but it is likely an issue related to the new Marport sensors used in the last two surveys. Germany will investigate this in their next surveys.
- For the second year in a row, a number of participants collected information on the gill parasites of haddock. For the first year, a number of participants collected information on liver weight and liver parasites of cod.
- Dietary data (stomachs) of whiting, monkfish and megrim were collected as part of the new EU-map obligations, both by participating vessels from the EU and other countries. These were the species of the first year of the five-year-rotating scheme.
- Only about 60% of the MIK-stations were sampled, with similar issues in spatial coverage as the GOV-stations. However, the main areas for herring larvae were covered and the MIK-coordinators believe the indices are representative.

2.2.3 Planning and coordination

For 2023, all participants indicated to be part of the survey again and they all plan to use their own national vessels. The start dates of the national surveys are therefore likely to be very similar as in 2022-Q1, with the survey area and allocation of rectangles shown in Figure 2.1. The allocation of rectangles in the Skagerrak to Norway stays the same as in 2022, to create some overlap between the countries/vessels.

- Denmark requested Sweden to take over rectangle 44F9 officially, in recent years Sweden already did a second haul in this rectangle.
- Netherlands requested France to take over rectangle 32F2. Due to the construction of the Belgium and Dutch wind farms in and near that rectangle, the steaming time for the Netherlands has increased, which had resulted in a whole survey day being required to cover this single rectangle.
- Following the five-year-rotating scheme, dietary data for horse mackerel, plaice and skates and rays will be collected (see Section 5.4).
- Scotland has informed to group that half of the hauls west of Shetlands will be covered with the new Bottom Trawl (based on BT237; see Section 4).

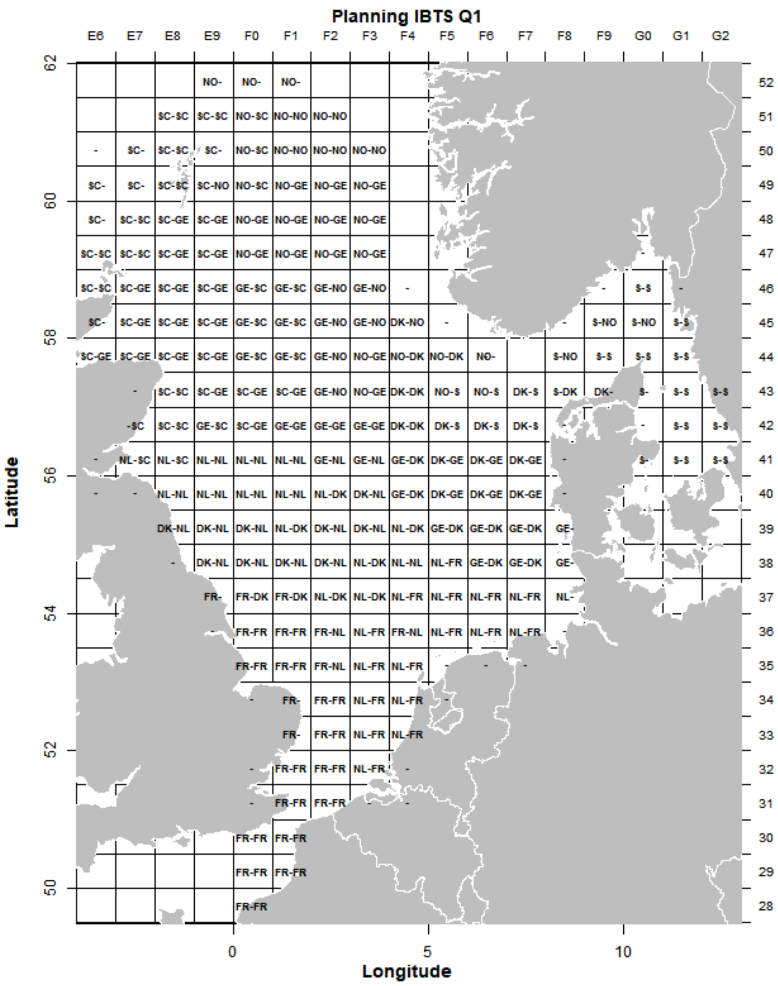

Figure 2.1. Allocation map for NS-IBTS-Q1 in 2023

2.3 Summary report of the North Sea Q3 IBTS

(Coordinator: Kai Wieland)

2.3.1 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 Subarea 4 and Division 3.a. The GOV (Grand Ouverture Verticale) bottom trawl with standard ground gear A for normal bottom conditions or ground gear B for rough ground (Scotland in Division 4.a only) is used during daytime. Age and biological data for individual fish were collected for the standard species (herring, sprat, cod, haddock, whiting, saithe, Norway pout, mackerel and plaice) and for a number of additional species. A CTD was deployed at most trawl stations to collect temperature and salinity profiles.

Six nations participated in the Q3 survey in 2021, using five different research vessels. The overall survey period extended from 22 July to 9 September. In this period, 349 valid GOV hauls were conducted. Three rectangles allocated to the survey area were not covered, whereas the remaining ones were fished by at least one GOV haul. However, the total number of tows was still among the highest in the past five years. The average tow duration decreased slightly compared to the most recent years (Figure 2.2). More details of the 2021 surveys are given in Annex 5.

2.3.2 Highlights and issues

- Except for the three rectangles not fished at all, only a few rectangles did not get full coverage with two hauls, and the number of rectangles covered by only one haul was lower than in the past ten years. Of the rectangles with only one haul, most were rectangles that are largely covered by land, areas with obstructions, or are not fishable with the GOV.
- 34 tows reported as valid to DATRAS were shorter than 25 minutes. Except for four of these tows, which were shorter than 15 min, limited space due to safety distance rules from an increasing number of obstructions (e.g. cables and pipelines and rough bottom conditions) were the main reason for this.
- A mass occurrence of the bryozoan *Electra pilosa* was observed in the south-eastern part of the area during the combined Danish/German survey with RV Dana which resulted in the four tows being shorter than 15 min and prevented successful fishing in one of the rectangles there (Figure 2.3). England made a similar observation in rectangle 34F4 during their survey about a month earlier.
- Compared to the other countries, Sweden and in particular Norway, reported relative low values for vertical net opening, below the lower theoretical limits. Considering the differences between countries and changes over time it appears advisable that a vessel/country effect is included in modelling abundance indices, especially for pelagic species (e.g. mackerel).
- The upload of Norwegian age data of all target species to DATRAS was delayed (upload date: 08/04/2022)
- Small (< 7 cm) anchovy *Engraulis encrasicolus*, sardine *Sardina pilchardus* and striped red mullet *Mullus surmuletus* were found in the German Bight and the southern area covered by the combined Danish/German survey. The occurrence of 0-groups of these three species may indicate recent spawning in the area, though it should be noted that the timing of the survey was about two weeks later than normal.

2.3.3 Planning and coordination

All regularly contributing countries intend to participate in the NS-IBTS-Q3 program in 2022. The expected survey dates for each country and vessel this coming year are:

Country	Vessel	Survey dates
Denmark	Dana	16 August to 2 September
England	Cefas Endeavour	1 August to 30 August
Germany	Walther Herwig III	18 July to 16 August
Norway	Kristine Bonnevie	21 July to 15 August
Scotland	Scotia	8 August to 20 August
Sweden	Svea	21 August to 2 September

The actual rectangle allocation to the countries is shown in Figure 2.4. Country specific maps (and allocation to rectangle base files) as well as information on additional sampling requests will be distributed to the participants in the international survey program by the coordinator in early June at the latest.

Deadlines for data submission to DATRAS are set to 15 October 2022 for gadoids (including age data) and 1 March 2023 for the remaining species (final complete submission).

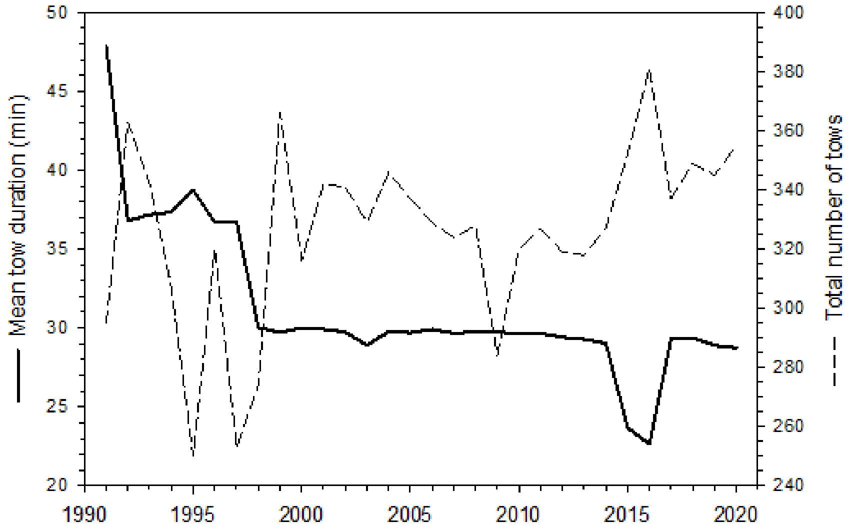

Figure 2.2. Mean tow duration and total number of valid tows in the 3rd quarter NS-IBTS (1991–1997: standard tow duration of 30 min adopted by all countries first in 1998; 2009: no participation of Norway, 2015–2016: 50 % of the tows in area 4 planned as 15 min tows).

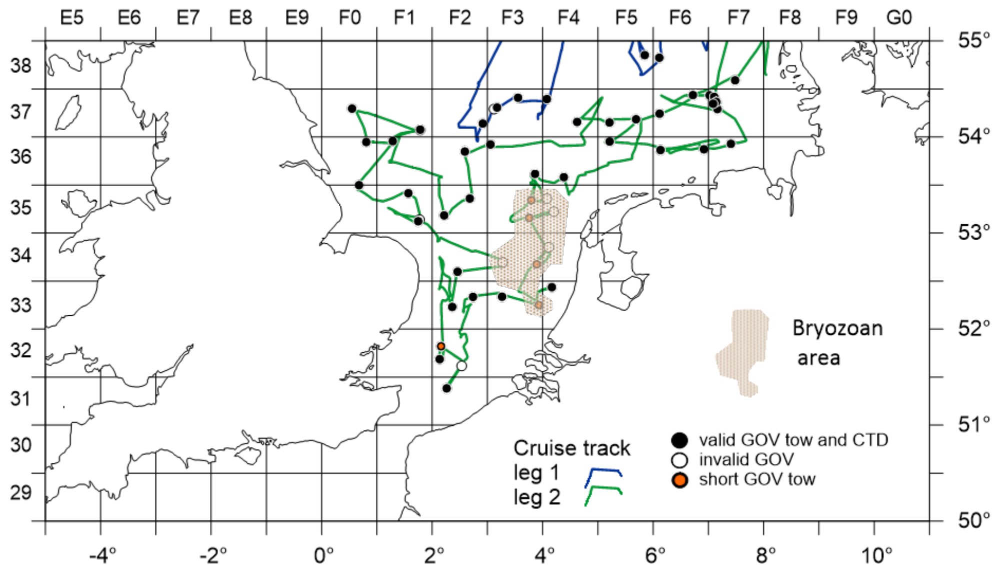

Figure 2.3. Area a mass occurrence of bryozoans as observed during the combined Danish/German 3Q IBTS 2021.

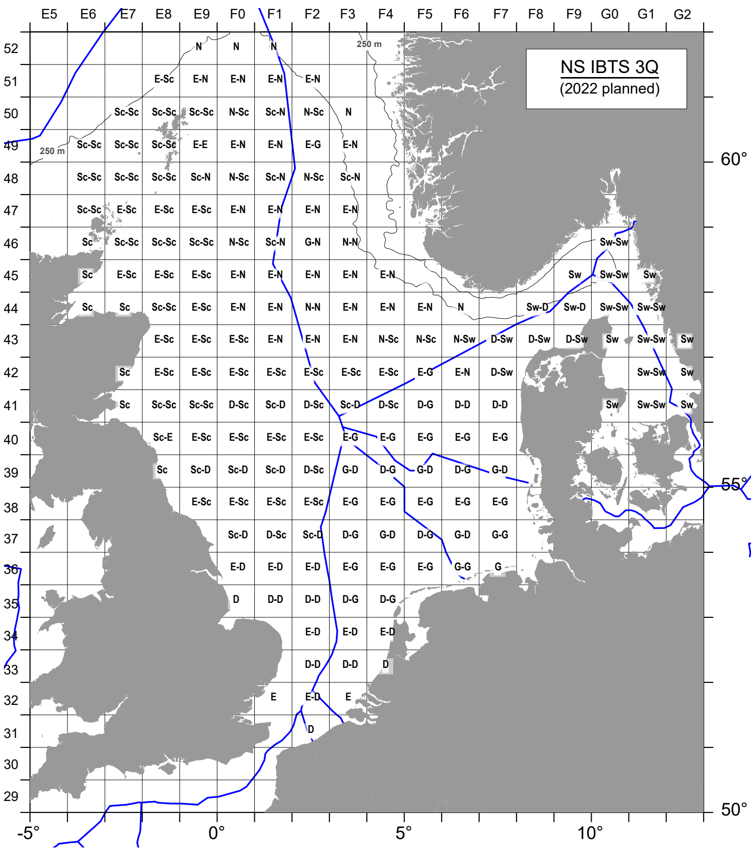

Figure 2.4. Rectangle allocation by country for the North Sea IBTS in 3Q 2022 (D: Denmark, E: England, G: Germany, N: Norway, Sc: Scotland, Sw: Sweden; EEZ limits indicated by blue lines).

2.4 Summary report of the North-eastern Atlantic IBTS

(Coordinator: Finlay Burns)

2.4.1 General overview

In 2021, seven vessels from seven nations performed 12 surveys along the North-eastern Atlantic (NEA) IBTS area. A total of 1045 valid hauls, out of the 1185 hauls planned, were accomplished over 328 survey days distributed between all quarters of 2021 (see Annex 6).

With the exception of the two Spanish groundfish surveys in the Gulf of Cádiz (SP-GCGFS-1Q/4Q), the surveys were undertaken successfully, and the majority were completed without significant issue. Despite the COVID pandemic continuing throughout 2021, its affect on the 2021 NEA survey schedule can overall be described as slight, although in several instances vessel operations as well as additional objectives were compromised due to requirements for social distancing while onboard. This resulted in a reduction in scientific staff and/or vessel crew in several surveys. Despite this, in most cases these did not appear to have had any significant affect on the survey's progress nor their ability to fulfil core objectives.

The IBTSWG welcomed the return of the Q4 Portuguese Groundfish survey after a two-year absence and now with a new research vessel, the "Mario Ruivo".

Three Q1 surveys (Scotland, Northern Ireland and Ireland) were undertaken in February and March, with the Irish anglerfish survey once again extending into April. Scotland and Spain were also active during Q3, with surveys of Rockall, Porcupine Bank, and the Northern Spanish Coast shelf (in part), with Portugal, France, Northern Ireland, Ireland, Scotland and Spain all active during Q4.

Survey programme highlights as well as the realized and provisional survey dates are contained below, with a more comprehensive account of survey activities and the individual survey reports provided in Annex 6.

2.4.2 Highlights and issues

- A welcome return of the Portuguese survey (PT-GFS-Q4) in 2021 and with a new research vessel ("Mario Ruivo"). No significant issues were reported during the survey with >97% of survey stations completed successfully. The trawl remained the same while the groundgear now uses rock-hoppers rather than metal bobbins. The trawl doors now used are smaller but heavier than the previous ones. The changes are highlighted in Table 2.1.
- IPMA is considering options regarding some form of retrospective intercalibration study comparing gear parameters and catch data from the previous research vessel "Noruega" and that of the "Mario Ruivo". Preliminary analyses are promising and suggest the performance of the modified gear with the new vessel is not very different from that when deployed from "Noruega". Portugal hopes to present the results of the comparative analysis during IBTSWG in 2023.
- Vessel-related issues resulted in the loss of both of the Gulf of Cádiz surveys (SP-GCGFS-1Q/4Q) and the same vessel ("Miguel Oliver") broke down again during the North Coast survey in October. This resulted in the North Coast survey being completed using two different vessels, the "Miguel Oliver" during the first half and the "Vizconde de Eza" completing the survey, albeit with a three-week hiatus in between. There is some concern regarding the affect of an additional vessel and any subsequent effect on trawl performance. The standard baca trawl rig gear is deployed routinely on both vessels, and the door spread and wing spread results from the "Vizconde de Eza" were broadly in line with previous time-series deployments undertaken at similar depths. The catches also displayed the usual proportion of bentho-demersal species. However, after a more careful examination of gear parameters (see Figure A6.1h and comments in Annex 6) and the catches, some concerns were highlighted regarding the vertical opening and ground contact that could underestimate the abundance of megrim and hake. Otherwise, all other bentho-demersal species encountered in the catches appeared to display the expected proportions associated with this trawl.
- France added acoustic pingers to all of their EVHOE demersal trawls for the first time this year. This decision was taken this year for the offshore surveys in the Bay of Biscay (Pelgas and EVHOE), given an accidental capture in one haul during the pelagic survey Pelgas, and accidental catches of dolphins by commercial fleets.
- All of the trawls undertaken in the Bay of Biscay (72 stations out of a total of 157) part of the FR-EVHOE-Q4 survey were undertaken with a mean speed significantly lower than in previous year (median speed slightly under 3.5 knots). No discernible affect on catches or on generated indices for target species can been easily attributed to this speed problem.

- A burst hydraulic pipe feeding the trawl winch resulted in the "Corystes" having to return to port during her first day out on the UK-NIGFS-Q4 survey. The survey finally resumed 11 days later, but was only able to complete 45 of the planned 62 fixed trawl stations due to time constraints.
- Once again, COVID restrictions in place during the IE-IAMS-Q1 resulted in the operational working window being reduced from 24 hours to 12 hours, with staffing levels and survey targets being reduced by 31%. In keeping with the last two years, three survey days were devoted to deep-water trawling. In addition, six hauls were completed in the adjoining strata on the Scottish west coast in Division 6.a to help fill in missing survey effort.
- SCOWCGFS-Q1 survey during 2021 undertook additional Clean Seas Environmental Monitoring Programme work (CSEMP) while in the Firth of Clyde. This comprised three sea surface litter runs within the lower Clyde area using the Manta Trawl and 30 sediment grab deployments spread across 15 fixed monitoring sites within the Clyde. Disruption earlier in the year, due to Covid, had prevented this work being undertaken by the Scottish Environmental Protection Agency (SEPA) vessel, with "Scotia" able to complete the objective at short notice.
- SCOROC survey in 2021-Q3 surpassed 2020 in recording yet again the second highest recruitment of 0-group haddock on the Rockall Bank since the start of the new survey series in 2011.

2.4.3 Planning and Coordination

The expected dates for the NEA IBTS surveys taking place in 2022 are shown in Table 2.2. Due to vessel breakdown, the UK-SCOWCGFS-Q1 was cancelled for 2022.

Table 2.1. Changes between the NCT gear used on the RV Mario Ruivo compared to the earlier surveys undertaken on RV Noruega

Element of the gear design	Original gear configuration	Updated gear configuration
Net and cod-end liner		No change
Flotation		No change
Groundgear	Metal bobbins	18 m rockhopper section with 12' 'rubber disks
Sweeps and bridles		No change
Trawl doors	Polyvalent 650 kg	Thyboron T23 1.75m^2, 500 kg
Vertical net opening	4.6 m	4.5 m (provisional data)
Door spread	45.7 m	43.1 m (provisional data)
Wing spread	15.1 m	14.2 m (provisional data)

Table 2.2. Provisional/realized dates for 2022 NEA surveys and any planned intercalibration.

Survey	Code	Starting	Ending	Expected hauls	Planned intercal.
UK-Scotland West (spring)	UK-SCOWCGFS-Q1	Cancelled			-
UK-Scotland Rockall	UK-SCOROC-Q3	01/09/2022	13/09/2022	40	-
UK-Scotland West (autumn)	UK-SCOWCGFS-Q4	14/11/2022	06/12/2022	62	-
UK-North Ireland (spring)	UK-NIGFS Q1	07/03/2022	29/03/2022	60	-
UK-North Ireland (autumn)	UK-NIGFS Q4	03/10/2022	21/10/2022	60	-
Ireland – Anglerfish Survey 7bcjk	IAMS-Q1	05/02/2022	01/03/2022	45*	-
Ireland - Anglerfish Survey 6a	IAMS-Q2	13/04/2022	22/04/2022	40*	-
Ireland - Groundfish Survey	IE-IGFS-Q4	31/10/2022	16/12/2022	170	-
France – EVHOE	FR-EVHOE-Q4	24/10/2022	04/12/2022	155	-
France - Eastern Channel	FR-CGFS-Q4	15/09/2022	17/10/2022	122	-
Spain – Porcupine	SP-PORC-Q3	08/09/2022	14/10/2022	80	-
Spain - North Coast	SP-NSGFS-Q4	17/09/2022	21/10/2022	116	-
Spain - Gulf of Cádiz (spring)	SP-GCGFS-Q1	14/02/2022	26/02/2022	44	-
Spain - Gulf of Cádiz (autumn)	SP-GCGFS-Q4	26/10/2022	11/11/2022	45	-
Portugal (autumn)	PT-PGFS-Q4	04/10/2022	05/11/2022	96	

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3 DATRAS and related topics on data quality

3.1 Introduction

This section of the report provides information on updates to DATRAS and any issues relating to data quality. This report section addresses ToR (b).

3.2 Data quality checking in the DATRAS database for swept area assessment outputs

The Workshop on the production of swept-area estimates for all hauls in DATRAS for biodiversity assessments (WKSAE-DATRAS), held in 2021 (ICES, 2021b), recommended that the DATRAS database needed some extra quality procedures upon upload for HH fields which are crucial in the swept area product calculation. DATRAS database already implemented a range of checks for some of the fields such as door spread and wing spread.

Calculated WingSpread and DoorSpread values in DATRAS use a condition base. There is a requirement that such condition-based checking is also needed in the screening facility, so that if a compulsory parameter is missing it will be indicated on submission and an error or warning message is raised.

Parameters for the calculation procedures are stated below:

DoorSpread,WingSpread,ShootLat,ShootLong,HaulLat,HaulLong,Distance,HaulDuration,Depth,GroundSpeed,SweepLngt,Warplngt

Proposal of the new extra checks:

1. Regression plot with outlier for GroundSpeedvs.Distance, which gives an overview to data submitters upon upload at 0.5 confidence interval
2. Regression plot with outlier for calculated distance (based on ShootLat,ShootLong,HaulLat,HaulLong)vs.Reported Distance, which give an overview to data submitter upon upload at 0.5 confidence interval
3. Regression plot with outlier for Groundspeed, DoorSpread, WingSpread from the values of the same file, which give an overview to data submitter upon upload at 0.2 confidence interval

3.3 Catch weights

Systematic errors in the variable *CatchWgt* (and *CatCatchWgt*) were identified in the third quarter NS-IBTS data (see the Working Document in Annex 8 for further details).

Comparisons of the German dataset in the national database and in DATRAS showed deviations by a factor of 100, with the values reported in DATRAS being 100 times smaller than those values available in the German national database. When assessing the occurrence of such deviations in datasets from other NS-IBTS nations, similar patterns were found, with weight data being close to zero when plotted in kg for years prior to 2004. The exact years affected, however, varied with the reporting country, likely due to corrections and subsequent re-uploads of data that had been performed by individual nations for particular years.

The issue of incorrect catch weight data had previously been brought up in the IBTSWG in 2016, but so far no actions have been taken to correct it.

The root of this error is assumed to lie in the change of the reporting format for catch weights with the establishment of the DATRAS exchange format in 2003. Up until then, catch weight was reported in 100 g units (ICES, 1999). With the exchange format, the reporting unit was altered to grams, and therefore a lack of conversion of historical weight records to the new unit might serve as an explanation for the deviation factor of 100 (ICES, 2003).

Based on the content of the Working Document provided in Annex 8, a set of graphs was created using the *getCatchWgt()* function in the R package icesDatras (Millar *et al*., 2019), showing the *CatchWgt* of each individual countries for Q1-Q4 (Figure 3.1–Figure 3.4, respectively). For Q1, the function produced an error when downloading the data for the period 1983–1995, therefore this period is missing for all countries in Figure 3.1.

In order to resolve the issue of erroneous *CatchWgt*, the data providers of each country are requested to check catch weights for those years indicated by the plots in Figure 3.1–Figure 3.4 and in Table 3.1. All data for Q1 in the period 1983–1995 should be checked for errors in catch weight by the respective national data providers. In cases where catch weights are found to deviate by a consistent conversion factor (of, e.g. 100), the data providers may report these factors and the data that are in fact concerned to the ICES Data Centre, where corrections can then be made by multiplication with the reported conversion factor.

The progress on this task will be re-evaluated at the next IBTSWG annual meeting in 2023. To keep track of the progress being made in data correction, the ICES Data Centre proposed that notification of corrections should be reported and made accessible on the DATRAS News and Updates webpage.

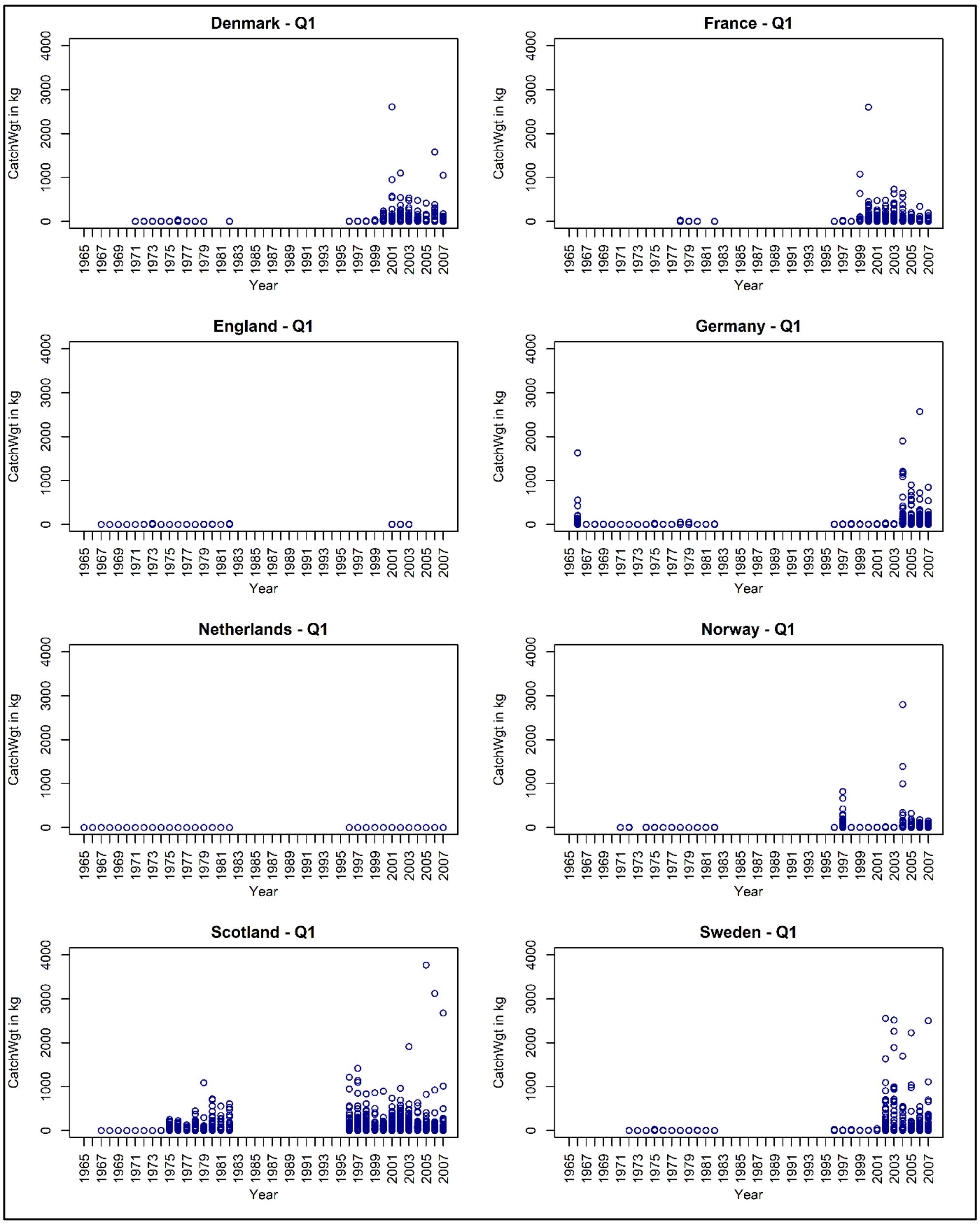

Figure 3.1. CatchWgt in kg, plotted for a subset of five species (herring, lemon sole, cod, haddock, dab) per country for quarter 1. The gap between 1983 and 1995 is the result of an inherent error in the r function used to download the data.

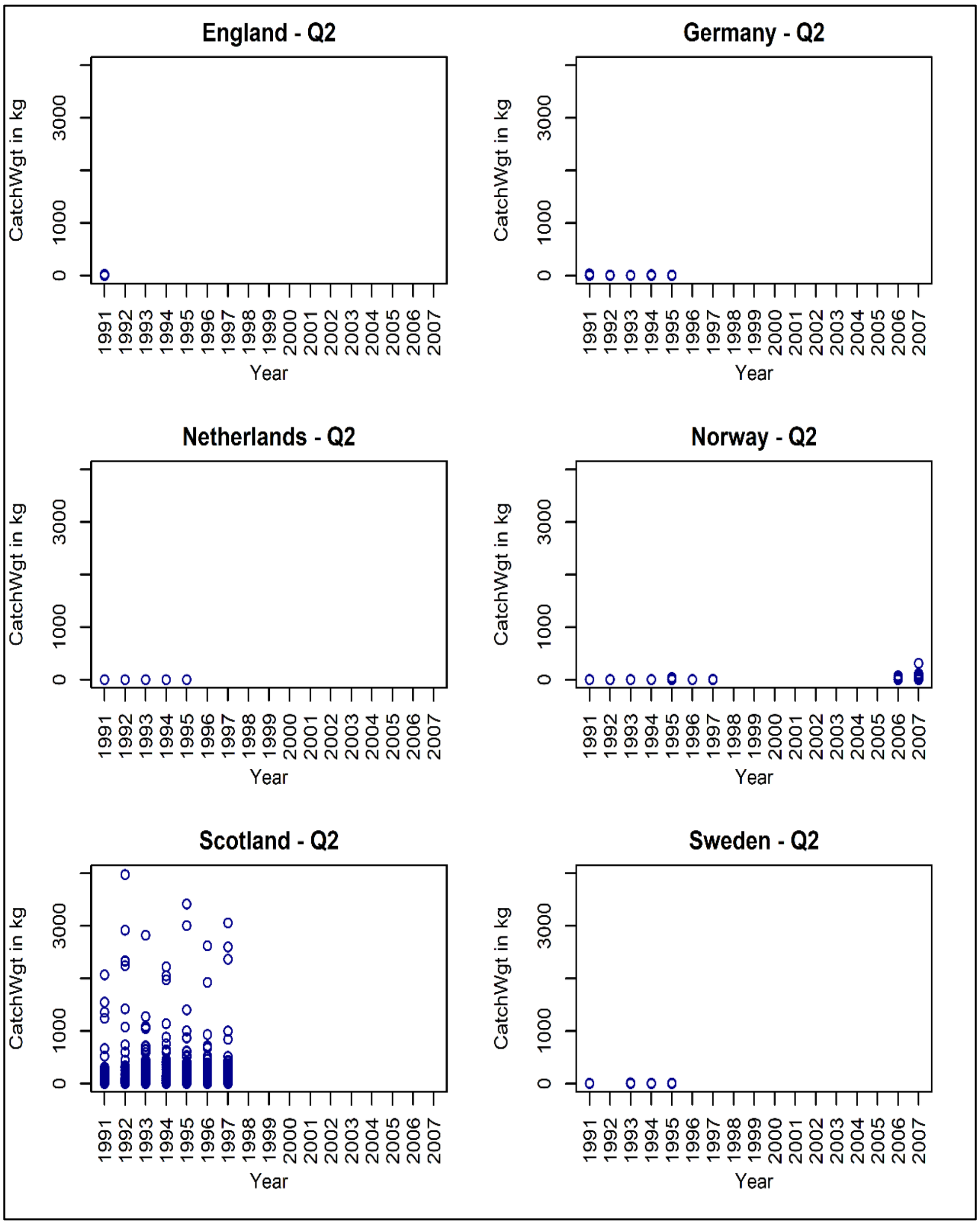

Figure 3.2. CatchWgt in kg, plotted for a subset of five species (herring, lemon sole, cod, haddock, dab) per country for quarter 2.

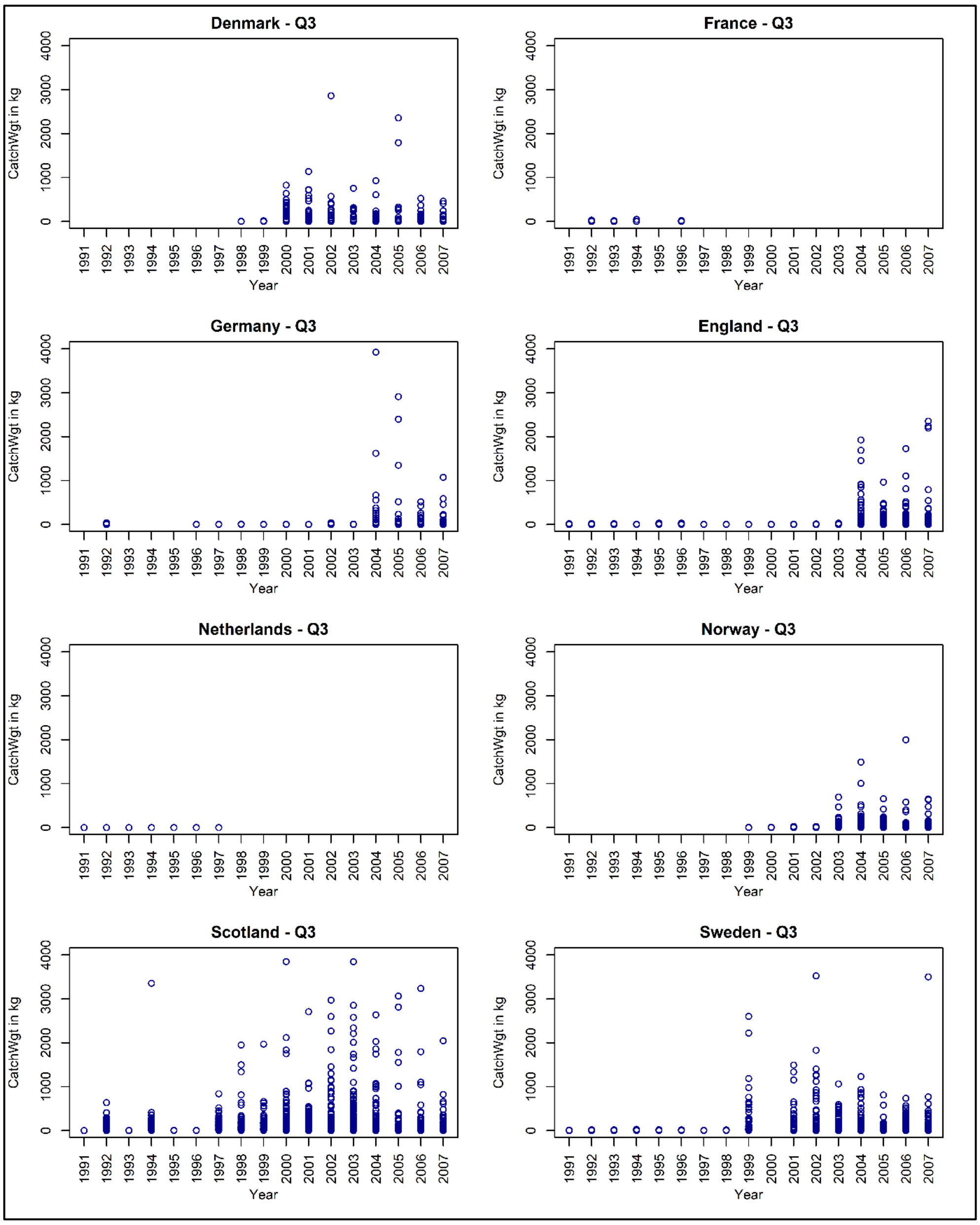

Figure 3.3. CatchWgt in kg, plotted for a subset of five species (herring, lemon sole, cod, haddock, dab) per country for quarter 3.

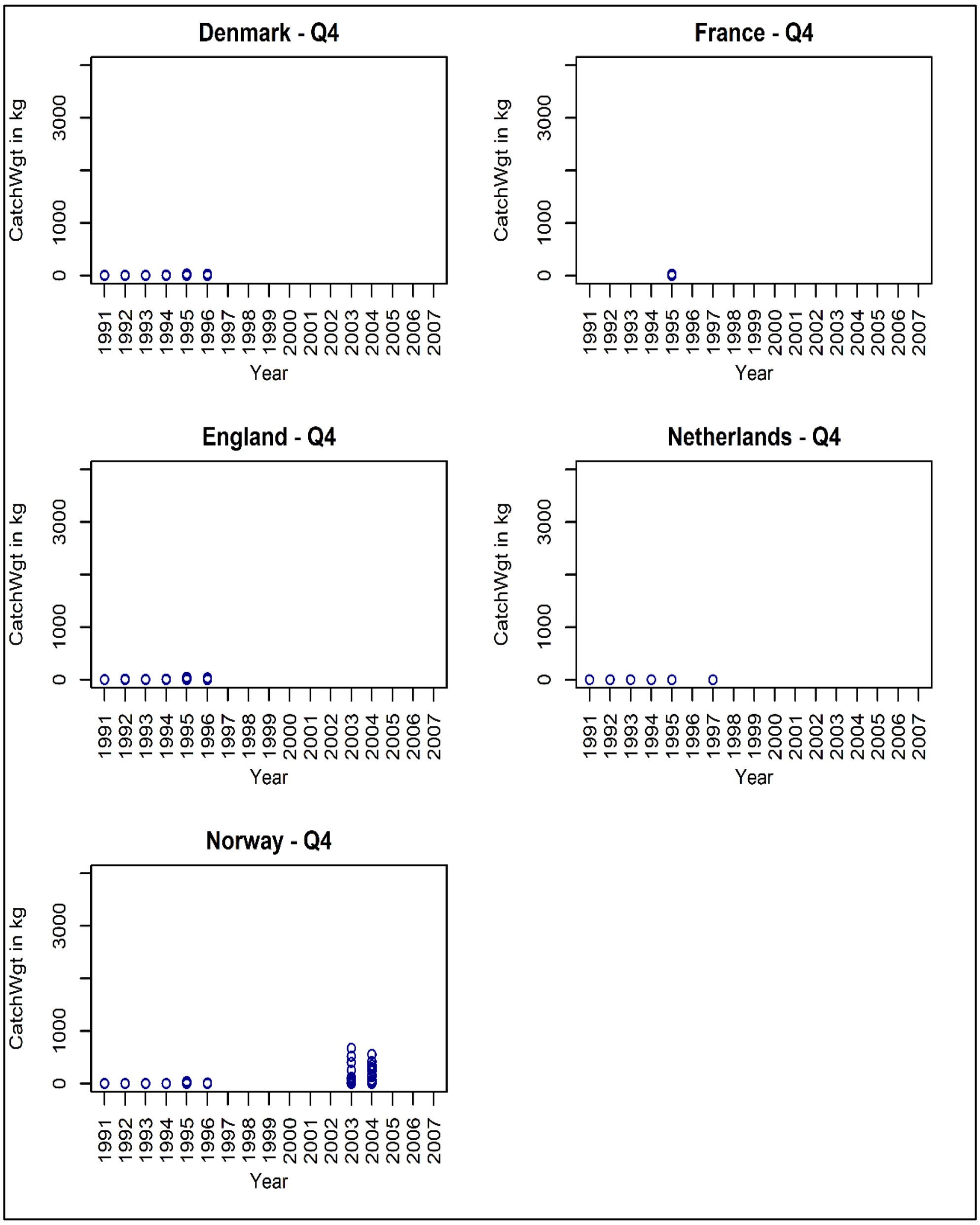

Figure 3.4. CatchWgt in kg, plotted for a subset of five species (herring, lemon sole, cod, haddock, dab) per country for quarter 4.

Table 3.1. Summary of the years potentially concerned by conversion errors in catch weights. The years and quarters for which checks are required are reported per country.

Country	Quarter	Years in which catch weight needs checking
Denmark	1	1971–1979, 1982–1999
	2	-
	3	1998–1999
	4	1991–1996
England	1	1967–2003
	2	1991

	3	1991–2003
	4	1991–1996
France	1	1978–1980, 1982–1998
	2	-
	3	1992–1994, 1996
	4	1995
Germany	1	1967–2003
	2	1991–1995
	3	1992, 1996–2003
	4	-
Netherlands	1	1965–2007
	2	1991–1995
	3	1991–1997
	4	1991–1995, 1997
Norway	1	1971–1972, 1974–1996, 1998–2003
	2	1991–1997, 2006
	3	1999–2002
	4	1991–1996
Scotland	1	1967–1974
	2	-
	3	1991, 1993, 1995–1996
	4	-
Sweden	1	1972–2001
	2	1991, 1993–1995
	3	1991–1998
	4	-

3.4 Species identification issues

3.4.1 Identification of smooth-hounds (*Mustelus* spp.) in the North Sea using morphology and genetics

A study on the identification of smooth-hounds *Mustelus* spp. using morphology characteristics and genetic analyses was conducted, based on measurements and samples collected during the joint Danish/German North Sea IBTS in 2021-Q3. The Working Document showing the results of this study is provided in Annex 9.

The results revealed that (a) neither the absence of white spots nor the position of the pectoral fin relative to the first dorsal fin were suitable criteria to distinguish between starry smooth-hound *Mustelus asterias* and common smooth-hound *Mustelus mustelus*, (b) morphometric measurements, i.e. the ratio of internarial distance to nostril width were congruent to the results of the genetic analysis of tissue samples, and (c) that all individuals examined were starry smooth-hound. Common smooth-hound is either much less common than its name implies, or not even occur in the North Sea (see the Working Document in Annex 9 for further details).

IBTSWG agreed that starry smooth-hound (presence of white spots) should be reported as *M. asterias,* whereas any individuals of questionable identification (e,g, absence of white spots and morphological criteria that deviate from *M. asterias,* such as the ratio of internarial distance to nostril width being >1.4) should be reported to genus level (*Mustelus* ssp.) and *M. mustelus* should only be applied when identification has been confirmed by genetic analysis.

3.5 Future work planned for the reporting cycle

Given the recent influx of blue-mouth redfish in the North Sea, further studies on this and related species could usefully be undertaken, as potential misidentifications may have occurred in some data (Ellis, 2021).

There is increased interest in members of the common skate complex (which comprises common blue skate *Dipturus batis* and flapper skate *Dipturus intermedius* – see Section 26 of ICES, 2021a), and further appraisal of data for *Dipturus* spp. could usefully be undertaken.

3.6 References

Ellis, J. R. 2021. Occurrence of blue-mouth redfish *Helicolenus dactylopterus* in the southern North Sea. *Transactions of the Suffolk Naturalist's Society*, 57: 1–3.

ICES. 1999. Manual for the International Bottom Trawl Surveys. Revision VI. ICES CM 1999/D:2, Addendum 2

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Millar, C., Large, S., Magnusson, A. 2019. icesDatras: DATRAS Trawl Survey Database Web Services. R package version 1.3-0. https://CRAN.R-project.org/package=icesDatras

4 New survey trawl

4.1 Introduction

There have been longer term discussions regarding trawl design for many of the surveys undertaken under the auspices of IBTSWG. For example, in the early 2000s, the Study Group on Survey Trawl Gear for the IBTS Western and Southern Areas (SGSTG; ICES, 2003, 2004) and the subsequent Study Group on Survey Trawl Standardization (SGSTS; ICES, 2005, 2006, 2007, 2008, 2009) highlighted the need for a survey trawl that was more robust than the GOV trawl as used in the North Sea.

Although initial work on this topic focused on the North-eastern Atlantic surveys, the NS-IBTS has subsequently seen a need to extend survey coverage to the north-western parts of the Subarea 4, in areas where the standard GOV is prone to damage, and there is increased interest in sampling other coarse ground areas which may be important habitats for some target species. Furthermore, many participants in the NS-IBTS are finding it increasingly difficult to source spare materials for the GOV trawl, necessitating some nations to change netting materials etc.

IBTSWG has recognized the need to introduce a more robust trawl for survey work, and this led to two recent ICES workshops, namely the Workshop on Affects of planned changes in the North Sea IBTS (WKNSIMP; ICES, 2019) and the Workshop on the Further Development of the New IBTS Gear (WKFDNG; ICES, 2022).

4.2 Outputs from WKFDNG

ICES (2021) made considerable progress relating to a potential new survey trawl, which focused on the work undertaken by Marine Scotland Science (the trawl BT237) and Ireland's Marine Institute (the trawl MI001). WKFDNG also made a series of recommendations to IBTSWG and provided an updated roadmap (Table 4.1).

Table 4.1. Roadmap for implementation of the new gear in the North Sea IBTS (Q1 and Q3) from WKFDNG (ICES, 2021) and updated comments following the 2022 meeting of IBTSWG.

Original comments from WKFDNG				
Nr	Step	Planned schedule	Comments	Additional comments
1	IBTSWG decision on the new gear	April 2022	Based on WKFDNG advice, decision list in Table 2.1 Additionally: give a name to the new gear. Ground gear naming: Clean ground gear Light hopper ground gear	IBTSWG agreed that the trawl should be based largely on BT237, albeit with a 70 mm cod-end. The net plans would be updated in April 2022 and IBTSWG would meet online (May/June) to finalise the agreed design. IBTSWG agreed that two ground gears would be required, one for fine ground and one for coarse grounds.

2	Operational gear tests by every country/vessel	Now till end 2023	Based on the expertise of the countries implemented, appointments can be made on specific elements that may not be defined in the WKFDNG plans. Decisions should be listed in the new gear manual.	IBTSWG agreed that nations should endeavour to trial the new gear during 2022 and 2023.
3	IBTSWG prepare final manual on the new gear based on WKFDNG advice	April 2022 drafting, final version available at IBTSWG 2023	In this manner countries that are ready to shift gears (i.e. Scotland) can move forward from Q1 2023 onwards. Important elements for the gear manual available in Annex 5.	Time constraints prevented initial drafting, with some of this work to be conducted intersessionally.
4	Plan for structured implementation by the different countries, including a final implementation date for all countries	Initiate April 2022- final version 2023	This requires homework for IBTSWG members, to investigate how fast a new gear can be implemented. WKNSIMP has pointed out that an index calibration should be done, as opposed to haul-by-haul comparison trawls for GOV and [new] gear. Important elements for the implementation plan available in Annex 6.	IBTSWG agreed to meet intersessionally (September 2022) to initiate plans for introducing the new trawl gear.
5	Dialogue with end users on the transition of the index series	2022-full implementation of the new time-series		IBTSWG to present the initial decisions to WGNSSK in April 2022, and to encourage members of WGNSSK (and other relevant assessment groups) to contribute to the implementation plan.
6	Decide on implementation plan for a new survey gear in other areas, based on choices made for and experiences in the North Sea	IBTSWG 2023		To be discussed in 2023.

4.3 Updated roadmap and rationale for decisions

IBTSWG discussed the outcomes from WKFDNG and emphasized coordination in the next steps, given that there were some initial plans to implement one net plan option over another in the absence of final discussion and agreement.

To that end the revised BT237 proposed at WKFDNG was acknowledged to integrate much of the previously discussed strong points of both gears and was, therefore, a good platform to move forward.

Evolution in the BT237 mesh sizes, bridles and cuts were supported by the results from sea trials for both gears under this ToR. Where there was more limited supporting data available was in the use of 70 mmvs.55 mm mesh in the straight section and into the cod–end.

IBTSWG agreed that, at least initially, 70 mm will be trialled for ease of access to checking the liner as well as improved simplicity in design (see below for further details).

It was also highlighted that the BT237 design had the benefit of being used to sample pelagic fish in some national surveys. Conversely, the relatively high headline of the trawl may not be optimal for some countries/vessels, and this would also be evaluated during initial national trials.

IBTSWG agreed several aspects of the new survey trawl, as detailed below.

4.3.1 Trawl

IBTSWG agreed that the new trawl should be based on BT237, albeit with a 70 mm cod end (as per the MI001 trawl), noting that the 20 mm liner would be retained.

Irish and Scottish gear technicians would update the gear and rigging diagrams.

During the transition from the GOV (50 mm cod end) to the new trawl (70 mm cod end), data on catch composition and size composition will be examined. Any evidence of a loss of juvenile (0-group) fish during initial gear trials that may relate to the 70 mm section will result in a review of this decision.

4.3.2 Sweep lengths

Historically, the NS-IBTS-Q1 survey would use shorter sweeps (60 m, including back-strops and connectors) in shallower (<70 m) water, and longer sweeps (110 m, including back-strops and connectors) in deeper water, although some vessels had stopped using sweeps of different lengths.

IBTSWG agreed that there were practical considerations for having a single sweep length, irrespective of water depth. This is as practiced in the NS-IBTS-Q3 as well as various NEA surveys.

4.3.3 Trawl doors

There was discussion regarding Scottish trials of Thyborøn type 11 trawl doors. IBTSWG noted concerns regarding the trials and implementation phase and that some research vessels may not be able to change doors safely at sea, especially in poor weather.

Consequently, **IBTSWG agreed that, at least in the trials and implementation phase, all nations would use the new trawl with the doors that are used currently for the GOV surveys.** Future analyses of net parameters would inform whether there was a rationale for changing to a new standard trawl door in the medium-term.

4.3.4 Ground gears

IBTSWG noted that there has been increased interest in sampling coarser ground types, especially those that may be inhabited by some gadoids, and that the increasing number of offshore constructions and obstructions meant that some previously unfished haul locations might need to be sampled.

IBTSWG recognized that a single type of ground gear would not allow for all grounds to be sampled without risk of gear damage. Consequently, **IBTSWG agreed that two ground gears should be used, one for us on clean/fine grounds and a gear with hopper discs for use on rough grounds.**

IBTSWG would identify those areas where the rockhopper ground gear should be used, and areas where the clean ground gear configuration would be used, in order to prevent/minimize spatial and temporal variation in ground gear used.

Having better delineated areas where the rockhopper ground gear should be used would also allow survey leaders and fishing skippers to design survey routes that would minimize the number of changes between ground gear, in those cases where the survey coverage of individual vessels straddles ground types.

4.3.5 Towing speed

According to the current survey manual (ICES, 2020), the GOV trawl should be towed at a speed of 4 knots (range of 3.5–4.5 knots), which is slightly faster than most commercial trawlers. IBTSWG noted that some research vessels can struggle to maintain this towing speed in certain tidal/weather conditions, and that there would be likely implications about fuel consumption. Further information on trawling speed is given in Section 5.1.

IBTSWG agreed that the towing speed for the new trawl should be 3.4–3.8 knots.

4.3.6 Restrictor ropes

Some vessels have trialled the use of restrictor ropes as an approach to providing a more standardized spread of the trawl over the depth range being surveyed. However, different vessel layouts and health and safety considerations meant that not all vessels could attach restrictor ropes to the warps.

IBTSWG agreed that the new survey trawl should not have restrictor ropes. If future analyses of net geometry data indicate that there could be a rationale for restrictor ropes, then IBTSWG would revisit this issue.

4.3.7 Ratio of warp out to depth

Although the IBTS manual originally defined the warp out to depth ratio, subsequent iterations of the manual stated that this ratio “should be adjusted to remain within accepted limits of net geometry; this ratio can vary between vessels” (ICES, 2020).

IBTSWG considered that nations should use an indicative 3:1 ratio initially, but that the ratio would likely need to be changed, especially in shallower or deeper parts of the survey area. Future analyses of net geometry data for the new trawl will allow for clearer guidance on the ration to be developed for the participating survey vessels.

4.4 Next steps

The next step is for the net builders of both nets to finalize these amendments to the BT237 and make a full net plan available to the IBTSWG. This will have sufficient detail so that IBTS participants can initiate discussion with their gear experts and local suppliers around costs and timelines to build and maintain these trawls locally. Other IBTSWG/WKFDNG participation in finalizing the detailed plans is welcomed.

IBTSWG agreed to have an online meeting in late May-early June 2022 to review the final net plans and begin discussions on trials and initial implementation.

Marine Scotland Science (MSS) will then amend/build a BT237 using the existing light hopper ground gear. The Marine Institute (MI) will use the same plan to build a BT237 with the recommended clean ground gear, both to be available by Q4 2022 with the intention for countries to be in a position to trial the gear from Q1 in 2023 onwards.

IBTSWG also agreed to have an online meeting in September 2022 to have further discussions on gear trials and planning of the introduction of the new trawl.

All nations participating in the North Sea IBTS (and other areas if desired) are strongly encouraged to trial the new gear during 2023. This should consider the practicalities of deploying the trawl on the relevant survey vessel, collecting data on net geometry and catch volume and composition, and trialling the gear on an appropriate range of depths and ground types as would normally be encountered during the survey.

IBTSWG also agreed that it would be advantageous to have the final trawl design tested using the DynamiT software developed by scientists at IFREMER, and for a scale model of the trawl to be constructed and tested in flume tank conditions. The results of such studies can provide important data to supplement field data collected from at-sea studies using full-scale trawls (e.g. Nguyen *et al.*, 2015). Opportunities for this work should be explored.

4.5 Other considerations and future consultation

4.5.1 Volume of net drums

Noting that the proposed trawls will have hopper discs and increased flotation (instead of a kite), several countries raised concerns that the volume of the BT237 trawl may be over the capacity of their net drums.

Other nations reported that when using trawls with hopper discs, that part of the trawl would be wound onto the net drum and part kept on deck, although the ability to do this obviously depends on the layout of individual vessels.

Data on net drum capacity across the IBTS vessels are being collated to evaluate whether some adjustment in the final net plan could facilitate ease of use across the fleet.

IBTSWG agreed that data on the net drum capacity should be collated as soon as possible.

4.5.2 Catch weight and volume

Some countries raised concerns about whether there would be an expected increase in catch weight and volume. Initial studies from MSS indicated that the sizes of catches were not appreciably different from those made with the GOV. Further gear trials will provide additional data on catch volume.

4.5.3 Consultation with relevant Expert Groups

Some countries questioned whether the new trawl design had been reviewed by the ICES-FAO Working Group on Fishing Technology and Fish Behaviour (WGFTFB).

One of the current co-chairs of WGFTFB also co-chaired WKFDNG, and some members of IBTSWG and WKFDNG are also members of WGFTFB. Although there has been some input from WGFTFB members, **IBTSWG considered that the final net plans should be sent to**

WGFTFB for review and comment, given that one of the ToRs of WGFTFB is to "support survey working groups with fishing gear expertise upon request".

Ensuring appropriate indices of stock size are available to assessment working groups is obviously fundamental to the role of IBTSWG. It is highly unlikely that there would be sufficient resource for undertaking haul-by-haul comparative trawling with the GOV and the new trawl. Hence, and as indicated by ICES (2021), having a period whereby there are representative data for both the GOV and the new trawl would allow for two indices that could then be calibrated.

IBTSWG also recognized that communication with relevant assessment groups, especially WGNSSK, but also WGWIDE, HAWG and WGEF, was required, and that relevant scientists working on survey indices should be involved in discussing the implementation phase.

4.6 Future work planned for the reporting cycle

Gear experts from MSS and Ireland will update the gear and rigging diagrams in preparation for an intersessional meeting of IBTSWG, planned for May/June 2022. Following final agreements of the gear design and rigging, the new survey trawl should be used in a testing phase from late 2022 onwards.

4.7 References

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Nguyen, T.X., Winger, P.D., Orr, D., Legge, G., Delouche, H. and Gardner, A. 2015. Computer simulation and flume tank testing of scale engineering models: how well do these techniques predict full-scale at-sea performance of bottom trawls? *Fisheries Research*, 161: 217–225.

5 Survey design and data collection

5.1 Trawl speed

A Working Document on “Effect of trawl speed on catchability” was provided by Ralf van Hal (see Annex 10), following recommendations from WKFDNG (ICES, 2022b). Whilst too slow a trawling speed may allow some faster moving fish to escape capture, too fast a trawling speed may result in the net being more prone to lifting off the seabed, and thus allowing escapement of some more demersal species.

As also indicated above (Section 4.3.5), there are potential implications of whether some research vessels can maintain trawl speed in relation to more extreme conditions of tide speed and weather, and fuel consumption.

5.2 Autotrawl and recording of tidal speed and direction

The WKDNFG report (ICES, 2022b) recommended that IBTSWG keeps an up to date overview of vessels using an (active) autotrawl system in the manual, including the type of system for maintaining the gear symmetry during the IBTS trawl hauls. This should be as far back in time as possible.

Some countries (Northern Ireland, Denmark, Portugal and the Netherlands) do not use an autotrawl, whilst Ireland and England use autotrawl only for balancing tension controls without integration of trawl sensors. Spain has been using autotrawl for the Porcupine for the full time-series, and for the other regions since the introduction of the Miguel Oliver. The autotrawl in Scotland and Spain is used for shooting, towing and retrieving the trawl. Winch dynamics are adjusted pre-shooting dependent on weather conditions to ensure tensions remain stable during tow and gear geometry.

Information on the use of Autotrawl systems by participating fishery research vessels are summarized in Table 5.1.

The WKFDNG report also recommended that information on tidal direction and tidal current is during the haul is recorded and reported in DATRAS (BotCurDir, BotCurSpeed), which has been discussed at the meeting and data were collated as to what countries report.

Some countries do report to DATRAS, some collect the information (however, the collection is not coordinated), same countries do not collect it at all. Denmark uses a Doppler sonar, other labs generally report from the modelled data that are available on electronic navigation systems (see Table 5.2).

Table 5.1. Use of Autotrawl systems on current fishery research vessels participating in surveys coordinated by IBTSWG.

Institute	Vessel	Autotrawl		Other Details
		Present	Active	
SLU Aqua (Sweden)		Y	Active	Scantrol autotrawl used for shooting, towing and hauling. Normally the Synchronization function is used (balancing tension on wires) but Scantrol also has a symmetry function communicating with sensors.
CEFAS (UK)	Cefas Endeavour	Y	Active	Autotrawl used to balance tensions only, no integration with trawl sensors.
MSS (Scotland)	Scotia	Y	Active	Autotrawl is used for shooting, towing and retrieving the trawl. Winch dynamics adjusted pre-shooting, dependent on weather conditions to ensure tensions remain stable during tow. No integration with trawl sensors.
IEO-CSIC (Spain)	Miguel Oliver Vizconde de Eza	Y	Active	Autotrawl is used for shooting, towing and retrieving the trawl. Winch dynamics adjusted pre shooting dependent on weather conditions to ensure tensions remain stable during tow and gear geometry. Autotrawl use started with the change to the Miguel Oliver in SP-NORTH and Gulf of Cádiz (in 2013) and the full-time-series of the Porcupine survey.
AFBI (Northern Ireland)	Corystes	-	-	broken/does not work
MI (Ireland)	Celtic Explorer	Y	Active	SCANTROL used to balance tensions only, no integration with trawl sensors.
	Tom Crean	Y	Active	iSYM used to balance tensions only, no integration with trawl sensors.
DTU Aqua (Denmark)	Dana	N	-	-
WMR (Netherlands)	Tridens	N	-	-

Thünen Institute (Germany)		Y	Active	Used to balance tensions only, no integration with trawl sensors.
IMR (Norway)	G.O. Sars	Y	Active	Selected options: Shoot, Tow, and haul. Then the computer selects the best way to tow the trawl by tension on the warp, or based on the data from the 'symmetry/speed' sensor.
	Kristine Bonnevie	Y	Active	Autotrawl option on the Scantrawl system always used. During tow confirmed; during hauling and shooting likely but TBC.

Table 5.2. Collection of data in tidal speed and direction on board the fishery research vessels participating in surveys coordinated by IBTSWG.

Institute	Vessel	Data collected on tidal speed/tidal direction	
		Yes/No	Details
SLU Aqua (Sweden)		No	
CEFAS (UK)	Cefas Endeavour	Yes	Transas system used to collect predicted tidal current and tidal direction once per trawl station
MSS (Scotland)	Scotia	Yes	Scotland records the surface current direction and surface current speed at the middle of the trawl point. This is then up-loaded to DATRAS with the rest of the HH data.
IEO-CSIC (Spain)	Miguel Oliver Vizconde de Eza	No	There are ADCP but data are not used and records not kept routinely.
AFBI (Northern Ireland)	Corystes	Yes	Information taken from the plotter (Scanmar)
MI (Ireland)	Celtic Explorer	Yes	Tide model from chart plotter noted during the tow, but not uploaded to DATRAS. Chart plotter traditionally used for fishing is Sodena, but licence now very expensive for the tide module so using the tides from MaxSea which is also on the vessel.

	Tom Crean	Yes	Tide model from chart plotter noted during the tow, but not uploaded to DATRAS.
DTU Aqua (Denmark)	Dana	Yes	DK records surface and bottom current speed and direction in 5 min intervals with a simple Doppler sonar (Furuno CI-68) and reports the average values to DATRAS in the HH records
WMR (Netherlands)	Tridens	Yes	Tide model from chart plotter noted during the tow.
Thünen Institute (Germany)	Walther Herwig III	No	There is a DOLOG system on board, but the data are not used routinely.
IMR (Norway)	G.O. Sars	Yes	ADCP surface current recorded continuously., however not sure if data are kept, not reported to DATRAS
	Kristine Bonnevie	Yes	ADCP surface current recorded continuously., however not sure if data are kept, not reported to DATRAS

5.3 MIK sampling for sprat larvae

Bastian Huwer gave a presentation on “Sprat larvae pilot surveys in the North Sea during night-time on the Q3 IBTS”.

As sprat is a short-lived species, the stock size is influenced strongly by the recruiting year class, with catches composed mainly of one year old fish. The fishery is, therefore, highly dependent on the incoming year class and, given the high interannual variability of recruitment, the assessment and advisory process would benefit from earlier indications of recruitment.

In 2018-2021, Denmark has used the NS-IBTS-Q3 survey as a platform to undertake MIK sampling at night, partly supported by Germany in 2020 and 2021, in order to evaluate if this additional MIK sampling could provide the basis for a North Sea sprat recruitment index. Besides, Scotland conducted MIK sampling during their survey in 2021. To minimize affects on the main trawl survey and to limit extra steaming, MIK sampling stations were usually sited in transects running between the last trawl station fished that day and the first trawl station to be fished the following day (Figure 5.1). This was found to allow 4–5 MIK hauls per night, separated by approximately 15 nm.

The results indicated that sprat larvae were found in large numbers during the NS-IBTS-Q3, and the larvae were considered to be at a size at which their abundance may indicate recruitment. Highest abundances of sprat larvae were found in the central parts of the North Sea, while abundances were low in the southern areas. There was also a tendency to decreasing abundances in the north-western parts of the investigated area, indicating that the pilot surveys in 2018-2021 covered the main distribution of sprat larvae. However, it would be useful to further corroborate the northern boundary of the main sprat larvae distribution. Whereas annual data are currently limited to 4 years, preliminary examination of these data indicated that larval abundances did compare favourably with estimates of recruitment (Figure 5.2).

Consequently, the Working Group on Surveys on Ichthyoplankton in the North Sea and adjacent Seas (WGSINS) recommended to continue the survey and encourages additional participants to join the survey.

IBTSWG considered that such work was designed in such a way to minimize affects on the trawl survey and encouraged participants in the Q3 survey to undertake such work, resources permitting. During IBTSWG 2022, Denmark and Scotland already announced that they will conduct the MIK sampling again on their NS-IBTS-Q3 in 2023.

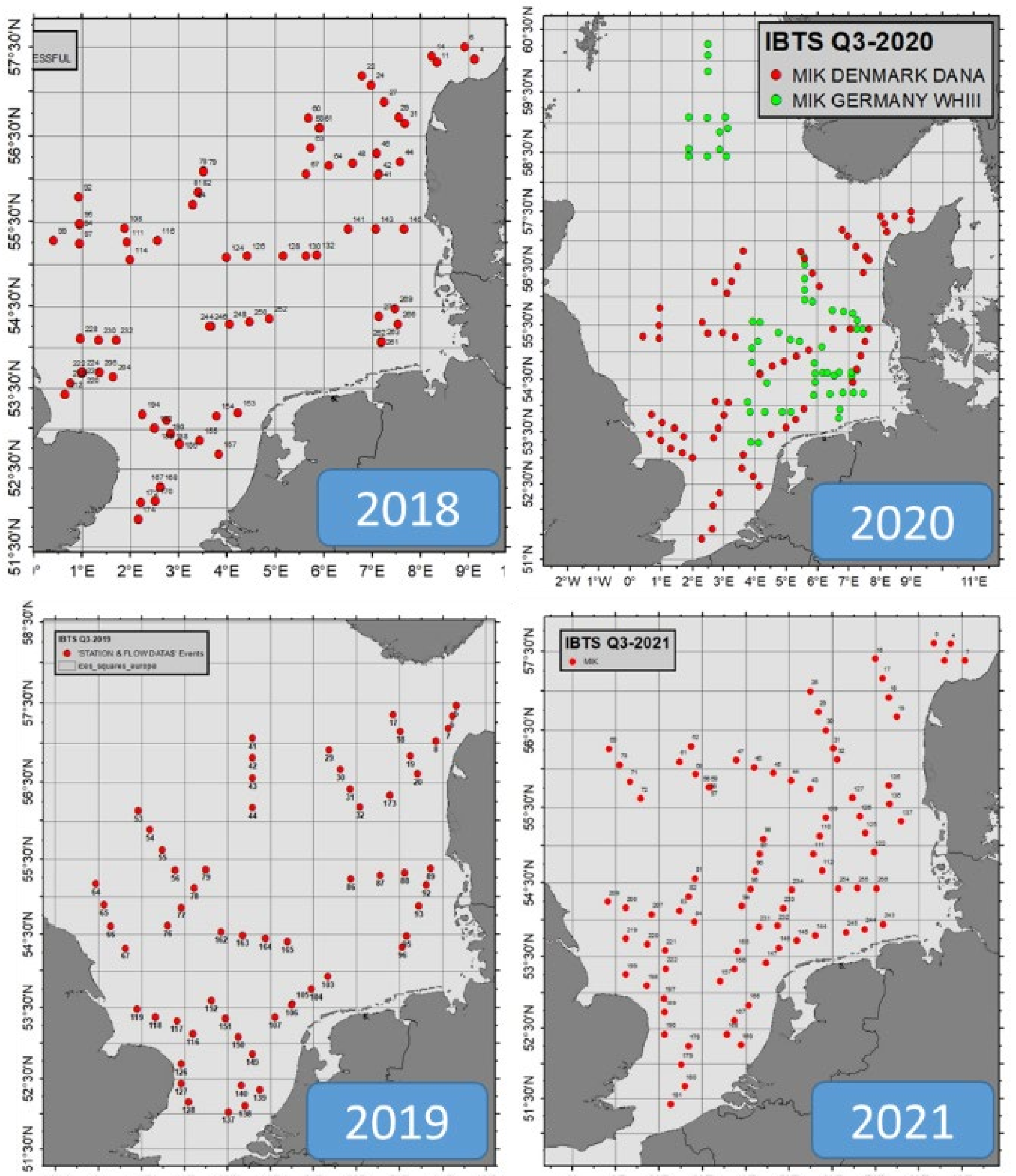

Figure 5.1. Distribution of MIK sampling stations (2018–2021) during the Danish and German NS-IBTS-Q3. Note that the 2021 sampling was conducted during a joint Danish-German cruise on RV DANA.

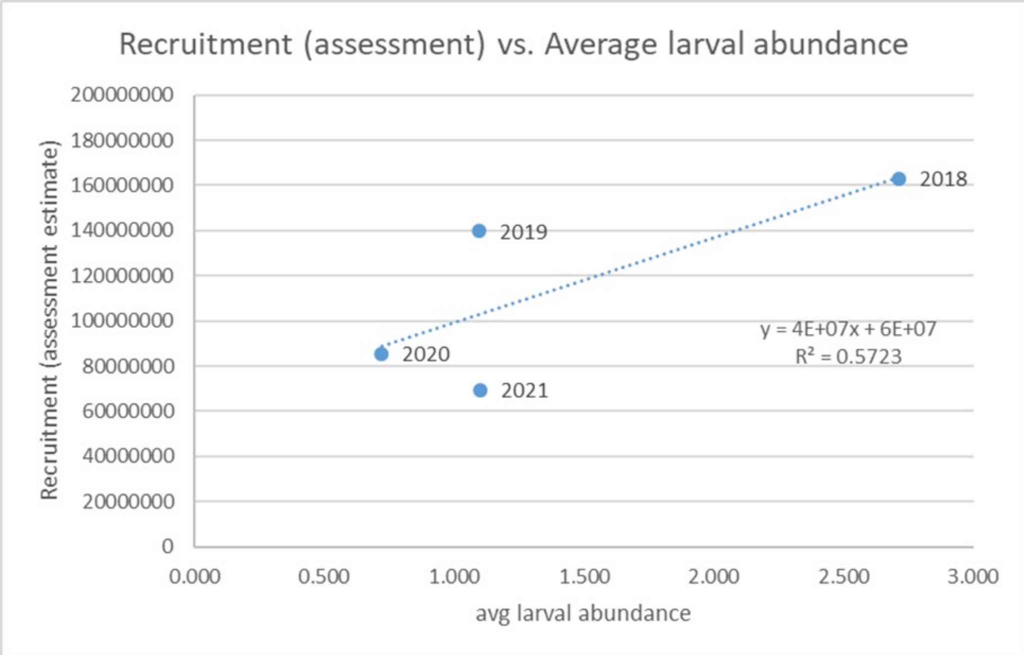

Figure 5.2. Relationship between sprat recruitment (as estimated for the assessment) and the average larval abundance (preliminary data).

5.4 Stomach sampling

Pierre Cresson provided an update on the collection of stomach sampling being overseen by the Intersessional subgroup (ISSG) for Stomach sampling, under the Regional Coordination Group for the North Atlantic, North Sea and Eastern Atlantic (RGC NaNSea).

The provisional plan for stomach sampling in 2022 is for **whiting, megrim and anglerfish**, as already collected for NS-IBTS-Q1 and planned for NS-IBTS-Q3.

The provisional plan for 2023 is for **horse mackerel, plaice and skates and rays (including starry ray,** although the ISSG and RGC would be discussing options for modifying the sampling scheme (Figure 5.3). That various participating tag and release skates and rays was highlighted by ICES (2021), which may affect on the sample sizes available for stomach sampling for that group. Further details of the sampling protocol were provided in ICES (2021) and RCG NA NS&EA RCG Baltic (2021).

It was also highlighted that there was some uncertainty as to the processing of the stomach samples being collected. It was originally anticipated that certain institutes would process the samples, but it was indicated recently that individual institutes might need to process their own samples. In relation to the latter, it was noted that not all nations would have the resource to support additional work in the laboratory, with some nations also not eligible for EU funding. **Hence, clarification on the resource for processing and analysing stomach samples is required.**

A further presentation on stomach sampling in the Irish Sea and northern Celtic Sea, as being undertaken by various institutes was given by Steven Beggs (Northern Ireland). This presentation summarized some of the work being undertaken under the Fisheries Knowledge for Optimal Sustainable Management (FishKOSM) project. For this, stomach contents data were being collected for 18 species of fish (cod, hake, haddock, whiting, lesser-spotted dogfish, grey gurnard, red gurnard, tub gurnard, mackerel, herring, sprat, spurdog, thornback ray, spotted ray, anglerfish, black-bellied anglerfish, boarfish and poor cod (>15 cm)).

Year	Quarter	Species	expected n of stomachs	Sum of all stomachs per year	"Minor" species sampled each year	Species to be sampled opportunistically each year
1	1	Whiting	1727	3547		
	3		1350			
	1	Anglerfish	75			
	3		67			
	1	Megrim	148			
	3		180			Starry ray
2	1	Cod	1257	3346	Turbot	
	3		1208			Cuckoo ray
	1	Horse Mackerel	306		Brill	
	3		575			Thornback ray
3	1	Hake	505	3856	Halibut	
	3		934			Spotted ray
	1	Plaice	1206		Pollack	
	3		1211			Common skate-complex
4	1	Haddock	1362	3665	Tusk	
	3		1221			
	1	Mackerel (Q3 only)			Ling	Spurdog
	3		1082			
5	1	Saithe	534	4112	Tub gurnard	Tope
	3		820			
	1	Red gurnard	159			
	3		58			
	1	Grey gurnard	1373			
	3		1168			

Figure 5.3. Potential sampling scheme for stomach contents.

5.5 Additional sampling for genetic studies

IBTSWG discussed various ongoing additional activities applying genetic methods. Obviously, the IBTS surveys provide a useful platform to obtain samples for genetic analyses on fish species with a broad spatial coverage, and thereby have the potential to support research activities which need samples from the respective survey areas.

A number of investigations have been ongoing, which explore options to use genetic methods to support or improve information obtained through traditional fisheries research methods. One example is the international EU funded project 'FishGenome', in which project partners have been exploring various genetic methods, and for which IBTS has served as a sampling platform. Investigations include eDNA approaches to use for non-invasive sampling, recording of presence of fish species and the biodiversity of fish communities, as well as first attempts of using eDNA techniques for monitoring of fish stocks. In the same project, further genetic methods are used to explore the possibilities of aging fish through molecular techniques, instead of age-readings of otoliths. The recent ICES Workshops on Stock Identification of North Sea Cod (WKNSCodID; ICES, 2020) and Stock Identification of West of Scotland Sea Cod (WK6aCodID; ICES, 2022a) may serve as good examples how to combine genetics with all the other biological data.

IBTSWG is aware that several expert groups within ICES deal with genetics methods, e.g. WGAGFA (Working Group on Application of Genetics in Fisheries and Aquaculture), WGIMT (Working Group on Integrated Morphological and Molecular Taxonomy), and the application and interpretation of population genetics is fundamental to informing on stock identification (e.g. the work of the Stock Identification Methods Working Group (SIMWG)).

IBTSWG is in favour of exchanging experiences with groups, where the application of genetic methods may foster the development of new insights, particularly if they may (a) provide additional information, (b) reduce sampling effort or (c) promote less-invasive or even non-invasive sampling.

Some IBTS participants have collected tissues for similar species for different research projects over time. The establishment of a tissue bank (with appropriate sample sizes by species, size class and area) that could be accessed by researchers could usefully be considered by relevant bodies.

5.6 Additional sampling for parasites

5.6.1 North Sea cod infestation with liver worms

Considering recent findings for Baltic cod that infestation by liver worms had a negative effect on cod condition and may thus have contributed to the deterioration of the Central Baltic cod stock (Ryberg *et al.*, 2021), IBTSWG agreed to conduct a pilot study for North Sea cod in 2021-Q3, with additional sampling in 2022-Q1.

The same liver infestation category scale as used in the Baltic Sea study, and as described by Ryberg *et al*. (2021) was used, and, together with 'liver category', individual fish length and weight data were collected, with some participants also recording liver weight (Annex 5). The data from all participants in the NS-IBTS in 2021-Q3 were sent to the survey coordinator for analysis prior to the IBTSWG 2022 meeting.

In total, 1395 cod ≥ 25 cm length were examined and, for 1123 individuals, liver weight were recorded from the survey in 2021-Q3. The spatial distribution of prevalence expressed as mean liver category (weighted by the number of observations) by rectangle showed high values in the northern and north-western part of the North Sea, in particular around the Shetland and Orkney islands (Figure 5.4).

Liver categories > 1 occurred first at cod lengths larger than 38 cm, which corresponds to age 2+, and almost all cod > 90 cm were infested. Whereas parasite load had a significant effect of individual fish condition (Figure 5.5), simple box plots did not indicate a negative effect on condition at a population level (Figure 5.6). However, future analysis should consider an effect of size implicitly together with a spatial segregation, such as the current borders for presumed North Sea cod subpopulations (North-western, Viking 4.a, Skagerrak, and Southern; see Annex 4). In this respect, the data from 2022-Q1 as collected during or close to the spawning period may become highly valuable.

Additional data from 2022-Q1 collected by, for example, Scotland and the Netherlands were received too late for inclusion in the present analysis but will be considered in future work.

Sweden and Denmark will continue to collect liver worm infestation data in 2022-Q3 in Division 3.a (Skagerrak/Kattegat) and all NS-IBTS participants agreed to conduct a full-scale sampling in 2023-Q1, which will also include the collection of livers for identification of the nematode liver worm species from different parts of the North Sea.

Further details, data exchange template and contact person(s) responsible for data compilation, analysis and reporting will be given in the international cruise programs provided by the survey coordinators.

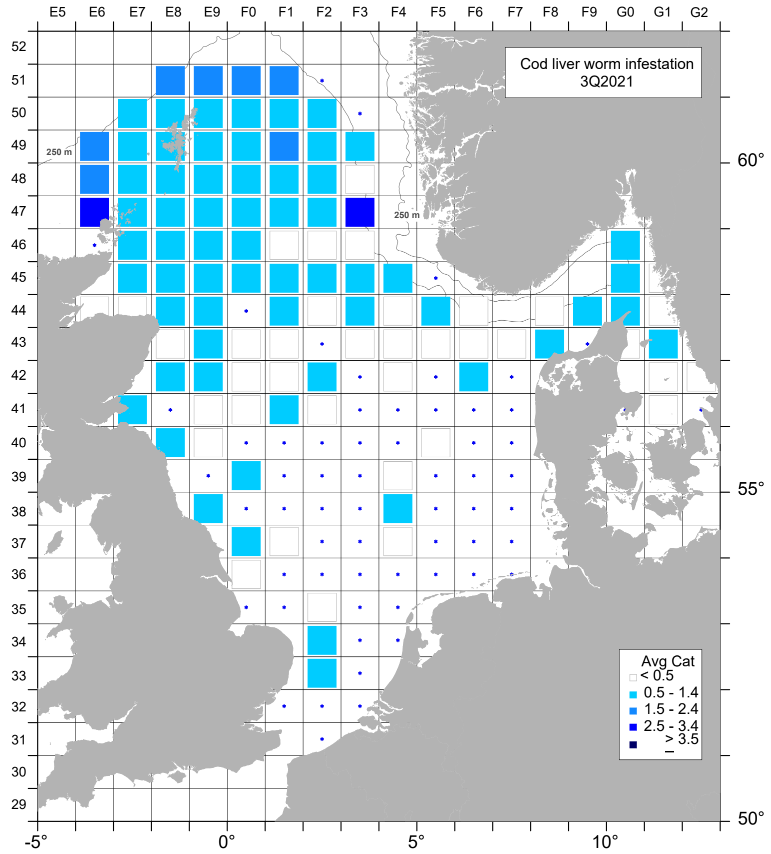

Figure 5.4. Spatial distribution of cod liver worm prevalence (for cod ≥ 25 cm, *: no information / no cod ≥ 25 cm caught).

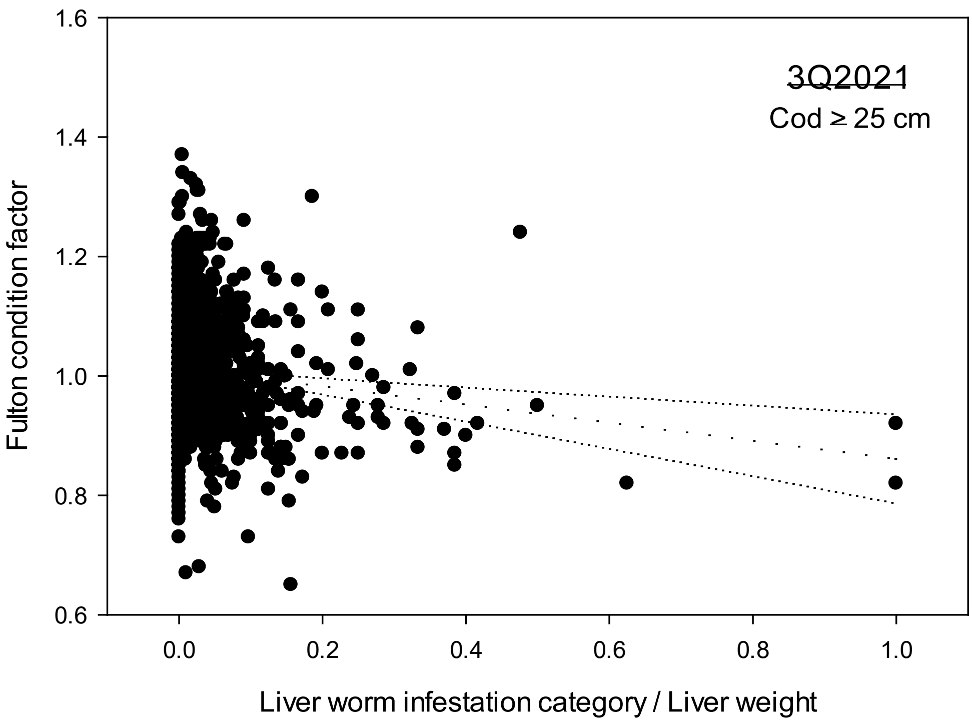

Figure 5.5. Infestation load effect on individual condition in area 4 (Linear regression: $r^2 = 0.013$, $P < 0.001$).

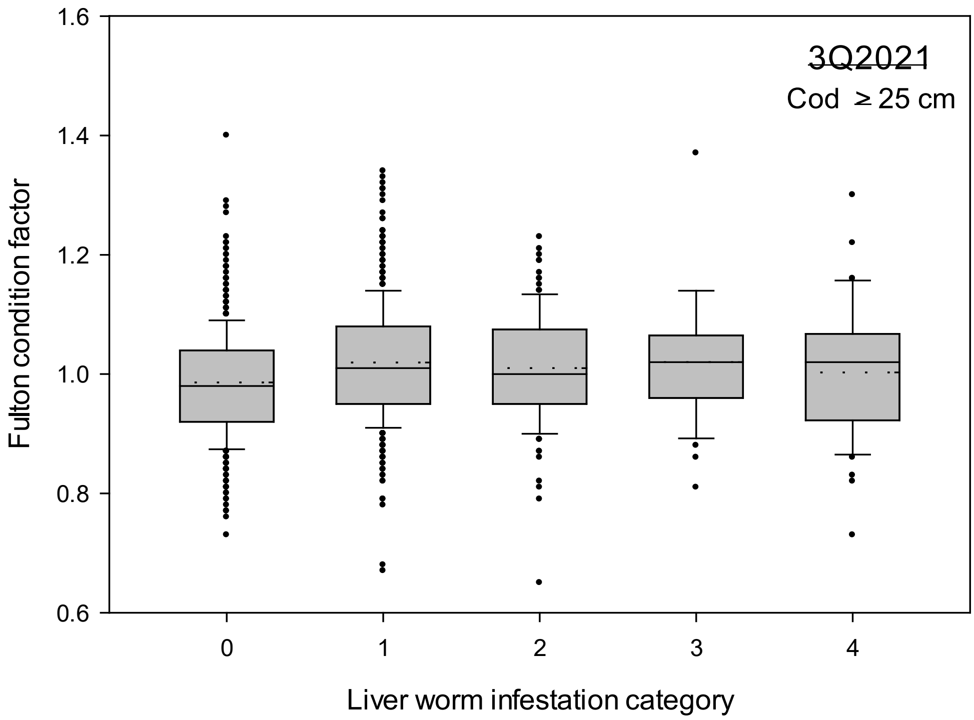

Figure 5.6. Liver worm infestation category and average condition in areas 4 and 3a.

5.7 Future work planned for the reporting cycle

Members of IBTSWG recognized the importance of the IBTS as a platform for additional data collection (e.g. stomach contents and parasites), and updated information on these aspects will be provided in future reports.

For survey design, future work is needed to trial the new survey trawl (see Section 4) and consideration of the most effective plan for implementing the new trawl.

5.8 References

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Ryberg, M.P., Huwer, B., Nielsen, A., Dierking, J., Buchmann, K., Sokolova, M., Krumme, U. and Behrens, J.W. 2022. Parasite load of Atlantic cod *Gadus morhua* in the Baltic Sea assessed by the liver category method, and associations with infection density and critical condition. *Fisheries Management and Ecology*, 29: 88–99.

6 Joint session with assessment groups

6.1 Introduction

A new TOR was agreed for the reporting cycle to increase the communication between user groups and survey groups. This year a dedicated session between invited chairs of the assessment groups (WGNSSK, WGBIE and WGCSE) and IBTSWG was planned. Due to time constraints the chairs of WGCSE could not attend.

IBTSWG also hoped to meet some of the scientists using trawl survey data for wider ecosystem studies, including for OSPAR indicators, but this could not be achieved this year given the meeting dates

Discussion between the chairs of WGBIE and WGNSSK and the IBTSWG, however, were successful and created a positive start to this ToR in 2022.

Future communication with user groups will facilitate the better use and interpretation of data, a deeper understanding of the survey indices by the stock assessors and to enhance science by better understanding between the groups.

6.2 Working Group for the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK)

Several members of WGNSSK attended a joint session of the IBTSWG meeting, and a short summary presentation of recent surveys coordinated by the IBTSWG was given at the WGNSSK meeting on 21 April 2022.

Discussions included the affect of the lower survey coverage during the Q1 survey in 2022, the planned new trawl and its introduction, and changes in maturity data (see Annex 4; Section A4.1). For the latter, the reader is also referred to ICES (2018).

6.3 Working Group for the Celtic Seas Ecoregion (WGCSE)

The current chair of WGCSE was unable to attend the joint session with IBTSWG, although several members of IBTSWG also participate in WGCSE. A summary of the 2021 surveys coordinated by the IBTSWG was presented at the WGCSE meeting.

6.4 Working Group for the Bay of Biscay and the Iberian Waters Ecoregion (WGBIE)

Several members of WGBIE attended a joint session of the IBTSWG meeting. A summary of the 2021 surveys coordinated by the IBTSWG was presented at the WGCSE meeting on 3 May 2022.

6.5 Working Group on Elasmobranch Fishes (WGEF)

The co-chairs of WGEF were unable to attend IBTSWG, although members of IBTSWG also contribute to WGEF. A summary of the 2021 surveys coordinated by the IBTSWG will be presented to WGEF in June 2022.

6.6 WK Pilot NS FIRG

Ingeborg de Boois gave a presentation on the background to the upcoming Workshop on Pilot North Sea Fisheries Independent Regional Observation (WK-Pilot NS-FIRMOG), which is scheduled to meet sometime in October/November 2022.

This workshop follows on from the recent Workshop on Realigning of the Ecosystem Observation Steering Group (WKREO; ICES, 2020). The latter workshop highlighted the need to move from fishery-independent single-species information towards improved integrated information for ecosystem-based advice. WKREO indicated that establishing Fisheries Independent Regional Monitoring Groups (FIRMOGs) may assist in this process, with WK-Pilot-NS the initial trial of such a forum. The ToRs for WK-Pilot-NS are to:

a) Compare a suite of currently used quantitative estimates from different fisheries independent monitoring activities on a regional level with the perception of importance of the survey for data users and policy people to describe the likely drivers for those views.
b) Synthesize a suite of currently used quantitative estimates from different fisheries independent monitoring activities on a regional level based on the outcomes of a).
c) Evaluate if the set up is feasible, based on the workshop experiences and the proposed tasks for FiRMOGS in the WKREO report. This evaluation includes an overview of elements that add value to the current organization of groups in ICES, as well as aspects that need to be improved to be useful, and elements that are not within reach and should not become tasks of the FiRMOGs.

It is expected that the maximum number of participants required for WK-Pilot-NS should be 30, allowing for representation from both different nations/institutes as well as different expertise (e.g. data collectors, data users, specialists in survey design, pelagic/demersal ecosystems, fish, shellfish, epifauna, environmental data etc.), and input from some relevant members of IBTSWG would be useful.

6.7 Other groups

IBTSWG envisages and plans further communication and collaboration with other relevant working groups, such as other assessment working groups (e.g. HAWG) and groups using the wider trawl survey data (e.g. for biodiversity studies and OSPAR).

There would also be merit in IBTSWG having closer communication with the Working Group on Biological Parameters (WGBIOP).

6.8 Recent studies using DATRAS data

IBTSWG are aware that the trawl survey data available on DATRAS continue to be used widely by the scientific community. Some of the recent published studies that have utilized DATAS are listed below, with members of IBTSWG involved in some of these papers.

- Bluemel, J.K., Fischer, S.H., Kulka, D.W., Lynam, C.P. and Ellis, J.R. 2022. Decline in Atlantic wolffish *Anarhichas lupus* in the North Sea: Affects of fishing pressure and climate change. *Journal of Fish Biology*, 100: 253–267.
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- Pan, R.Y., Kuo, T.C. and Hsieh, C.H. 2021. Hump-shaped relationship between aggregation tendency and body size within fish populations. *Ecography*, 44: 1418–1427.
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- Rademaker, M., Smallegange, I.M. and van Leeuwen, A. 2021. Causal links between North Sea fish biomass trends and seabed structure. *Marine Ecology Progress Series*, 677: 129–140.
- Sokolova, N., Butzin, M., Dahlke, F., Werner, K.M., Balting, D., Lohmann, G. and Pörtner, H.O. 2021. Exploring the role of temperature in observed interpopulation differences of Atlantic cod (*Gadus morhua*) growth with a 4-dimensional modelling approach. *ICES Journal of Marine Science*, 78: 1519–1529.
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6.9 Future work planned for the reporting cycle

IBTSWG intend to continue fostering improved communication and collaboration with other relevant expert groups using the data collected under the auspices of IBTSWG.

6.10 References

ICES (2018). Report of the Workshop for Advancing Sexual Maturity Staging in Fish (WKASMSF), 30 April - 4 May 2018, ICES Headquarters, Copenhagen, Denmark. ICES CM/EOSG: 38; 75 pp.

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Annex 1: List of participants

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Annex 2: Resolutions

2021/FT/EOSG01 The **International Bottom Trawl Survey Working Group (IBTSWG)**, chaired by Pia Schuchert*, Northern Ireland and Jim Ellis*, UK, will work on ToRs and generate deliverables as listed in the Table below.

	Meeting dates	Venue	Reporting details	Comments (change in Chair, etc.)
Year 2022	4-8 April	Online Meeting	Report by 20 May 2022 to EOSG	Outgoing: Ralf van Hal (Netherlands) and Pascal Laffargue (France). Incoming: Pia Schuchert, Northern Ireland and Jim Ellis, UK
Year 2023			Report by 20 May 2023 to EOSG	
Year 2024			Report by 20 May 2024 to EOSG	

ToR descriptors

ToR	Description	Background	Science Plan Codes	Duration	Expected Deliverables
a	Coordination and reporting of North Sea and Northeastern Atlantic bottom trawl surveys, including appropriate field sampling in accordance to the EU Data Collection Framework. Review and update (where necessary) IBTS survey manuals in order to achieve additional updates and improvements in survey design and standardization. (ACOM)	Intersessional planning of Q1, Q3 and Q4 surveys; communication of coordinators with cruise leaders; combining the results of individual nations into an overall survey summary. Intersessional activity, ongoing in order to improve survey and manuals quality.	3.1, 3.2	Recurrent annual update	1) Survey summary including collected data and description of alterations to the plan, to relevant assessment WGs and other EGs (WGCSE, WGNSSK, HAWG, WGBIE ,WGDEEP, WGWIDE, WGEEL, WGCEPH, WGEF, WGML) 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 4) Updated version of survey manual, whenever substantial changes are made.
b	Address DATRAS-related topics in cooperation with DGG: data quality checks and the progress in re-uploading corrected datasets, quality checks of indices calculated, and prioritizing further developments in DATRAS. (ACOM)	Issues with data handling, data requests or challenges with re-uploading of historical or corrected data to DATRAS have been identified and solutions are being developed	2.1, 3.1	Multi-annual activity.	Prioritized list of issues and suggestion for solutions and for quality checking routines, as well as definition of possible new DATRAS products, submitted to DATRAS group at ICES.

					Annual check of recent survey data.
c	Develop a new survey trawl gear package to replace the existing standard survey trawl GOV. (SCICOM)	The divergence in the GOV specification from the one given in the survey manual due to historical drift and technical creep has been acknowledged by the group (IBTSWG 2015). Furthermore, the deviation from the specification contained in the manual and between users has widened to the point where it will never be reversed. Therefore, the perefered option is to maintain the status quo of national GOV specifications and develop a new survey trawl package to replace the GOV. A number of IBTS members are due to replace vessels in the next few years and this provides an oppertunity to review time-series and undertake inter-calibration trials between the GOV and a new trawl. A further driver for a new gear has been highlighted by the Celtic Sea area where the necessity to optimize sampling opportunities are not been provided by the GOV. In parellel with trawl development the process of replacing the GOV will need to be defined with reference to continuing the assessments and existing time-series. (For this ToR, the IBTS WG seeks support from gear technology experts and welcomes their advice and input into the development of the new survey gear package)	3.1, 3.2	3 years	Final design(s); Full documentation of the gear, and how it should be rigged and operated at sea. Roadmap for implementing the gear in the ongoing survey. This will be developed at the WKFDN workshop as well as WKUSER 2 with support from WGISDAA and FTFB. There will also be linkages with the relevant assessment groups using IBTS data (WGNSSK, WGCSE, WGBIE, , WGWIDE, WGEF).
d	Evaluate the current survey design and explore modifications or alternative survey designs, identifying any potential benefits and drawbacks with respect to spatial distribution and frequency of sampling. Consider the effects of enforced changes in the distribution of survey stations (e.g. in relation to MPAs and offshore indutries). Explore potential additional data collection, e.g.	The requirements for the surveys are continuously evolving. Additional information, like dietary data, are also required, while reductions in other parts being sampled might be possible and wished for in relation to ethical discussions. New techniques, like eDNA sampling, might be relevant to add to the surveys. Furthermore, the ecological footprint of the survey (fuel consumption, bottom impact, impact in MPAs) is a	3.2	1-3 years	Resources permitting, stomach sampling program to be included in the NS-survey and in draft for the other regions

	stomach sampling and tagging (SCICOM) and engage with the Workshop on Pilot North Sea Fisheries Independent Regional Observation (WKPilot NS-FIRMOG).	topic having potential consequences for the current survey design.		
e	Making data from IBTS available to be used by different ICES end-users, such as assessment groups, OSPAR and others. Establish a communication with end user groups as to the needs of the users and the data available within DATRAS. Collate a user document that outlines the important caveats in the data with regards to non-target species (e.g. when a non-target species was first recorded as a species, the confidence in sampling). Establish a continued working relationship between user groups and survey group.	IBTS/DATRAS has got a wealth of data, which might be used in a number of applications. Originally set up to collect data on target species, data on other species and environmnental factors were often collected (sometimes sporadically), and the identification to species-level of some taxa has been dependent on the available time, the SIC at the time and the knowledge of the team. Using data without previous knowledge on all these factors could result in invalid assumptions. To get the most value out of the surveys, there needs to be a clear communication established with data users and the survey team. Often the current SIC or survey team does not even know how the data were collected historically. It is important to get a deeper understanding of the historic processes and how to progress into the future.	Multi-annual project	Establish closer coordination and communication channels with user groups and possible user groups: how do they use the data, how can we enhance the value of the data, what questions do arise? In which format should (historical) documentation be provided? Establish a guideline with user groups. What is actually being read, what is important. Create a more detailed chronology of historical and contemporary surveys, with this bing a 'live document' (to be taken forward) about survey data capabilities and issues. Enable users to interact with the survey team to establish new possibilities, e.g. use the data for multispecies analysis, biodiversity questions. Also a personal link between users and survey people will enable the users to form specific requests or propose collaborative work.

Summary of the Work Plan

Year 1	**Develop a roadmap for the implementation of the new survey gear (ToR c) ; Develop a stomach sampling program for the NS-IBTS and drafts for the other regions (ToR d).**
Year 2	Start the implementation of the roadmap for the new survey gear (ToR c); Depending on the outcomes of stomach sampling during the North Sea IBTS in year 1, and the resources available, refine and extend the stomach sampling programme as appropriate.
Year 3	Continue the roadmap of the new survey gear.

Recurrent annual activity	Updates for ToRs a, and b and initiate and updates for ToR e.

Supporting information

Priority	Essential. The general need for monitoring fish abundance using surveys is evident in relation to fish stock assessments, and it has increasing importance in relation to MSFD GES descriptors, including biodiversity, foodwebs, populations of commercially exploited fish species, sea floor integrity and marine litter.
Resource requirements	A 5-day IBTS meeting. Prepared documents from members following ToR Leaders identified above. 8-day Chair's time to edit. It is estimated that each ToR will require at least 8 hours of preparation.
Participants	The Group is normally attended by some 25–30 members and guests.
Secretariat facilities	SharePoint plus normal secretariat support.
Financial	No financial implications.
Linkages to ACOM and groups under ACOM	ACOM. IBTS indices are used in the assessment of multiple stocks.
Linkages to other committees or groups	There are relations with other bottom-trawl surveys (WGBEAM, WGBIFS) that also use DATRAS as the international repository for its data (WGDG, DIG). There are also linkages with Assessment WGs using IBTS indices. Also relevant to the Working Group on Ecosystem Effects of Fishing Activities (WGECO) , the Working Group on Improving use of Survey Data for Assessment and Advice (WGISDAA), Working Group on Integrating Surveys for the Ecosystem Approach (WGISUR), Working Group on Biodiversity Science (WGBIODIV) and the Workshop on Pilot North Sea Fisheries Independent Regional Observation (WKPilot NS-FIRMOG).
Linkages to other organizations	IOC, GOOS, OSPAR, Regional Coordination groups (DCF).

Annex 3: List of survey names and survey codes

Survey	Nation	ICES divisions	Quarter	Survey Code
North Sea IBTS-Q1				
NS-IBTS	INT	3.a, 4.a–c, 7.d (in part)	1	G1022
North Sea IBTS-Q3				
NS-IBTS	INT	3.a, 4.a–c	3	G2829
North-eastern Atlantic surveys				
SCOWCGFS	GB-SCT	6.a	1	G4748
SCOWCGFS	GB-SCT	6.a, 7.b	4	G4815
SCOROC	GB-SCT	6.b	3	G4436
NIGFS	GB-NIR	7.a	1	G7144
NIGFS	GB-NIR	7.a	4	G7655
IE-IGFS	IE	6.a, 7.b, 7.g–j	4	G7212
IE-IAMS	IE	6.a, 7.b–c, 7.j–k	1–2	G3098
EVHOE	FR	7.e–j. 8.a–b,d–e	4	G9527
FR-CGFS	FR	7.d–e	4	G3425
SP-PORC	ES	7.b,c,k	3	G5768
SP-NORTH	ES	8.c, 9.a (north)	4	G2784
SP-ARSA	ES	9.a (south)	1	G7511
SP-ARSA	ES	9.a (south)	4	G4309
PT-IBTS	PT	9.a	4	G8899

Annex 4: Report of North Sea IBTS-Q1

(Coordinator: Ralf van Hal)

A4.1 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 Subarea 4 and Divisions 3.a and 7.d. During daytime a GOV (Grand Ouverture Verticale) bottom trawl, with ground gear A or B, was used to sample fish, with age data collected for the target species (cod, haddock, whiting, saithe, Norway pout, herring, mackerel, and sprat) and a number of additional species. 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). Dietary data (stomachs) were collected for whiting, monkfish and megrim.

The 2022-Q1 fleet consisted of seven vessels: “Dana” (26D4, Denmark), “GO Sars” (58G2, Norway), “Scotia” (748S, Scotland), “Thalassa” (35HT, France), “Walther Herwig III” (06NI, Germany), “Tridens II” (64T2, Netherlands) and “Svea” (77SE, Sweden). The survey covered the period 18 January to 24 February 2022 (Table A4.1).

A total of 248 GOV hauls (11 of which were invalid; Table A4.2) were uploaded to DATRAS and 433 valid MIK hauls (Table A4.3) were deployed. 26 rectangles were not covered at all with the GOV, and a larger number of the other rectangles were only covered once (Figure A4.1). Similar issues in coverage occur related to MIK hauls. One of the Norwegian GOV hauls was deployed in the Norwegian Trench (denoted area X in Table A4.2)

Biological data (weight and/or gender and/or maturity and/or age material) were collected for a number of species (Table A4.4). Coordinated stomach collection was undertaken for whiting, monkfish and megrim (Table A4.5) An impression of the catches is given in Figure A4.2, by presenting the total fish catch (mean kg per haul per rectangle). Gear geometry plots are given in Figures A4.3a to A4.3d (lines represent theoretical values for the GOV from flume tank experiments, ICES 2015).

The IBTS 2022 was affected by severe weather conditions. Four named-storms (Corrie, Dudley, Eunice and Franklin) passed over the North Sea during the survey period survey. The storms have a direct affect on the execution of the survey, as participants were unable to sample during the storms. Directly following the storms, the sea state was still sufficiently rough to affect sampling. The storms might also affect the catches in the days following storms. As observed by Denmark off the Danish west coast. there was high turbidity resulting in low visibility at the shallow stations caused by the windstress. The low visibility might affect the catchability of roundfish due to its influence on the herding of these species (Wieland *et al.*, 2009).

In recent years, various participants had issues receiving permits to enter and survey in UK waters. This year all participants received the permits in time, and also the additional permits for entering and sampling in MPAs and SACs were received without any delays.

Remarks

Scotland reported their data with datatype=P (Pseudocategory sampling). With re-uploads of older data they will change the datatype to P in historic years as well (see ICES, 2021).

Maturity data are uploaded in the A–E format by Denmark, France and the Netherlands, while being uploaded in the 61–66 format by the other countries.

No staff exchange occurred during the IBTS-Q1 in 2022. COVID-19 made it difficult to execute the surveys already, and additional travelling or staff exchange was either not allowed or not encouraged by institutes this year.

A4.2 Issues and problems encountered

The above-mentioned weather conditions were, obviously, a major issue. However, the mechanical issues experienced by Scotland and Netherlands and the COVID-related issues experienced by Germany and Denmark also caused problems for the proper execution of the survey this year.

The Scottish issue resulted in the cancelation of the survey after five days. The Dutch mechanical issue resulted in the vessel needing to steam from the most northern part back to the Dutch harbour Scheveningen. Fortunately, repairs could take place over the weekend allowing reasonably quick departure again. However, it occurred in the middle of the only long stint of 10 days which is the only possibility for the Dutch to cover their survey stations in the north. The shipping company was fortunately flexible enough to combine the last two weeks into another long stint of 10 days. If that would not have occurred, covering the northern part of the Dutch survey would not have been possible. The COVID-issue in Germany resulted in that the vessel had to stay in the harbour for the first weeks of their survey period. In Denmark it resulted in less experienced staff having to undertake the survey resulting in a reduced number of hauls that could be done per day.

The presence of huge amounts of bryozoans in the Dutch coastal areas resulted in a single Dutch haul in 35F4 being declared invalid, as it was impossible to handle and sort the catch owing to the amounts in the net. Various countries encountered this issue in the same area in the Q3 IBTS, as did the various Dutch beam trawl surveys in the same area.

For a second year in a row, the German net opening was unexpectedly high, especially in shallow water Figure A4.3b. A reason might be the short warp length used at the shallow waters, but it is likely related to the new Marport sensors used in the last two surveys. Germany will investigate this issue on their upcoming surveys.

A4.3 Additional activities

In addition to the GOV and MIK tows, all countries have collected additional data. All countries collected seabed 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 A4.6.

A4.4 Trawl survey results

The preliminary indices for the recruits of seven commercial species based on the 2022 Q1 survey were not produced this year. The straightforward calculation of these indices would have been inappropriate given the incomplete and reduced spatial coverage of the survey.

Distribution maps of the 1-groups of NS-IBTS target species with the limits of the species-specific stock assessment or index areas are given in Figures A4.4a to A4.4e.

A4.5 MIK sampling

During the International Bottom Trawl Survey in the first quarter (Q1 IBTS), night-time catches are conducted with the MIK net, a fine meshed (1600 μm) 2-m midwater ringnet (ICES, 2017) providing abundance estimates for large herring larvae (0-ringers) of autumn spawning stock components. In addition, the Q1 IBTS also provides the time-series for the 1-ringer herring abundance index in the North Sea from GOV catches carried out during daytime.

The total abundance of 0-ringers in the survey area is used as a recruitment index for the stock. Since 2017, this 0-ringer index (also called MIK index) time-series is calculated with a new algorithm, which excludes larvae of Downs origin more rigorously. This is done by excluding the smaller larvae – presumably of Downs origin – from the analyses in certain parts of the survey area. The index from the 2022 survey (corresponding to the 2021 year class) is 47.8. This is one of the lowest values in the time-series, with only four other year classes being even lower (2003, 2007, 2014 and 2016).

The 2022 IBTS survey was faced with numerous challenges concerning the weather as well as technical and Covid-19 related issues (for details see Section 2.2 and above), which also affected the MIK sampling. Only 433 depth-integrated hauls were completed with the MIK-net, which was only approximately 60% of the planned MIK stations. However, thanks to intensive coordination between participants during the survey and improved weather in the final part of the survey period, at least 1 MIK haul could be conducted in most ICES rectangles. Nevertheless, 24 rectangles were not covered at all by the MIK sampling, but these were mainly located in the north-western parts of the survey area and usually yield small numbersmall numbers of herring larvae. Thus, the majority of the main herring larvae distribution area could be covered, and several data tests showed that the poor coverage had only a minor effect on the index. In summary, despite the encountered issues and low overall number of MIK hauls, it can be assumed that the 2022 MIK survey provides a representative 0-ringer index.

Figure A4.5 shows the size distribution of MIK larvae in 2022. Herring larvae measured between 7 and 44 mm standard length (SL). Again, and as in most years, the smallest larvae <12 mm were the most numerous and the larvae between 7 to 11 mm made up almost 50% of the total number of larvae. Larger larvae (>18 mm SL) were rarer, making up about 10% of all larvae, and were caught in lower densities than last year. An interesting feature in the 2022 length distribution is the peak at 15 mm SL. Figure A4.6 illustrates the spatial distribution of 0-ringers in 2020, 2021 and 2022. The smallest larvae were chiefly caught in 7.d and in the Southern Bight. The large larvae appeared in moderate to high quantities in both the central, western and southern parts of the North Sea. In the southeastern and eastern part of the North Sea, the potential nurseries, abundance of large herring larvae was lower than last year.

As in previous years, sardine larvae were again found in the samples. Most sardine larvae occurred in the southern and south-eastern North Sea as well as in the Skagerrak.

References

ICES. 2015. Report of the International Bottom Trawl Survey Working Group (IBTSWG), 23–27 March 2015, Bergen, Norway. ICES CM 2015/SSGIEOM:24; 278 pp.

Wieland, K., Olesen, H.J., Fenger Pedersen, E.M. and Beyer J.E. 2011. Potential bias in estimates of abundance and distribution of North Sea cod (*Gadus morhua*) due to strong winds prevailing prior or during a survey. *Fisheries Research*, 110: 325–330.

Table A4.1. Overview of the surveys performed during the North Sea IBTS Q1 survey in 2022. In grey fishing activity, in purple no fishing due to storm, in red no fishing due to mechanical issues.

									January															**February**																									
country	**Vessel**	10	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	24	25	26
Sweden	Svea (77SE)											2	4	2	3	4	3	4	3	3	2		4	4	3																								
France	Thalassa II (35HT)									2	3	3	2	2	3	3	3	3	3	2				3	4	4	3	3	3	3	1																		
Norway	GO Sars (58G2)																	1		3			2			3	2	1	3	3			1	3	3	4	4	3	1	1	3	3	3						
Germany	Walther Herwig III (06NI)																														2	3	4																
Scotland	Scotia III (748S)				active fishing										4	2	2	4	3																														
Denmark	Dana (26D4)				due to weather no activities															4				2	1	4				2	4	4	2	2		2													
Netherlands	Tridens 2 (64T2)				mechanical/COVID issues											3	4	4	3						4	1				2	4	4	4				2	4	4	1	3	3	4		1				

Table A4.2. Overview of the GOV stations sampled in the North Sea IBTS Q1 survey in 2022.

ICES divisions	Country	Gear	Tows			% stations fished
			Planned	Valid	Invalid	
3.a	SWE	GOV-A	40	32	3	80%
	DEN	GOV-A	3	3		100%
	NOR	GOV-A	3	0		0%
4.a–c	GFR	GOV-A	67	10		15%
	SWE	GOV-A	6	5		83%
	NO	GOV-A	41	47	1	115%
	FRA	GOV-A	43	40	3	93%
	DEN	GOV-A	42	23	1	55%
	NED	GOV-A	57	53	2	93%
	SCO	GOV-A	11	14	1	127%
	SCO	GOV-B	46			0%
7.d	FRA	GOV-A	10	10		100%
X	NO	GOV-A	1	1		100%

Table A4.3. Overview of the MIK stations sampled in the North Sea IBTS Q1 survey in 2022.

ICES divisions	Country	Gear	Tows		% stations fished
			Planned	Valid	
3.a	SWE	MIK	41	37	90%
	DEN	MIK	8	8	100%
4.a–c	GFR	MIK	134	17	13%
	SWE	MIK	12	9	75%
	NO	MIK	84	85	101%
	FRA	MIK	86	86	100%
	DEN	MIK	84	46	55%
	NED	MIK	114	100	88%
	SCO	MIK	116	28	24%
7.d	FRA	MIK	20	17	85%

Table A4.4. Overview of individual length, weight and/or maturity and/or age samples collected during the North Sea IBTS Q1 survey in 2022.

Species	DE	DK	FR	GB-SCT	NL	NO	SE	Total
Melanogrammus aeglefinus	10	187	90	345	2276	6055	274	9237
Clupea harengus	171	368	407	190	604	1577	1116	4433
Merlangius merlangus	48	298	894	172	412	1092	610	3526
Pleuronectes platessa	76	278	825	108	315	31	300	1933
Sprattus sprattus	107	120	452	106	325		529	1639
Scomber scombrus	2	16		16	51	956	70	1111
Trisopterus esmarkii		57	5	121	114	575	153	1025
Gadus morhua	6	39	55	75	171	408	202	956
Micromesistius poutassou						381		381
Pollachius virens		2		3	8	263	22	298
Limanda limanda		149						149
Mullus surmuletus			118					118
Glyptocephalus cynoglossus		16		1			98	115
Scyliorhinus canicula	5				18	89		112
Eutrigla gurnardus		99						99
Solea solea			64				20	84
Microstomus kitt	15	47		18				80
Lepidorhombus whiffiagonis						80		80
Merluccius merluccius				11	14	7	37	69
Lophius piscatorius		2		9	8	46		65
Mustelus sp.						60		60
Raja montagui		6		33	10			49
Sardina pilchardus						36		36
Platichthys flesus		17						17
Trachurus trachurus						14		14
Squalus acanthias						13		13
Leucoraja naevus		1		4		7		12
Engraulis encrasicolus	1	10						11

Amblyraja radiata	5	3				8
Raja clavata	1	4		3		8
Dipturus intermedius			7			7
Scophthalmus maximus		4				4
Lophius budegassa					3	3
Raja brachyura			2	1		3
Nephrops norvegicus					2	2
Galeus melastomus					1	1
Leucoraja fullonica			1			1
Molva molva				1		1

Table A4.5. Overview of stomach samples collected during the North Sea IBTS Q1 survey in 2022.

Species	DE	DK	FR	GB-SCT	NL	NO	SE
Merlangius merlangus	36	156	523	37	412	463	310
Lophius piscatorius	0	2	0	7	8	46	0
Lophius budegassa	0	0	0	0	0	3	0
Lepidorhombus whiffiagonis	0	0	0	0	0	80	0

Table A4.6. Overview of additional activities undertaken in the North Sea IBTS Q1 survey in 2022.

Activity	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
Egg samples (Small fine-meshed ringnet; CUFES)	x	x	x	X	x		x
By-caught benthic animals		x			x		x
Fish/Benthic genetics		x			x	x	
Fish diet	x	x	x	X	x	x	x
Fish tagging					x		
Additional biological data on fish		x	x	X	x	x	
Observer for mammals and/or birds							x
Zoo and phytoplankton		x					x

Jellyfish	x	x
Hydrological transects		x

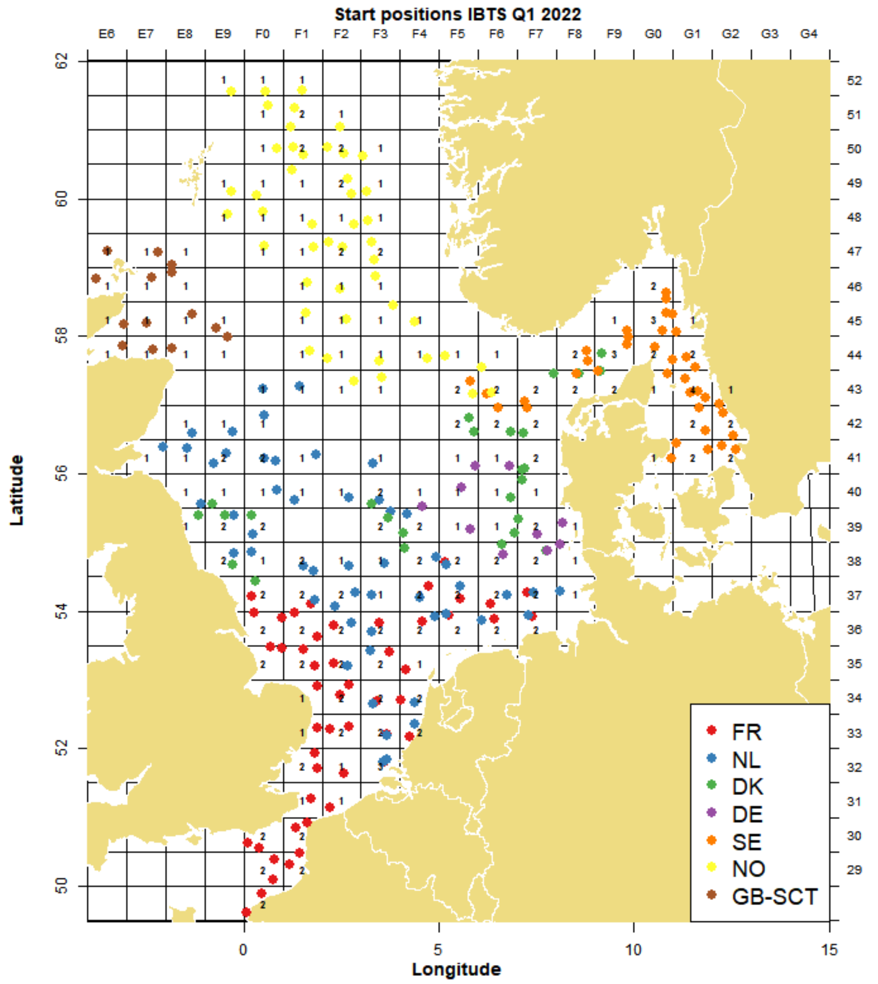

Figure A4.1 Number of hauls per ICES rectangle with GOV during the North Sea IBTS Q1 2022 and the start positions of the trawls by country.

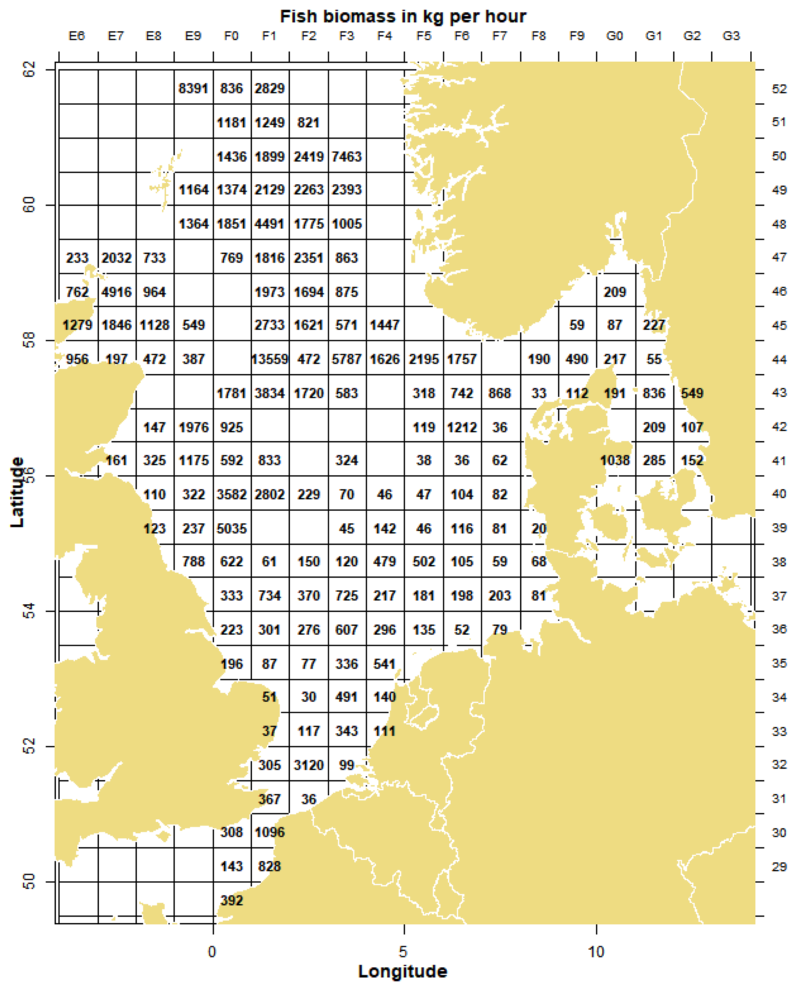

Figure A4.2. Distribution of fish biomass in IBTS hauls by rectangle in the North Sea, Q1 2022 (values standardized to kg per hour haul duration; mean per rectangle).

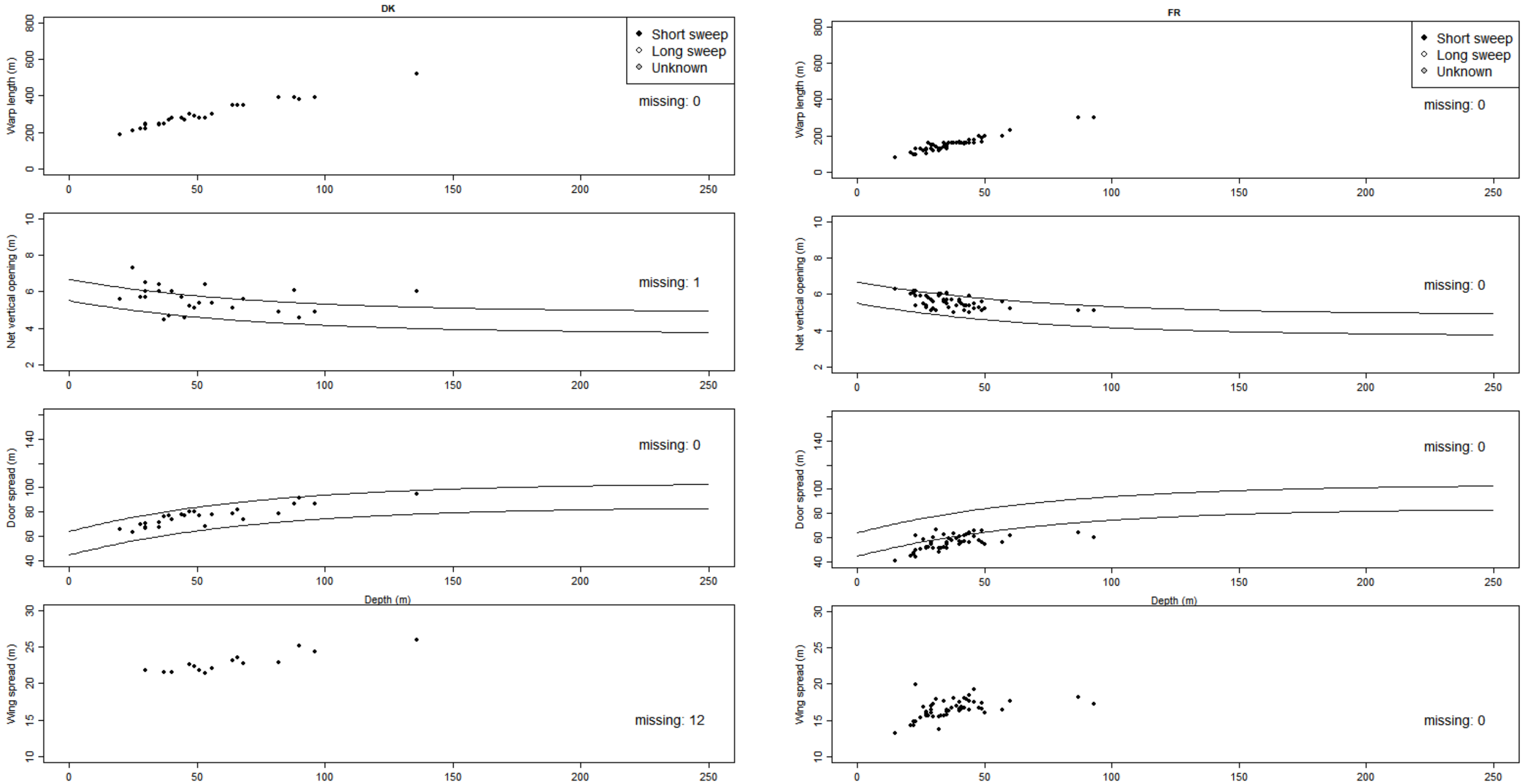

Figure A4.3a. Danish and French warp length and gear geometry

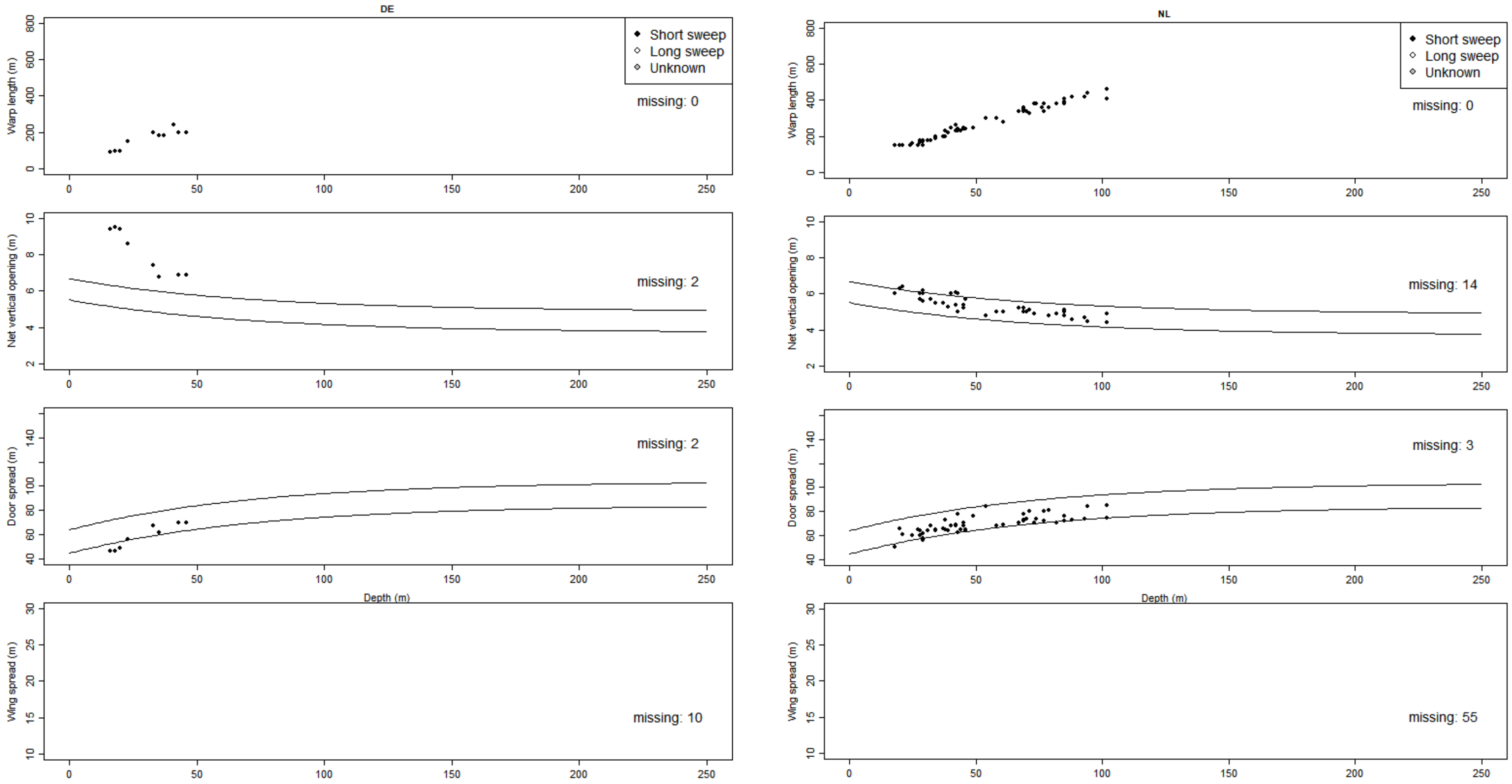

Figure A4.3b. German and Dutch warp length and gear geometry.

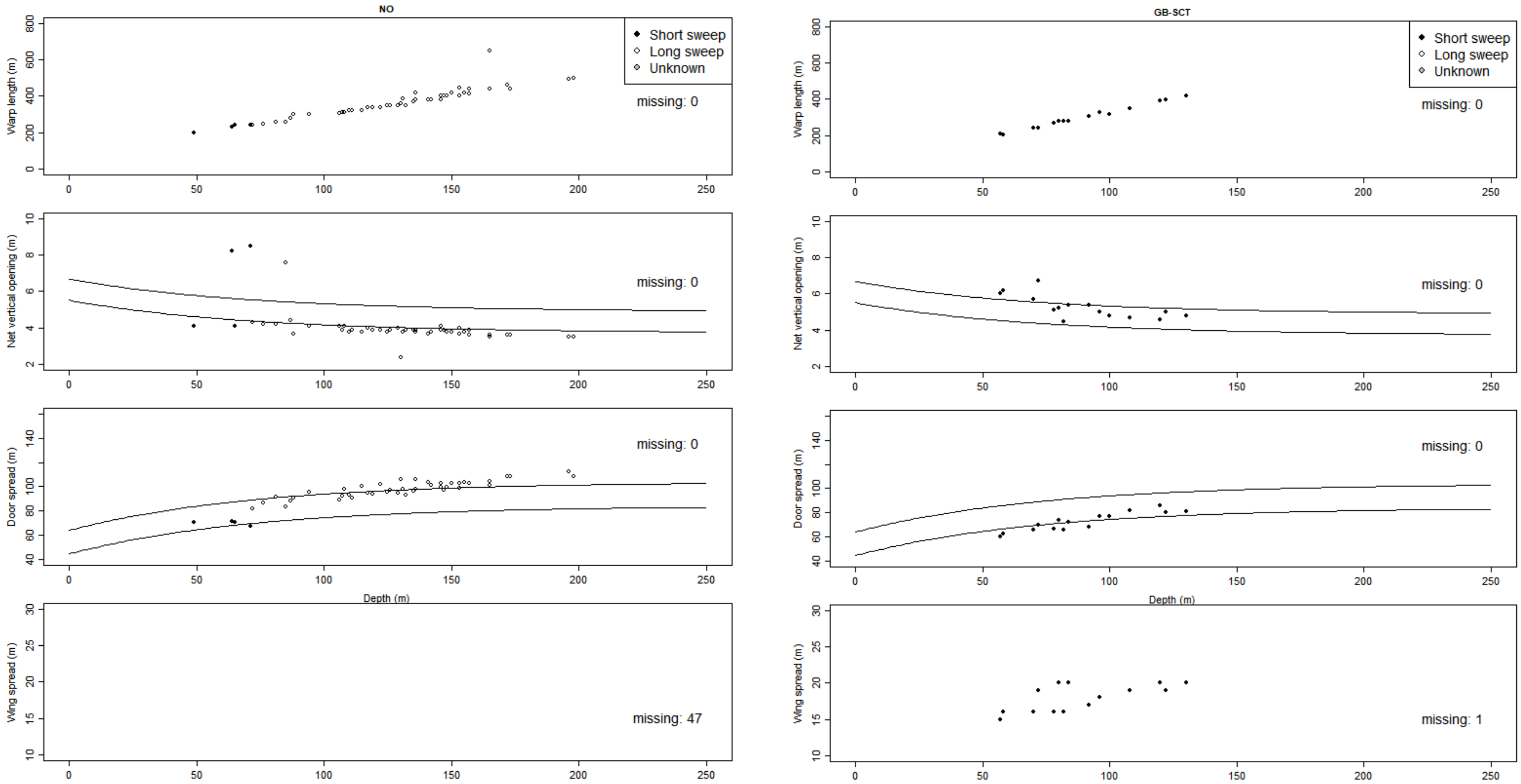

Figure A4.3c. Norwegian and Scottish warp length and gear geometry.

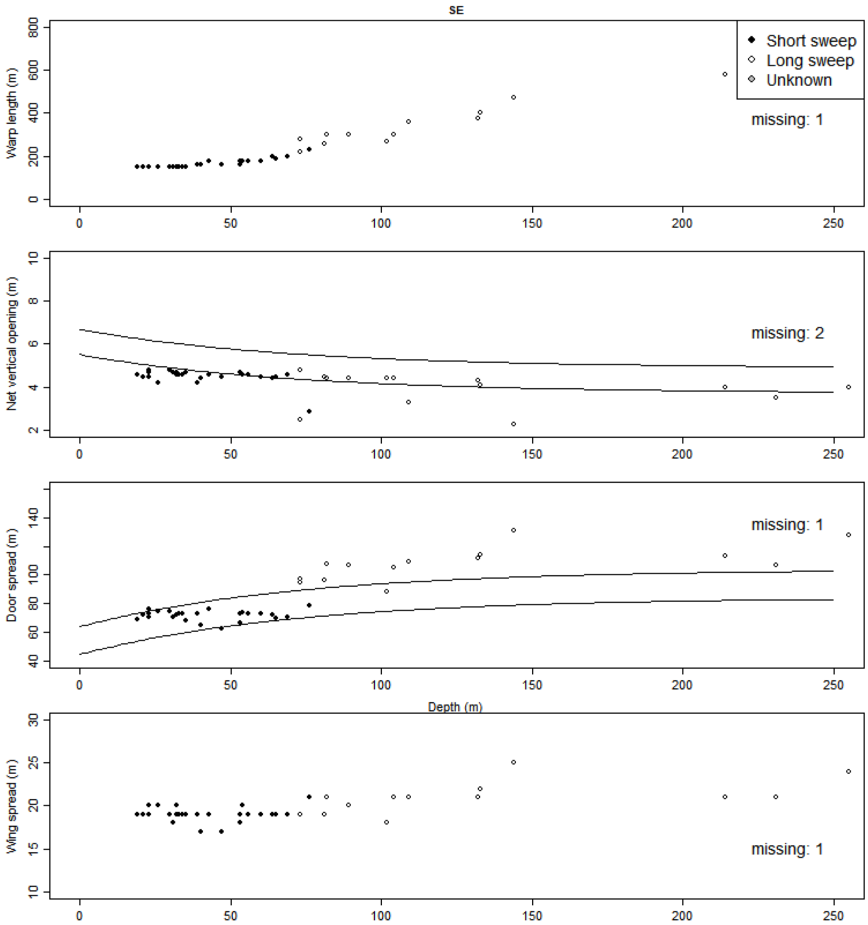

Figure A4.3d. Swedish warp length and gear geometry. Note: Hauls deeper than 70 m in the Skagerrak are carried out using long sweeps.

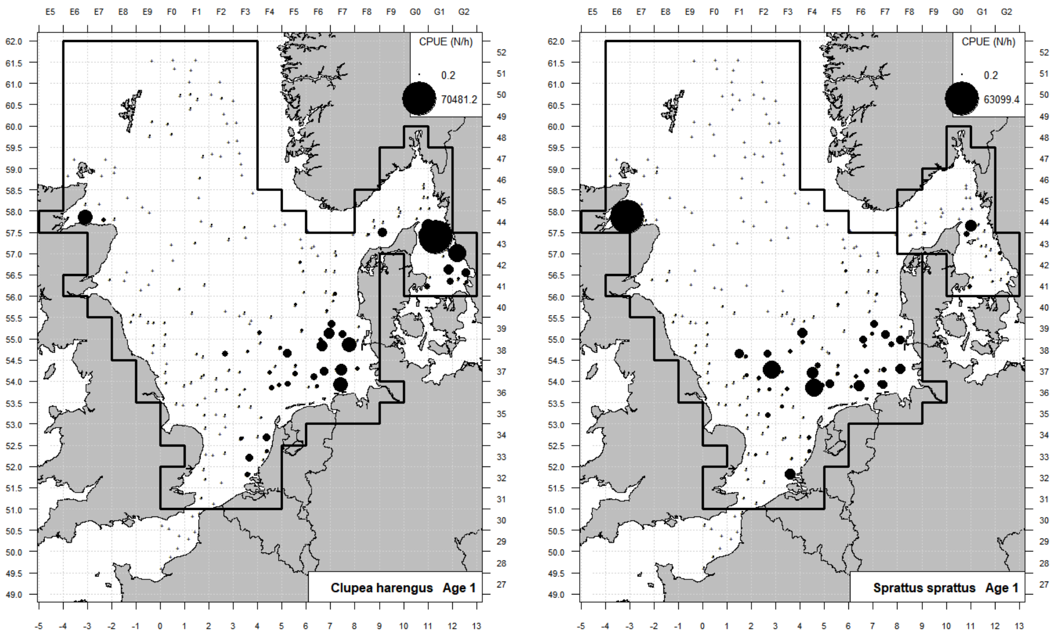

Figure A4.4a. Distribution of herring and sprat age 1 in the quarter 1 IBTS 2022 (thick lines: index areas for sprat in Q1 but for herring in Q3).

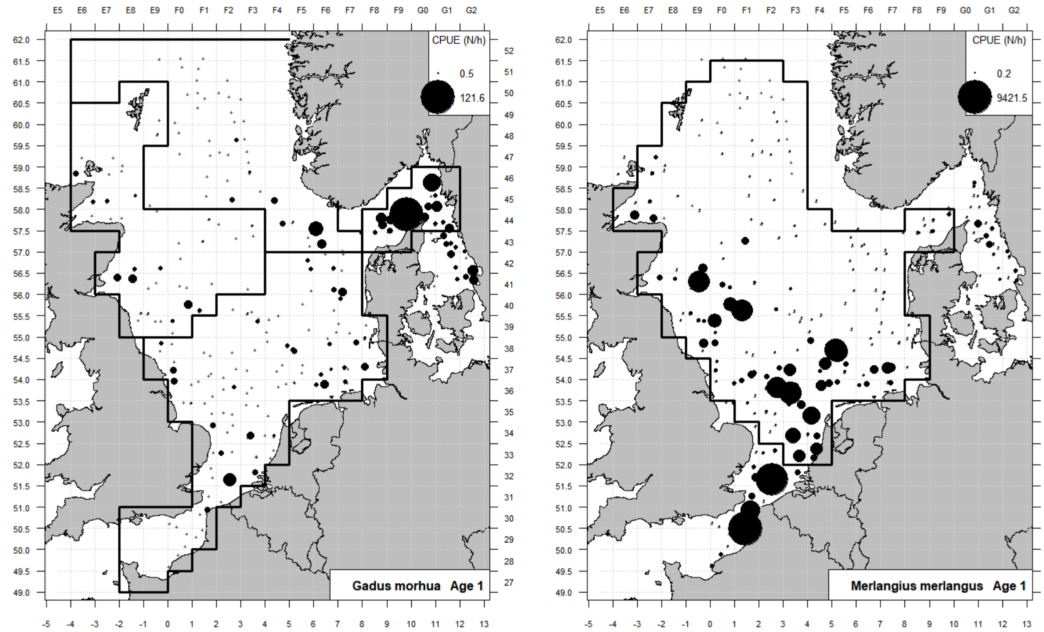

Figure A4.4b. Distribution of cod and whiting age 1 in the quarter 1 IBTS 2022 (thick lines: Subpopulation separation for cod, index areas for whiting).

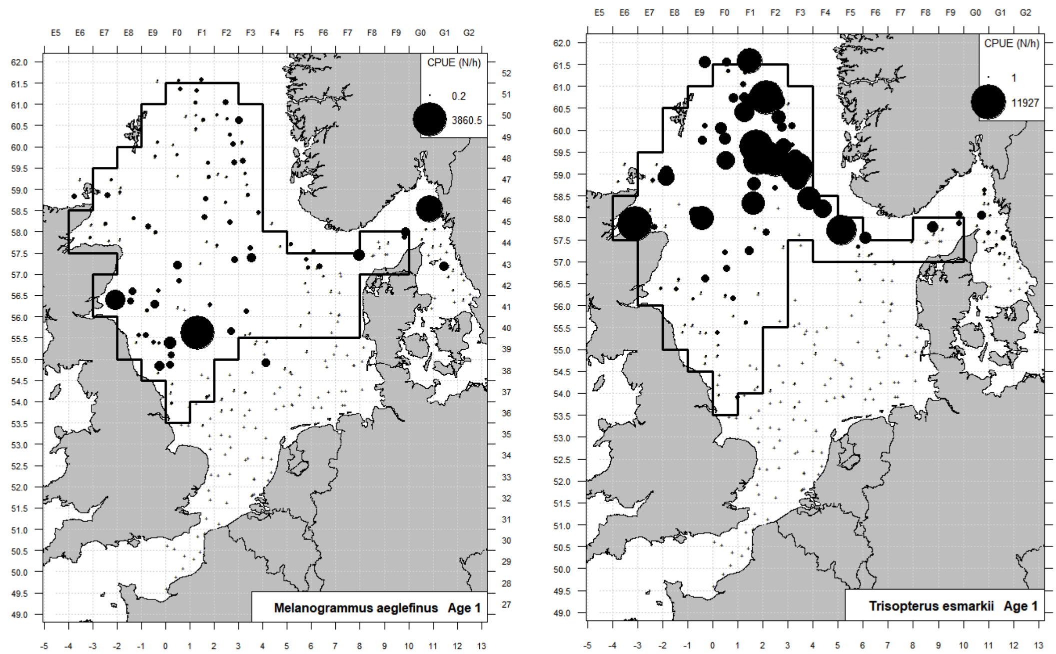

Figure A4.4c. Distribution of haddock and Norway pout age 1 in the quarter 1 IBTS 2022 (thick lines: index areas).

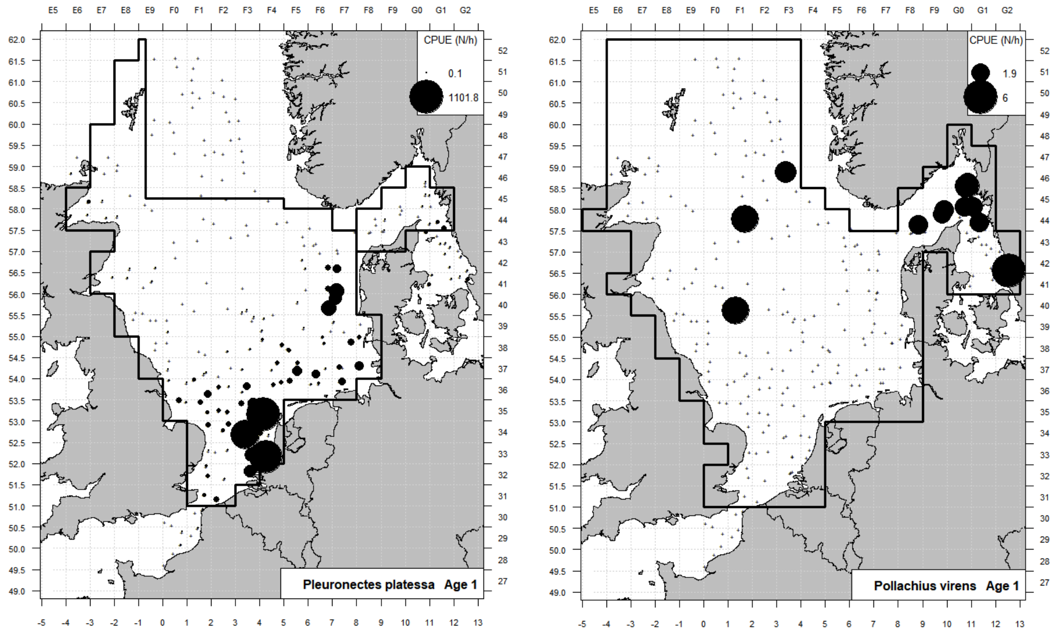

Figure A4.4d. Distribution of plaice and saithe age 1 in the quarter 1 IBTS 2022 (thick line: old index areas).

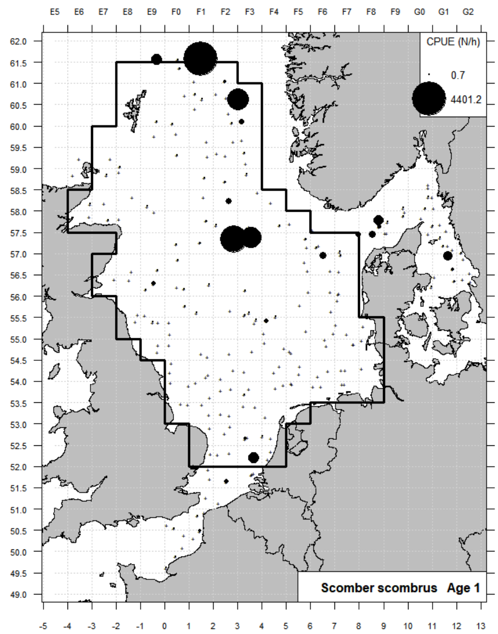

Figure A4.4e. Distribution of mackerel age 1 in the quarter 1 IBTS 2022 (thick line: index area).

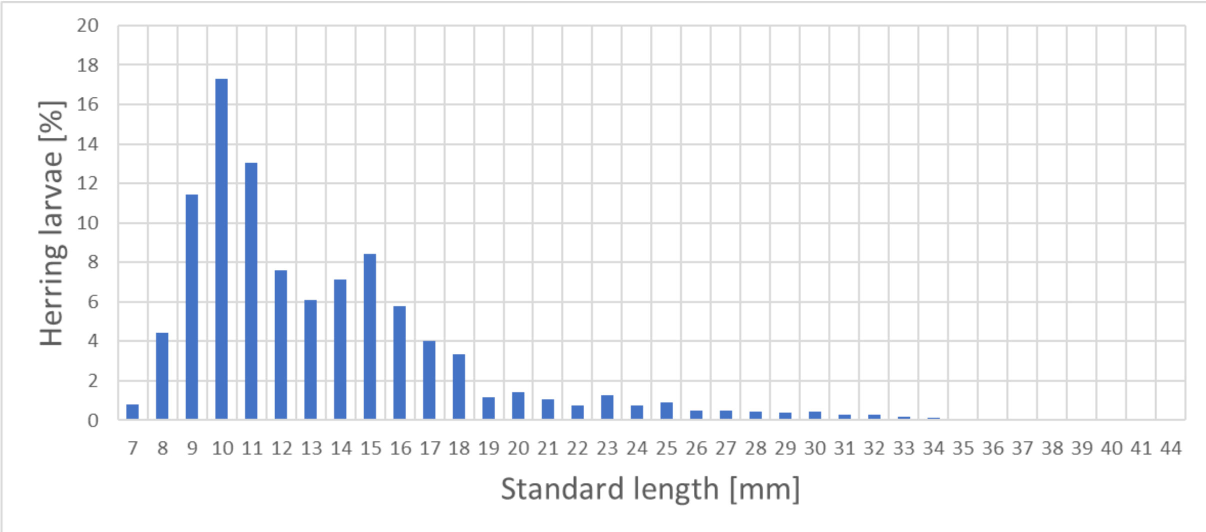

Figure A4.5. North Sea herring. Length distribution of all herring larvae caught in the MIK during the 2022 Q1 IBTS.

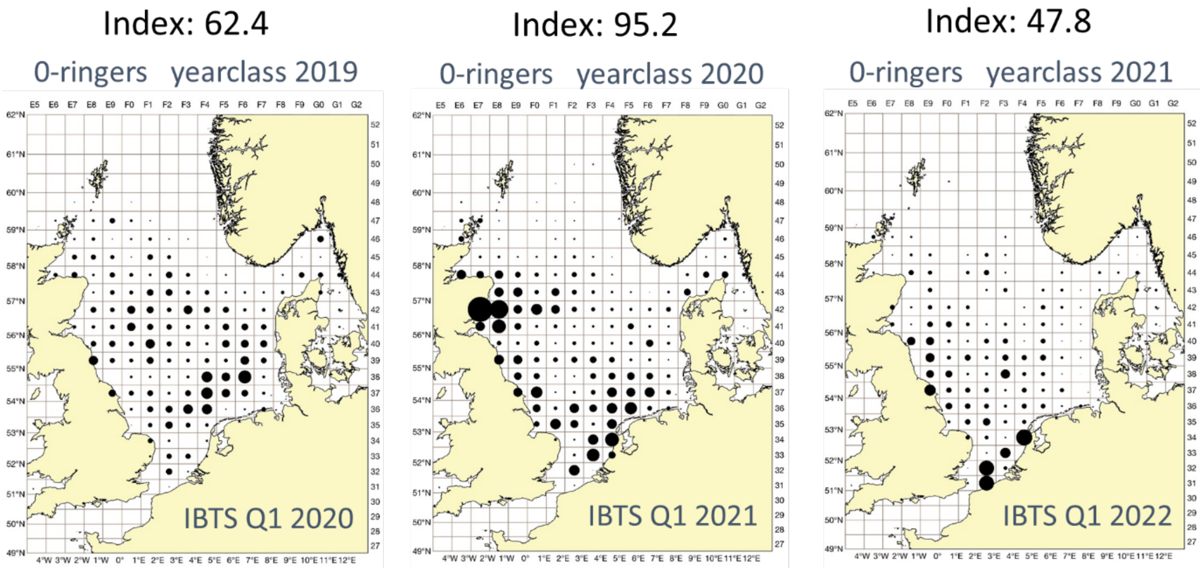

Figure A4.6. North Sea herring. Distribution of 0-ringer herring, year classes 2019–2021. Density estimates of 0-ringers within each statistical rectangle are based on MIK catches during IBTS in January/February 2020–2022. Areas of filled circles illustrate densities in no m-2, the area of the largest circle represents a density of 3.82 m-2. All circles are scaled to the same order of magnitude of the square root transformed densities.

Annex 5: Report of North Sea IBTS-Q3

(Coordinator: Kai Wieland)

A5.1 General overview

Five vessels participated in the 2021-Q3 survey: “Dana” (Denmark and Germany), “Kristine Bonnevie” (Norway), “Cefas Endeavour” (England), “Scotia” (Scotland) and “Svea” (Sweden). Due to a technical breakdown, “Walter Herwig III” was not available. Germany joined the Danish survey with “Dana” which was extended to cover an additional 26 stations allocated to Germany. Other countries covered the remaining German stations in the northern part of the survey area (England and Scotland: two stations each; Norway: three stations).

The overall sampling period extended from 22 July to 9 September (Table A5.1). Denmark and Sweden conducted their survey relatively late compared to the other countries and previous years.

In total, 349 valid standard GOV hauls were made in the planned rectangles (Table A5.2). The number of rectangles with only one haul was less than in any year since 2010, but three rectangles were not covered at all. A few rectangles did not get sampled by two hauls, but these were generally rectangles that are covered largely by land, have a small amount of area at depths < 250 m (the maximum survey depth limit; Figure A5.1), or in which only a few trawlable areas are known that can be fished with the GOV without risk of gear damage.

All standard hauls were planned of 30 min duration. However, 34 tows reported as valid to DATRAS were shorter than 25 minutes (Table A5.3). This may indicate that it is becoming increasingly difficult to find full 30 min tracks due to the increasing number of obstacles (e.g. wind farms, cables and pipelines) in the North Sea. In addition, rough bottom conditions in parts of the survey area make it difficult to find alternative tracks which are suitable for the GOV. Four of the short tows, classified as valid (no trawl damages) were even shorter than 15 min, and this was due to a mass occurrence of bryozoans in the south-eastern part of the area covered by the joint Danish/German survey (see Section 2.2).

Biological data (weight, sex, maturity stage, and age material) were collected for many species (Tables A5.4–A5.5); maturity stage can be difficult to determine outside of the spawning period and was therefore not recorded as routinely as in quarter 1.

A5.2 Additional activities

All countries are required to collect data on litter found in the GOV catches and CTD data (temperature and salinity, oxygen for some countries) at all GOV stations when possible. A list of other additional activities undertaken is given in Table A5.6.

A5.3 Gear geometry

The current manual (ICES 2020: SISP 10 Revision 11) no longer specifies a fixed warp length to depth ratio, as this may not be appropriate to the different survey vessels. It has, however, been emphasized that each country should carefully measure net geometry, i.e. door spread and headline height over bottom (vertical net opening) and, if possible, wing spread. Nations should also adhere to their “historical” standards for warp length-to-depth as far as possible. The number of missing observations of these parameters by nation are listed in Table A5.7.

The applied warp length to depth ratio and the observed values for vertical net opening, door spread and, if available, wing spread, are shown in Figures A5.2a-c by country and are compared across countries in Figure A5.3. Most observed values for door spread were close to the theoretical values. For wing spread, missing values and highly variable observations were common. Differences between the countries were most pronounced for vertical net opening for which the values for Sweden and, in particular, Norway were much lower than those for the other countries. The Norwegian data have been revised and an updated submission to DATRAS has been made (upload date 08/04/2022).

Differences in swept-area at depth based on door spread between the countries were encountered where in particular the values for Scotland (low door spread and low groundspeed) deviated from the others (Figure A5.4).

All country fished according to the manual with a speed over ground (SOG) between 3.5 and 4.5 knots. On average, SOG was about 4 knots for Denmark, England and Germany, 3.9 knots for Norway and about 3.7 knots for Scotland and Sweden (Figure A5.5). The instances of lower average SOG were related to either a need to ensure that the same SOG could be applied irrespective of weather conditions and tidal currents (Scotland) or for historical reasons (Sweden).

A5.4 Distribution of target species

Distribution maps (in number per km^2, swept-area based on door spread) for the recruits of the NS-IBTS standard species for the 2021-Q3 survey are shown in Figures A5.6.

A5.5 Other issues

Staff exchange: A mixed Danish/German team worked successfully together during the joint survey with RV Dana. IBTSWG continues to encourage staff exchange.

Data exchange: During the cruises, information about successfully completed hauls are regularly exchanged between survey vessels. It has been agreed that preliminary indices based on length splitting for the standard species will no longer be exchanged during the Q3 survey, since the final data for the NS-IBTS main target species (if not all species), including age information, were usually submitted to DATRAS within 2–3 weeks after completion of the survey. This, however, has not been the case in the past two years and thus preliminary length-based indices might be produced shortly after the survey using HH and HL records provided by the participants.

Table A5.1. Sampling periods in the North Sea IBTS Q3 survey in 2021.

	July											August																															September									
Country	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	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10
DEN/GER																														■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
ENG		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■																									
NOR		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■																																
SCO								■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■																									
SWE																																			■	■	■	■	■	■	■	■	■	■	■	■						

Table A5.2. Overview of valid GOV stations fished in the North Sea IBTS Q3 survey in 2021 (*: DEN missing valid in 35F4, NOR missing valid tows in 52E9 and 52F1; experimental tows are usually not reported to DATRAS but should be available at https://github.com/ices-eg or IBTSWG 2022 sharepoint).

ICES Division	Country	Gear	Number of tows planned (IBTSWG 2021)	Number of valid tows (as planned*)	Proportion of requested stations fished (%)	Number of additional valid tows	Number of additional experimental tows
3.a	SWE	GOV-A	25	25	100	19	-
4.a–b			3	3	100	0	-
3.a	DEN	GOV-A	4	4	100	0	-
4.a–c			48	47	98	0	-
	ENG	GOV-A	78	78	100	2	-
	GER	GOV-A	32	26	88	0	-

4.a–b	NOR	GOV-A	49	47	96	2	2 (deep water)
4.a	SCO	GOV-B	50	50	100	4	-
4.b		GOV-A	40	40	100	2	-

Table A5.3. Achieved tow durations in valid tows (by country) during NS-IBTS-Q3 in 2021.

Nominal tow duration (min)	DEN	ENG	GER	NOR	SCO	SWE	Total
5	1	0	0	0	0	0	1
6	2	0	0	0	0	0	2
13	1	0	0	0	0	0	1
14	0	0	0	0	0	0	0
15	0	0	1	1	3	0	5
16	0	0	0	1	1	0	2
17	1	0	0	0	0	0	1
18	0	0	0	3	1	1	5
19	0	0	0	0	2	2	4
20	0	4	0	1	3	0	8
21	0	0	0	0	1	0	1
22	0	0	0	1	1	0	2
23	1	0	0	0	0	1	2
24	0	0	0	0	0	0	0
25	2	0	0	0	2	1	5
26	1	0	0	0	1	0	2
27	1	0	0	0	0	0	1
28	0	0	0	0	1	0	1
29	2	1	0	0	1	1	5
30	39	75	25	39	79	38	295
31	0	0	0	3	0	3	6

Table A5.4. Number of age readings of NS-IBTS target species available in DATRAS (downloaded 30/03/2022) from the survey in 2021 (-: species not caught, +: otoliths not yet read, ÷: no otoliths taken; *: SWE area 4a only; Note: NOR data uploaded to DATRAS 08/04/022).

Species	DEN	ENG	GER	NOR	SCO	SWE	Total
Clupea harengus	498	888	277	*370*	812	1261	4106
Sprattus sprattus	301	÷	149	*20*	122	438	1030
Gadus morhua	71	471	8	*353*	702	318	1923
Merlangius merlangus	599	1882	243	*634*	1262	615	5235
Melanogrammus aeglefinus	307	2076	41	*1081*	1973	425	5903
Trisopterus esmarki	23	528	-	*331*	508	160	1550
Pollachius virens	11	166	-	*193*	111	121	602
*Scomber scombrus**	252	373	92	*200*	475	6	1398
Pleuronectes platessa	608	1300	304	*132*	437	375	3156

Table A5.5. Overview of additional individual biological data collected in addition to the regular measurements specified in the manual during the North Sea IBTS Q3 survey in 2021 (*Dipturus batis* is now considered to be two species (*D. batis* and *D. intermedius*; 1): individual weight, 2): individual weight and sex, 3): individual weight, sex and maturity, 4): individual weight, sex, maturity and age, 5): individual weight, sex and male maturity, 6): carapace length, sex and maturity, 7): individual weight, sex and age;, *: genetic samples, **: stomach samples).

Species	DEN	ENG	GER	NOR	SCO	SWE
Amblyraja radiata		147 3)		106 2)	52 5)	
Anarhichas lupus						
Cancer pargurus						
Chelidonichthys cuculus		7 4)				
Chelidonichthys lucerna		4 4)				
Chimaera monstrosa				20 2)		
Dipturus batis- species complex		0 3)				
Dipturus intermedius		4 3)			19 5)	
Dipturus batis (=D. flossada)		0 3)				
Dipturus oxyrinchus		0 3)				
Engraulis encrasicolus	16 1)*		12 4)*			
Etmopterus spinax		0 3)		173 2)		
Eutrigla gurnardus		212 4)				
Galeorhinus galeus		1 3)				
Galeus melastomus		40 3)		28 2)		
Glyptocephalus cynoglossus	13 1)	37 4)				40 4)
Gymnammodytes semisquamatus						
Helicolenus dactylopterus						
Hippoglossus hippoglossus					2 2)	
Homarus vulgaris						
Hyperoplus lanceolatus				1 1)		
Leucoraja fullonica		0 3)			1 5)	
Leucoraja naevus		40 3)		14 2)	58 5)	
Limanda limanda	33 1)	211 4)				
Lithodes maja				2 1) / 22 2)		
Lophius budegassa		6 4)				
Lophius piscatorius		67 4)			29 3)*	
Merluccius merluccius	16 3)*	154 4)	1 3)*	6 1) / 129 3)	129 2)*	91 3)
Micromesistius poutassou				1206 1)		
Microstomus kitt		228 4)				
Molva molva		26 4)				
Mullus surmulletus		21 4)				
Mustelus asterias / M. mustelus	15 1)*	58 3)				
Nephrops norvegicus				5 1) / 61 2)		1152 6)
Pollachius pollachius						
Raja brachyura						
Raja clavata		17 3)			1 5)	
Raja montagui		47 3)			18 5)	
Rajella fyllae						
Sardina pilchardus						
Scopthalmus maximus	13 1)**	10 4)	12 1)**		1 2)	
Scopthalmus rhombus	6 1)**	5 4)			1 2)	
Scyliorhinus canicula				6 2)		
Squalus acanthias		44 3)			327 5)	
Solea solea		19 4)				16 4)
Trachurus trachurus				57 1)		
Zeus faber		1 3)				

Table A5.6. Overview of additional activities in the North Sea IBTS Q3 survey in 2021 (Water samples for CTD calibration not explicitly listed, x: routinely (data submitted to ICES databases), (x): ad hoc studies (data available from the national representatives)).

Activity	DEN	ENG	GER	NOR	SCO	SWE
CTD	x	x	x	x	x	x
Seafloor Litter	x	x	x	x	x	x
Recording of GOV deployment and retrieval time		(x)		(x)	(x)	
Cod liver worm registration	(x)	(x)	(x)	(x)	(x)	(x)
Recording of cod liver weight		(x)		(x)	(x)	
Water sampler (Nutrients, eDNA)		(x)			(x)	
Jellyfish from GOV or MIK	(x)	(x)		(x)	(x)	
Benthos (from GOV)		(x)				
Ichthyo- and zooplankton (e.g. MIK for sprat larvae)	(x)		(x)		(x)	
Plankton biodiversity					(x)	
Sediment (Grab)						(x)
Acoustics (Ichthyofauna)		(x)				
Fish tagging (mark-ID tags)		(x)				
Fish and shellfish genetic samples	(x)	(x)	(x)		(x)	
Fish stomach samples	(x)		(x)			

Table A5.7. Number of valid tows with missing gear parameters, NS-IBTS 3Q 2021.

Parameter	DEN	ENG	GER	NOR	SCO	SWE
Net opening	0	0	0	0	2	0
Door spread	0	0	0	0	0	0
Wing spread	23	8	9	0	1	2

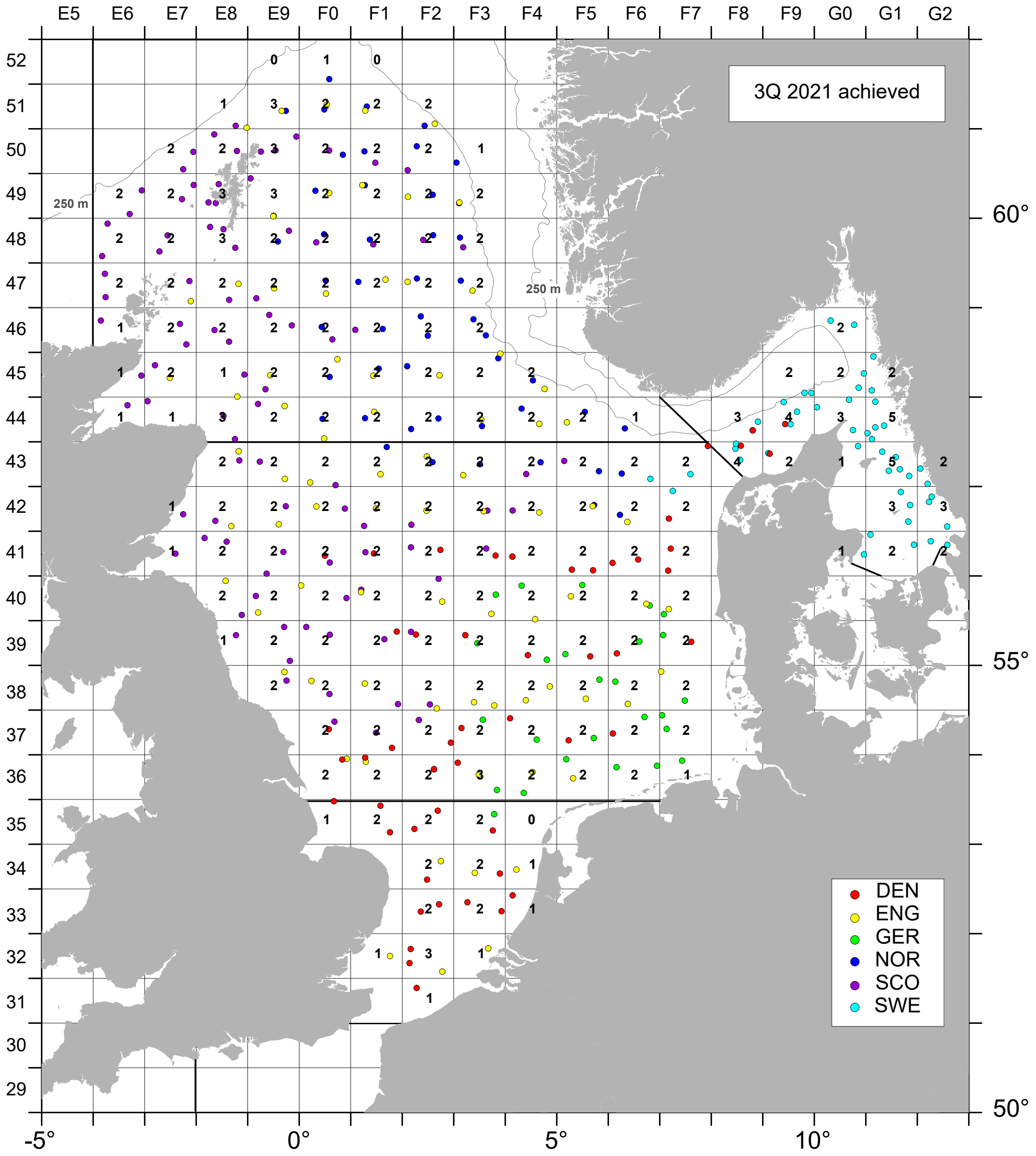

Figure A5.1. Number and start position of hauls per ICES statistical rectangle as taken with the GOV during the North Sea IBTS Q3 2021. Tows are separated into ICES divisions in the North Sea (4.a–c), the Skagerrak/Kattegat (3.a).

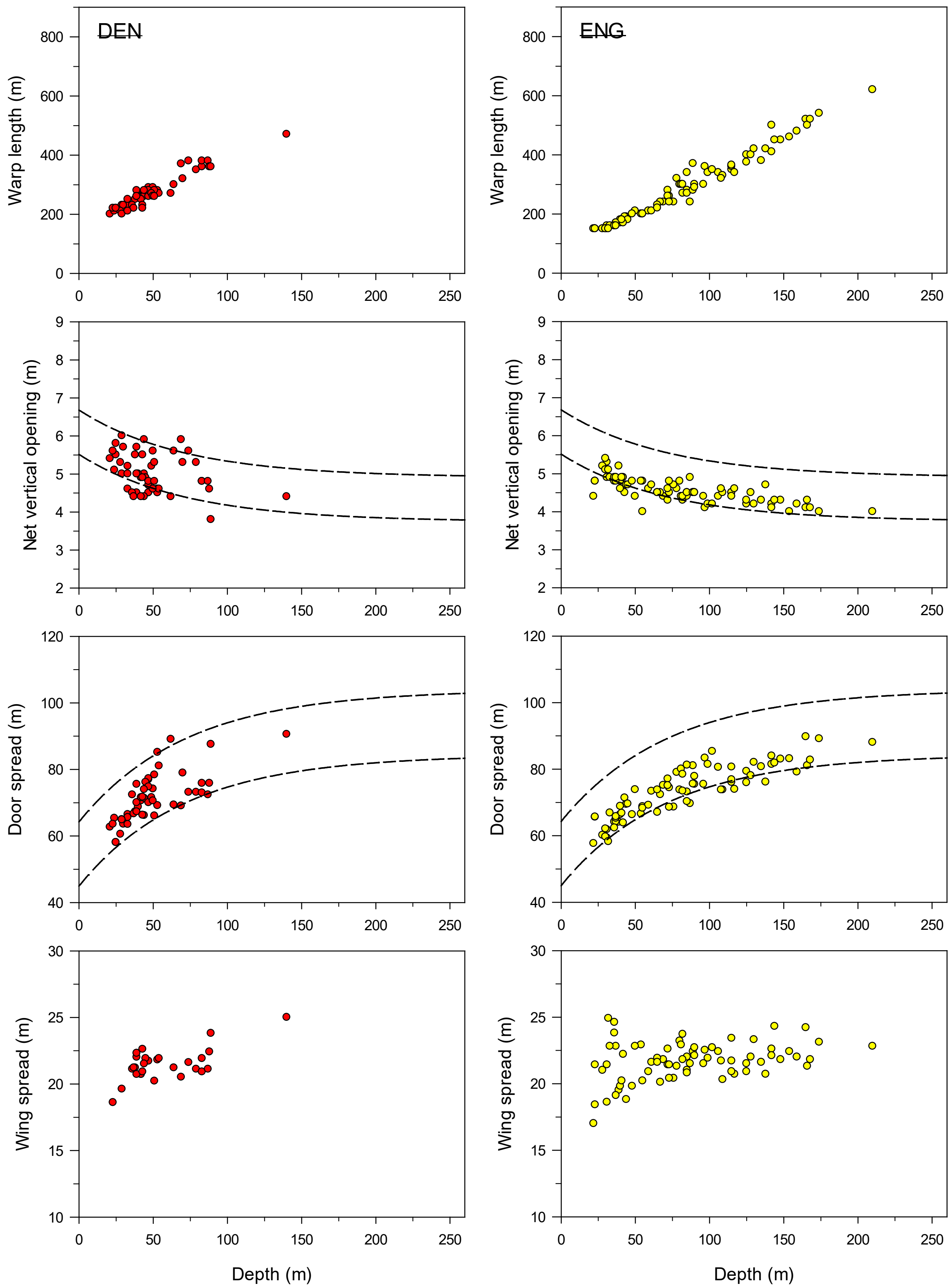

Figure A5.2a. Warp length and net geometry related to depth by country for the North Sea IBTS Q3 2021, Denmark (all tows with Vonin flyers instead of the standard Exocet kite) and England. Dashed lines: theoretical lower and upper limits for the standard GOV 36/47 based on flume tank experiments, see manual.

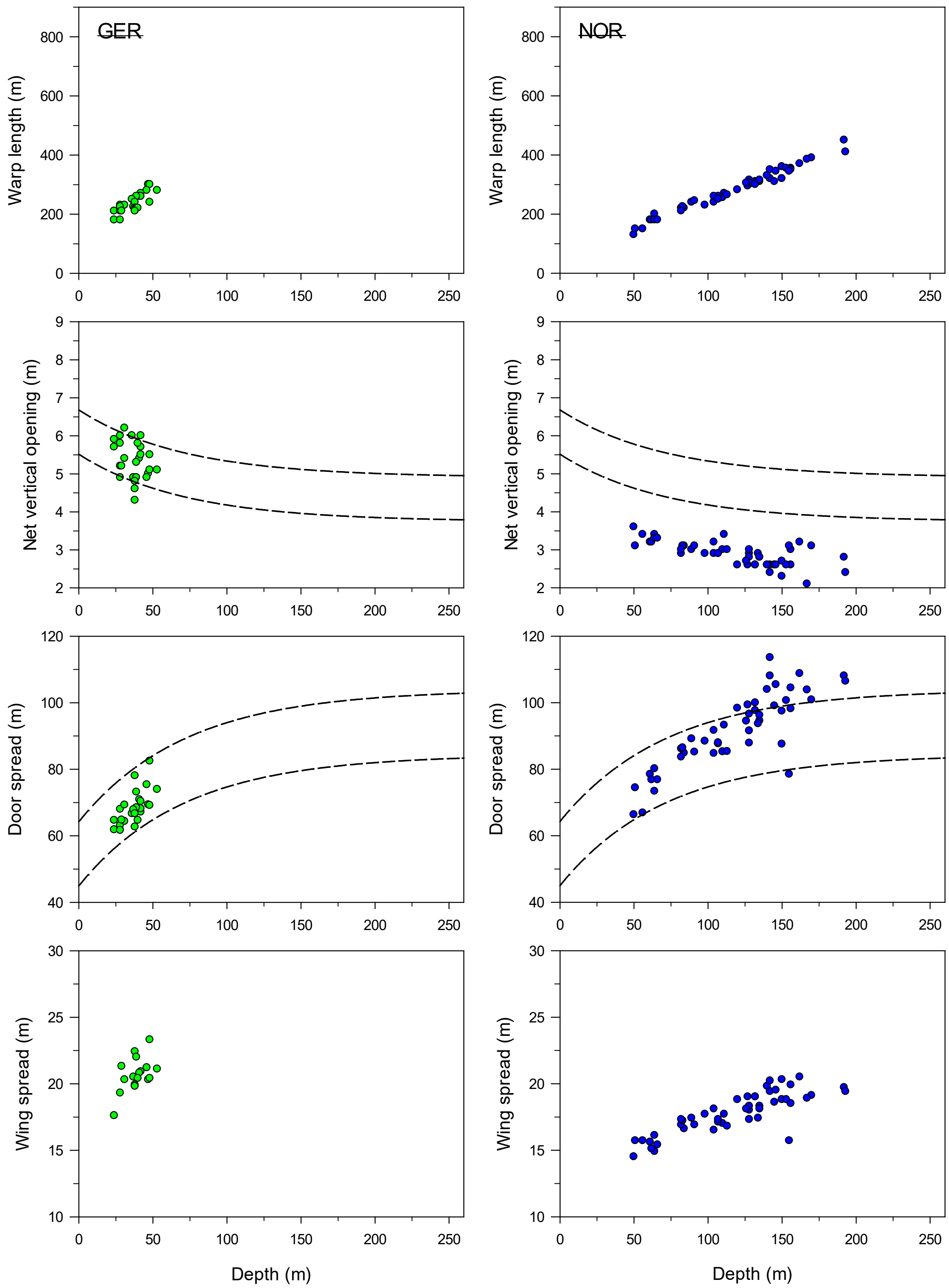

Figure A5.2b. Warp length and net geometry related to depth by country for the North Sea IBTS Q3 2021, Germany and Norway. Dashed lines: theoretical lower and upper limits for the standard GOV 36/47 based on flume tank experiments, see manual.

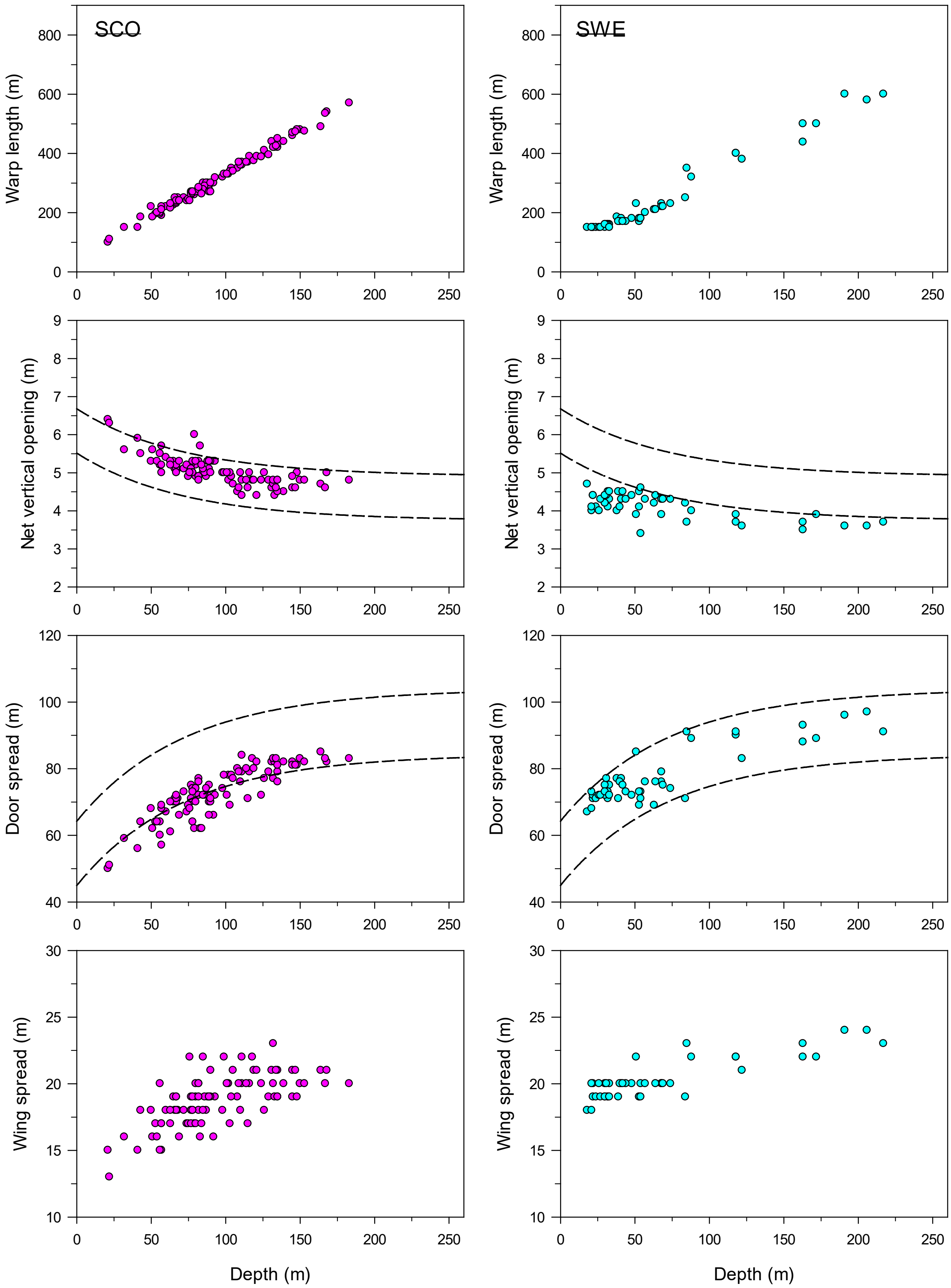

Figure A5.2c. Warp length and net geometry related to depth by country for the North Sea IBTS Q3 2021, Scotland and Sweden. Dashed lines: theoretical lower and upper limits for the standard GOV 36/47 based on flume tank experiments, see manual.

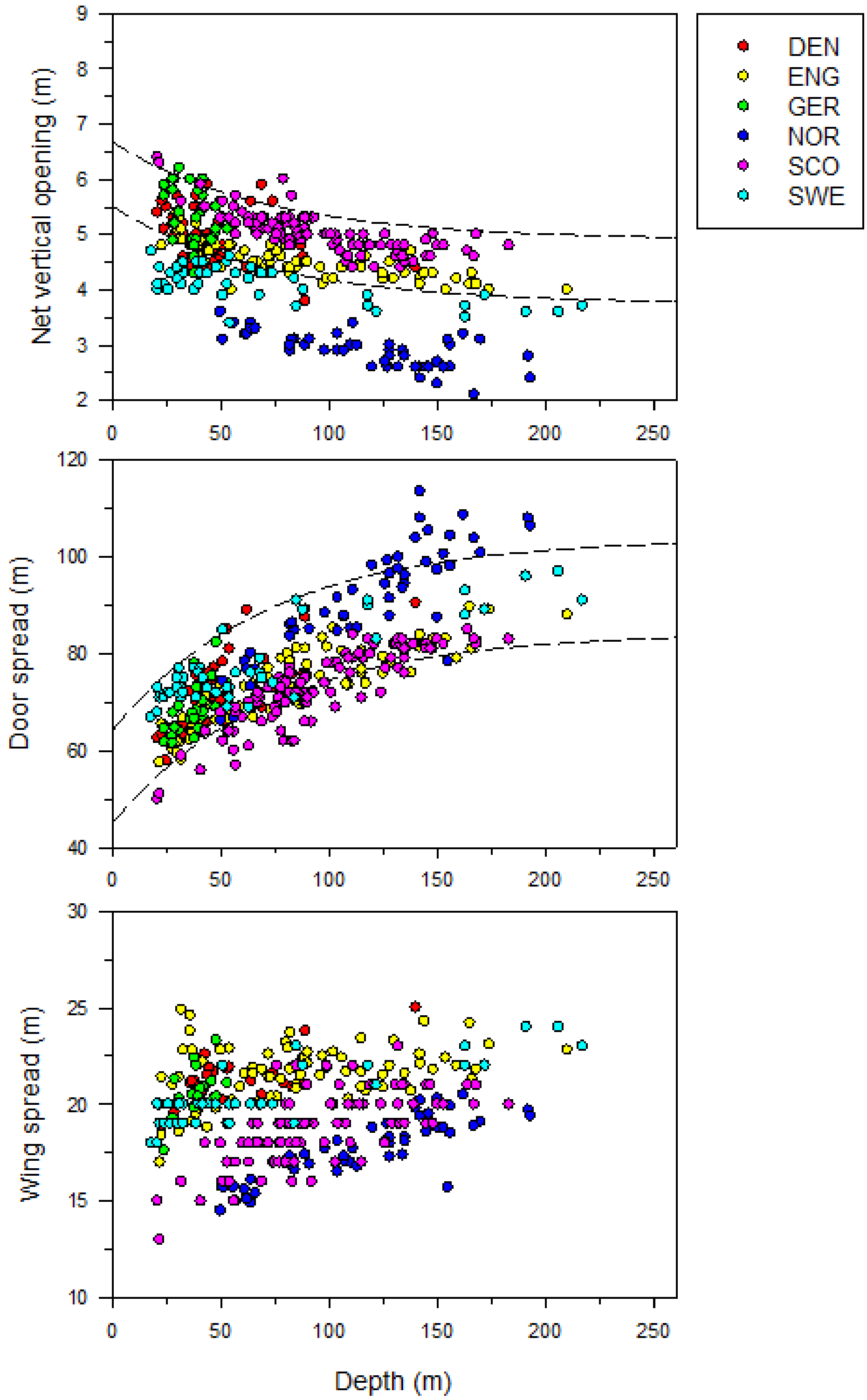

Figure A5.3. Comparison of trawl geometry related to depth between countries for the North Sea IBTS Q3 2021. Dashed lines: theoretical lower and upper limits for the standard GOV 36/47 based on flume tank experiments, see manual.

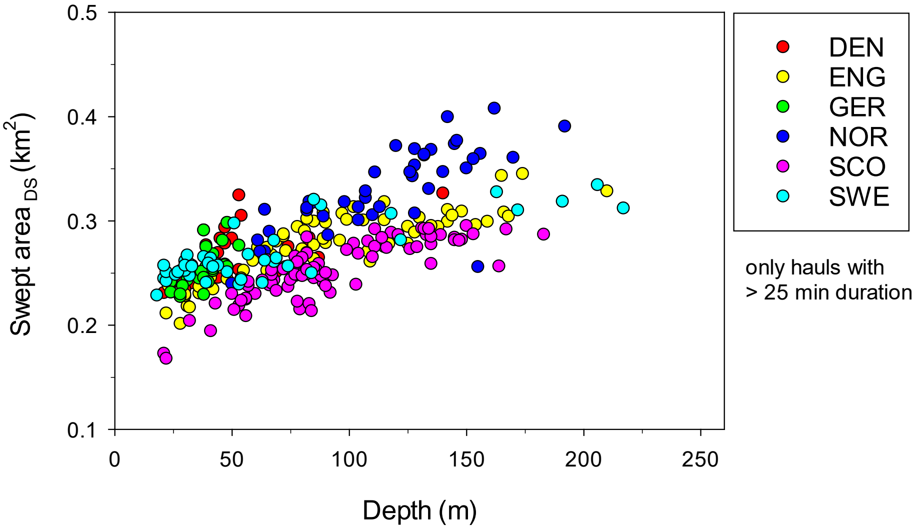

Figure A5.4. Comparison of swept area (based on door spread) related to depth between countries for the North Sea IBTS Q3 2021 (only hauls with a duration of > 25 min considered).

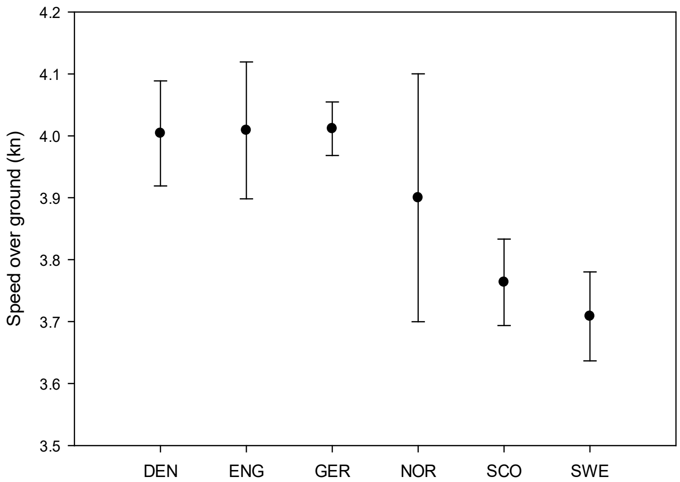

Figure A5.5. Average towing speed over ground by country for the North Sea IBTS Q3 2021 (mean ±; 1 standard deviation; NOR: data not yet included).

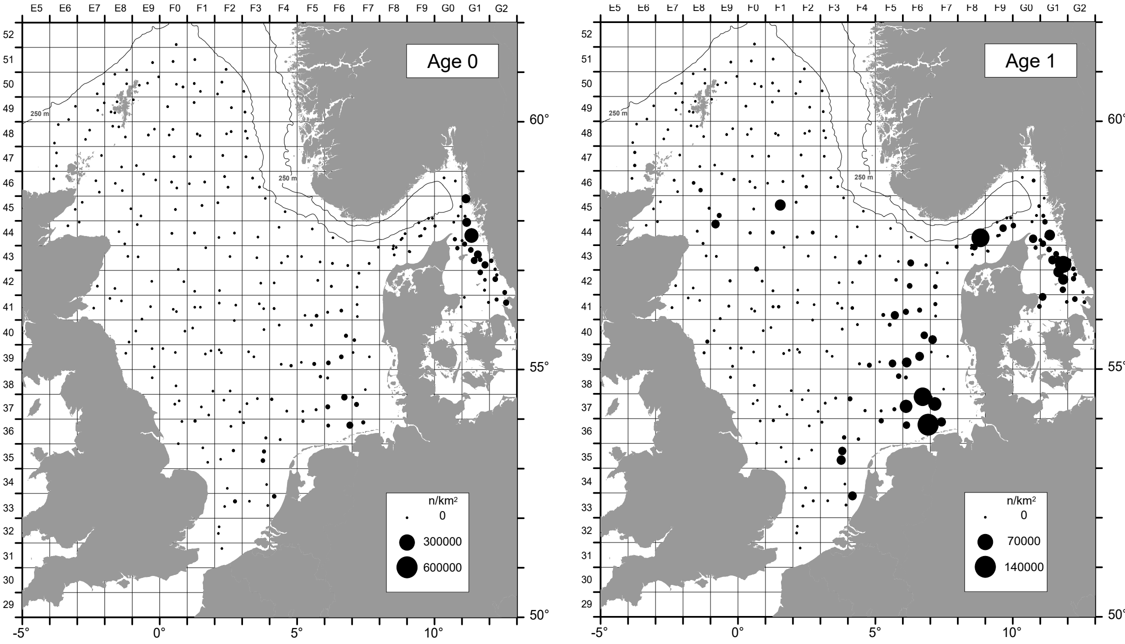

Figure A5.6a. Distribution of age 0 and age 1 herring in 3Q 2021.

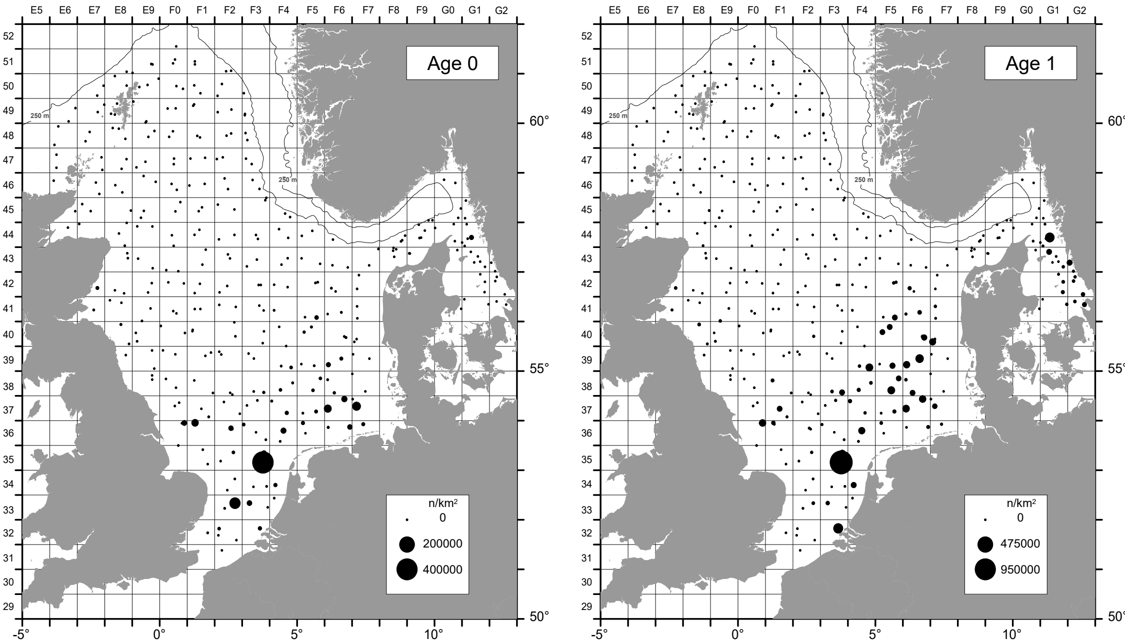

Figure A5.6b. Distribution of age 0 and age 1 sprat in 3Q 2021.

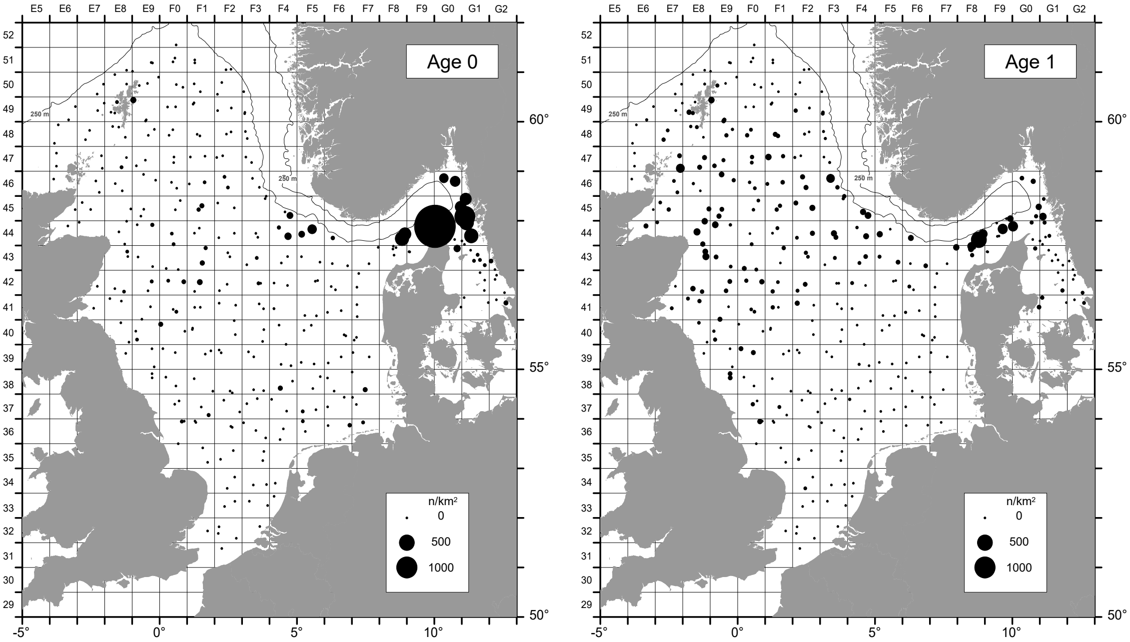

Figure A5.6c. Distribution of age 0 and age 1 cod in 3Q 2021.

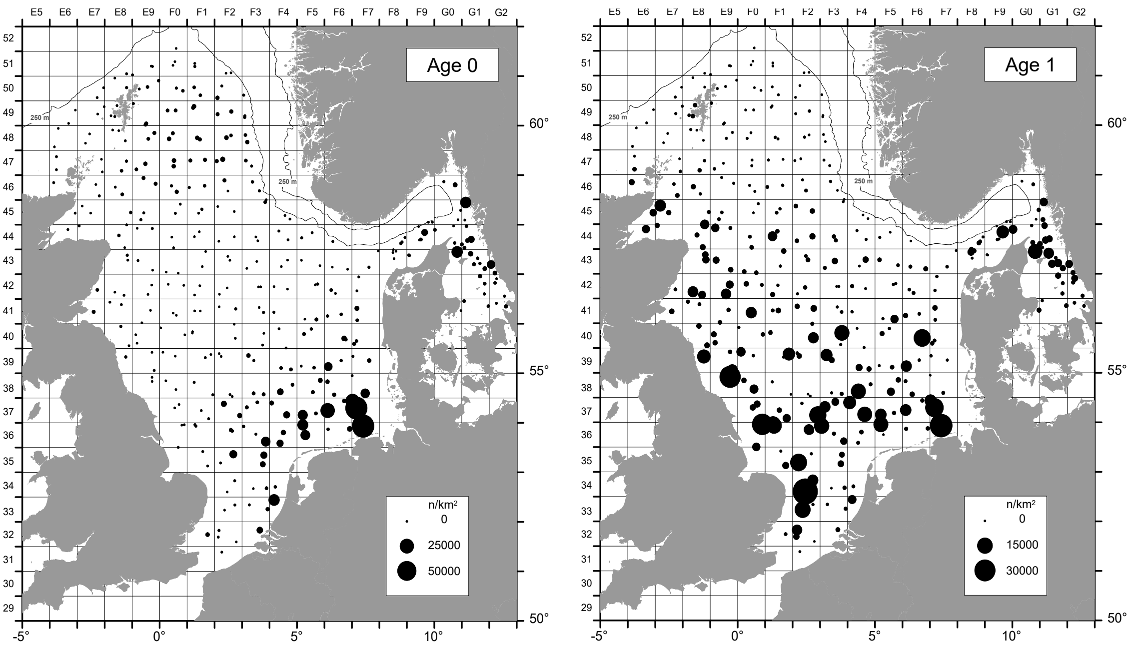

Figure A5.6d. Distribution of age 0 and age 1 whiting in 3Q 2021.

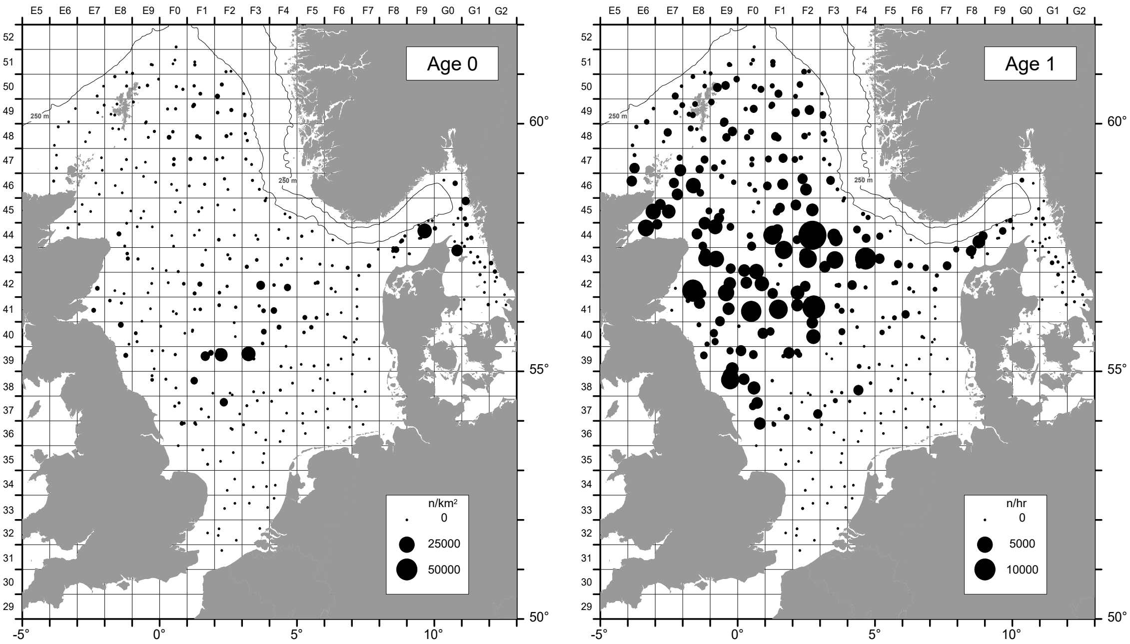

Figure A5.6e. Distribution of age 0 and age 1 haddock in 3Q 2021.

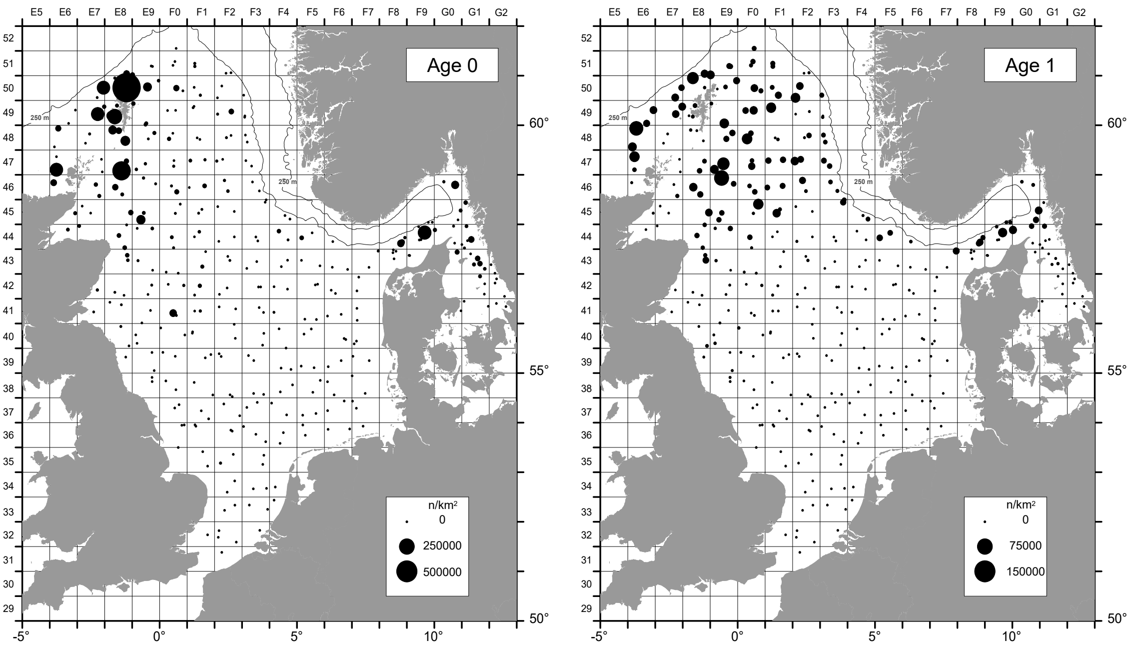

Figure A5.6f. Distribution of age 0 and age 1 Norway pout in 3Q 2021.

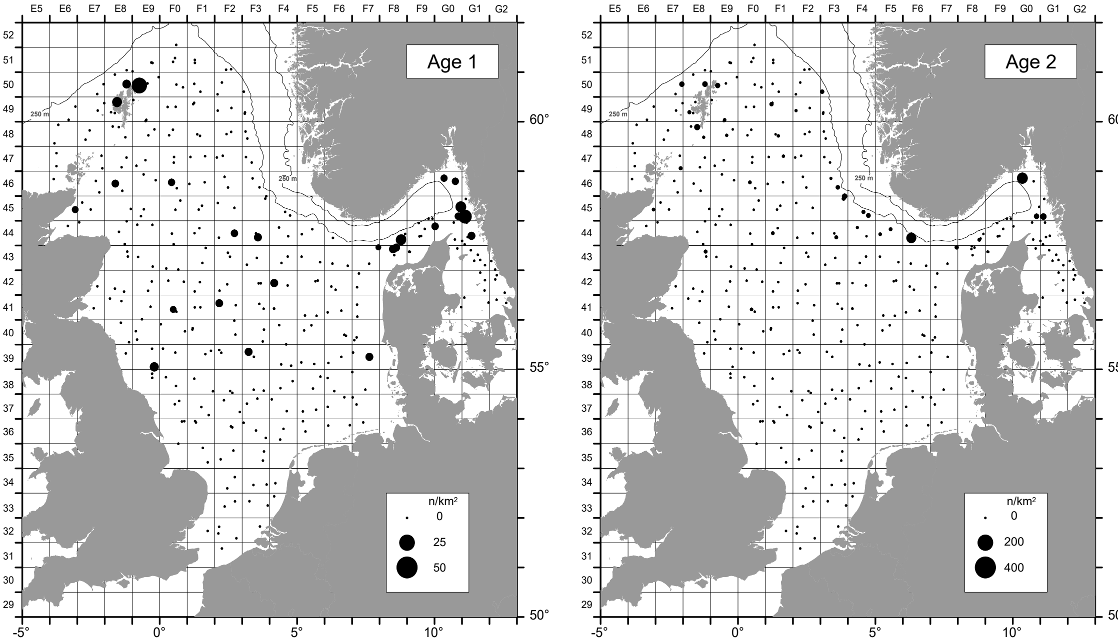

Figure A5.6g. Distribution of age 1 and age 2 saithe in 3Q 2021.

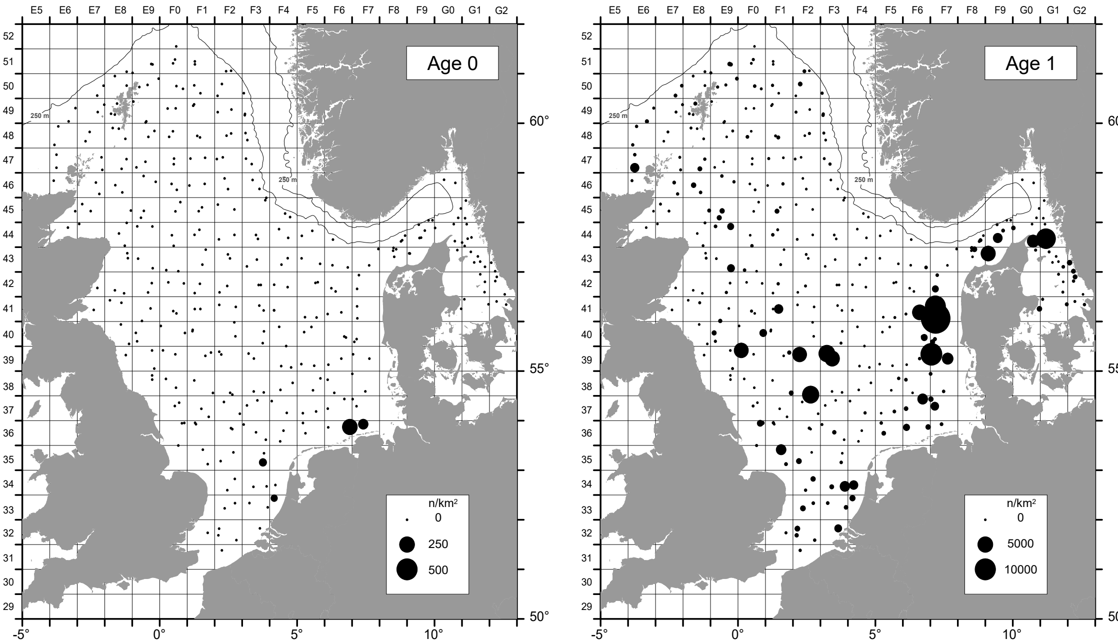

Figure A5.6h. Distribution of age 0 and age 1 mackerel in 3Q 2021.

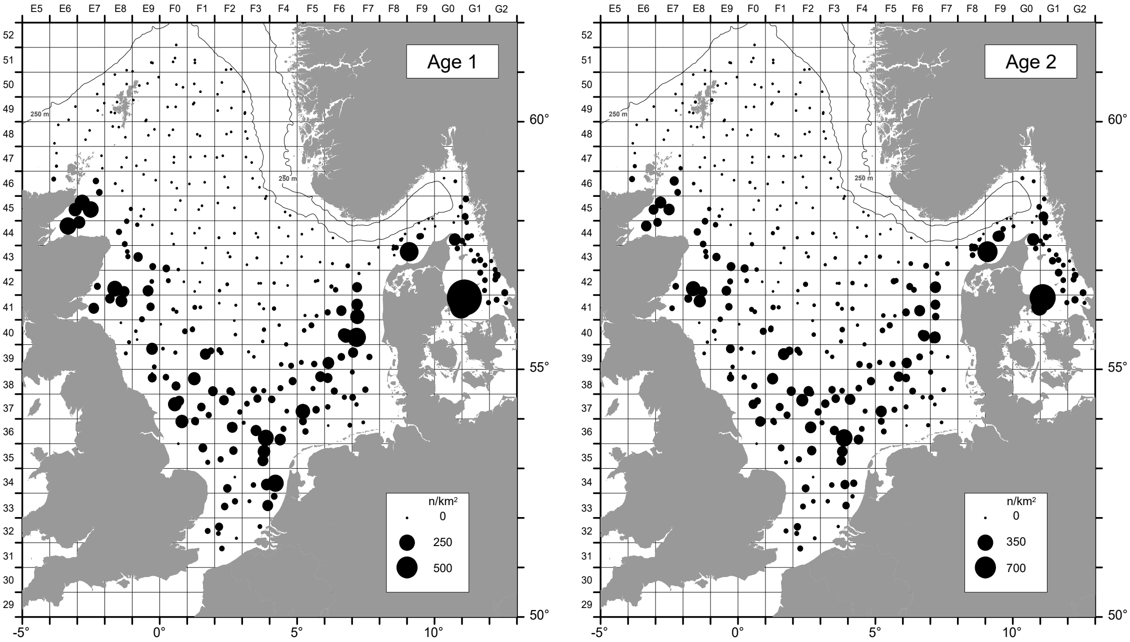

Figure A5.6i. Distribution of age 1 and age 2 plaice in 3Q 2021.

Annex 6: North-eastern Atlantic surveys

A6.1 General overview

In 2021, seven vessels from seven nations performed 12 surveys along the North-eastern Atlantic (NEA) IBTS area. A total of 1045 valid hauls, out of the 1185 hauls planned, were accomplished over 328 days distributed between all quarters of 2021 (Tables A6.1 and A6.2).

With the exception of the two Spanish groundfish surveys in the Gulf of Cádiz (SP-GCGFS-1Q/4Q), the other surveys were undertaken successfully and the majority completed without significant issue.

Three Q1 surveys (Scotland, Northern Ireland and Ireland) were undertaken in February and March with the Irish anglerfish survey once again extending into April. Scotland and Spain were also active during Q3 with surveys of Rockall and the Porcupine Bank, as well as the Northern Spanish Coast shelf (in part), with Portugal, France, Northern Ireland, Ireland, Scotland and Spain all active during Q4.

Data from all NEA surveys reported here during 2021 have been uploaded to DATRAS. Table A6.3 provides an overview of the numbers of fish for which individual biological data were collected per survey during the 2021 NEA IBTS. Additional activities for all reported surveys are summarized in Table A6.4, with more detailed information for all reported surveys, including survey coverage plots and catch per unit effort (CPUE) estimates for target species, presented in the subsequent individual survey summary reports.

Gear parameter plots (warp out, door spread, wing spread, vertical opening) are also provided for each survey undertaken in the 2021 NEA IBTS (Figures A6.1a-j). Where different sweep configurations exist (long and short) within an individual survey, these are plotted separately within the same plot window.

Table A6.1. Summary of surveys, hauls and days at sea per country performed in the IBTS North-eastern Atlantic area in 2021.

Country	Survey	Hauls					Days
		Planned	Valid	Null	Additional	Total	
UK-Scot	UK-SCOWCGFS-Q1	62	63	2	-	65	20+2*
	UK-SCOROC-Q3	40	45	-	1	46	13
	UK-SCOWCGFS-Q4	62	59	3	-	62	21+2*
UK-NI	UK-NIGFS-Q1	60	60	-	-	60	15
	UK-NIGFS-Q4	62	45	-	-	45	11
Ireland	IE-IAMS-Q1/Q2	(115**)	76	4***	9****	89	38
	IE-IGFS-Q4	171	156	8	-	156	45
France	FR-CGFS-Q4	74	66	6	-	72	17
	FR-EVHOE-Q4	158	149	8	-	157	44

Spain	SP-PORC-Q3	80	80	3	14	97	32
	SP-NSGFS-Q4	116	113	-	15	128	37
	SP-GCGFS-Q1	45	-	-	-	0	-
	SP-GCGFS-Q4	45	-	-	-	0	-
Portugal	PT-PGFS-Q4	96	93	9	-	102	31
Total		1186	1006	41	39	1086	328

* Additional days for COMPASS moorings

**Planned surveys reduced to 85 for 2022, due to Covid restrictions

*** Null tows not uploaded to DATRAS

**** Additional 4 trawls for deep-water monitoring and further 5 to cover reduced Scottish survey effort.

Table A6.2. Overview of the North-eastern Atlantic IBTS surveys performed during 2021 (Q1–Q4).

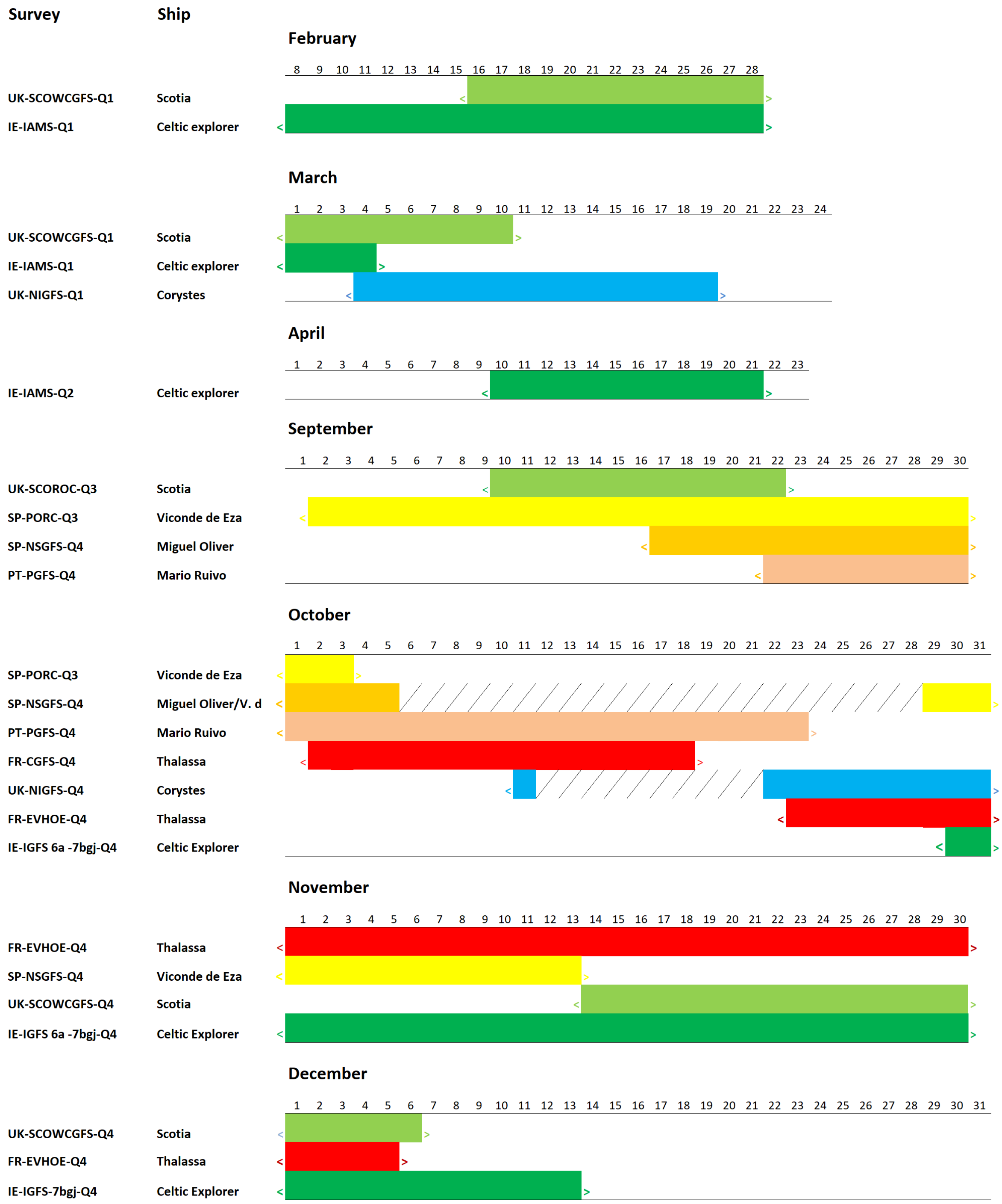

Table A6.3. Number of individuals sampled for maturity and/or age during the NEA IBTS in 2021.

Target species	UK-SCOWCGFS-Q1	UK-SCOROC-Q3	UK-SCOWCGFS-Q4	UK-NIGFS-Q1	UK-NIGFS-Q4	IE-IAMS-Q1/Q2	IE-IGFS-Q4	FR-CGFS-Q4	FR-EVHOE-Q4	SP-PORC-Q3	SP-NSGFS-Q4	PT-PGFS-Q4
Clupea harengus	870		199				271					
Gadus morhua	139	8**	184**	141	11	55	77		20			
Lepidorhombus boscii						160**			14	423	521	509
Lepidorhombus whiffiagonis						882	1883		408	584	724	423
Lophius budegassa						341	301		310	57[2]	57[2]	23
Lophius piscatorius						741	442		149	162[2]	82[2]	
Melanogrammus aeglefinus	1963	1981**	1622**	911	634	515	2179	235	476			
Merlangius merlangus	1361	49**	960**	1190	784	257	1550	605	557			
Merluccius merluccius	345		297**	77*	22	931**	985		936	559	627	2386
Nephrops norvegicus										401*		91
Pollachius virens	30	2**	10**	5*		67	3		2			
Scomber scombrus	410	29	179				416		147	1	241	153
Sprattus sprattus	389**		130**									
Trachurus trachurus							995				399	647
Additional species												
Argyrosomus regius									48			
Chelidonichthys cuculus								226	185			
Chelidonichthys lucerna												
Conger conger										34	57**	
Trisopterus esmarkii	469		492**									
Dicentrarchus labrax							2*	188	482			
Dipturus batis (*cf. flossada*)	8†	135†	10†			76*						
Dipturus intermedius	41†		28†			110**						
Dipturus oxyrinchus		10†										
Engraulis encrasicolus									147		255	72
Galeorhinus galeus			5†			18†						

Glyptocephalus cynoglossus						205**	272**		92			
Helicolenus dactylopterus										184	73	
Leucoraja fullonica		16[†]										
Leucoraja naevus	14[†]		20[†]	15	6	242						
Loligo vulgaris												676
Micromesistius poutassou							869				599	1347
Microstomus kitt						233**	953		175			
Molva dypterygia												
Molva molva	42		32**			164	26			6		
Mullus surmuletus								143	121		62	
Mustelus spp.	28[†]		4[†]									
Octopus vulgaris												
Parapeneus longirostris												1581
Phycis blennoides									176	283	68	
Pleuronectes platessa	209		145	461	215			312	146			
Trisopterus luscus								173	183		247	
Sardina pilchardus									260			
Sepia officinalis												
Solea solea							181	200	133			
Scomber colias											1	191
Scophthalmus maximus			4***					16	5			
Scophthalmus rhombus	1***							6	4			
Zeus faber											95	

Key: [†] length, weight, sex and externally determined maturity only; * samples collected for maturity only; ** no maturity data collected; ***length, weight and sex only; [(2)] otoliths + illicia

Table A6.4. Additional activities undertaken during the NEA IBTS in 2021.

	UK-SCOWCGFS-Q1	UK-SCOROC-Q3	UK-SCOWCGFS-Q4	UK-NIGFS-Q1	UK-NIGFS-Q4	IE-IAMS-Q1/Q2	IE-IGFS-Q4	FR-CGFS-Q4	FR-EVHOE-Q4	SP-PORC-Q3	SP-NSGFS-Q4	PT-PGFS-Q4
CTD (Temp + salinity)	1	1	1			1	1	1	1	1	1	1
Seafloor Litter	1	1	1	1	1	1	1	1	1	1	1	1
1Water sampler (Nutrients)								1	1			
Plankton sampling								1	1			
Benthos sampling							1	1	1	X	X	1
Observers: mammals, birds								1	1		*	
Additional biological data on fish	X	X	X			1	1	1	1	X	X	X
Fish stomach contents						*		X			1	X
Benthic samples (boxcore, video, dredge)	X								X	X	*	
Jellyfish	1	1	1	1	1	*	1	1	1			
Hydrological transect						*	1	1	1			
Acoustic for fish species								X	X			
Multibeam: seabed mapping						*		X	X			
Manta trawl; microplastics	X							1	1			
Acoustic mooring deployment	1		1			*	X	X				
Elasmobranch tagging				*	*		1	X	X			

1: Annually, X: Occasional

*: Not performed due to COVID-19 reduction in crew.

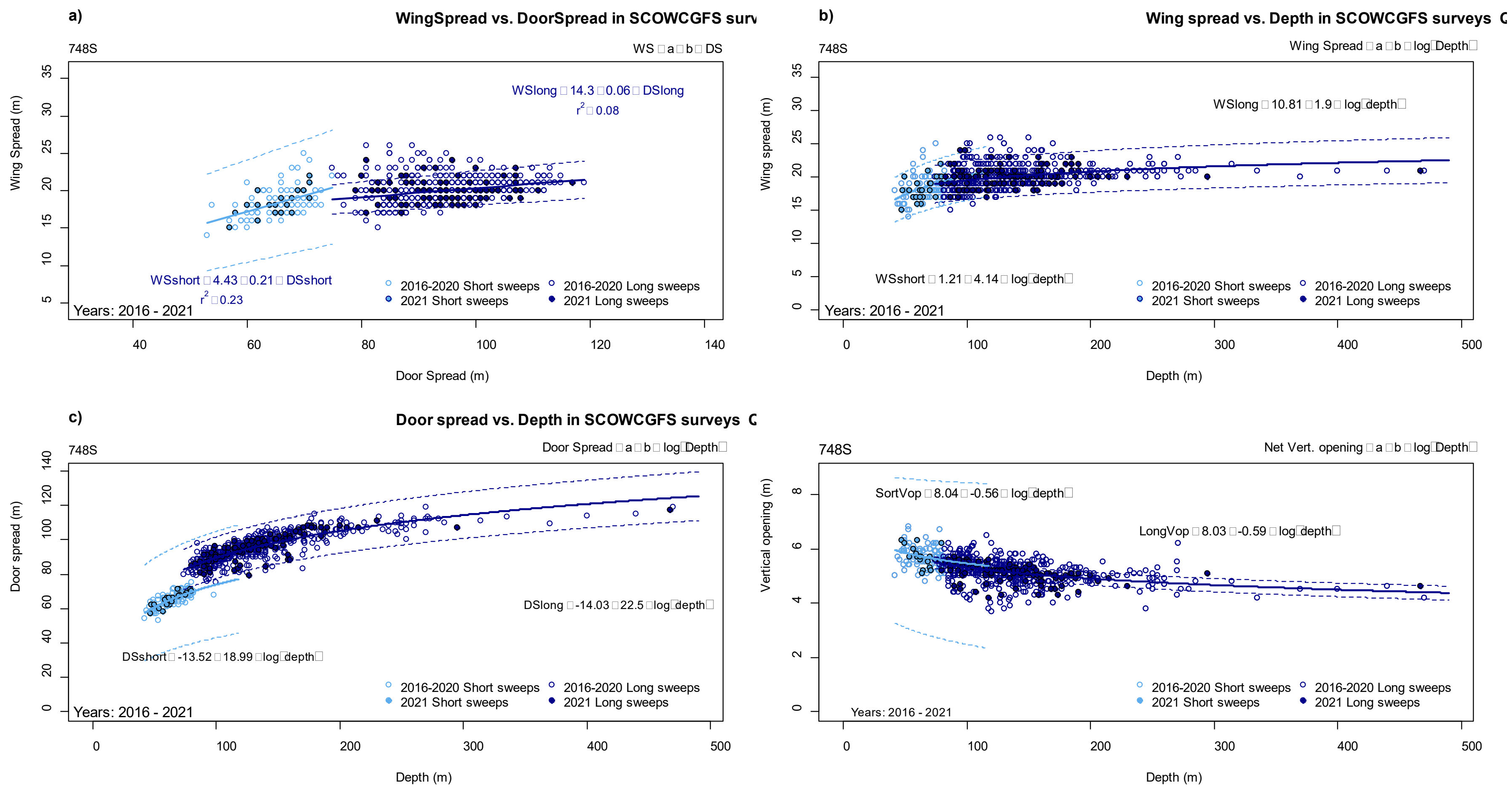

Figure A6.1a. Gear parameter plots for SCOWCGFS-Q1 and SCOWCGFS-Q4 combined.

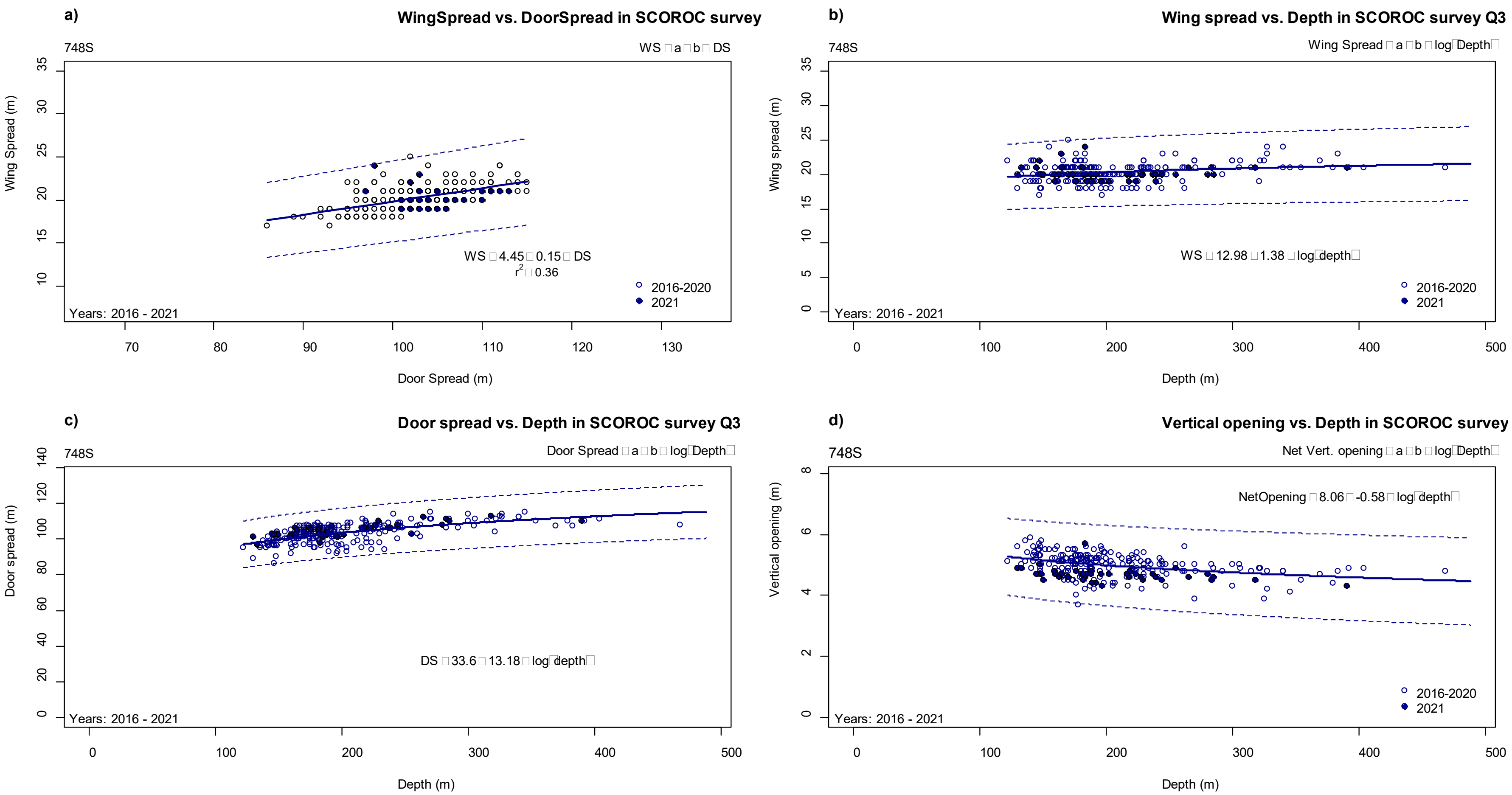

Figure A6.1b. Gear parameter plots for UK-SCOROC-Q3.

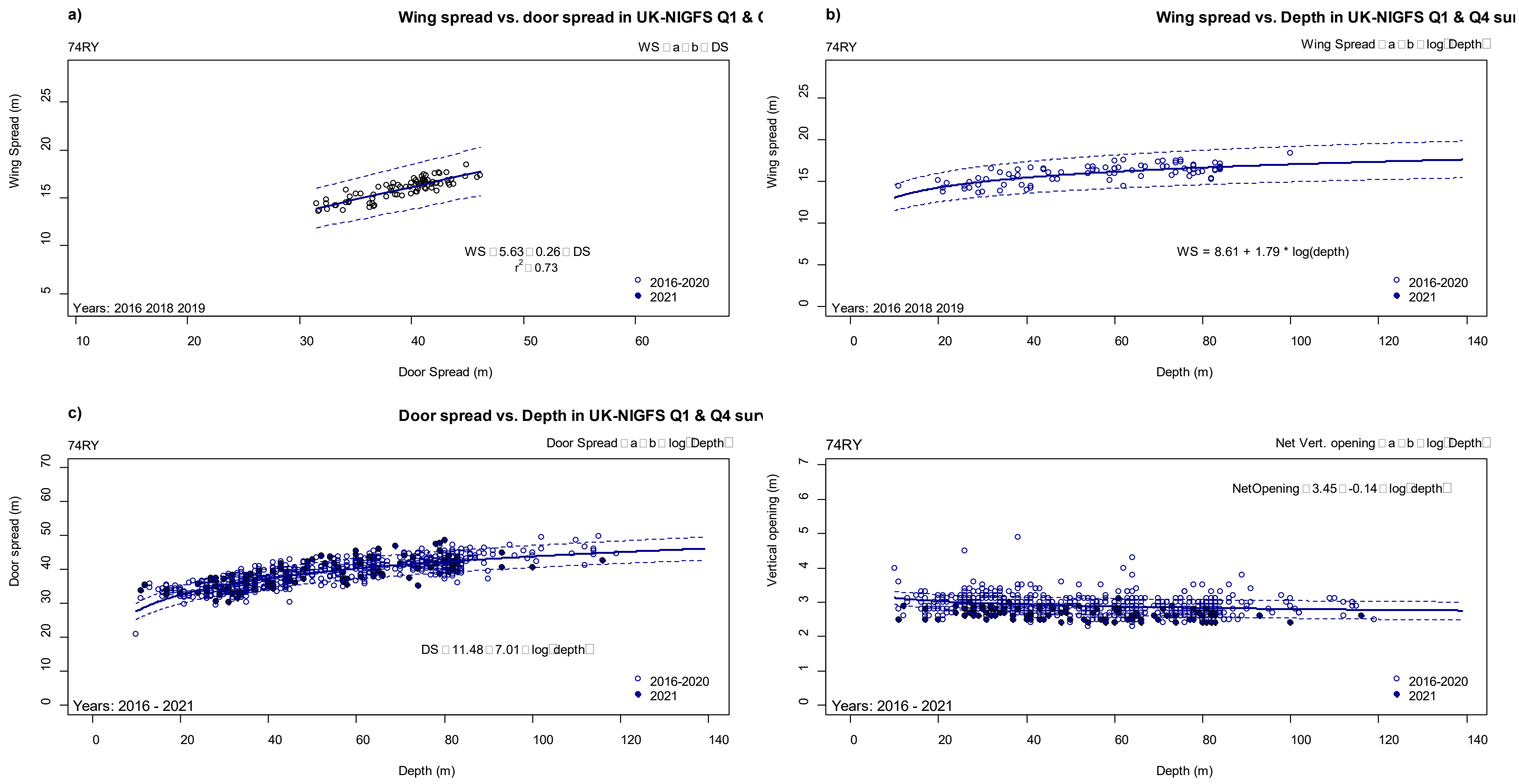

Figure A6.1c. Gear parameter plots for UK-NIGFS-Q1. Notes: The reported depth (191 m) of one haul (2018, haul no. 37) was considered an input error and changed to 34 m (thus similar to the depth of hauls in the same area from other years). Wing spread data were only from 2016, 2018 and 2019, so no 2021 points to compare for graphs a) and b) that use wing spread.

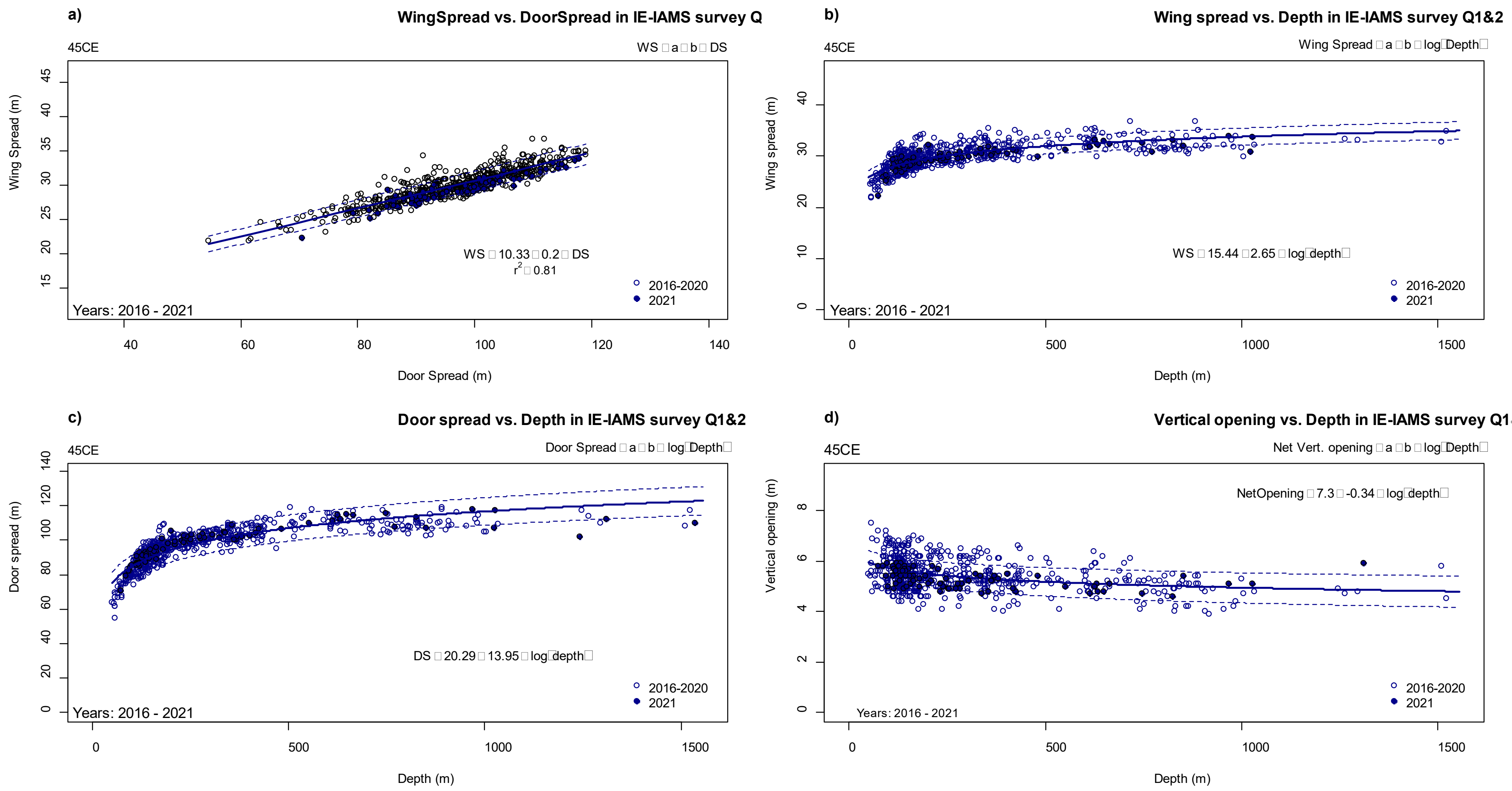

Figure A6.1d. Gear parameter plots for IE-IAMS-Q1.

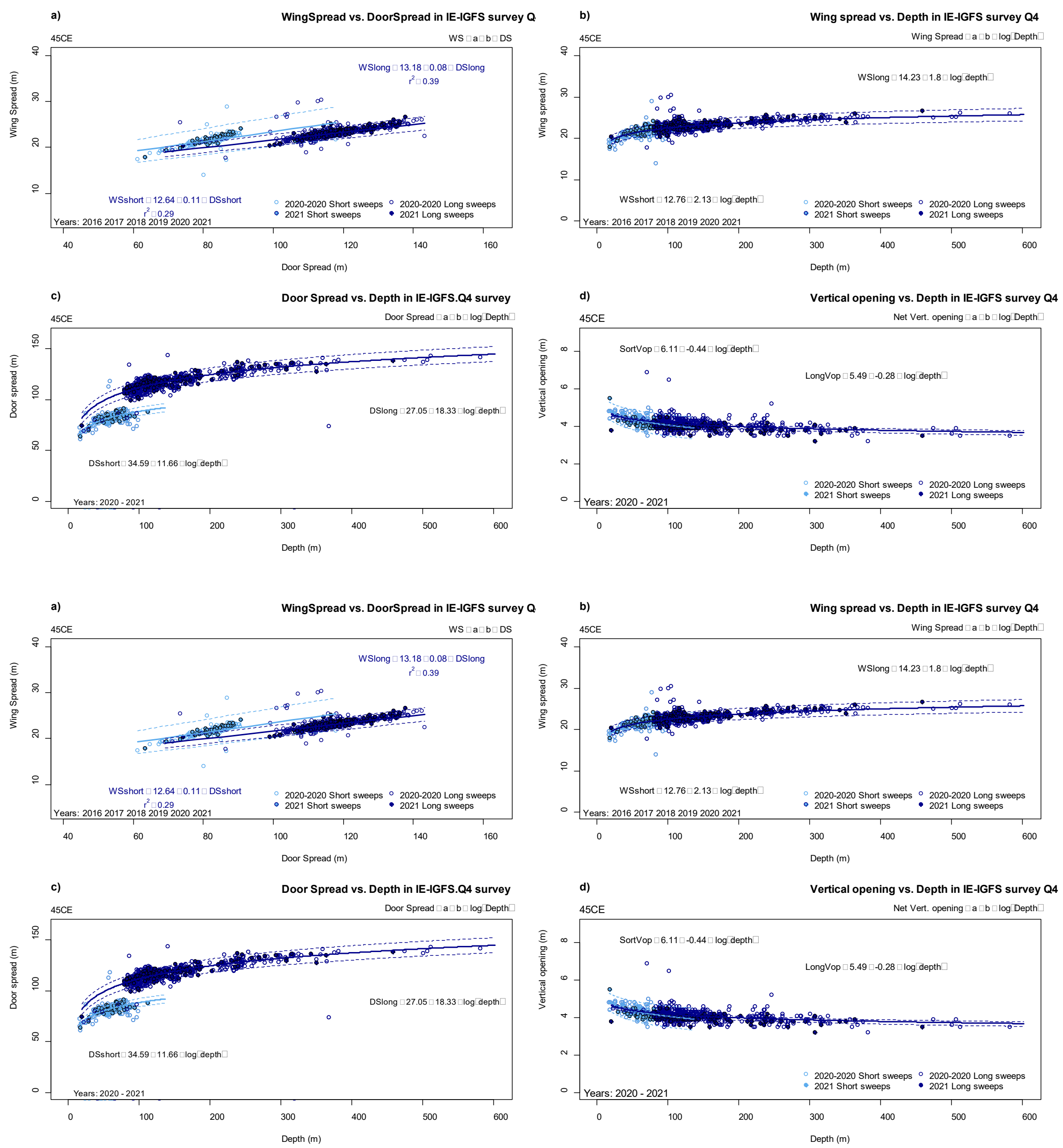

Figure A6.1e. Gear parameter plots for IE-IGFS-Q4. Notes: There is an issue of the sweeps/depth changing. The data in DATRAS (top) were corrected here (bottom) by assigning 55 m sweeps to hauls shallower than 75 m, and 110 m sweeps to hauls deeper than 75 m, but there is still a degree of overlap between both sweeps ranges in panels b-d.

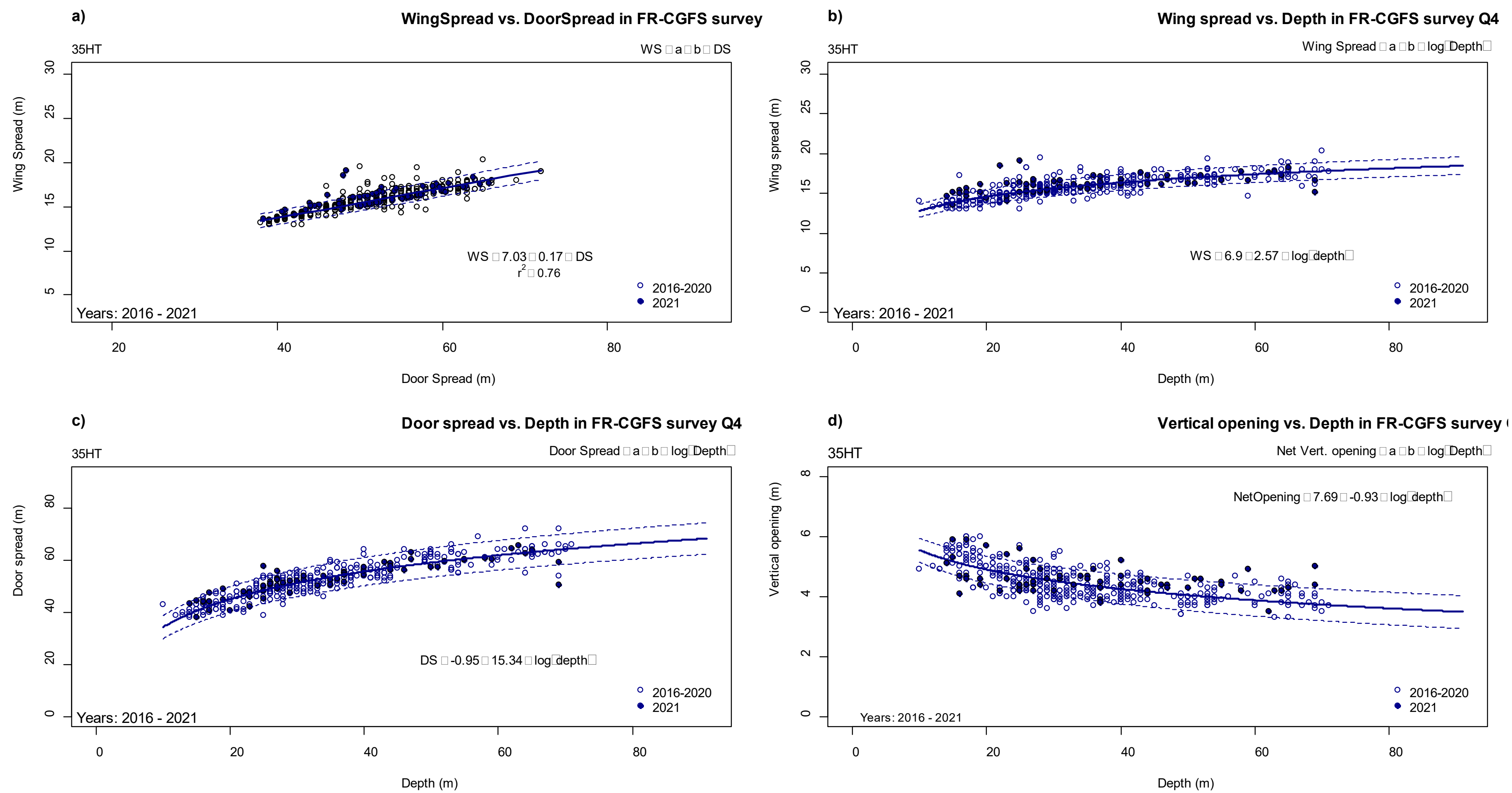

Figure A6.1f. Gear parameter plots for FR-CGFS-Q4.

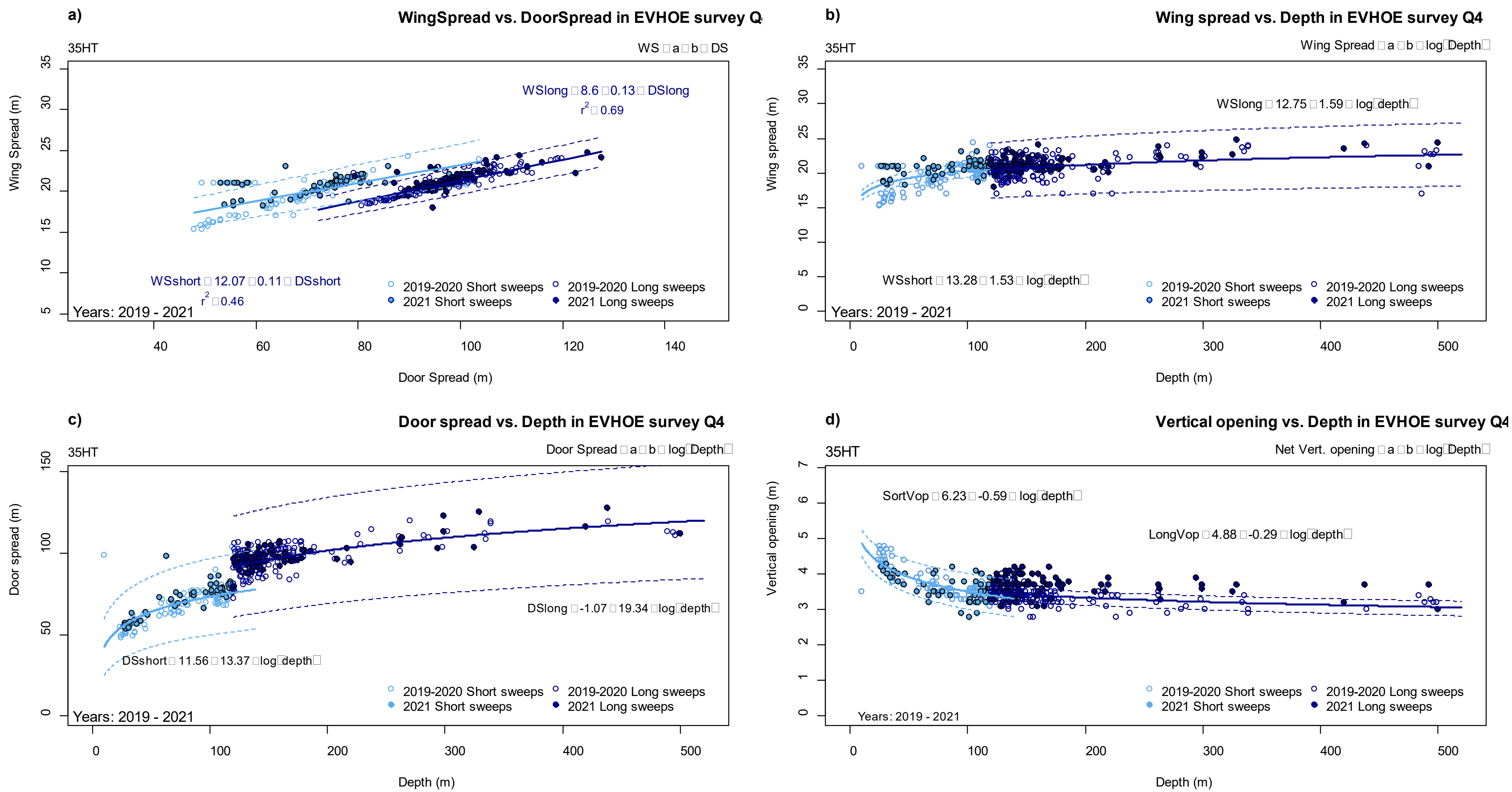

Figure A6.1g. Gear parameter plots for EVHOE-Q4. Notes: Seven HH records from 2018 with door spread = 0 were excluded; potential problems with the assignment of long and short sweeps, or input errors. Data for 2019 indicates 50 m sweeps used at depths of 10-120 m and 100 m sweeps in depths >120 m, but earlier data are not consistent in this assignment. Two points from 2019 with depth = NA and sweeps = 50.

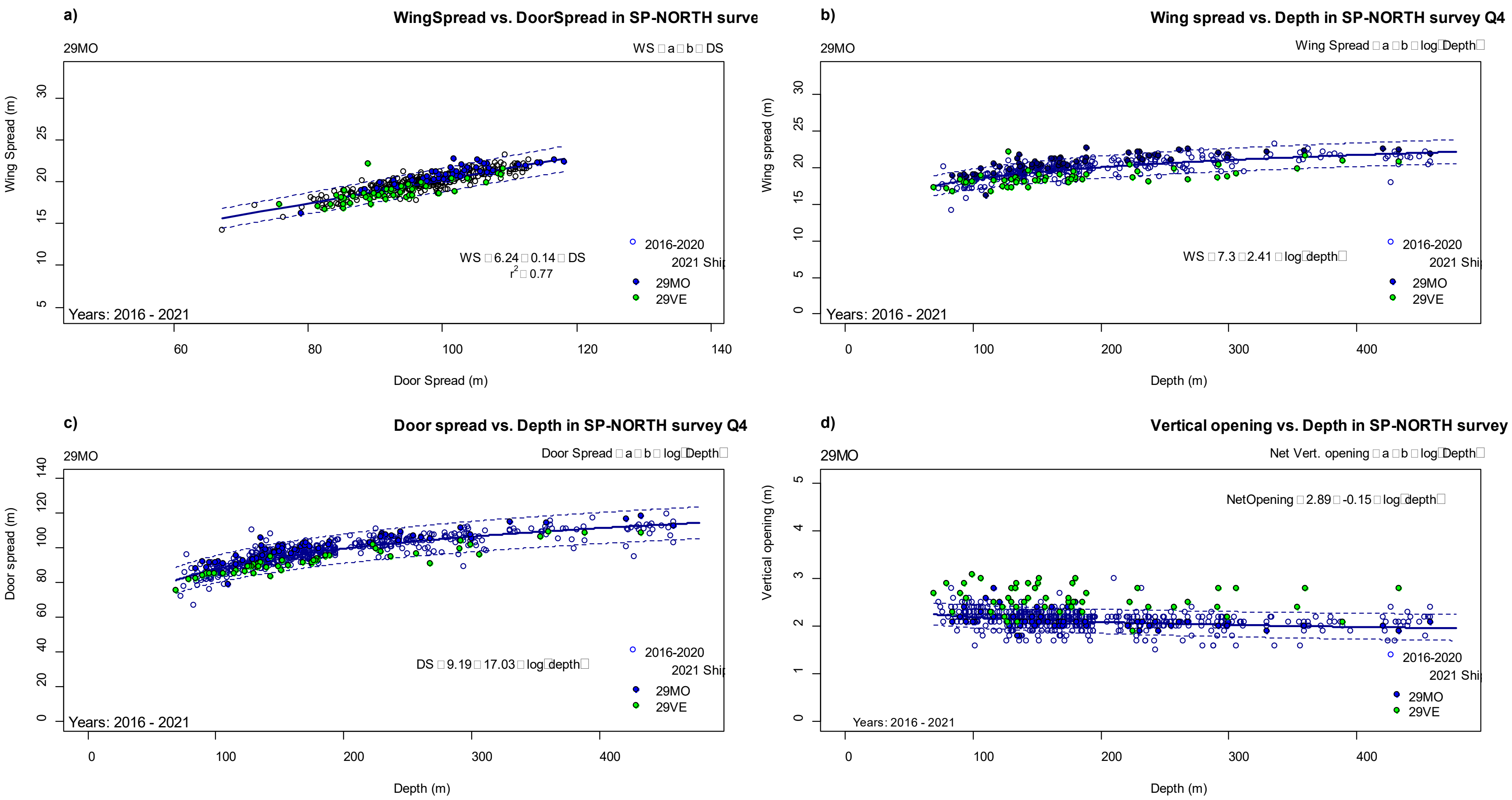

Figure A6.1h. Gear parameter plots for SP-NSGFS-Q4. Notes: A different ship was used in the second leg of the 2021 survey. Differences have been found, mainly in vertical opening that is larger in the second vessel and therefore affects results on the easternmost part of 8.c. Comparing the catches of both vessels, this different behaviour of the gear has apparently had an effect on the catchability of recruits of megrims and possibly hake, which is less abundant in that area. The possibility of an underestimation of recruitment has been reported to the relevant assessment Working Groups.

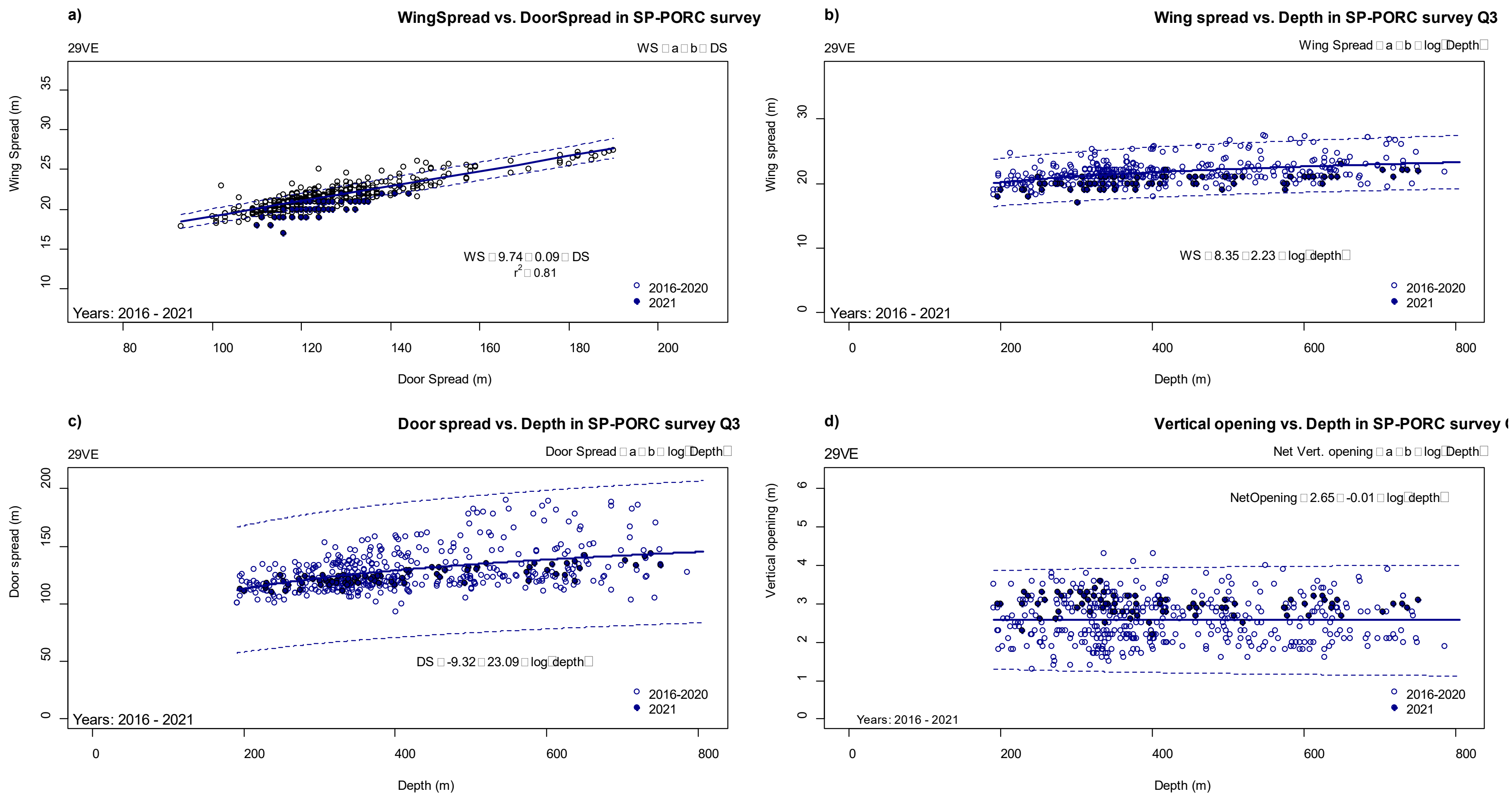

Figure A6.1i. Gear parameter plots for SP-PORC-Q3.

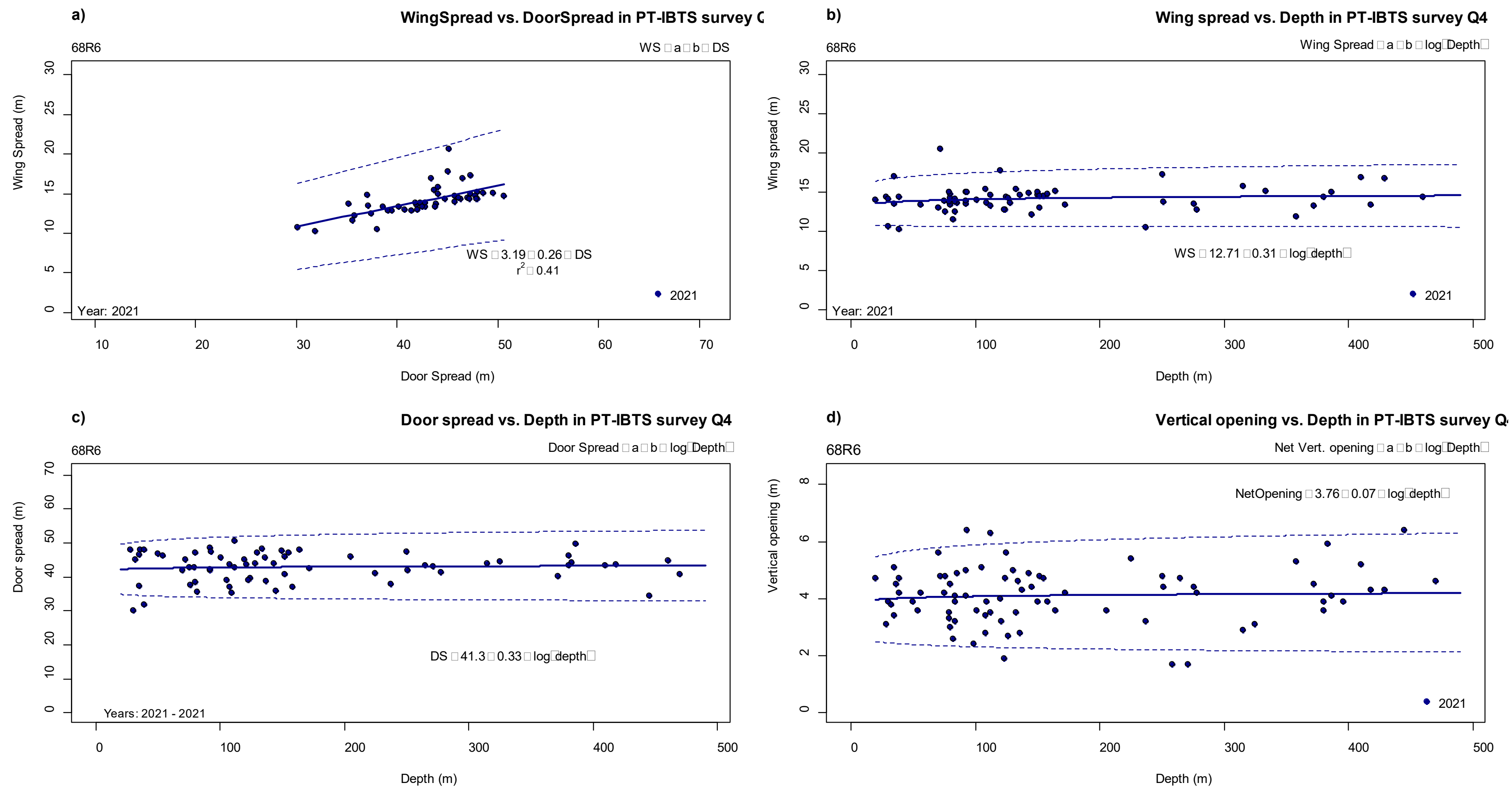

Figure A6.1j. Gear parameter plots for PT-PGFS-Q4. Notes: The new vessel used for the first time on this survey this year has also been the first opportunity to use the net sensors; the results are shown above without comparisons, as no previous data are available.

A6.2 Scottish West Coast Groundfish Survey (SCOWCGFS-Q1)

Nation:	**Scotland**	**Vessel:**	**Scotia**
Survey:	0321S (SCOWCGFS-Q1)	Dates:	16 February – 10 March 2021
Cruise:	Objectives of SCOWCGFS-Q1: Demersal trawling survey (SCOWCGFS-Q1) off the north and west of Scotland and in ICES Division 6.a. To collect surface and bottom water temperature and salinity data from each trawling station. Collect additional biological data in connection with the EU Data Collection Framework (DCF). Retrieval and re-deployment of COMPASS project moorings located at discreete sites within the trawl survey area (two additional days added to the survey). Undertake sediment and sea surface litter sampling deployments for the Clean Seas Environmental Monitoring Programme (CSEMP) in the Clyde region.		
Gear details:	GOV incorporating groundgear D was used at all stations and was deployed on 65 occasions (Table A6.5). Sweeps were 97 m in all cases where the mean depth was >80 m (n = 51), otherwise 47 m sweeps were used (n = 14). 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 to aid validation of touchdown and lift-off times for the trawl.		
Notes from survey (e.g. problems, additional work etc.):	Demersal Survey Despite challenging weather conditions experienced during much of part 1 the GOV (BT137) was deployed on 65 occasions during 0321S. The shorter 47 m sweeps were used where the depth was 80 m or less (12 valid and 2 invalid hauls) and the longer 97 m sweeps used on the remaining 51 deeper hauls (all valid). Of the 63 valid hauls completed all but one were completed during daylight hours. During both occasions when hauls were deemed invalid, severe damage was sustained while attempting to trawl within the hard ground in and around Tory Island, NW Ireland. The locations used for the valid trawl positions during this survey were a combination of established MSS survey tows, commercial trawled areas and also completely new tows. On 31 occasions, grounds were successfully sampled that had previously been unfished by MSS. See Figure A6.2 for a plot of all survey tows. Hauls were typically of 30 min duration however various factors (indications of excessively large marks of pelagic fish, hard/rocky terrain with net coming fast, strong tide and vessel issues) resulted in lesser durations for 14 hauls (haul nos. 81, 90, 91, 93, 104, 105, 110, 113, 117, 122, 126, 128, 132, 136 and 137). No valid hauls were <15 min duration, s thus complying with recommendations pertaining to minimum haul duration referenced in the 2009 IBTSWG report. The CTD recorder (Seabird19+) was deployed at 60 of the 63 valid trawling stations in order to obtain a temperature and salinity profile to within approximately 5 m of the seabed. Three sites (hauls 85, 103 and 107) had no associated hydrographic profile data. These were dropped in order to save time thus allowing the completion of another trawl station within the daylight period. COMPASS Acoustic Moorings Deployments/Retrieval Six acoustic moorings were successfully retrieved by "Scotia" from a possible seven different locations within the survey area. This included all the COMPASS moorings with only the additional acoustic mooring deployed off Mingulay that "Scotia" was unable to retrieve. Contact was made and the release command accepted and completed however the mooring failed to surface so one can only surmise that something was obstructing it from doing so. No re-deployment was programmed for this location. Six new COMPASS moorings were successfully deployed back onto the regular deployment locations (see Figure A6.2 for mooring locations).		

	Clean Seas Environmental Monitoring Programme (CSEMP) This was an additional objective that "Scotia" was able to undertake subsequent to completion of the GOV trawling stations in the Clyde area. Three sea surface litter runs were successfully completed within the lower Clyde area using the Manta Trawl and 30 sediment grab deployments were successfully made with Day grab. These were spread across 15 fixed monitoring sites within the Firth of Clyde and were undertaken prior to "Scotia" going alongside in Greenock. Figure 1 provides a plot of CSEMP deployments made. Additional sampling undertaken during 0321S Species diagnostic work on *Dipturus spp*. (MSS project) Regional provenance work for research project – cod (MSS partner in project) Whole juvenile mackerel retained for investigations into variations in field metabolic rate (FMR) proxy using sagittal otoliths – Southampton University. Pelagic fish sample collection – Retention of 6 kg each of mackerel and herring from the Minch area for environmental monitoring (CRCE Scotland, Glasgow) Retention of Phakellid and Craniella sponges. Collaborative phylogenetic study between MSS and the Natural History Museum. Bobtail squid identification. All bobtail squid (Sepiolidae) caught were frozen for identification at Naturalis Biodiversity Centre, Leiden. Spring-spawning herring: Fin clips retained for analysis by MSS to enhance ongoing stock discrimination work within Division 6.a. All shelled molluscs retained for the Mackay reference collection.
No. fish species recorded and notes on any rare species or unusual catches:	Catch Results (Note: 2020 results presented in parentheses) A total of 92 (101) species were recorded for an overall catch weight of ~37.5 (35.5) tonnes. Major species components in approximate tonnes included: haddock *Melanogrammus aeglefinus*: 5.77 (5.45), mackerel *Scomber scombrus*: 10.6 (10.8), cod *Gadus morhua*: 0.30 (0.29), Norway pout *Trisopterus esmarkii*: 6.17 (4.52), whiting *Merlangius merlangus*: 1.87 (2.85), herring *Clupea harengus*: 2.41 (1.56), and scad *Trachurus trachurus*: 2.84 (0.84). "Scotia" was able to achieve slightly more valid hauls than were undertaken during this survey in 2020 (59 hauls), however overall effort in hours fished was broadly similar so catch estimates between the two years are comparable. The total herring caught was 30% up from the previous year, as was Norway Pout, but the total whiting was 30% lower. Catches of haddock, mackerel and cod were very similar to 2020, whereas horse mackerel was over 250% percent up from 2020. Interesting that haul 126 (15 nm NE of Tory Island) yielded over 400 kg of very large and very ripe spring-spawning herring. Table A6.6 provides overall catch rates per unit effort (CPUE) of the above species and several other major species. The CPUE index (numbers caught per hour fishing) for 1-group gadoids (cod, haddock, whiting and saithe) weights the indices for each of the 11 sampling strata by the surface area of said stratum. These are then pooled to produce the index for ICES Division 6.a. Results for Q1 2021 for all age classes of the major commercial gadoid species are shown in Table A6.7 while those of 1-groups only for period 2012–2021 are shown in Table A6.8. Species CPUE by weight (all ages) for the survey over the same period is displayed in Table A6.9. Although overall survey CPUE indices provided mostly a mixed bag regarding catch-rates, the 1-group abundance indices were down for all major species bar haddock which saw a 50% increase on 2020. Numbers of 1 group whiting meanwhile are down almost 80% on 2020, whereas 1 year old cod are down 90% (0.12) albeit the survey high for 1 year old cod in 2020 being only 1.44. For the third year in succession no 1 group saithe were recorded during the survey. Overall CPUE by weight (kg/hr) was more or less unchanged for both haddock and cod, and up for Norway Pout whereas down for whiting and significantly down for saithe compared with 2020 (see Tables A6.8 and A6.9). Notable species encountered during the survey included a sea lamprey Petromyzon marinus that was recorded from the shelf edge NW of the Butt of Lewis (station 81). Biological Sampling In total 6630 biological observations on selected species were collected including a number collected in support of EU Data Collection Framework (DCF). A summary of numbers collected for all species is displayed in Table A6.10. All otoliths were aged back at MSS.

	Marine Litter All litter picked up in the trawl was classified, quantified and recorded prior to being retained for appropriate disposal ashore. Monitoring of Non-indigenous Invasive Species (NIS) All catches were screened for the presence of selected NIS species with the results being reported back to the project coordinator at CEFAS. A sooty shearwater *Ardenna grisea* was spotted around Scotia's stern during hauling at station 132, just South of Blackstone Bank and within the Stanton Bank area. Although not an unusual species in summer, it is extremely rare to see this species in Scottish waters during March. A pod of 20 common dolphin Delphinus delphis were spotted while deploying the trawl on station 118, 5nm ENE of Tory Island.

Table A6.5. Number of stations surveyed/gear during 0321S.

			Hauls					
ICES Division	Strata	Gear	Planned	Valid	Additional	Invalid	% Achieved	Comments
6.a	All	GOV-D	62	63	1	2	102	None

Table A6.6. Overall CPUE of major components of combined catch Q1 2021.

Species	Common name	kg/hr	no/hr
Melanogrammus aeglefinus	Haddock	196	893
Scomber scombrus	Mackerel	359.3	1270
Gadus morhua	Cod	10.2	4.8
Trisopterus esmarkii	Norway pout	209.6	9614
Merlangius merlangus	Whiting	63.7	382
Clupea harengus	Herring	83.4	707
Trachurus trachurus	Horse mackerel	96.6	332
Scyliorhinus canicula	Lesser-spotted dogfish	48	82
Pleuronectes platessa	Plaice	3.6	27
Eutrigla gurnardus	Grey gurnard	20.5	218
Capros aper	Boarfish	30.3	593
Squalus acanthias	Spurdog	13.7	30
Pollachius virens	Saithe	1.9	1
Merluccius merluccius	Hake	19.4	63.9
Dipturus intermedia	Flapper skate	5.2	1.8
Loligo spp.	Long-finned squid	7.4	46.2
Raja montagui	Spotted ray	13.7	30.1

Lophius piscatorius	Anglerfish	2.5	1.4
Sprattus sprattus	Sprat	1.3	147
Raja clavata	Thornback ray	2.3	1.8
Chelidonichthys cuculus	Red gurnard	5.8	16.5
Micromesistius poutassou	Blue whiting	39.2	1440
Limanda limanda	Common dab	2.5	39.9
Microstomus kitt	Lemon sole	3.7	29.5
Lepidorhombus whiffiagonis	Megrim	2.7	6.7

Table A6.7. CPUE indices (no/hr) by year class of major demersal species Q1 2021.

Age	Cod	Haddock	Whiting	Saithe	N. Pout
0	0.00	0.00	0.00	0.00	0.00
1	0.12	152.38	77.37	0.00	2271.07
2	1.21	356.86	167.93	0.00	6337.78
3	2.30	300.66	70.35	0.97	2059.79
4	0.29	18.37	27.18	0.04	0.00
5	0.25	21.11	14.02	0.06	0.00
6	0.12	4.97	2.43	0.00	0.00
7	0.04	50.77	1.09	0.07	0.00
8	0.00	0.22	0.00	0.04	0.00
9	0.00	0.03	0.00	0.03	0.00
10	0.00	0.00	0.00	0.04	0.00
11	0.00	0.00	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00	0.00
13	0.00	0.00	0.00	0.05	0.00
14	0.00	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00	0.00

Table A6.8. CPUE indices (no/hr fishing) of 1-groups of major demersal species since 2012.

Species	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Cod	1.4	2	1.1	0.82	0.47	0.29	0.17	1	1.44	0.12
Haddock	14.7	5.2	53	680	56	217	39.8	763	95.8	152
Whiting	344	5.5	580	254	323	497	196	323	380	77.3
Saithe	0.0	0.04	0.0	0.0	0.0	0.0	1.28	0	0	0
Norway pout	1012	4238	2136	4649	3245	4370	538	4693	3698	2271

Table A6.9. CPUE indices (kg/hr fishing) of major demersal species since 2012.

Species	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Cod	21.2	29.3	11.6	72.5	44.1	190	20.4	4.5	10.4	10.2
Haddock	153	180	114	169	191	325	206	189	198	196
Whiting	46.9	63.8	35.0	58.7	96.9	110	100	56	103	63.7
Saithe	6.1	15.2	25.0	24.0	17.1	16.2	42.5	2.18	16	1.9
Norway pout	131	131	126	65.4	73.9	127	44.1	58.6	165	210

Table A6.10. Numbers of biological observations per species collected during 0321S. These consist of length, weight, sex and age, unless specified otherwise (*a* = length, weight, sex, maturity and otoliths retained to be aged at a later date; *b* = length, weight, sex and maturity; *c* = length, weight and age; *d* = length, weight, sex and externally determined maturity only).

Species		No.	Species		No.
Melanogrammus aeglefinus		1963	*Scophthalmus maximus*	b)	-
Merlangius merlangus		1361	*Scophthalmus rhombus*	b)	1
Gadus morhua		139	*Dipturus batis*	d)	8
Pollachius virens		30	*Dipturus intermedius*	d)	41
Trisopterus esmarkii		469	*Leucoraja naevus*	d)	14
Clupea harengus		870	*Mustelus asterias*	d)	28
Sprattus sprattus	c)	389	*Raja brachyura*	d)	7
Scomber scombrus		410	*Raja clavata*	d)	28
Merluccius merluccius	a)	345	*Raja montagui*	d)	89
Pleuronectes platessa		209	*Squalus acanthias*	d)	184
Molva molva	b)	42	*Galeorhinus galeus*	d)	3

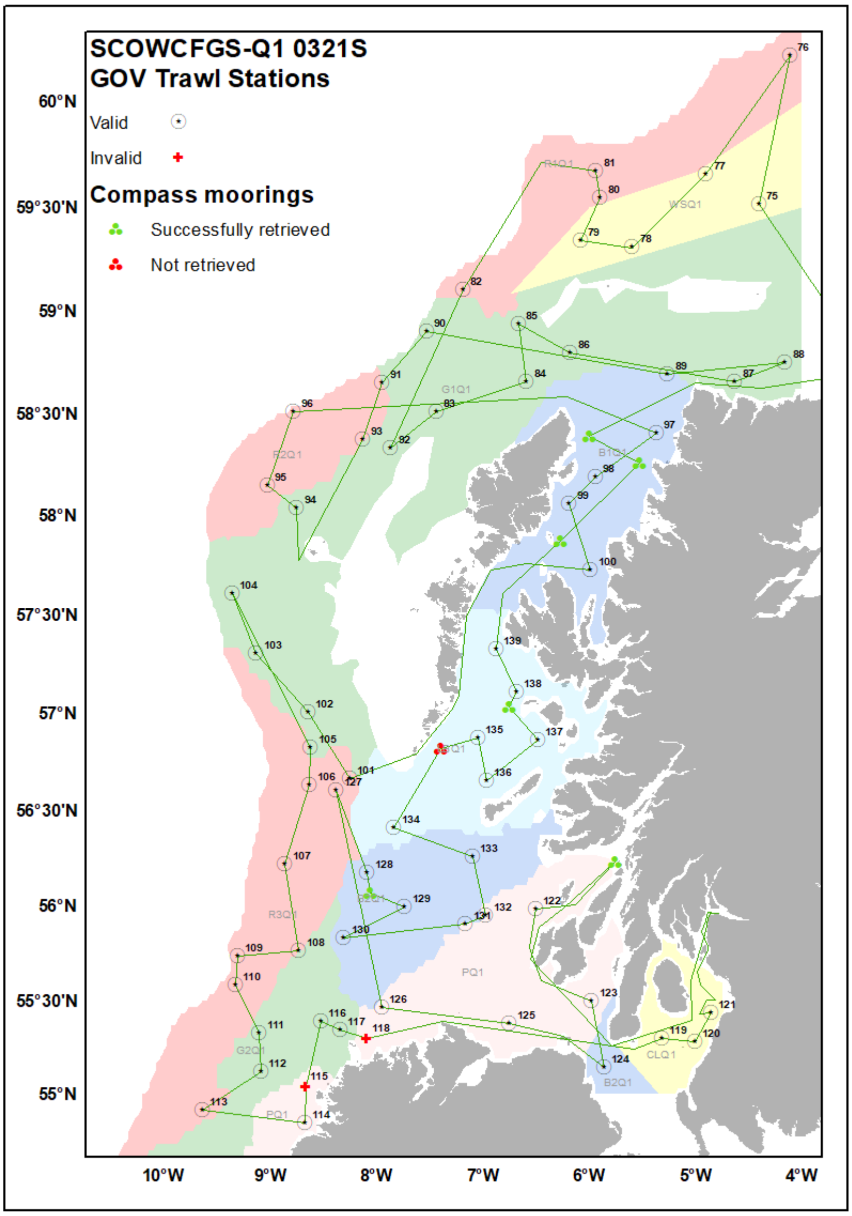

Figure A6.2a. Survey map for 0321S showing survey strata (coloured polygons), GOV trawl and COMPASS mooring positions and survey track.

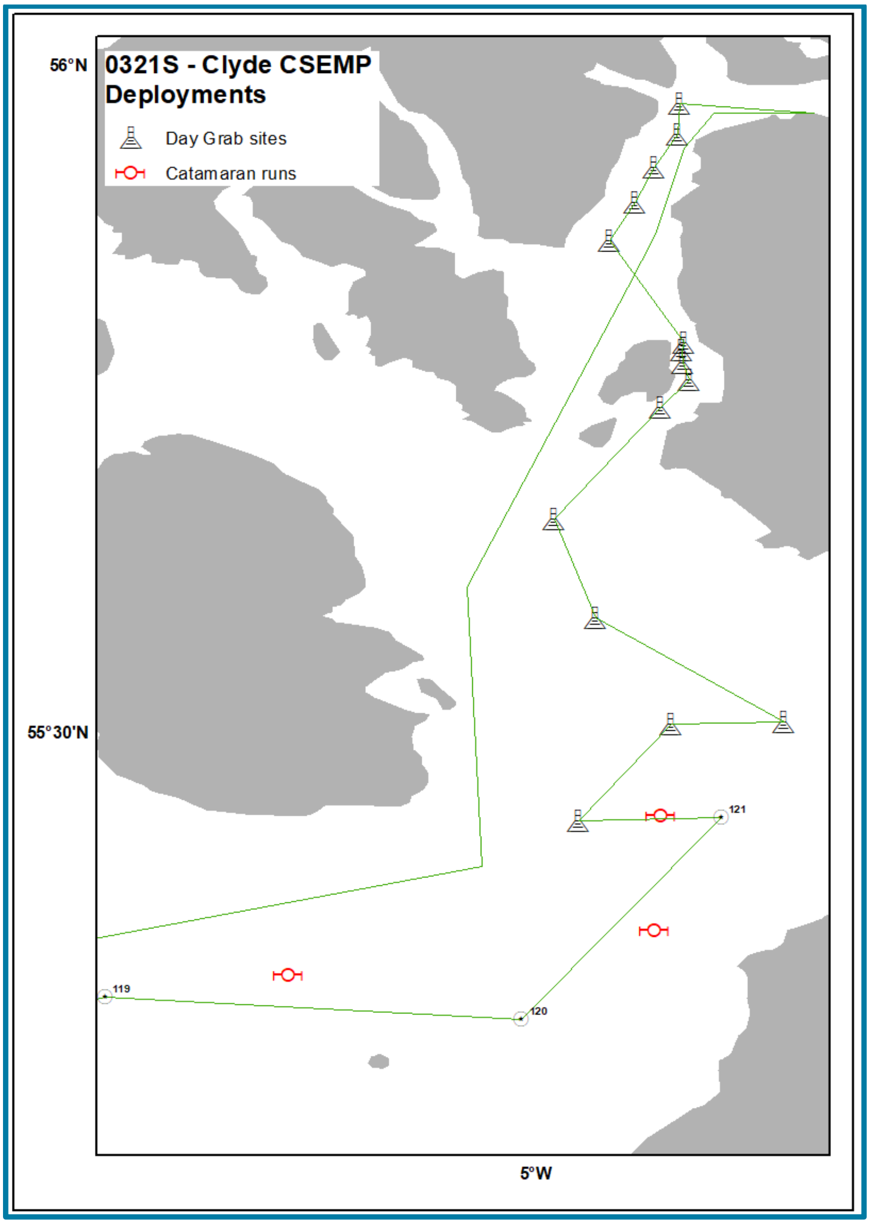

Figure A6.2b. Additional CSEMP sampling undertaken within the lower Clyde basin.

A6.3 Northern Irish groundfish survey (Q1)

Nation:	**UK (Northern Ireland)**	**Vessel:**	**Corystes**
Survey:	Groundfish Survey CO1021	Dates:	March 04– March 19 2021
Cruise	To obtain information on spatial patterns of abundance of different size-and-age classes of demersal fish in the Irish Sea. To obtain abundance indices of cod, whiting, haddock and herring for use at ICES Working Groups. To quantify external parasite loads in whiting and cod by area. To collect additional biological information on species as required under DCF. To collect tissue samples for genetics studies on mature cod and hake.		

	To collect information on the extent of marine litter in the Irish Sea.
Gear details:	A commercial rockhopper trawl fitted with a 20 mm liner in the cod-end was towed over three nautical miles (or one nautical mile) in the Irish Sea and St George's Channel. Gear and towing procedures were those employed on all previous AFBI groundfish surveys.
Notes from survey (e.g. problems, additional work etc.):	A stratified survey with fixed station positions was employed. The survey was divided into strata defined by depth and substratum. The species composition of the catch at each station was determined, and length frequencies were recorded for each species. All cod, most hake and representative subsamples of haddock and whiting were taken for recording length, weight, sex and maturity stages and for the removal of otoliths for ageing. The level of infestation of whiting and cod by external parasites was estimated from biological samples collected at each station. For all hauls fishing was carried out during daylight, commencing each day at first light. 60 valid hauls were completed, 20 stations were towed for one hour and 37 stations were 20-minute tows. Stations 70, 77 and 247 were trawled for 1.5 nm. The width of seabed swept by the trawl doors increased from around 35 m in shallow water (30 m sounding) to around 45 m in deeper water (80 m sounding), with variations due to tidal flow. The range of average headline heights across all hauls was 2.5–3.4 m. Trawl parameters were consistent with previous surveys. Cod and whiting taken for biological analysis were screened for external parasites. Trawl data and length frequencies were archived using the newly developed groundfish survey database. Preliminary indices of abundance for 0-group and 1-group cod, whiting and haddock were obtained from the length distributions. More accurate indices will be available once the otoliths collected during the cruise have been aged. Additional Sampling: All litter picked up in the trawl was classified, quantified and recorded and uploaded to the national litter database from where it will eventually be uploaded to DATRAS. The litter was retained onboard for appropriate disposal ashore. Additional biological data and stomach samples were taken for foodweb analysis.
Number of fish species recorded and notes on any rare species or unusual catches:	A total of 130 species were recorded during the survey of which 76 were measured for length frequencies. Biological data were recorded for a number of species in accordance with the requirements of the EU Data Regulations. A total of 2,913 biological samples were taken during the survey.

Table A6.11. Number of stations surveyed/gear.

			Hauls					
ICES Division	Strata	Gear	Planned	Valid	Additional	Invalid	% Achieved	Comments
7.a	All	Rockhopper	61	60	0	0	98	None

Table A6.12. Numbers of biological observations per species collected during CO1021. These consist of length, weight, sex and age, unless specified (*a* = age data not collected length; *b* = weight, length and sex recorded).

Species	No.	Species		No.
Gadus morhua	141	*Scophthalmus maximus*	*b)*	0
Merlangius merlangus	1190	*Raja brachyura*	*b)*	22
Melanogrammus aeglefinus	911	*Raja clavata*	*b)*	19

Merluccius merluccius		77*	*Raja montagui*	*b)*	30
Pollachius pollachius	*a)*	5	*Leucoraja naevus*	*b)*	15
Molva molva		0	*Squalus acanthias*	*b)*	42
Zeus faber		0			
Scophthalmus rhombus		0			
Pleuronectes platessa		461			
Microstomus kitt		0			
Lepidorhombus whiffiagonis		0			
Chelidonichthys cuculus		0			

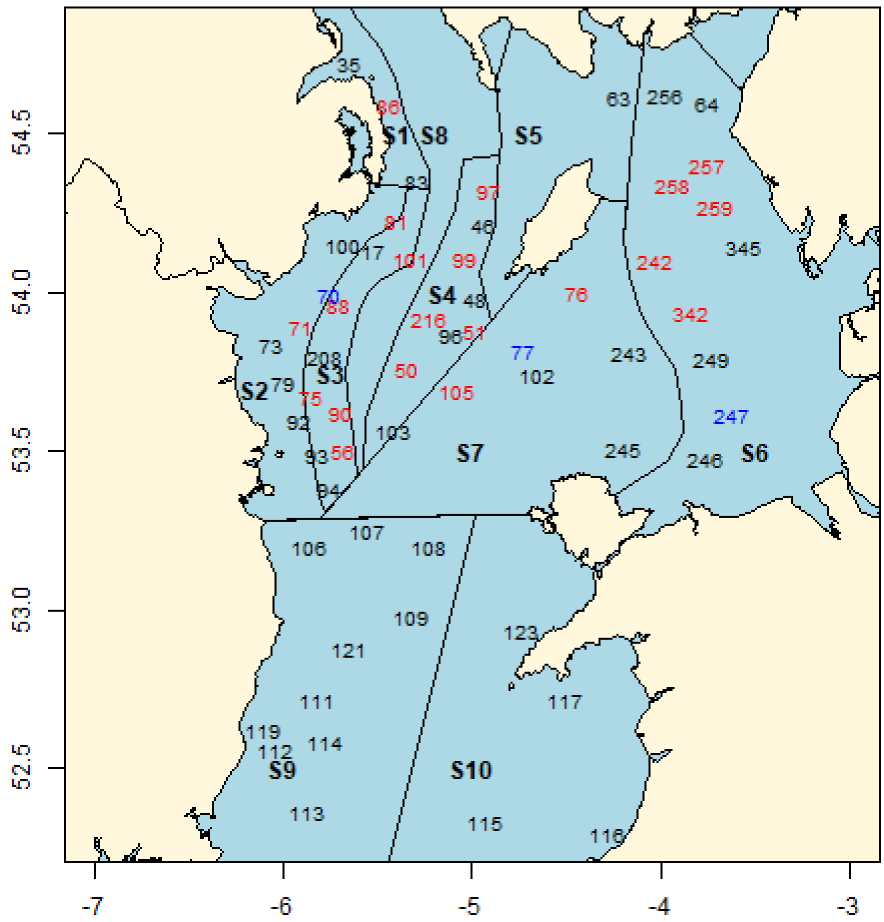

Figure A6.3. Map of the NI groundfish survey stations completed during CO1021. Stations sampled for either 60 min (3 nm; red), 30 min (1.5 nm; blue) or 20 min (1 nm; black).

A6.4 Irish Anglerfish and Megrim Survey (IAMS)

Nation:	**Ireland**	**Vessel:**	**Celtic Explorer**
Survey	IE-IAMS-Q1	Dates:	8 Feb – 4 Apr 2021 (7.b,c,j,k) 10 – 21 April 2021 (6.a)
Cruise	The main objective of the Q1 Irish Anglerfish and Megrim Survey is to obtain abundance and biomass indices for anglerfish (*Lophius piscatorius and L. budegassa*) and megrim (*Lepidorhombus whiffiagonis* and *L. boscii*) in Division 6.a (south of 58°N) and parts of Subarea 7 (west of 8°W). Secondary objectives are to collect data on the distribution and relative abundance of anglerfish, megrim and other commercially exploited species. The survey also collects maturity and other biological information for commercial fish species. The Irish Anglerfish and Megrim Survey (IE-IAMS-Q1) data are uploaded to DATRAS. The survey is used as a tuning index for mon.27.78abd (WGBIE) and will be submitted for ank.27.78abd and meg.27.78abd for the WKMEGRIM benchmark in 2021–2022. Information on the IAMS-Q1 is also included as an annex of the Manual of the IBTS North Eastern Atlantic Surveys, SISP 15 (ICES, 2017).		
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). See: Reid, D.G., Allen, V.J., Bova, D.J., Jones, E.G., Kynoch, R.J., Peach, K.J., Fernandes, P.G. and Turrell, W.R. 2007. Anglerfish catchability for swept-area abundance estimates in a new survey trawl. ICES Journal of Marine Science, 64: 1503–1511.		
Notes	Operational working hours were reduced from 24 to 12 hours in order to comply with Covid-19 restrictions. Staffing levels and targets were reduced proportionally. 6 full days lost to bad weather in February; no weather downtime in April; 8 hours of technical downtime. Additional deep-water transects (500–1500 m) were added to survey protocols (three additional days have been added to facilitate this work). This work is funded independently through EMFF.		
Number of fish species, unusual catches	In 2021, 78 species of teleost, 27 species of elasmobranch, five species of cephalopods and 37 other species/groups were recorded. The following unusual species were recorded: *Lampadena speculigera, Cyttopsis rosea, Nessorhamphus ingolfianus, Magnisudis atlantica* and *Nesiarchus nasutus*.		

Table A6.13. Stations fished (aim to complete 115 valid tows per year; including deep-water stations).

Divisions	Stratum	Stratum area (km²)	Valid tows	Swept area (km²)
6.a	VIa_Shelf_L	37,003	11	5.1
6.a	VIa_Shelf_M	4,746	4	2.4
6.a	VIa_Slope_H	3,114	5	2.8
6.a	VIa_Slope_M	3,044	5	3.4
7.bcjk	VII_Shelf_H	50,764	10	5.4
7.bcjk	VII_Shelf_L	42,034	13	7.1
7.bcjk	VII_Shelf_M	14,621	5	2.4

7.bcjk	VII_Slope_H	35,768	17	8.7
7.bcjk	VII_Slope_M	29,406	6	3.7
6.a	DeepArea4	Additional sampling	(1)	
7.c	DeepArea5	Additional sampling	(3)	
	TOTAL	220,500	76+(4)	41

Table A6.14. Biological samples collected during IAMS2021. Sampling includes length, weight, sex, maturity and age material unless otherwise specified. Species denoted * sampled for length, weight, sex and maturity only; species denoted ** sampled for length and weight only.

Species	No.	Species	No.
Gadus morhua	55	*Deania calcea***	95
Lepidorhombus whiffiagonis	882	*Dipturus intermedia***	110
Lophius budegassa	341	*Etmopterus princeps***	17
Lophius piscatorius	741	*Etmopterus spinax***	6
Melanogrammus aeglefinus	515	*Galeorhinus galeus***	18
Merlangius merlangus	257	*Galeus melastomus***	139
Molva molva	164	*Glyptocephalus cynoglossus***	205
Pleuronectes platessa	169	*Hexanchus griseus***	2
Pollachius pollachius	37	*Lepidorhombus boscii***	160
Pollachius virens	67	*Leucoraja circularis***	12
Solea solea	18	*Magnisudis atlantica***	1
*Raja brachyura**	1	*Merluccius merluccius***	931
*Raja clavata**	119	*Microstomus kitt***	233
*Raja montagui**	149	*Mustelus mustelus***	72
Dipturus batis (D. cf. *flossada)**	76	*Neoraja caerulea***	5
*Leucoraja naevus**	242	*Raja microocellata***	1
*Squalus acanthias**	298	*Rajella bigelowi***	8
*Apristurus aphyodes***	4	*Rajella fyllae***	2
*Apristurus laurussonii***	1	*Scophthalmus maximus***	2
*Apristurus microps***	9	*Scophthalmus rhombus***	6
*Borostomias antarcticus***	2	*Zeus faber***	105

*Centrophorus squamosus***	24
*Centroscyllium fabricii***	21
*Centroscymnus coelolepis***	18
*Centroscymnus crepidater***	45
*Conger conger***	11

Table A6.15. Summary statistics by stratum. Stratum area is given in Km^2, No. hauls is the is the number of valid hauls in each stratum and Swept-area is the total area swept between the doors in each stratum (in Km^2), catch numbers are given for *L. piscatorius* (MON), *L. budegassa* (WAF), *L. whiffiagonis* (MEG) and *L. boscii* (LBI).

Stratum	Stratum area	No. hauls	Swept area	Catch number			
				MON	**WAF**	**MEG**	**LBI**
VIa_Shelf_L	37,003	11	5.1	75	7	63	0
VIa_Shelf_M	4,746	4	2.4	49	31	59	0
VIa_Slope_H	3,114	5	2.8	58	26	117	0
VIa_Slope_M	3,044	5	3.4	114	1	129	4
VII_Shelf_H	50,764	10	5.4	24	108	168	34
VII_Shelf_L	42,034	13	7.1	69	66	151	105
VII_Shelf_M	14,621	5	2.4	54	27	64	0
VII_Slope_H	35,768	17	8.7	94	100	360	179
VII_Slope_M	29,406	6	3.7	35	0	1	0
Total	220,500	76	40.9	572	366	1,112	322

Table A6.16. Estimated numbers (millions) and biomass (kT) in the survey area, with CV and confidence intervals (CIlo and CIhi). Only fish >500g live weight (approximately 32cm) were included in the estimate.

	VIa MON	VII MON	VIa WAF	VII WAF
NumMln	3.104	9.726	0.632	16.126
NumCV	17.669	14.988	28.768	19.226
NumCiLo	2.029	6.869	0.276	10.049
NumCiHi	4.179	12.583	0.989	22.203
BiomKT	4.752	15.901	0.564	8.300
BiomCV	18.977	13.302	27.938	12.555
BiomCiLo	2.985	11.756	0.255	6.258
BiomCiHi	6.520	20.047	0.873	10.342

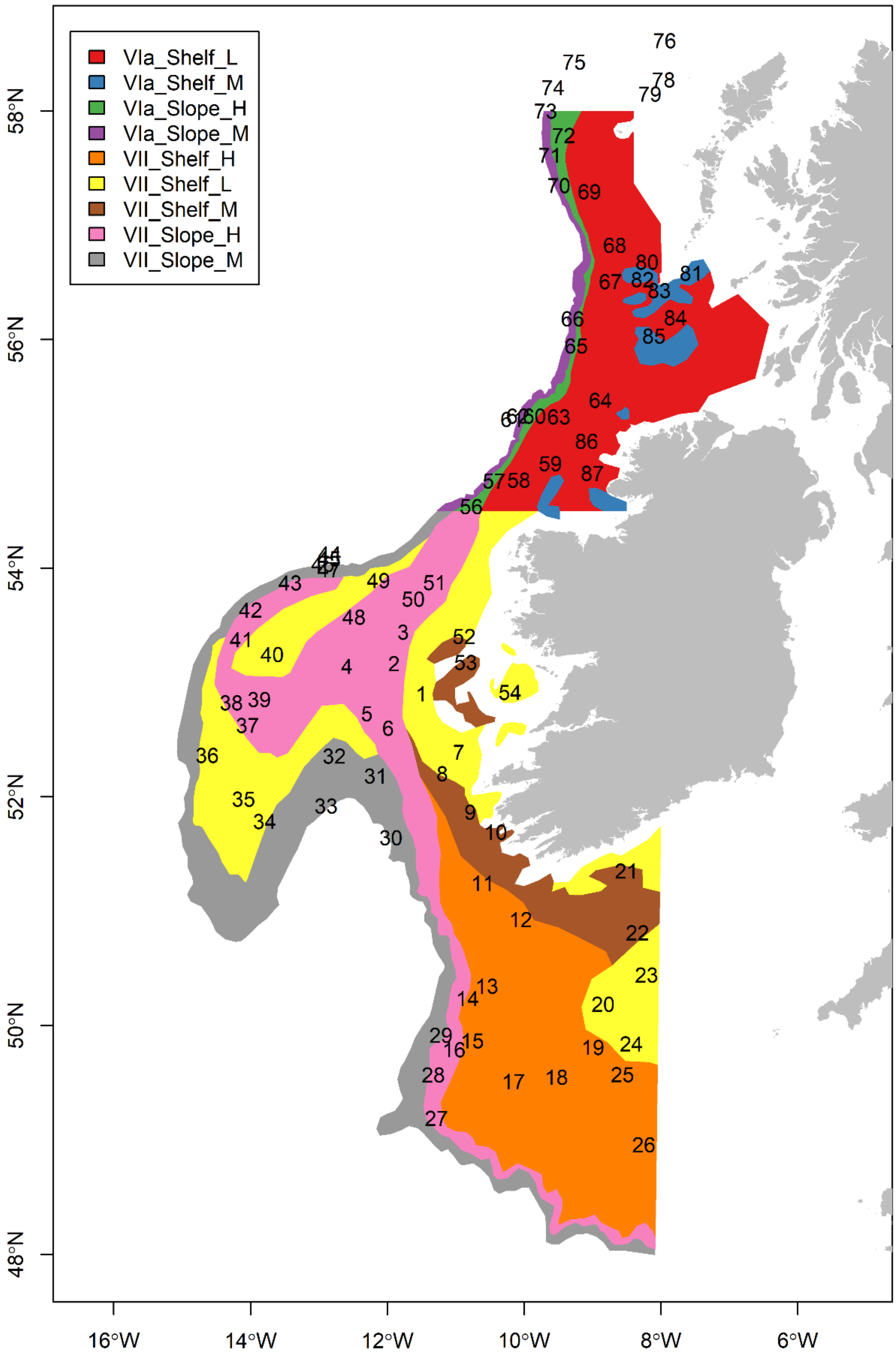

Figure A6.4. Map of valid survey stations completed by the Irish Anglerfish and Megrim Survey in 2021. The numbers refer to the haul number.

A6.5 Scottish Rockall Survey (SCOROC-Q3)

Nation:	**Scotland**	**Vessel:**	**Scotia**
Survey:	1221S (Rockall Haddock)	Dates:	10 – 22 September 2021
Cruise:	Q3 Rockall 2021 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 Division 6.b. 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.		
Gear details:	Strengthened GOV incorporating ground-gear D and 97 m sweeps was used at all stations. The following parameters were recorded during each tow using Scanmar hardware and vessel's own navigation system: headline height, wing spread, door spread, speed over the ground and distance covered. A bottom contact sensor was attached to the ground-gear and downloaded each tow to monitor contact with the seabed.		
Notes from survey (e.g. problems, additional work etc.):	The survey design since 2011 has been random-stratified with primary trawl locations randomly distributed within four sampling strata defined by depth contour (0–150 m, 150–200 m, 200–250 m, and 250–350 m). Trawls were undertaken within a radius of 5 nm 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 45 valid trawls completed within the survey area, with all fishing taking place during daylight hours. There were no invalid hauls. Due to the survey making remarkably quick progress this year the chance was taken to complete an additional station outside the standard survey area to provide evidence of absence (or otherwise) of haddock in greater depths at this time of year. Figure A6.5 shows the sampling strata, trawl locations and haul numbers. This year haddock recruitment again stood out as very strong, being observed spread throughout the upper bank representing the second highest recruitment since the new survey design of 2011 and an improvement on that of 2020 (Figure A6.6) which was itself very high. The CPUE of 1 year old haddock was good reflecting the high recruitment of 2020 and, similar to this year's 0-groups, were evenly distributed over the upper depth ranges. Catches of older haddock tended to be relatively low. Biological sampling: Ages were recorded for haddock, whiting *Merlangius merlangus*, cod *Gadus morhua* and mackerel *Scomber scombrus* along with sex, and weight data. All otoliths were aged post-cruise back at marine lab. Data on other species sampled for biological information are summarized in Table A6.20. Station outside survey area: The catch from station 459 (390m) contained no haddock. Hydrography: CTD casts (n = 25) were made at selected stations to give a representative coverage of the bank over the depth range surveyed. Marine litter: All litter picked up in the trawl was classified, quantified and recorded, then retained for appropriate disposal ashore. Non-indigenous Invasive Species: All catch, fish and benthos were screened as far as possible for the presence of non-indigenous species, though none were evident. Additional Samples and Miscellaneous Requests Blue whiting: Otoliths and weights were recorded at a rate of 1/cm/per (selected) haul to complement data from our directed blue whiting survey (MSS). Mackerel: A set of 60 juveniles (13–16 cm) were frozen whole for a study of the affect of temperature on capacity for mackerel growth (University of Southampton). Tunicates: Tissue samples were collected from two unidentified specimens with the remainder of each specimen preserved to contribute to studies on invasive species of this subphylum (MSS).		

	Porifera: *Axinellida*: Tissue samples and reference specimens from ~35 specimens of mainly *Phakellia ventilabrum* were collected for phylogenetic study (Natural History Museum). Cnidaria: *Pennatulacea*: Tissue samples along with reference specimens were collected for molecular study at the University of Seville: *Ptilella greyi* (11), *Kophobelemnon* sp. (30; MSS / University of Seville). Cnidaria: *Alcyonacea*: Tissue samples along with reference specimens were collected for future study*: Placogorgia sp*. (1), unidentified holaxonian (1; MSS). Ommastrephid squids: Tissue samples from all (4) squid of genus Illex were collected for eventual sequencing to confirm species (MSS) All shelled molluscs were retained frozen for identification and studies on distribution by D. Mackay.
No. fish species recorded and notes on any rare species or unusual catches:	Overall, a total of 62 species were recorded during the survey with a total catch weight of ~26.81 tonnes recorded from 22.4 hrs of combined trawl time. Among the overall catch haddock (~10.15 tonnes), Norway haddock Sebastes viviparous (~5.49 tonnes) and blue whiting *Micromesistius poutassou* (~3.87 tonnes) were prominent. As is currently typical, few cod Gadus morhua (eight individuals, ~50.0 kg) and saithe *Pollachius virens* (two individuals, 2.15 kg) were caught. Very small amounts of whiting *Merlangius merlangus* (~4.07 kg) were observed, many of these being 0-group fish. CPUE of major commercial species are summarized in Table A6.19 (see note on cod indices in caption of Table A6.18). Skates of all the various species featured strongly in the overall catches with haul 462 standing out, with a catch of 53 common blue skate *Dipturus batis* (D. cf. *flossada*) over the size range 36–127 cm for a total weight of 410 kg along with 15 thornback ray Raja clavata with a weight of 26.0 kg. Also of note was the presence of very small juvenile mackerel *Scomber scombrus* over a size range of 13–16 cm at station 443. In common with last year's survey there were no large catches of grey gurnard *Eutrigla gurnardus*, historically a semi-regular occurrence during this survey. Two stations in particular stood out as exhibiting particularly high catches of 0-group haddock: station 453 (471.9 kg for 30 minutes tow duration) and station 472 (490 kg for 20 minutes). In common with other years, these very high levels of recruitment were in the 151–200 m stratum however, unusually one of them occurred within the haddock box itself which has not been the case in recent years.

Table A6.17. Number of stations surveyed by gear.

ICES Division	Strata	Gear	Hauls					
			Planned	Valid	Additional	Invalid	% Achieved	Comments
6.b	All	GOV-D	40	45	1*	o	112	*outside survey area

Table A6.18. Rounded CPUE data (all strata combined) for the most abundant species caught during 1221S. Note the cod indices omit one fish of 79 cm that remains un-aged at the time of writing.

	Haddock	Whiting	Cod	Saithe
Age	No/10 hr	No/10 hr	No/10 hr	No/10 hr
0	29363	26.1	0	0
1	9445	0.9	0.5	0
2	680	0	0	0
3	864	0	1.1	0

4	414	0	0.6	0
5	893	0.2	0	0
6	45.3	0	0	0
7	4.0	0	0	0
8	20.5	0	0	0
9	14.2	0	0	0
10	16.6	0	0	0
11	0.5	0	0	0.3

Table A6.19. Rounded CPUE indices (no. per 10 hrs fishing) of prominent species.

Species	mean kg/hr	Mean no/hr
Melanogrammus aeglefinus	454	5653
Sebastes viviparus	245	3460
Micromesistius poutassou	173	3204
Helicolenus dactylopterus	110	1765
Gadiculus argenteus	39.8	1469
Eutrigla gurnardus	39.0	142
Dipturus batis (=D. cf. *flossada*)	35.9	6.0
Argentina sphyraena	19.9	307
Trisopterus minutus	13.4	149
Lepidorhombus whiffiagonis	8.9	36
Lophius piscatorius	8.6	3.4
Chimaera monstrosa	7.5	5.0
Raja clavata	5.9	2.8
Microstomus kitt	4.3	32.1
Dipturus oxyrinchus	4.1	0.4
Molva molva	3.7	0.5

Table A6.20. Numbers of biological observations per species collected during 1221S. Data recorded is individual length/whole weight/sex/eviscerated weight/age except * where eviscerated weight and age data were not collected.

Species	No.	Species	No.
Gadus morhua	8	*Dipturus batis (D.* cf. *flossada)**	135
Melanogrammus aeglefinus	1981	*Dipturus oxyrinchus**	10
Merlangius merlangus	49	*Leucoraja fullonica**	16
Scomber scombrus	29	*Raja clavata**	63
Pollachius virens	2	*Leucoraja circularis**	2
*Squalus acanthias**	1		

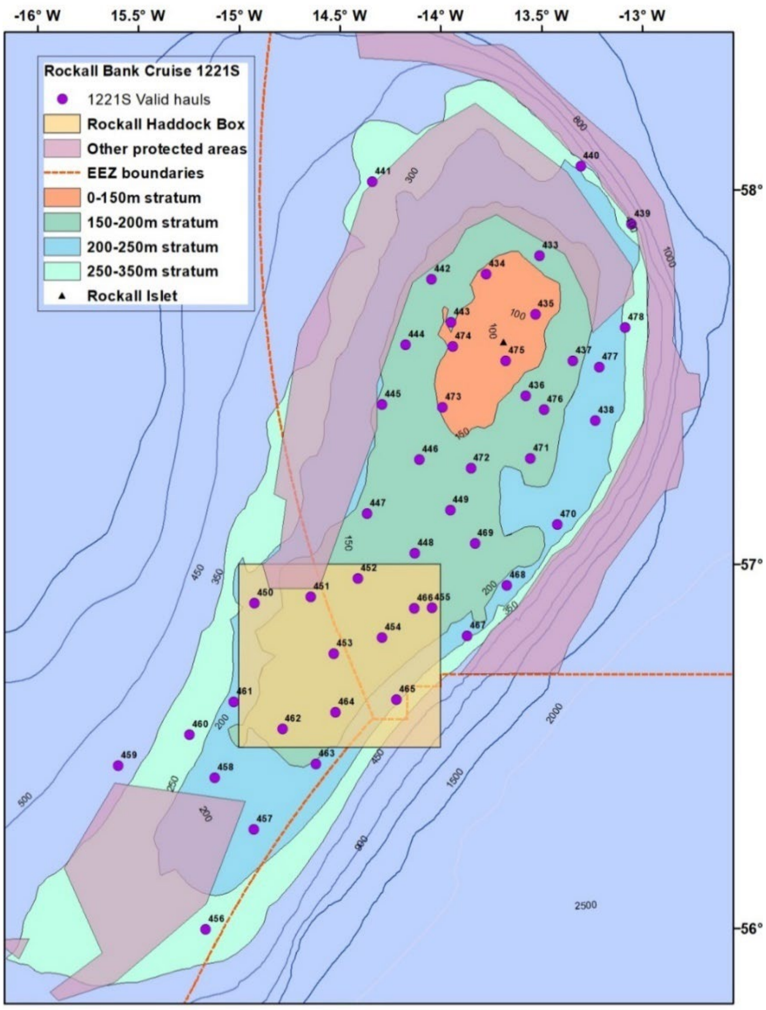

Figure A6.5. Survey strata, NEAFC closed areas and trawl positions along with haul numbers of stations completed at Rockall during 1221S.

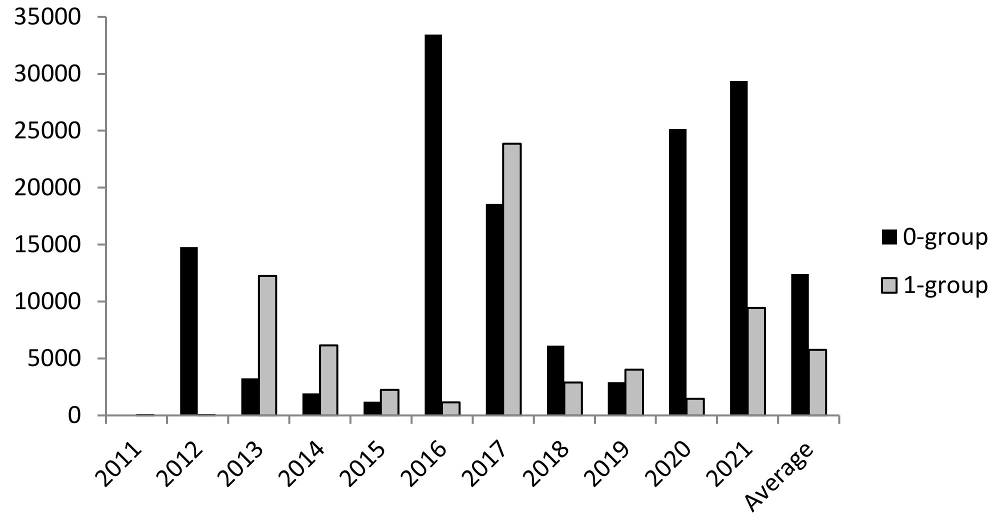

Figure A6.6. Indices of 0 and 1-group haddock at Rockall in 2021 shown relative to the previous years and the average since 2011 (beginning of new survey design).

A6.6 Spanish Porcupine bottom trawl survey (SP-PORC-Q3)

Nation:	**SP (Spain)**	**Vessel:**	**Vizconde de Eza**
Survey:	SP-PORC-Q3 (Porcupine 2021)	**Dates:**	2 September – 3 October 2021
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 divisions 7.b,c,k). The primary target species are hake, anglefish, 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 carried out for several other demersal fish species and invertebrates.		
Survey Design	The survey is random stratified with two geographical strata (northern and southern) and three depth strata (170–300 m, 301–450 m, and 451–800 m). Stations are allocated at random according to the strata surface.		
Gear details:	Porcupine Baca 39/52 with Polyvalent doors.		
Notes from survey (e.g. problems, additional work etc.):	Weather conditions were relatively good with few days lost due to bad weather. Standard tow duration was 20 minutes from gear ground contact, as implemented since 2016. Additional work undertaken included nine additional deep tows (>800 m) on the east margin of the study area and 100 CTD casts, at most trawl stations, four within the non-trawlable area, and seven in radials perpendicular to the bank limits.		
Number of fish species recorded and notes on any rare species or unusual catches:	Overall a total of 130 fish species, 49 crustacean taxa (including 45 identigfied to species), 30 mollusc taxa (29 species), 43 echinoderm taxa (38 species) and 39 other invrtebrate taxa (34 species) were identified.		

Table A6.21. Numbers of stations fished (aim: to complete 80 valid tows per year).

ICES Divisions	Strata	Gear	Stations					
			Planned	Valid	Additional	Invalid	% Fished	Comments
7.bc,k	All	Porcupine Baca	80	80	14	3	118%	
	TOTAL		80	80	14	3	118%	

Table A6.22. Numbers of individuals biologically sampled (length, weight, sex, maturity, age) by species. Species denoted * recorded for maturity only.

Species	No.	Species	No.
Merluccius merluccius	559	*Molva molva*	6
Lepidorhombus whiffiagonis	584	*Conger conger*	34
Lepidorhombus boscii	423	*Helicolenus dactylopterus*	184
Lophius budegassa	57	*Phycis blennoides*	283
Lophius piscatorius	162	*Nephrops norvegicus**	401

Table A6.23. Biomass estimates for the main species in the Porcupine bottom trawl survey.

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	All	80	28.43	4.3	-23.2	27.0	**-18.0**	-52.7
Lepidorhombus whiffiagonis	All	80	18.16	41.7	19.5	233.8	26.5	4.9
Lepidorhombus boscii	All	80	13.40	32.5	-3.5	133.5	27.0	-5.1
Lophius budegassa	All	80	1.04	20.9	-7.5	1.0	212.1	-10.9
Lophius piscatorius	All	80	12.59	**-20.6**	-18.4	3.8	13.6	-25.1
Micromesistius poutassou	All	80	728.83	**-15.2**	47.0	9178.1	**-28.4**	103.6
Nephrops norvegicus	All	80	0.98	15.3	-59.6	37.1	50.7	-62.0

y_i, year estimate (2021); y_{i-1}, previous year estimate (2020); $y_{(i,i-1)}$, Average of last two year estimates (2021 and 2020); $y_{(i-2,i-3,i-4)}$, Average of the previous three year estimates (2019, 2018 and 2017).

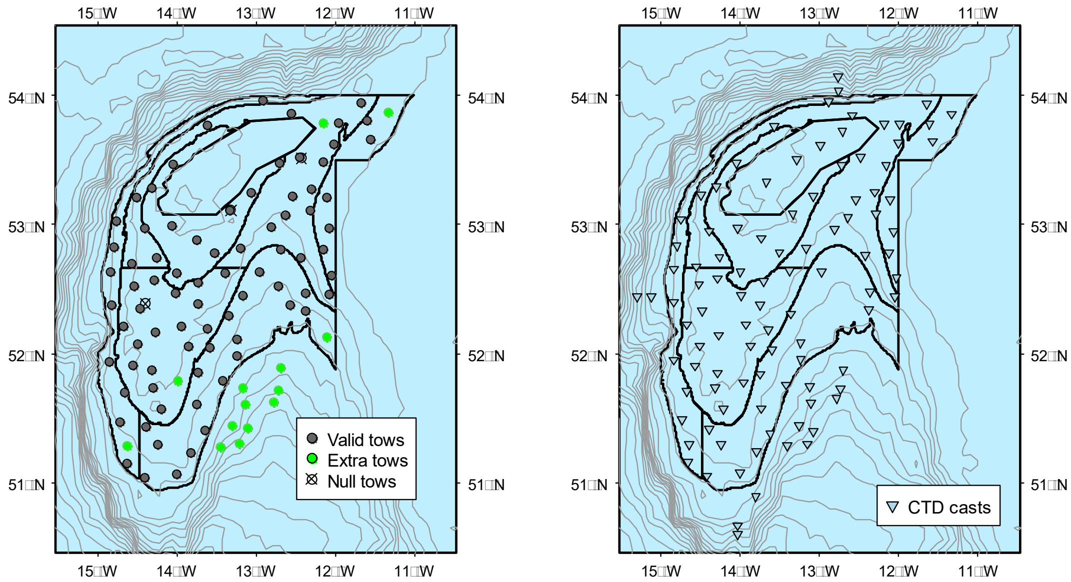

Figure A6.7. Spanish Porcupine Bank survey showing the distribution of trawl stations (left) and CTD stations (right) sampled during the 2021 survey.

A6.7 Scottish West Coast Groundfish Survey (SCOWCGFS-Q4)

Nation:	**Scotland**	**Vessel:**	**Scotia**
Survey:	1721S (SCOWCGFS-Q4)	Dates:	14 November – 6 December 2021
Cruise:	Objectives of SCOWCGFS–Q4: Demersal trawl survey (SCOWCGFS-Q4) of the grounds off the north and west of Scotland and Ireland in ICES divisions 6.a and 7.b. To collect surface and bottom water temperature and salinity data from each trawling station. Collect additional biological data in connection with the EU Data Collection Framework (DCF). Retrieval and re-deployment of COMPASS project moorings located at discreete sites within the trawl survey area (two additional days added to the survey).		
Gear details:	GOV incorporating groundgear D was used at all stations and was deployed on 62 occasions (Table A6.24). The sweeps were 97 m in all cases where the mean depth was >80 m (n = 52), otherwise 47 m sweeps were used (n = 10). 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 to aid validation of touchdown and lift-off times for trawl.		
Notes from survey (e.g. problems, additional work etc.):	Despite experiencing some periods of unfavourable weather during the survey the GOV was deployed on 62 occasions during 1721S. Shorter 47 m sweeps were used where the seabed depth was 80 m or less (nine valid and one invalid hauls) and the longer 97 m sweeps used on the remaining 52 deeper hauls (50 valid hauls and two invalid hauls). Of the 59 valid hauls completed, 55 of these were completed during daylight hours. There were three invalid hauls. Haul 562 was invalidated on account of the gear being fouled due to entanglement with prawn creels and associated creel leader lines. Invalid hauls 563 and 605 were attributable to damage sustained to the gear while trawling. The locations used for the valid		

trawl positions during this survey were a combination of established MSS survey tows, commercial trawled areas and also completely new tows. On 21 occasions grounds were successfully utilized that previously were unfished by MSS. The distribution of survey positions are shown in Figure A6.8.

Hauls were typically of 30 min duration however various factors (e.g. indications of excessively large marks of pelagic fish, hard/rocky terrain resulting in the trawl snagging, rapid changes in bottom depth observed during the trawl as well as close proximity to static gear) resulted in reduced durations being recorded at 10 valid haul locations (nos. 568, 585, 589, 595, 597, 606, 607, 608, 612 and 613). In keeping with the 2009 IBTSWG report, no valid hauls of less than 15 minutes were recorded.

The CTD recorder (Seabird19+) was deployed at 57 out of the 59 valid trawling stations in order to obtain a temperature and salinity profile to within approximately 5 m of the seabed. Hauls 556 and 609 had no associated hydrographic profile in order to save time so that an additional trawl station could be completed within the daylight period.

Compass Acoustic Moorings Deployments/Retrieval

Seven moorings were retrieved by Scotia from six different locations from within the Minches area (Figure A6.8), with the successful retrieval and subsequent redeployments being completed without incident and included an additional mooring from the Shiants location not retrieved during a previous attempt earlier in 2021. An unsuccessful attempt was made to salvage a second mooring from the Hyskier location where again a previous retrieval attempt has proved to be unsuccessful. The six redeployed moorings at Tolsta, Stoer Pt, Shiants, Garvellachs, Stanton Bank and Hyskier were deployed back onto the same or similar locations to those retrieved.

Additional sampling undertaken during 1721S

Bobtail squid identification. All bobtail squid (Sepiolidae) caught were frozen for identification at Naturalis Biodiversity Centre, Leiden.

Retention of Phakellid and Craniella sponges. Collaborative phylogenetic study between MSS and the Natural History Museum.

All shells retained and frozen for identification ashore.

Squid biological data as well as Statolith removal from specimens of *Illex coindetii* (15 specimens) and *Loligo forbesii* (66 specimens).

Genetic material retained from both anchovy and hake as part of an international project being led by scientists from IMR, Bergen.

Catch Results *(2020 results presented in parentheses)*

No. fish species recorded and notes on any rare species or unusual catches:

A total of 89 (89) species were recorded for an overall catch weight of ~39.04 (26.35) tonnes. Major species components in approximate tonnes included: haddock *Melanogrammus aeglefinus:* 15.15 (*7.03*), mackerel *Scomber scombrus:* 3.43 (*0.56*), cod *Gadus morhua:* 0.49 (*0.26*), Norway pout *Trisopterus esmarkii:* 1.66 (*0.76*), whiting *Merlangius merlangus:* 3.47 (*1.92*), herring *Clupea harengus:* 0.17 (*0.08*), and scad *Trachurus trachurus:* 4.74 (*4.1*).

Overall, catches during the 2021 survey were significantly larger than observed in 2020 and with comparable overall trawl times for both years (*27.2hrs, 2020 / 28hrs, 2021*). Catches of almost all of the larger gadoid species (cod, haddock and whiting) as well as Norway pout effectively doubled that reported from the same survey in 2020. With the exception of saithe, which was once again virtually absent during this survey (10 individuals; 11 kg), all other reported species listed above recorded significant increases on last year with haddock, whiting and mackerel providing the highlights (compared to results from 2020) with these three species combined providing over 50% by weight of the entire survey catch during the 2021 survey. Despite a doubling in the overall catch weight of herring during 2021, the reported catch weight for this species was still extremely low when compared against the previous reported survey results going back to 2011. Almost 90% of the mackerel reported by weight for the entire survey were derived from haul 606 and offshore from the Northern Irish coast. No large aggregations of juvenile mackerel were reported, although significant numbers were reported from stations located to the west of Ireland and North of the Sligo coast and also on the shelf edge stations, north of the Butt of Lewis. Table A6.25 provides overall catch rates per unit effort (CPUE) of the above species and several other major species.

The CPUE indices (numbers caught per hour fishing) for 1-group gadoids (cod, haddock, whiting, saithe and Norway Pout) weights the indices for each of the 11 relevant 6.a sampling strata by the surface area of said strata. These are then pooled to produce the index for ICES Division

6.a. Results for all age classes of the major commercial gadoid species are shown in Table A6.26 while those of 1-groups only for period 2014–2021 are shown in Table A6.27. Despite an increase in overall abundance being reported for most of the target species the outlook regarding the 1-group abundance estimates for the same species are less positive with both cod and whiting showing a significant decrease compared to 2020. In the case of whiting this amounts to a decrease of almost 60% on the 2020 estimates. Modest increases in 1 group haddock and Norway Pout were observed compared to results from 2020. No 1-group saithe were recorded during the survey for the second successive year (Table A6.27).

Notable and novel species encountered during the survey included three nurse hound *Scyliorhinus stellaris* that were recorded from stations 600 (n = 1) and 601 (n = 2) located off the southern tip of the Mull of Kintyre and the sound of Jura respectively. Three spiny lobster *Palinurus elephas* were recorded and subsequently returned alive from stations 593 (n = 2) and 606 (n = 1) located off the Sligo coast and NW of Donegal respectively.

Biological Sampling

In total, 4950 biological observations on selected species were collected including a number collected in support of EU Data Collection Framework (DCF). A summary of numbers collected for all species is displayed in Table A6.28. All otoliths were aged back at the institute.

Marine litter

All litter picked up in the trawl was classified, quantified, recorded and retained for appropriate disposal ashore. The data are uploaded to the MSS database from where it will eventually be uploaded to DATRAS.

Monitoring of Non-Indigenous Invasive Species (NIS)

All catches were screened for the presence of selected NIS species with the results being reported back to the project coordinator at CEFAS.

Table A6.24. Number of stations surveyed/gear during survey 1721S.

ICES Division	Strata	Gear	Hauls					
			Planned	Valid	Additional	Invalid	% Achieved	Comments
6.a	11	GOV-D	58	56	0	3	97	
7.b	1	GOV-D	4	3	0	0	75	

Table A6.25. Overall CPUE of major components of combined catch Q4 2021.

Scientific name	Common name	kg/hr	no/hr
Melanogrammus aeglefinus	Haddock	540.6	1787
Scomber scombrus	Mackerel	122.4	854.3
Gadus morhua	Cod	17.5	9.2
Trisopterus esmarkii	Norway pout	59	3837
Merlangius merlangus	Whiting	123.9	1103
Clupea harengus	Herring	5.9	59.4
Trachurus trachurus	Horse mackerel	168.9	868
Scyliorhinus canicula	Lesser-spotted dogfish	35.9	62.9
Pleuronectes platessa	Plaice	3.3	13.8

Eutrigla gurnardus	Grey gurnard	18.8	216.3
Capros aper	Boarfish	15.2	307
Squalus acanthias	Spurdog	61.6	74.4
Pollachius virens	Saithe	0.3	0.4
Merluccius merluccius	Hake	9.2	27.7
Dipturus intermedius	Flapper Skate	4.6	1.1
Loligo sp.	Long-finned Squid	12.9	140.9
Raja montagui	Spotted ray	5	5.7
Lophius piscatorius	Anglerfish	4.2	1.9
Sprattus sprattus	Sprat	1.1	224.6
Raja clavata	Thornback ray	4.5	3.7
Chelidonichthys cuculus	Red gurnard	4.7	14.1
Micromesistius poutassou	Blue whiting	121.2	5343
Limanda limanda	Common dab	2.6	32.1
Microstomus kitt	Lemon sole	3.4	23.3
Lepidorhombus whiffiagonis	Megrim	2.3	8.6

Table A6.26. CPUE indices (no/hr) by year class of major demersal species Q4 2021.

Age	Cod	Haddock	Whiting	Saithe	N. Pout
0	0.0863	66.6094	513.814	0.0219	3403.872
1	0.9348	314.6035	91.0573	0.0363	359.6715
2	8.912	991.7931	248.1718	0.1872	240.9483
3	1.4769	373.7324	75.4985	0.1241	16.485
4	0.0392	39.438	8.6442	0	0
5	0.1822	27.0997	4.1751	0	0
6	0.1158	7.1717	1.4287	0	0
7	0.0256	94.4865	0.0132	0	0
8	0	0.3263	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	0	0	0	0	0

12	0	0	0	0	0
13	0	0	0	0	0
14	0	0	0	0	0
15	0	0	0	0	0
16	0	0	0	0	0

Table A6.27. CPUE indices (no/hr fishing) for 1-groups of the main demersal species in Q4 since 2014.

Species	2014	2015	2016	2017	2018	2019	2020	2021
Cod	2.37	2.82	0.62	1	0.457	1.765	1.599	0.935
Haddock	67.87	995.6	93.55	168.8	98.91	627.5	290.3	314.6
Whiting	151.8	279.4	241.5	294.3	50.25	195.5	239.2	91.1
Saithe	0.004	0.5	0.06	0	0.036	0.083	0	0
Norway Pout	267	1481	1227	48.7	96.76	1797	296.9	359.7

Table A6.28. Numbers of biological observations per species collected during 1721S. These consist of length, weight, sex, age unless specified otherwise (*a* = length, weight, sex, and otoliths retained (to be aged at a later date); *b* = length, weight and sex; *c* = length, weight and age; and *d* = length, weight, sex and externally determined maturity only).

Species		No.	Species		No.
Melanogrammus aeglefinus		1622	*Scophthalmus maximus*	b)	4
Merlangius merlangus		960	*Dipturus batis* (=*D.* cf. *flossada*)	d)	10
Gadus morhua		184	*Dipturus intermedius*	d)	28
Pollachius virens		10	*Leucoraja naevus*	d)	20
Trisopterus esmarkii		492	*Mustelus asterias*	d)	4
Clupea harengus	c)	199	*Raja brachyura*	d)	3
Sprattus sprattus	c)	130	*Raja clavata*	d)	73
Scomber scombrus	c)	179	*Raja montagui*	d)	104
Merluccius merluccius	a)	297	*Squalus acanthias*	d)	449
Pleuronectes platessa		145	*Galeorhinus galeus*	d)	5
Molva molva	a)	32			

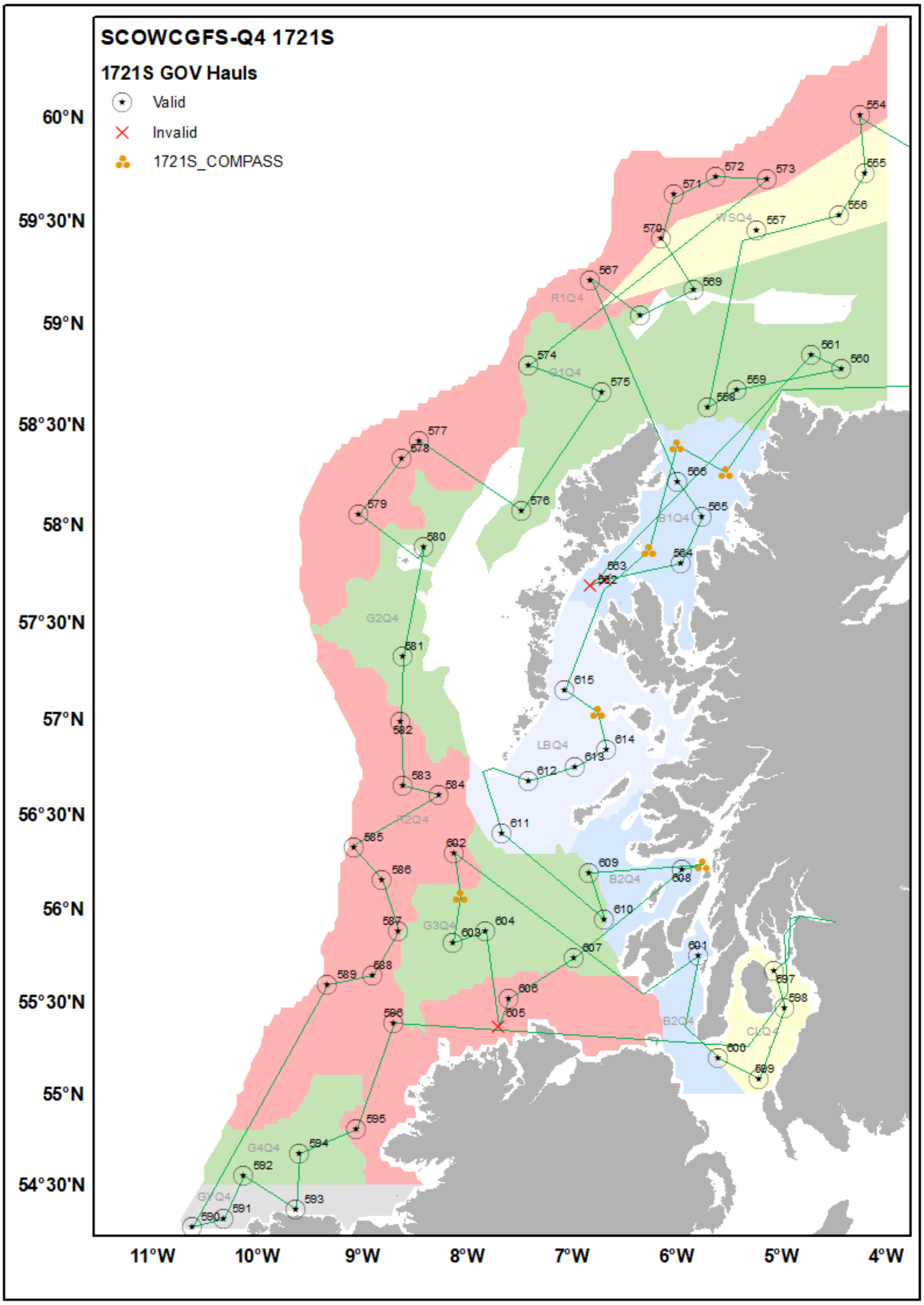

Figure A6.8. Survey map for 1721S showing survey strata (coloured polygons), trawl and COMPASS mooring deployments and the survey track

A6.8 Northern Irish groundfish survey (Q4)

Nation	**UK (Northern Ireland)**	**Vessel:**	**Corystes**
Survey:	Groundfish Survey CO-4121	Dates:	11 October and 22–31 October 2021
Cruise:	To obtain information on spatial patterns of abundance of different size-and-age classes of demersal fish in the Irish Sea. To obtain abundance indices of cod, whiting, haddock and herring for use at ICES Working Groups. To quantify external parasite loads in whiting and cod by area. To collect additional biological information on species as required under DCF. To collect tissue samples for genetics studies on mature cod and hake. To collect information on the extent of marine litter in the Irish Sea. Collect 15 fish samples for reverse ring test overseen by the NE Atlantic Marine Biological Analytical Quality Control Scheme (NMBAQC), recording species, length and station. To collect stomachs and fish samples from target species list for analysis of foodwebs.		
Gear details:	A commercial Rockhopper trawl fitted with a 20 mm liner in the cod-end was towed over three nautical miles (or one nautical mile) in the Irish Sea and St George's Channel. Gear and towing procedures were those employed on all previous AFBI groundfish surveys.		
Notes from survey (e.g. problems, additional work etc.):	A stratified survey with fixed station positions was employed. The survey was divided into strata defined by depth and substratum. The species composition of the catch at each station was determined, and length frequencies were recorded for each species. All cod, most hake and representative subsamples of haddock and whiting were taken for recording length, weight, sex and maturity stages and for the removal of otoliths for ageing. The level of infestation of whiting and cod by external parasites was estimated from biological samples collected at each station. For all hauls, fishing was carried out during daylight commencing each day at first light. In all, 45 valid hauls were completed, one haul was repeated. All tows were of 20 min duration. The width of seabed swept by the trawl doors increased from about 35 m in shallow water (30 m sounding) to about 45 m in deeper water (80 m sounding), with variations due to tidal flow. The range of average headline heights across all hauls was 2.5–3.1 m. Trawl parameters were consistent with previous surveys. Cod and whiting taken for biological analysis were screened for external parasites. Trawl data and length frequencies were archived using the newly developed groundfish survey database. Preliminary indices of abundance for 0-group and 1-group cod, whiting and haddock were obtained from the length distributions. More accurate indices will be available once the otoliths collected during the cruise have been aged. A hydraulic pipe to the winch and net drum burst on the first haul, on 11 October. The vessel returned to port and had to await arrival of new parts, and the survey recommenced on 22 October. Additional Sampling: All litter picked up in the trawl was classified, quantified and recorded and uploaded to the national litter database from where it will eventually be uploaded to DATRAS. The litter was retained onboard for appropriate disposal ashore.		
Number of fish species recorded and notes on any rare species or unusual catches	A total of 106 species were recorded during the survey of which 66 were measured for length frequencies. Biological data were recorded for a number of species in accordance with the requirements of the EU Data Regulations. A total of 1,764 biological samples were taken during the survey.		

Table A6.29. Number of stations fished.

ICES Division	Strata	Gear	Hauls					
			Planned	Valid	Additional	Invalid	% Achieved	Comments
7.a	All	Rockhopper	62	45	0	0	73	

Table A6.30. Numbers of biological observations per species collected during CO4121. These consist of length, weight, sex and age, unless specified (*a* = age data not collected length; *b* = weight, length and sex recorded).

Species	**No.**	**Species**		**No.**
Gadus morhua	11	*Scophthalmus maximus*		0
Merlangius merlangus	784	*Raja brachyura*	b)	11
Melanogrammus aeglefinus	634	*Raja clavata*	b)	17
Merluccius merluccius	22	*Raja montagui*	b)	63
Pollachius pollachius	0	*Leucoraja naevus*	b)	6
Molva molva	0	*Squalus acanthias*	b)	78
Zeus faber	0			
Scophthalmus rhombus	0			
Pleuronectes platessa	215			

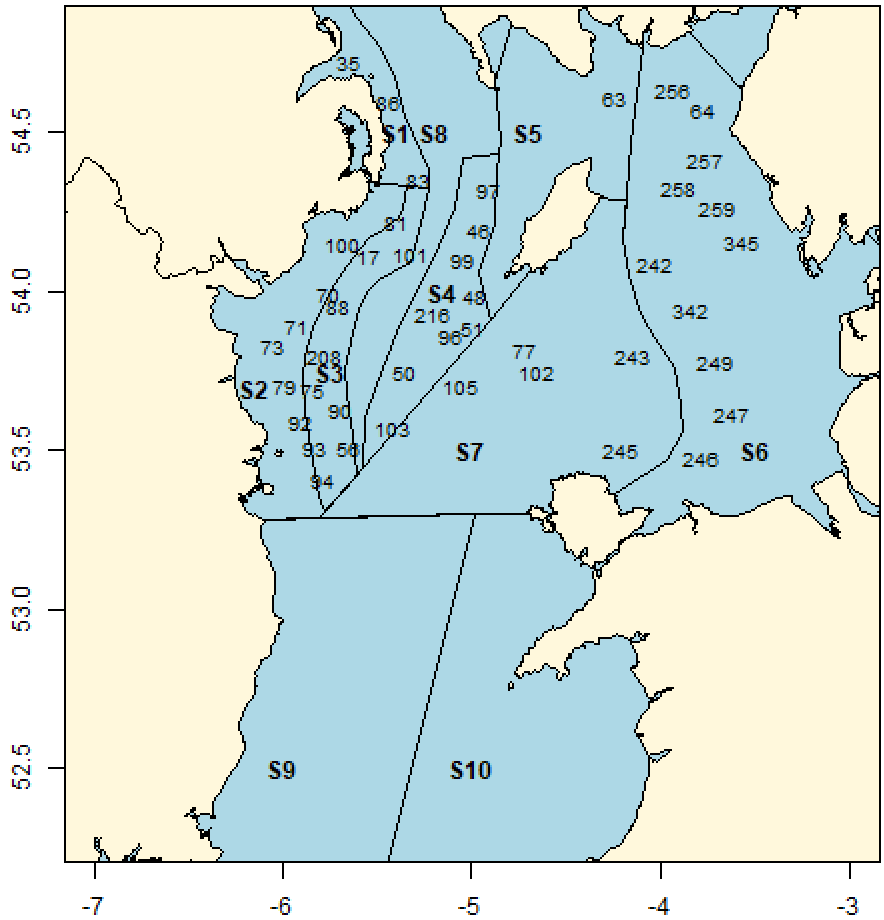

Figure A6.9. Map of the NI groundfish survey stations completed during CO4121.

A6.9 Irish Groundfish Survey (IGFS)

Nation:	**Ireland**	**Vessel:**	**Celtic Explorer**
Survey:	IE-IGFS	Dates:	30 Oct –13 Dec 2021
Cruise	The Q4 Irish Groundfish Survey (IGFS) collects data on the distribution, relative abundance and biological parameters of commercially exploited demersal species in Divisions 6.a (south), 7.b and 7.g,j (north). The indicess currently utilized by assessment WG's are for haddock, whiting, plaice, cod, hake and sole. Survey data are also provided for white and black anglerfish, megrim, pollack, ling, blue whiting and a number of elasmobranchs as well as several pelagic species (herring, horse mackerel and mackerel).		
Gear details:	Two gear survey since 2004, using GOV ground gear "A" for 7.b, 7.g and 7.j, and a 16" hopper gear (ground gear "D") for 6.a.		
Notes from survey (e.g. problems, additional work etc.):	4.5 days lost to bad weather during 2021, largely on Leg 4 (SW) due to storm Barra. No other mechanical or technical problems.		
Number of fish species recorded and notes on	In 2021, 87 species of fish, 19 elasmobranchs, 10 cephalopods, 63 crabs and shrimp (Malacostraca) and 119 other species/taxa were caught. The most significant increase in 6.a was again blue whiting *Micromesistius poutassou* for both biomass (231%) and numbers (277%),		

any rare species or unusual catches:	as compared to 2020 (see below). Likewise hake saw some increase from the 2020 survey. Most species however still appear on a downward trend over the recent 5 years. For the Celtic Sea and West of Ireland (7.b, 7.g and 7.j) herring again showed a good increase in biomass over the 5 year average, while numbers dropped slightly suggesting a maturing population with limited additional recruitment. Some increases again for blue whiting. However, the decline in numbers of plaice *Pleuronectes platessa* appeared to have stabalised a bit in 2021. These indices are very general, but the overall perception during the survey in 2021 was for a slightly improved fishing year on 2020. Patches of reasonable fishing with some sightings or small whiting, but nothing to really stand out for any area or species.

Table A6.31. Stations fished (aim to complete 171 valid tows per year).

ICES divisions	Strata	Gear	Tows planned	Valid	Additional	Invalid	% stations fished	comments
6.a	All	D	45	40	0	2	93	
7.b–c	All	A	38	36	0	2	100	
7.g	All	A	48	46	0	2	100	
7.j	All	A	40	34	0	2	90	
TOTAL			171	156	0	8	95	

Table A6.33. Abundance (numbers) and biomass of the main species sampled during 2021 IGFS compared with previous years. Year estimate 2021 (y_i); previous year estimate 2020 (y_{i-1}); average of last two years estimate ($y_{(i,i-1)}$); average of the previous three-year estimates 2017-19 ($y_{(i-2,i-3,i-4)}$). As results for survey trends are ratios, they are quite sensitive to stocks with high variance, therefore comparing the 2 yr vs. 5 yr trend is advisable.

Biomass and number estimates								
			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/Hr	%	%	No/Hr	%	%
Gadus morhua	6.a	31	0.9	-57.6	-40.9	0.6	-64.1	-35.8
Melanogrammus aeglefinus	6.a	31	452.9	28.0	62.9	1870.2	42.5	65.8
Clupea harengus	6.a	31	3.0	7.9	-91.4	124.6	356.8	-89.0
Merluccius merluccius	6.a	31	13.2	-1.5	96.8	34.9	-42.9	35.9
Trachurus trachurus	6.a	31	325.5	6.8	-15.3	2012.0	-4.8	-31.6
Scomber scombrus	6.a	31	122.4	355.4	-45.6	1559.3	182.0	-49.2
Lepidorhombus whiffiagonis	6.a	31	1.7	26.0	-4.8	11.8	-7.4	37.2
Lophius piscatorius	6.a	31	3.1	6.7	26.2	2.8	0.2	58.9

Pleuronectes platessa	6.a	31	7.4	-0.2	-29.0	43.2	-6.5	-29.9
Solea solea	6.a	31	0.4	-38.0	68.4	1.5	-46.6	74.9
Micromesistius poutassou	6.a	31	231.9	264.9	149.4	9689.1	277.3	488.2
Merlangius merlangus	6.a	31	138.2	-42.5	35.2	1022.4	-29.6	2.0
Gadus morhua	7.bgj	96	4.4	93.3	7.9	1.1	-22.7	-6.2
Melanogrammus aeglefinus	7.bgj	96	158.1	-18.4	24.1	995.7	5.4	-25.1
Clupea harengus	7.bgj	96	3.6	-90.5	195.0	58.5	-87.0	-35.5
Merluccius merluccius	7.bgj	96	14.3	-22.7	-40.0	52.4	-16.0	-71.2
Trachurus trachurus	7.bgj	96	115.2	0.5	-35.1	3109.0	40.2	-13.8
Scomber scombrus	7.bgj	96	17.3	-56.7	-60.8	268.2	-66.3	-62.9
Lepidorhombus whiffiagonis	7.bgj	96	4.9	15.4	6.8	45.6	18.8	2.3
Lophius piscatorius	7.bgj	96	8.4	47.0	-11.8	9.6	52.4	-19.3
Pleuronectes platessa	7.bgj	96	8.5	55.4	-0.3	49.4	72.1	-4.7
Solea solea	7.bgj	96	0.7	-15.0	4.6	2.6	-28.7	-10.3
Micromesistius poutassou	7.bgj	96	149.8	254.3	162.5	5219.8	302.2	420.8
Merlangius merlangus	7.bgj	96	60.7	30.2	16.3	564.2	-12.3	0.7

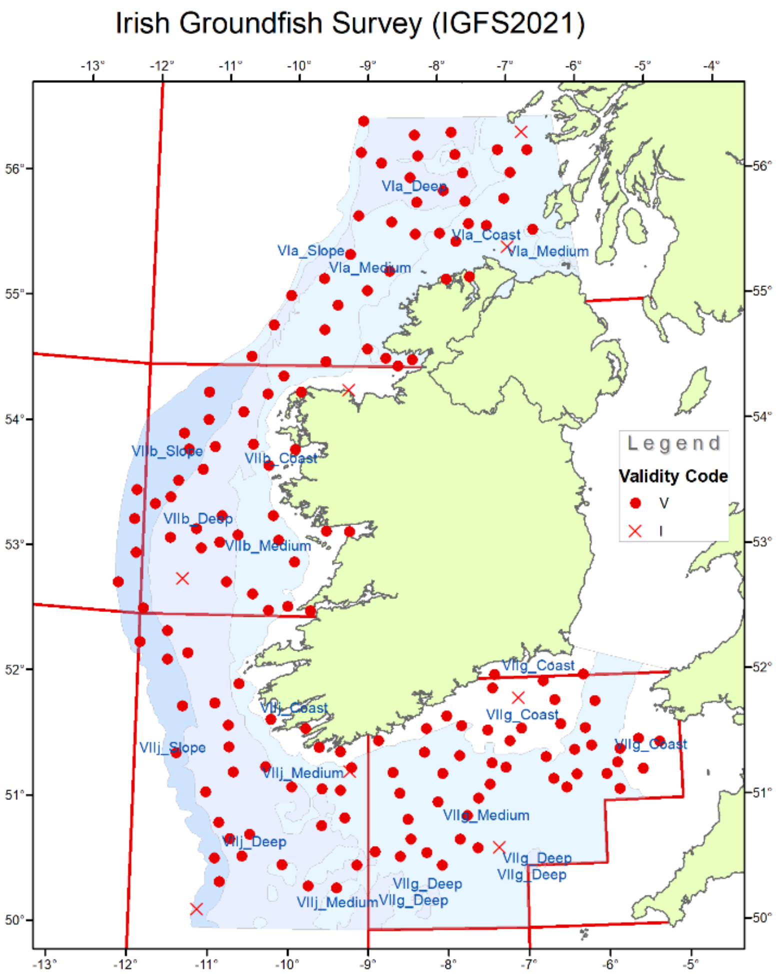

Figure A6.10. Map of survey Stations completed during the Irish Groundfish Survey in 2021 (circles = valid hauls; crosses = invalid hauls).

A6.10 French Channel Groundfish Survey Q4 (FR-CGFS)

Nation:	**France**	**Vessel:**	**Thalassa II**
Survey:	CGFS2021 (Eastern Channel)	Dates:	02 October – 18 October 2021
Cruise	As from 2018, France sampled both the Eastern (7.d) and Western (7.e) English Channel. Currently, only data from the Eastern French English Channel Q4 survey are submitted to DATRAS. Trawling was carried out during the day. CTD was deployed at each trawl station to collect temperature and salinity profiles. Age data were collected for 12 species.		
Gear details:	The gear used for the Eastern English Channel is the standard GOV 36/47 with ground gear A modified for CGFS (bobbins Ø 250 mm). The trawl used in the western channel (7.e) is a GOV 36/49 with a Ø 400 bobbin in the square. its rigging is a fork rig. Marport sensors to record door spread, wing spread and vertical opening are used on both gears.		

Notes from survey (e.g. problems, additional work etc.):	This year there were no problems with permissions to survey in UK waters, and all the planned sampling areas could be surveyed. Thalassa II left Cherbourg on 2 October and the eastern Channel was covered by 72 GOV trawl stations. Of these stations, 66 were valid, with four stations resulting in gear damage, and the net was clogged by brittlestars (*Ophiothrix fragilis*) at two stations. Two stations from the initial sampling plan of 74 trawls could not be fished due to the presence of commercial fishing gear. Additional work undertaken: The CUFES device (Continuous Underwater Fish Egg Sampler) was used during all the survey (day and night) and samples were scanned on board. Plankton samples were collected for analysis on the planktonic foodweb structure (110 stations with a plankton net (20µm), WP2 and Fluoroprobe) Microplastics were collected with a Manta net Observers for marine mammals and seabirds collected information throughout the survey.
Number of fish species recorded and notes on any rare species or unusual catches:	60 different fish species were recorded (sharks and rays included). Cephalopods and shellfish were also measured, and benthic fauna identified for each haul.

Table A6.34. Stations fished.

Division	Strata	Gear	Tows planned	Valid	Invalid	% stations fished	comments
7.d	ICES rectangles	GOV	74	66	6	89%	

Table A6.35. Number of biological samples (weight, maturity and age material (otoliths) collected by Division.

Species	Samples			Species	Samples		
	7.d	7.e	Total		7.d	7.e	Total
Merlangus merlangus	244	361	605	*Gadus morhua*	0	0	0
Mullus surmuletus	129	14	143	*Dicentrarchus labrax*	130	58	188
Pleuronectes platessa	295	17	312	*Chelidonichthys cuculus*	108	118	226
Trisopterus luscus	95	78	173	*Solea solea*	199	1	200
Melanogrammus aeglefinus	-	235	235	*Scophthalmus maximus*	15	1	16
Pollachius pollachius	-	2	2	*Scophthalmus rhombus*	6	-	6

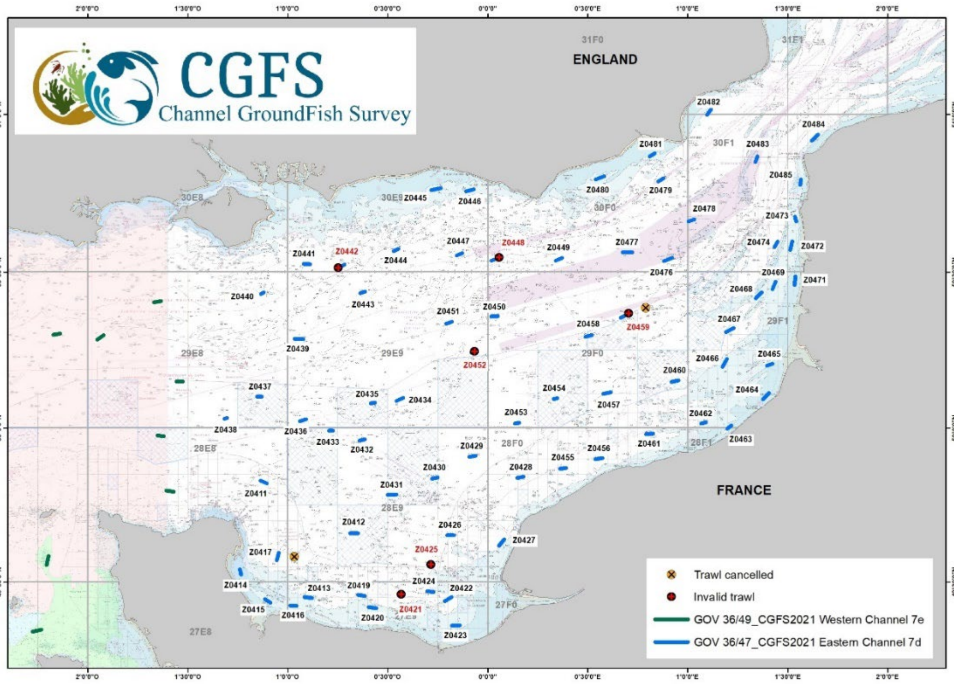

Figure A6.11a. French CGFS survey grid (2021) showing the GOV sampling sites in the eastern Channel

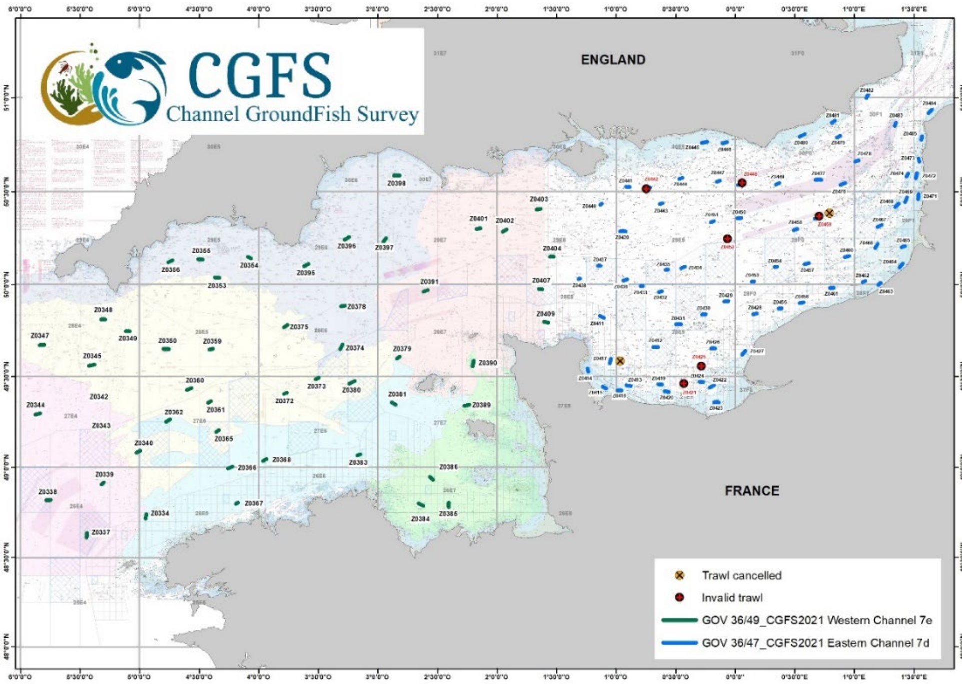

Figure A6.11. French CGFS survey grid (2021) showing the GOV sampling sites in the eastern Channel and eastern and western Channel

A6.11 French EVHOE-Q4 survey

Nation:	**France**	**Vessel:**	**Thalassa 2**
Survey:	EVHOE 2021	Dates:	23 October – 5 December 2021
Cruise	Realized on the RV Thalassa each autumn, the EVHOE groundfish survey aims to collect data on the distribution, relative abundance and biological parameters of all fish and selected commercial invertebrates in Divisions 7.f–j and 8.a–b,d. The primary species are hake, anglerfish, 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. Since 2016, the sampling design has been fixed stations, based on a previously randomly selected set of points based on bathymetric and sedimentary strata.		
Gear details:	A GOV (36/47) with standard Ground gear (A) is used, with the kite replaced by six extra floats. The boards have been replaced by new equivalent ones and the ground gear attachment has been adjusted to be more in line with the original plan of the trawl and to limit the risk of damage. Marport sensors have been utilized to record door spread, wing spread and vertical net opening.		
Notes from survey (e.g. problems, additional work etc.):	In 2021 the survey was carried out in two legs of about three-weeks each, and the sampling plan was equivalent to the previous year. A few stations in the Celtic Sea had to be moved to respect the rules of access to the marine protected areas of the UK and to avoid submarine cables. These stations were relocated as close as possible to the points initially planned and in the same strata. 94.3 % of the initial program have been realized and validated (149 valid hauls of 158 initially planned, see Table A6.36 and Figure A6.12). As in the previous year, we continued the strategy based on live acoustics in order to detect strong aggregations of pelagic fish and avoid the risk of damage and sorting difficulties. During EVHOE 2021, 24 hauls were shorter than the normal 30 minutes (from 20 to 29 minutes, distribution of trawling duration in Figure A6.16). The length of the tow was reduced slightly when strong acoustic detections were observed, but trying to keep the duration as valid (≥20 minutes) or sometimes by stopping the trawling in progress. We kept this year the additional observation of small pelagics as a complement to the pelagic survey which takes place in spring (PELGAS survey). This resulted in an increase in the acoustic monitoring with the multibeam echosounder and additional measurements and biological sampling, in particular for anchovy and pilchard. These additional operations did not affect the normal course of the EVHOE survey. Towing speed problems were encountered for the first part of the survey covering the Bay of Biscay, with speeds lower than the protocol and other years (comparisons given in Figure A6.15). The consequences on catches and indices are not clearly identified and are difficult to quantify. During the survey following additional data collection have been performed : A total number of 4774 biological samples (otoliths, scales and/or illicia) were collected for 23 fish species (Table A6.37). Trawl geometry data (Marport sensors) were collected during all the hauls. 157 CTD temperature and salinity profiles Continuous records with multibeam echosounder to collect data for pelagic ecosystem during transects and trawling hauls. Litter was enumerated and weighed at each trawl station. Invertebrates ("benthos", 158 taxa) were sorted, identified, counted and weighed at the lowest taxonomic level (mostly species) for each trawl station. Marine mammal and seabird observations during the legs 1 and 2. Additional works, partly for MSFD, were realized at night mostly in the evening or early morning: 42 Manta net hauls for collecting surface microplastics 34 samples with WP2 net for zoo- and phytoplankton Transects with CUFES device (Continuous Underwater Fish Egg Sampler)		

	34 vertical profiles with "SBE 19 Bathysonde" to collect temperature, phytoplankton, particle densities. 51 Photo/Video transects with PAGURE sledge 23 “profiles boxes” with multibeam echosounder to collect bathymetry and reflectivity data Acoustic transects (ME70 echo-sounder) for water column Additional samples and observations were collected on a set of selected species: muscle, stomach contents, fishes morphometry, shark and ray tagging
Number of fish species recorded and notes on any rare species or unusual catches:	About 110 fish and 15 cephalopod taxa were recorded. Overall, 11 fish and cephalopod taxa represented 87% of the total biomass caught (Figure A6.13). Among fish species, as in previous years, small demersal-pelagic species (*Capros aper*, and to a lesser extent *Micromesistius poutassou*, *Trachurus trachurus*, *Engraulis encrasicolus*) strongly dominated the biomass of fish species. We noted a large dominance in abundance and biomass of *Capros aper* especially a distribution a priori more to the south of the Bay of Biscay than seen in previous years. Catches of *Scomber scombrus* remained particularly low. Among the cephalopods, two species, *Loligo forbesii* and *Eledone cirrosa*, were predominant. The biomass of demersal fish was dominated by five species: hake *Merluccius merluccius*, haddock *Melanogrammus aeglefinus* (especially in the Celtic Sea; Figure A6.14), small-spotted catshark *Scyliorhinus canicula,* poor cod *Trisopterus minutus* and bib *Trisopterus luscus*. As in previous years, stronger catches of certain rays were also reported, including *Raja clavata* and *R. undulata* (both with a significantly greater occurrencegreater occurrence also), *Leucoraja naevus* and *Galeus melastomus*. For four consecutive years (especially the last three-years), the abundance of *Lophius budegassa* was particularly strong (this was not the case for the other anglerfish species, *L. piscatorius*). A similar dynamic was also observed for megrim *Lepidorhombus* spp. For hake, catches remained relatively stable in occurrence but continued the decline observed in the previous four years, with the level of abundance in 2021 among the lowest in the time-series.

Table A6.36 Trawl stations planned and completed during the EVHOE 2021 survey.

Strata	ICES divisions	Gear (sweep length)	Tows				% Stations sampled (valid)
			Planned	**Realized**	**Valid**	**Additional**	
Cc	**7g,h,j**	**GOV (m)**	**32**	**36**	**35**	**4**	**109**
Cc3	7g,h,j	GOV (100m)	8	9	9	1	112
Cc4	7g,h,j	GOV (100m)	17	17	16	0	94
Cc5	7g,h,j	GOV (100m)	4	3	3	0	75
Cc6	7g,h,j	GOV (100m)	3	6	6	3	200
Cc7	7g,h,j	GOV (100m)	0	1	1	1	
Cn	**7g,h,j**	**GOV (m)**	**16**	**14**	**11**	**0**	**69**
Cn2	7g,h,j	GOV (50m)	7	6	4	0	57
Cn3	7g,h,j	GOV (50m)	9	8	7	0	78
Cs	**7g,h,j**	**GOV (m)**	**36**	**34**	**31**	**0**	**86**
Cs4	7g,h,j	GOV (100m)	24	23	21	0	88
Cs5	7g,h,j	GOV (100m)	8	7	6	0	75
Cs6	7g,h,j	GOV (100m)	4	4	4	0	100

Gn	**8a,b**	**GOV (m)**	**51**	**50**	**49**	**0**	**96**
Gn1	8a,b	GOV (50m)	5	5	5	0	100
Gn2	8a,b	GOV (50m)	5	5	5	0	100
Gn3	8a,b	GOV (50m)	14	13	12	0	86
Gn4	8a,b	GOV (100m)	20	20	20	0	100
Gn5	8a,b	GOV (100m)	3	3	3	0	100
Gn6	8a,b	GOV (100m)	2	2	2	0	100
Gn7	8a,b	GOV (100m)	2	2	2	0	100
Gs	**8a,b**	**GOV (m)**	**23**	**23**	**23**	**0**	**100**
Gs1	8a,b	GOV (50m)	3	3	3	0	100
Gs2	8a,b	GOV (50m)	6	6	6	0	100
Gs3	8a,b	GOV (50m)	4	4	4	0	100
Gs4	8a,b	GOV (100m)	4	4	4	0	100
Gs5	8a,b	GOV (100m)	2	3	3	1	150
Gs6	8a,b	GOV (100m)	2	2	2	0	100
Gs7	8a,b	GOV (100m)	2	1	1	0	50
All		**GOV**	**158**	**157**	**149**	**6**	**94.3**

Table A6.37. Biological observations (sex, maturity and collected material for aging) for species sampled during EVHOE 2021 in ICES divisions 8.a-b and 7.f-j.

Species	**Female (%)**	**Male (%)**	**Not sexed (%)**	**Undeter-mined (%)**	**Total number of samples**	**Type of mate-rial**
Argyrosomus regius	0	64.6	0	35.4	48	Otolith
Chelidonichthys cuculus	58.9	21.1	0	20	185	Otolith
Dicentrarchus labrax	50	50	0	0	48	Scales
Engraulis encrasicolus	51	44.9	0	4.1	147	Otolith
Gadus morhua	60	40	0	0	20	Otolith
Glyptocephalus cyno-glossus	66.3	33.7	0	0	92	Otolith
Lepidorhombus boscii	92.9	0	0	7.1	14	Otolith
Lepidorhombus whiffi-agonis	57.6	39.5	0	2.9	408	Otolith

Lophius budegassa	47.1	41.6	0	11.3	310	Illicia
Lophius piscatorius	39.6	43	0.7	16.8	149	Illicia
Melanogrammus aeglefinus	55.7	41.2	0.4	2.7	476	Otolith
Merlangius merlangus	53.3	42.9	0	3.8	557	Otolith
Merluccius merluccius	41.6	38.4	0	20.1	936	Otolith
Microstomus kitt	57.1	42.9	0	0	175	Otolith
Mullus surmuletus	46.3	33.9	0	19.8	121	Otolith
Phycis blennoides	72.2	15.3	0	12.5	176	Otolith
Pleuronectes platessa	66.4	32.9	0	0.7	146	Otolith
Pollachius pollachius	50	50	0	0	2	Otolith
Sardina pilchardus	35.8	64.2	0	0	260	Otolith
Scomber scombrus	27.2	40.8	0.7	31.3	147	Otolith
Scophthalmus maximus	80	20	0	0	5	Otolith
Scophthalmus rhombus	50	50	0	0	4	Otolith
Solea solea	54.1	43.6	0	2.3	133	Otolith
Trisopterus luscus	51.4	30.1	0	18.6	183	Otolith

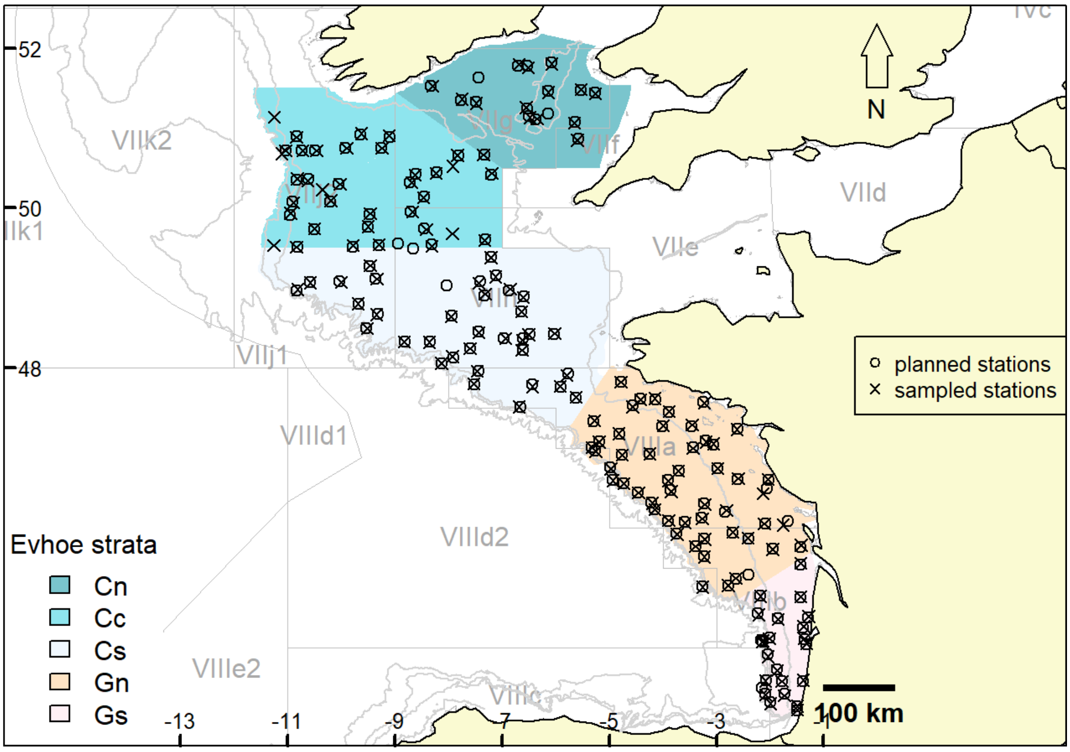

Figure A6.12. Planned stations in the fixed sampling plan (o) and validated tows (x) for EVHOE 2021. ICES areas as well as EVHOE strata (Gs, Gn, Cs, Cc, Cn) are indicated.

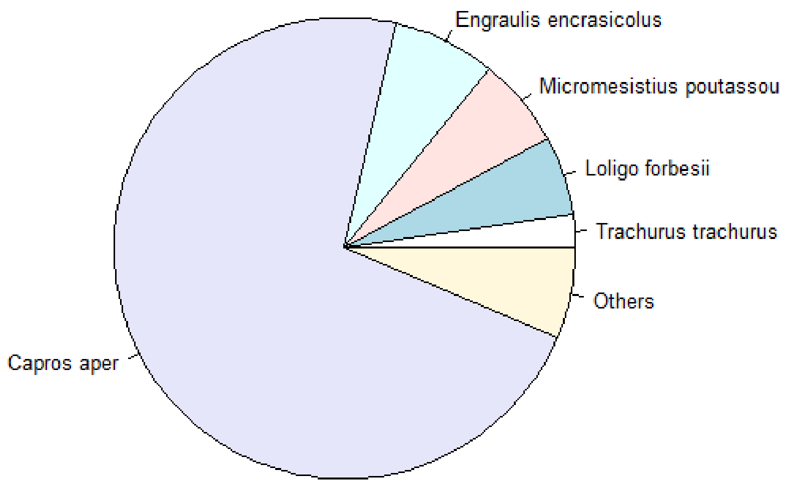

Figure A6.13a. Fish and cephalopods species dominance over the entire "EVHOE" sampling area in term of abundance

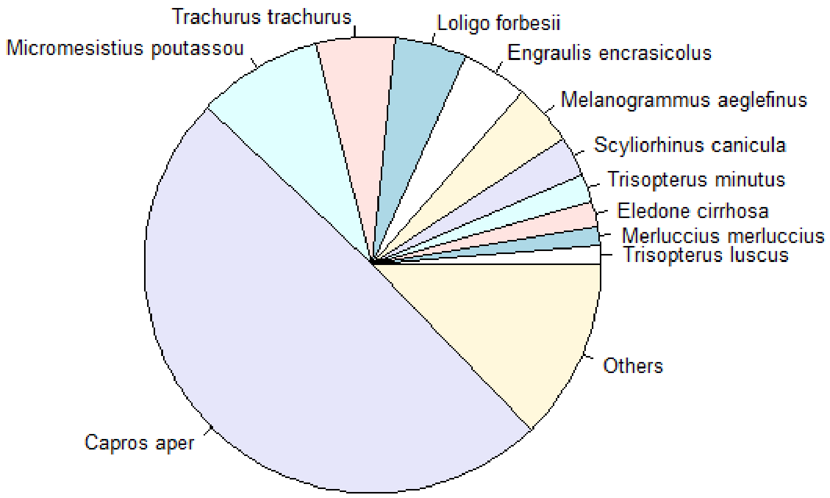

Figure A6.13. Fish and cephalopods species dominance over the entire "EVHOE" sampling area in term of biomass.

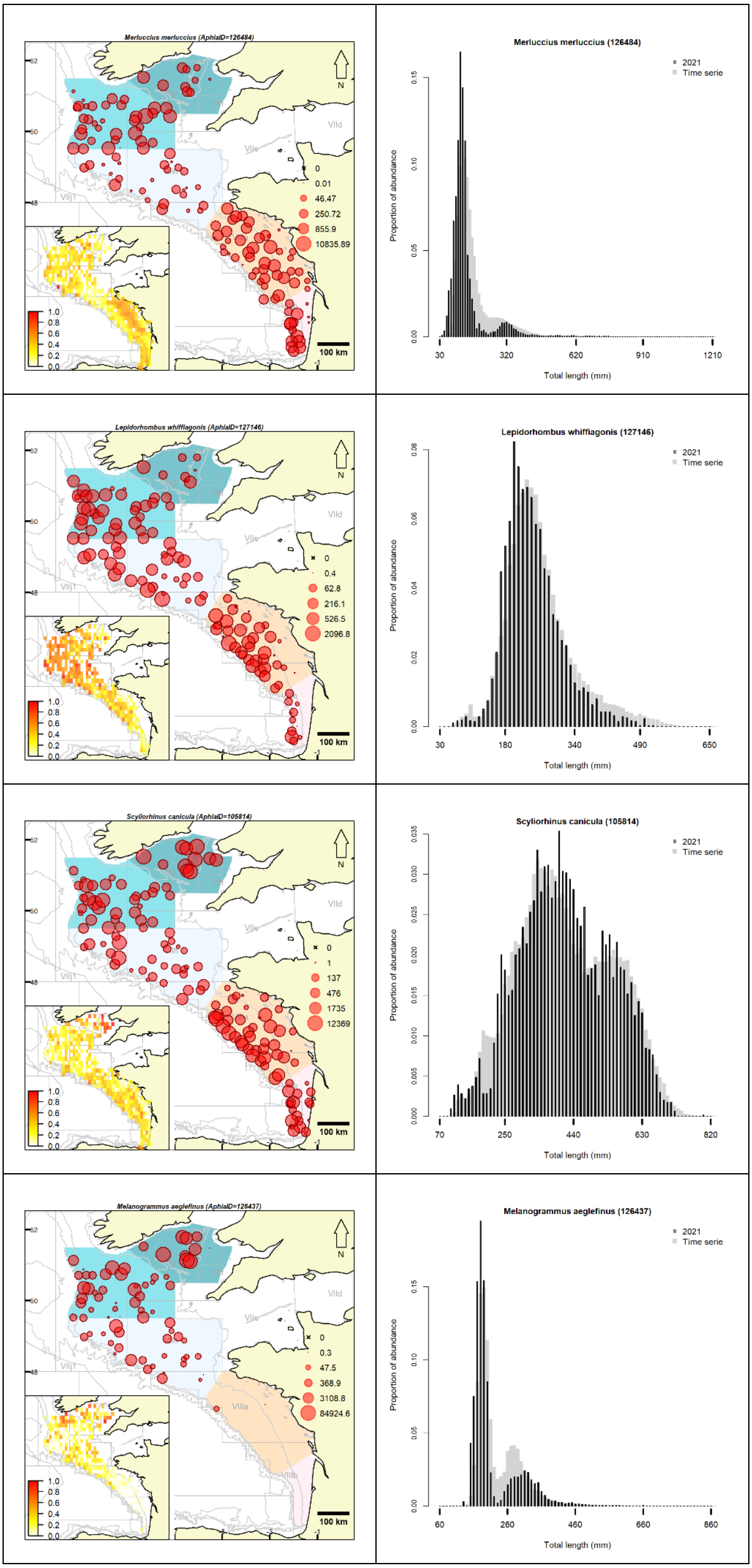
Merluccius merluccius (AphiaID=126484)
0
0.01
46.47
250.72
855.9
10835.89
100 km
Merluccius merluccius (126484)
2021
Time serie
Proportion of abundance
Total length (mm)
Lepidorhombus whiffiagonis (AphiaID=127146)
0
0.4
62.8
216.1
526.5
2096.8
100 km
Lepidorhombus whiffiagonis (127146)
2021
Time serie
Proportion of abundance
Total length (mm)
Scyliorhinus canicula (AphiaID=105814)
0
1
137
476
1735
12369
100 km
Scyliorhinus canicula (105814)
2021
Time serie
Proportion of abundance
Total length (mm)
Melanogrammus aeglefinus (AphiaID=126437)
0
0.3
47.5
368.9
3108.8
84924.6
100 km
Melanogrammus aeglefinus (126437)
2021
Time serie
Proportion of abundance
Total length (mm)

Figure A6.14. Spatial distribution of biomass and barplot of length distribution (logarithm of abundance by size class) for (top to bottom) hake, megrim, lesser-spotted dogfish and haddock caught during IBTS Q4 (EVHOE) survey in 2021 as compared to the whole time-series (1997–2020).

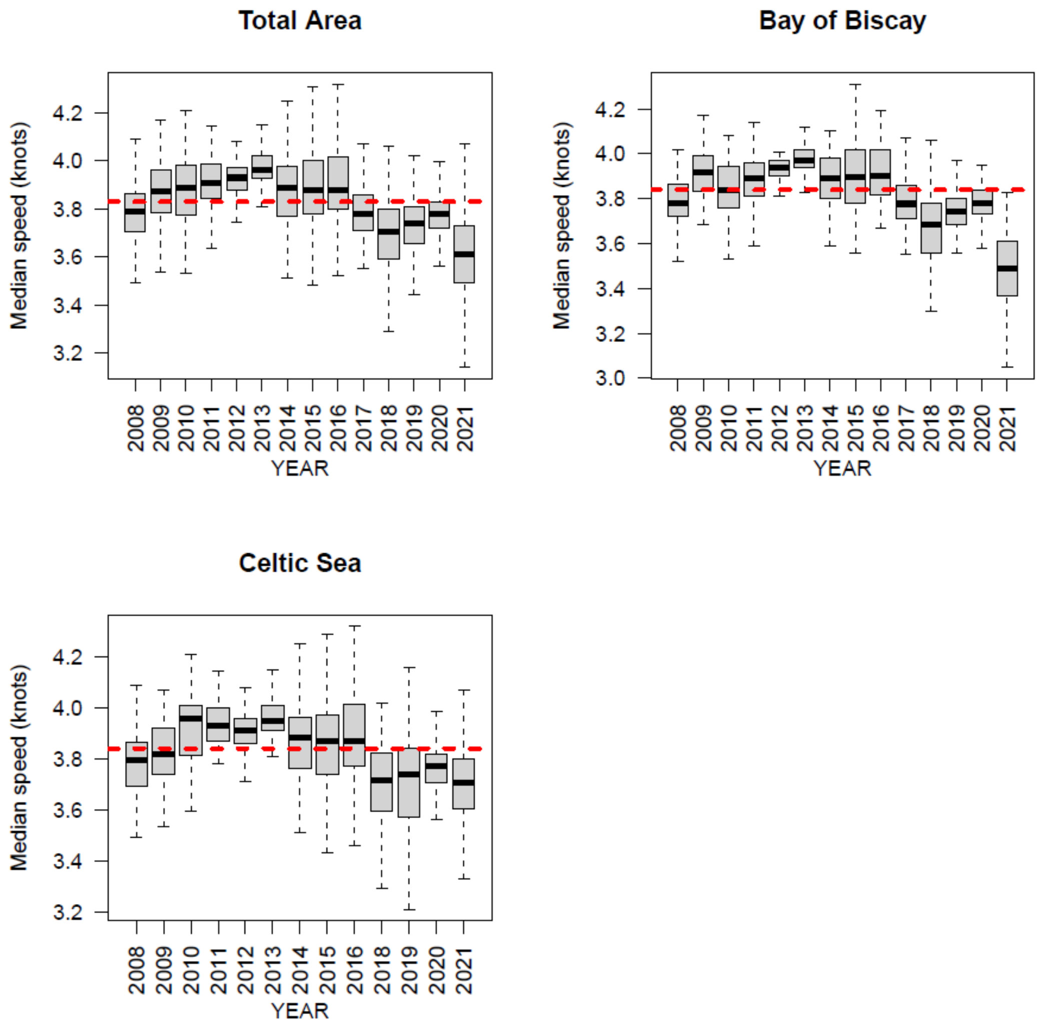

Figure A6.15. Distribution of the median trawling speed at sampling stations by year during EVHOE IBTS Q4 surveys.

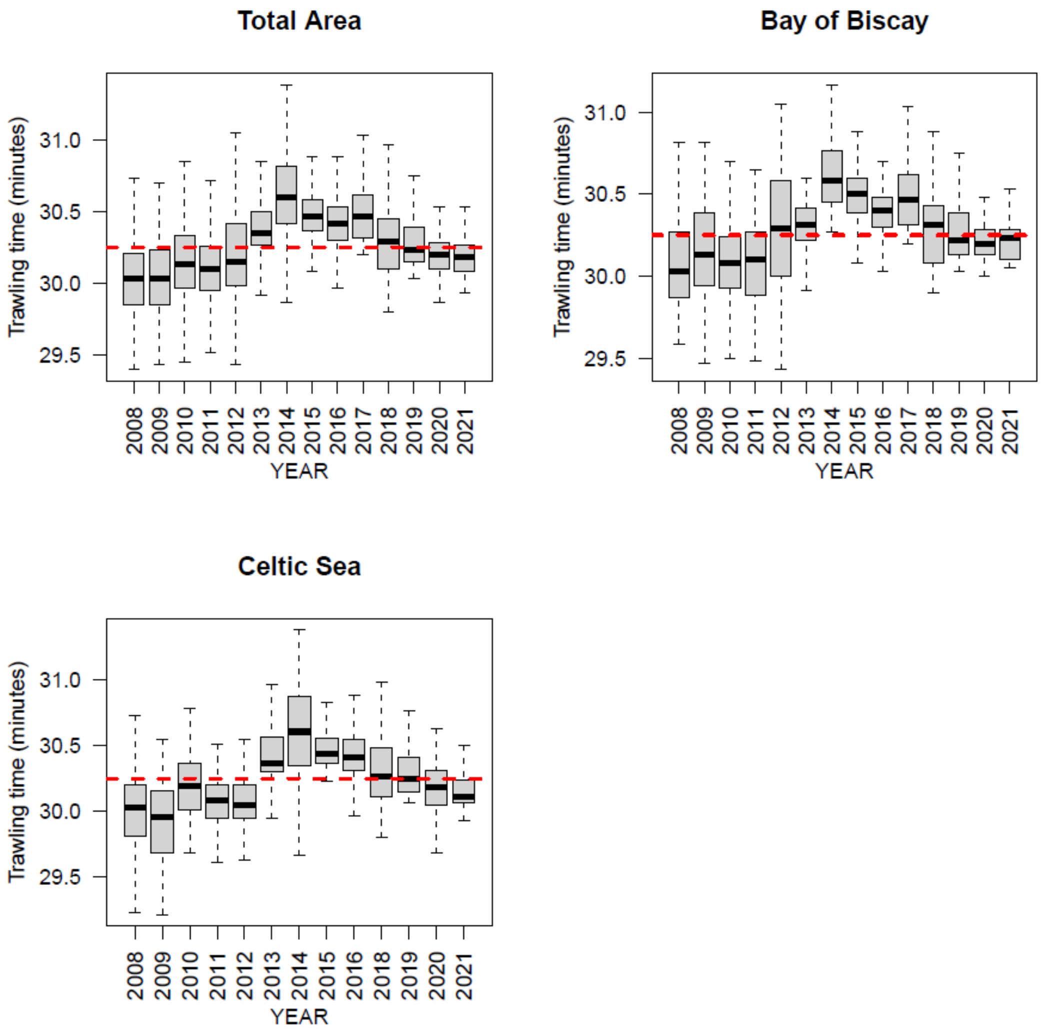

Figure A6.16. Distribution of the trawling duration (mins) at sampling stations by year during EVHOE IBTS Q4 surveys.

A6.12 Portuguese Autumn Groundfish Survey

Nation:	**PT (Portugal)**	**Vessel:**	**Mário Ruivo**
Survey:	PT-GFS-Q4 (Autumn 2021)	Dates:	22 September–23 October 2021
Cruise	The Portuguese Autumn Groundfish Survey (PT-GFS), an annual survey which started in 1979, aims to estimate indices of abundance and biomass, and distribution of hake and horse mackerel recruits, as well as indices of abundance and biomass of the most important commercial species, biological parameters, e.g. maturity, age, 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, focusing in providing the necessary information for stock assessment of commercial species.		

	This survey is the most important source of data for biodiversity, biological parameters, food habits and distribution for a large number of marine species on the Portuguese shelf and slope.
Area	Portuguese continental waters (Div. 9.a), from 20 to 500 m depth.
Survey design	This survey is a mixed fixed and random stratified with twelve geographical strata along the coast and three depth strata (20–100 m, 101–200 m, and 201–500 m). 96 fishing stations are allocated, 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 or during haul with a portable CTD. Scanmar is used to monitor gear parameters.
Gear details:	NCT (Norwegian Campbell Trawl) gear with rubber rockhopper and Thyborøn doors. The mean horizontal opening between the wings is 14.2 m , between doors is 42,1m and the mean vertical opening is 4.5 m. Codend mesh size is 20 mm.
Notes from survey (e.g. problems, additional work etc.):	This survey was not carried out in 2019 due to legal constraints, and not in 2020 due to a combination of legal and logistic constraints, Covid19 outbreak onboard and bad weather. As a result of this gap in data, abundance and biomass index are presented for the 2021 survey only. CTD at the end of haul was replaced by portable CTD on doors. Large catches of broadtail shortfin squid have been recorded.
Number of fish species recorded and notes on any rare species or unusual catches:	Overall, 151 fish taxa, 20 cephalopod taxa and 51 crustacean taxa were recorded during the survey. 79 species of other groups were recorded, including echinoderms, cnidarians, bivalves, gastropods, polychaetes, ascidians and nudibranchs.

Table A6.38. Stations fished (aim: to complete 2 valid tows per strata).

ICES Division	Strata	Gear	Tows planned	Valid	Additional	Invalid	% stations fished	comments
9.a	All	NCT	96	93	0	9	97%	
	TOTAL		96	93	0	9	97%	

Table A6.39. Biological samples (length, weight, sex, maturity and age material) collected for maturity (Mat.) and otoliths (Oto.).

Species	**Samples**	**Mat.**	**Oto.**	**Species**	**Samples**	**Mat.**	**Oto.**
Boops boops	*24*	*233*	*221*	*Merluccius merluccius*	*77*	*2386*	*441*
Chelidonichthys lastoviza	*5*	*43*	*42*	*Micromesistius poutassou*	*24*	*1347*	*658*
Engraulis encrasicolus	*2*	*72*	*72*	*Nephrops norvegicus*	*4*	*91*	
Diplodus vulgaris	*22*	*472*	*282*	*Pagellus acarne*	*30*	*228*	*217*
Illex coindetii	*72*	*637*		*Parapenaeus longirostris*	*15*	*1581*	
Lepidorhombus boscii	*37*	*509*	*133*	*Scomber colias*	*10*	*191*	*144*

Loligo vulgaris	*25*	*676*		*Scomber scombrus*	*20*	*289*	*153*
Lophius budegassa	*13*	*23*	*11*	*Trachurus trachurus*	*33*	*1149*	*647*

Table A6.40. Biomass and abundance index for the PT-PGFSQ4-2021 survey. Year estimate (y_i) shown for 2021, but due to the 2-year gap in the survey, comparisons with earlier years are not shown.

Biomass and number estimates								
			Biomass index			Number index		
Species	Strata	Valid tows	y_i kg/h	y_i/y_{i-1} %	$y_{(i,i-1)}/y_{(i-2,i-3,i-4)}$ %	y_i n/h	y_i/y_{i-1} %	$y_{(i,i-1)}/y_{(i-2,i-3,i-4)}$ %
Merluccius merluccius	9.a	93	21.3			272.5		
Trachurus trachurus	9.a	93	56.8			1010.0		
Trachurus picturatus	9.a	93	4.4			45.1		
Micromesistius poutassou	9.a	93	168.3			4929.7		
Scomber colias	9.a	93	1.9			17.9		
Scomber scombrus	9.a	93	14.1			90.7		
Lepidorhombus boscii	9.a	93	1.1			14.2		
Lepidorhombus whiffiagonis	9.a	93	0.1			0.2		
Lophius budegassa	9.a	93	0.3			0.5		
Lophius piscatorius	9.a	93	0.0			0.0		
Capros aper	9.a	93	19.9			719.6		
Phycis blennoides	9.a	93	0.2			3.3		
Raja clavata	9.a	93	6.0			5.1		
Scyliorhinus canicula	9.a	93	4.3			14.3		
Illex coindetii	9.a	93	16.6			295.5		
Nephrops norvegicus	9.a	93	0.1			1.5		

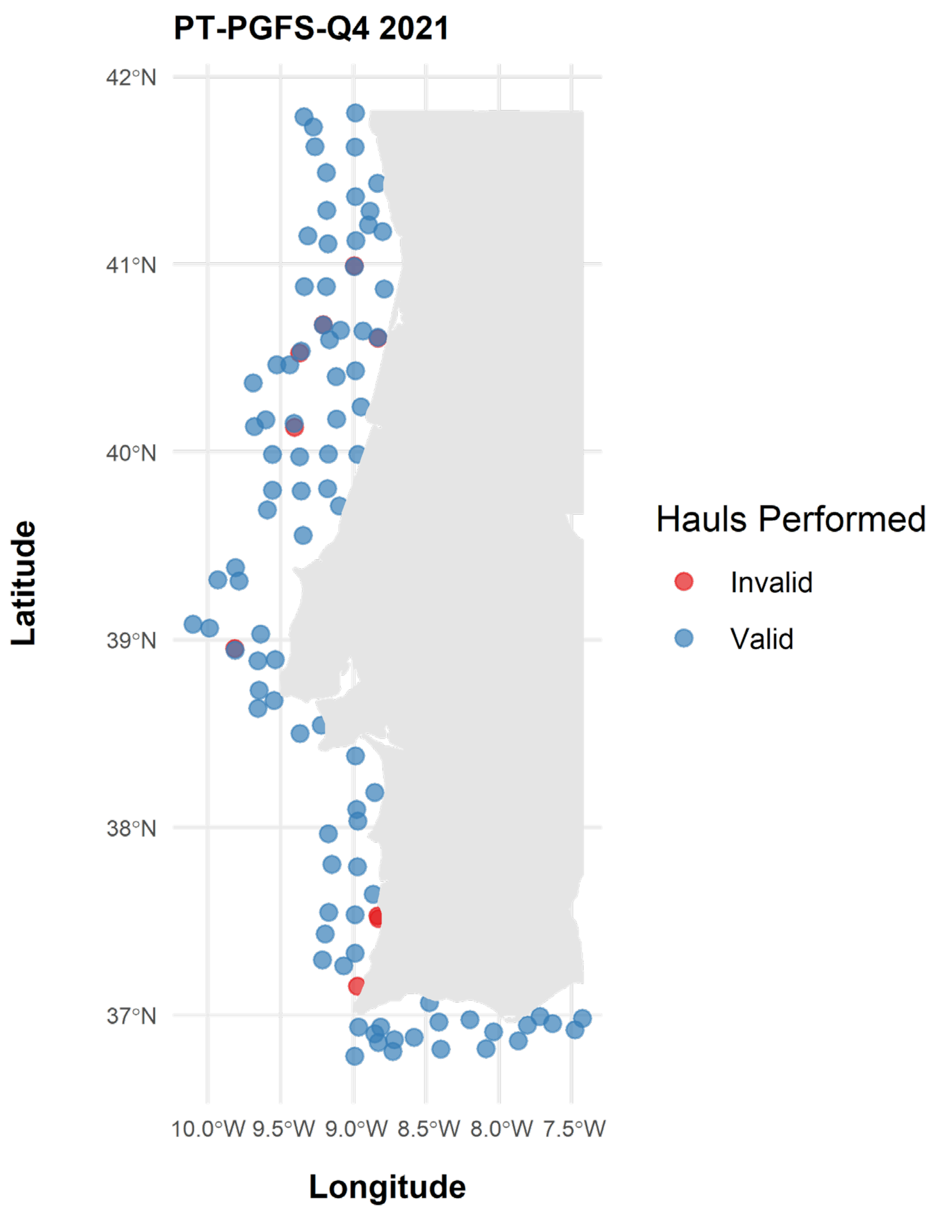

Figure A6.17. Location of hauls sampled during PT-PGFS-Q4 in 2021.

A6.13 Spanish North Coast bottom trawl survey (NSGFS-Q4)

Nation:	**SP (Spain)**	**Vessel:**	**Miguel Oliver / Vizconde de Eza**
Survey:	SP-NSGFS-Q4 (N21)	Dates:	17 September – 13 November 2021
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 Division 8.c and the northern part of 9.a. The primary species are hake, monkfish, white anglerfish, megrim, four-spot megrim, blue whiting and horse mackerel, with abundance indices estimated by age. Abundance indices are 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 three 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.):	Due to a breakdown of the *Miguel Oliver*, the 2021 survey had to be carried out by two different vessels, the *Miguel Oliver* and the *Vizconde de Eza* used to complete the survey, albeit with a three-week gap in between. The gear was the standard gear on both vessels, despite few differences regarding the door and wingspread, results were in line with those from the time-series, showing the usual proportion of bentho-demersal species as megrims and skates. As in previous years, two additional hauls were undertaken to cover shallow stations between 30 and 70 m, and 12 deeper (500–700 m) stations also fished. Additional work undertaken included CTD casts at all trawl stations, and sampling with a boxcorer and a meso-boxcorer was undertaken to collect sediment and infauna samples. Seabird census, dredge and sediment sampling were not carried out because of crew limitations due to COVID-19 restrictions. 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, 104 fish taxa (99 to species level), 51 crustacean taxa (45 species), 46 mollusc taxa (40 species), 37 echinoderm taxa (33 species) and 47 other taxa of invertebrates (24 species).

Table A6.41. Stations fished (aim: to complete 116 valid tows per year).

ICES Division	Strata	Gear	Tows planned	Valid	Additional	Invalid	% stations fished
8.c	All	Standard baca	96	93	12(1)	0	97%
9.a North	All	Standard baca	20	19	3	0	99%
8.b	All	Standard baca	0	0	1	0	N/A
TOTAL			116	112	15	0	97%

(1) Additional 15 hauls on shallow and deep grounds.

Table A6. 42. Biological samples (length, weight, sex, maturity and age material). Species denoted * sampled for otoliths and vertebrae (only the former read for John dory); no age determination for species denoted **.

Species	No.	Species	No.
Merluccius merluccius	627	*Scomber scombrus*	241
Lepidorhombus whiffiagonis	724	*Mullus surmuletus*	62
Lepidorhombus boscii	521	*Scomber colias*	1
Lophius budegassa	57	*Zeus faber**	95
Lophius piscatorius	82	*Trisopterus luscus*	247
Trachurus trachurus	399	*Helicolenus dactylopterus*	73
Micromesistius poutassou	599	*Phycis blennoides*	68

Engraulis encrasicolus	255	*Conger conger**	57
*Nephrops norvegicus***	79		

Table A6.43. Biomass and abundance estimates. y_i, year estimate (2021); y_{i-1}, previous year estimate (2020); $y_{(i,i-1)}$, Average of last two-year estimates (2021 and 2020); $y_{(i-2,i-3,i-4)}$, Average of the previous three year estimates (2019, 2018 and 2017).

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	9.aN	19	5.73	-12.8	42.0	189.0	-5.5	13.6
Lepidorhombus boscii	9.aN	19	4.93	20.2	-12.6	77.6	17.8	-21.4
Lepidorhombus whiffiagonis	9.aN	19	0.31	29.2	75.5	2.1	-23.8	19.7
Lophius budegassa	9.aN	19	0.13	160.0	-62.5	0.1	0.0	-64.3
Lophius piscatorius	9.aN	19	0.00	--	-100.0	0.0	--	-100.0
Micromesistius poutassou	9.aN	19	217.14	-42.9	670.7	8194.1	-6.4	620.3
Trachurus trachurus	9.aN	19	1.72	-92.8	-69.1	12.9	-93.9	-75.9
Scomber scombrus	9.aN	19	2.88	-92.7	983.2	17.0	-96.5	1531.9
Nephrops norvegicus	9.aN	19	0.00	--	-100.0	0.0	--	-84.6
Merluccius merluccius	8.c	93	5.13	-1.5	-22.7	133.3	14.0	-42.3
Lepidorhombus boscii	8.c	93	5.95	1.5	-0.2	98.8	-5.4	-1.0
Lepidorhombus whiffiagonis	8.c	93	3.99	-11.7	-4.3	52.2	-14.4	2.7
Lophius budegassa	8.c	93	0.54	58.8	-33.0	0.6	78.1	48.3
Lophius piscatorius	8..c	93	1.10	25.0	49.2	0.9	108.9	189.6
Micromesistius poutassou	8.c	93	124.54	53.2	-1.5	4973.2	157.6	20.3
Trachurus trachurus	8.c	93	4.59	-57.2	-69.8	67.6	-61.7	-78.2
Scomber scombrus	8.c	93	0.43	-80.1	-37.8	1.7	-92.2	-78.3
Nephrops norvegicus	8.c	93	0.02	-50.0	-18.2	0.5	-10.2	-25.0
Merluccius merluccius	Total	112	5.23	-4.0	-15.0	142.9	8.9	-34.4
Lepidorhombus boscii	Total	112	5.77	3.8	-2.0	95.1	-2.7	-4.2
Lepidorhombus whiffiagonis	Total	112	3.35	-11.6	-3.8	43.6	-14.5	2.9

Lophius budegassa	Total	112	0.47	62.1	-34.9	0.5	77.8	38.9
Lophius piscatorius	Total	112	0.91	24.7	44.7	0.8	110.8	173.8
Micromesistius poutassou	Total	112	140.46	5.8	46.6	5526.9	78.0	67.3
Trachurus trachurus	Total	112	4.1	-68.4	-69.6	58.2	-68.1	-77.9
Scomber scombrus	Total	112	0.85	-90.0	128.0	4.3	-95.8	14.3
Nephrops norvegicus	Total	112	0.02	-33.3	-16.7	0.5	-8.2	-26.6

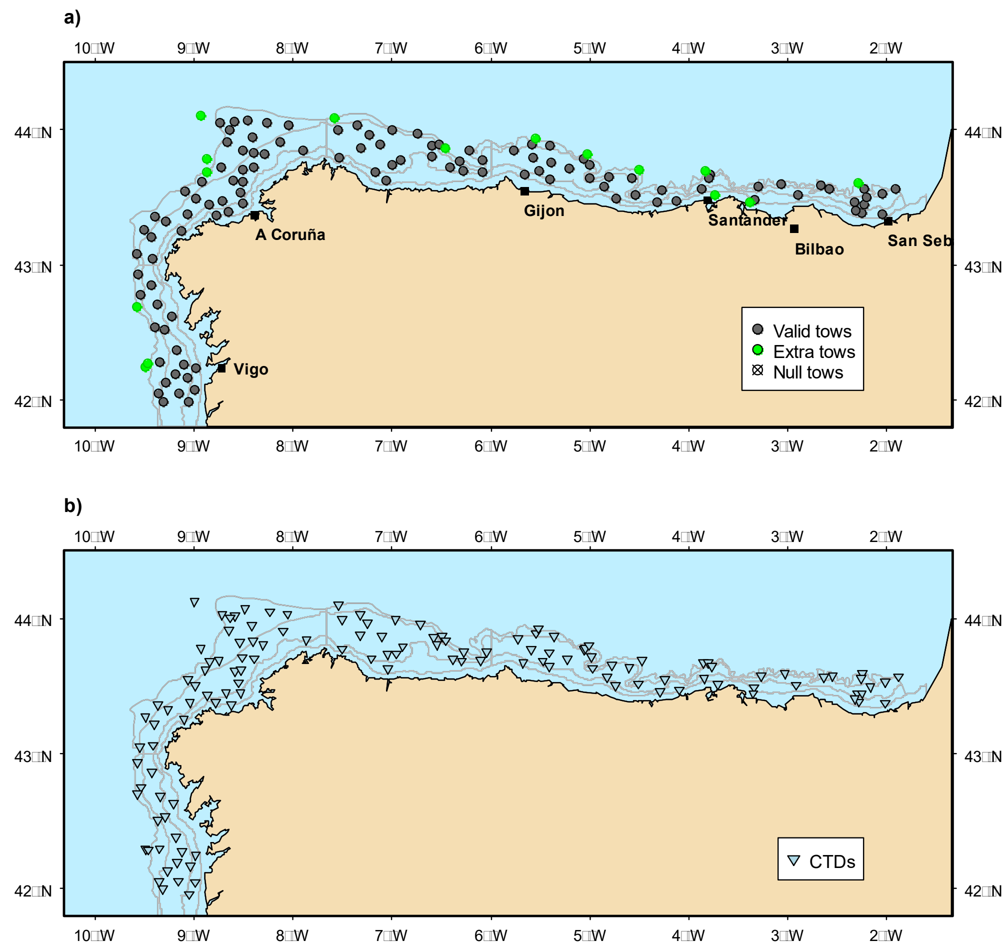

Figure A6.18. Map of (a) trawl stations and (b) CTD stations sampled during the northern Spanish Shelf survey in 2021.

Annex 7: Species distribution maps

Table A.7.1. 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 North-eastern Atlantic Areas).

Scientific	Common	Code	Fig No	Length Split (<cm)
Capros aper	Boarfish	BOC	44	
Clupea harengus	Herring	HER	6-7	17.5
Conger conger	Conger	COE	45	
Gadus morhua	Atlantic cod	COD	2-3	23
Galeorhinus galeus	Tope shark	GAG	33	
Galeus melastomus	Blackmouthed dogfish	DBM	31	
Lepidorhombus boscii	Four-spotted megrim	LBI	16-17	19
Lepidorhombus whiffiagonis	Megrim	MEG	14-15	21
Leucoraja naevus	Cuckoo ray	CUR	35	
Lophius budegassa	Black-bellied anglerfish	WAF	20-21	20
Lophius piscatorius	Anglerfish (Monk)	MON	18-19	20
Merlangus merlangius	Whiting	WHG	24-25	20
Melanogrammus aeglefinus	Haddock	HAD	4-5	20
Merluccius merluccius	European hake	HKE	8-9	20
Micromesistius poutassou	Blue whiting	WHB	26-27	19
Mustelus spp.	Smooth-hound	SMH	34	
Nephrops norvegicus	Norway lobster	NEP	28	
Pleuronectes platessa	European plaice	PLE	22-23	12
Raja brachyura	Blonde ray	RJH	40	
Raja clavata	Thornback ray	THR	36	
Raja microocellata	Small-eyed ray	PTR	37	
Raja montagui	Spotted ray	SDR	38	
Raja undulata	Undulate ray	UNR	39	
Scomber scombrus	European mackerel	MAC	12-13	24
Scyliorhinus canicula	Lesser-spotted dogfish	LSD	29	

Scyliorhnus stellaris	Nurse hound	DGN	30	
Sprattus sprattus	European sprat	SPR	41	
Squalus acanthias	Spurdog	DGS	32	
Trachurus picturatus	Blue jack mackerel	JAA	43	
Trachurus trachurus	Horse mackerel (Scad)	HOM	10-11	15
Trisopterus smarkii	Norway pout	NPO	42	
Zeus faber	John dory	JOD	46	

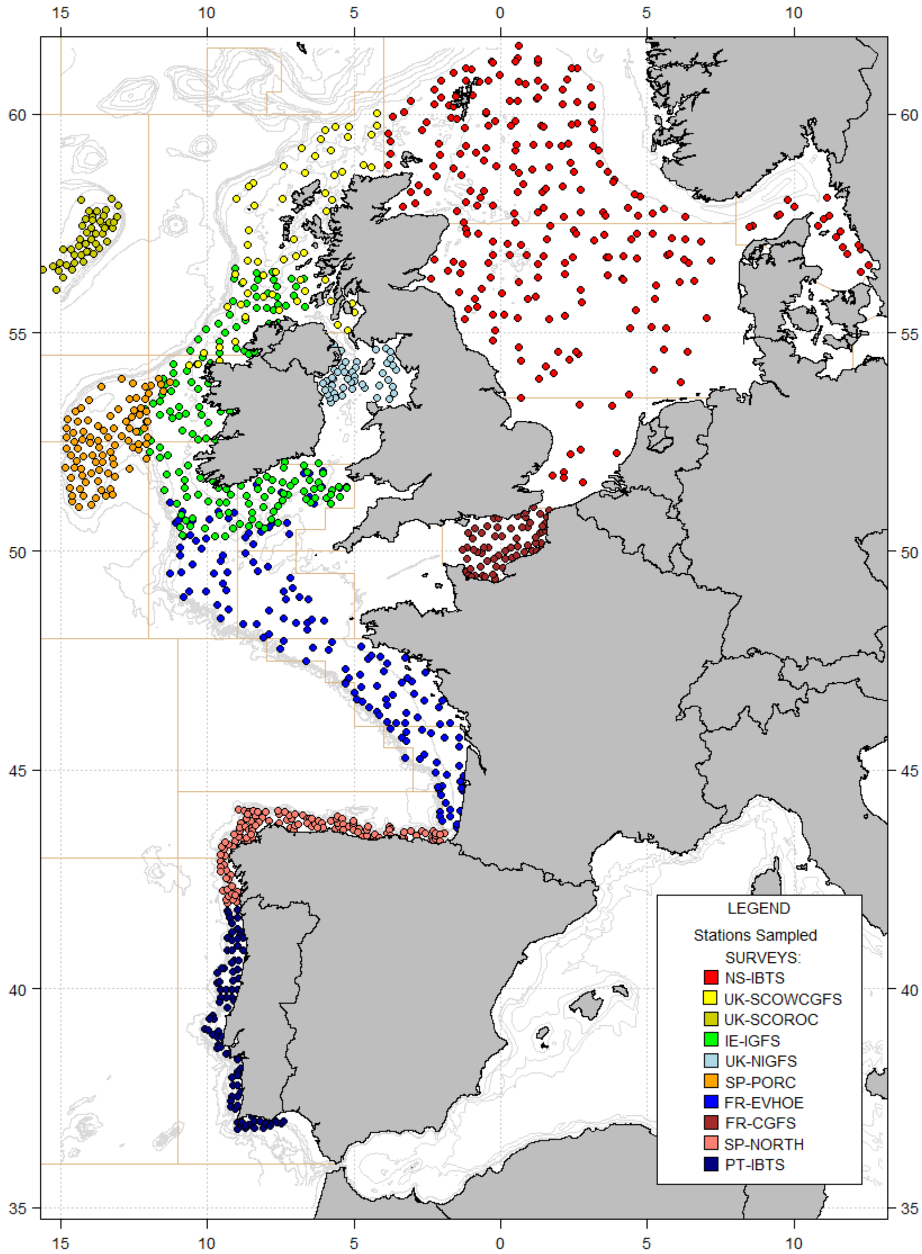

Figure A7.1. Station positions for the IBTSurveys carried out in the North-eastern Atlantic and North Sea area in summer/autumn of 2021: Quarters 3 and 4. Note: <u>The catchability of the different gears used in the NEA surveys is not constant. Therefore, the following maps do not reflect proportional abundance across the areas, but within each survey.</u>

The catchability of the different gears used in the NEA surveys is not constant. Therefore, the following maps do not reflect proportional abundance across the areas, but within each survey

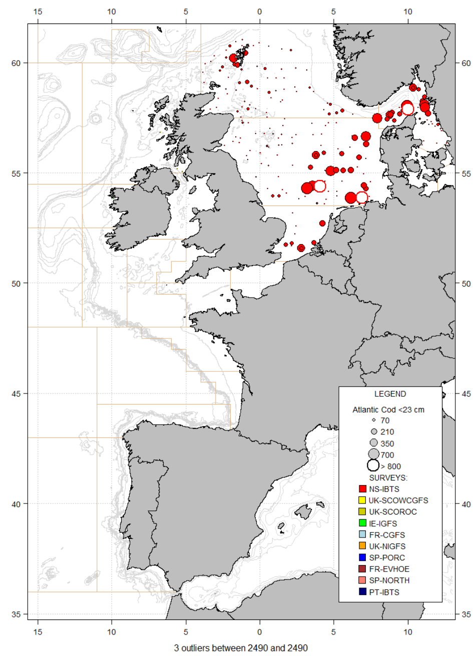

Figure A7.2. Catches in numbers per hour of 0-group cod *Gadus morhua* (<23cm) in summer/autumn 2021 IBTSurveys.

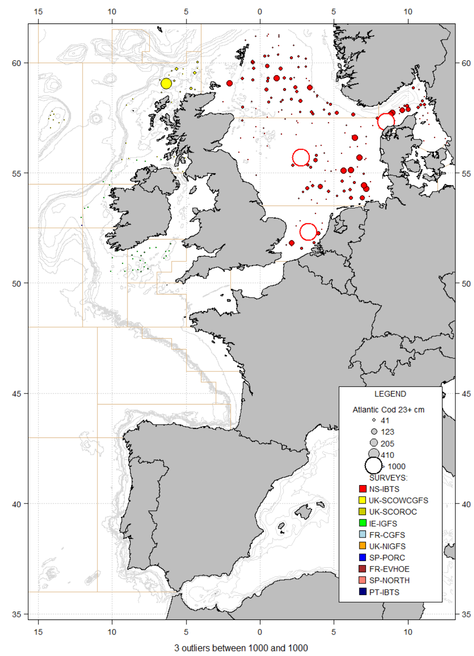

Figure A7.3. Catches in numbers per hour of 1+ cod *Gadus morhua* (≥23cm) in summer/autumn 2021 IBTSurveys.

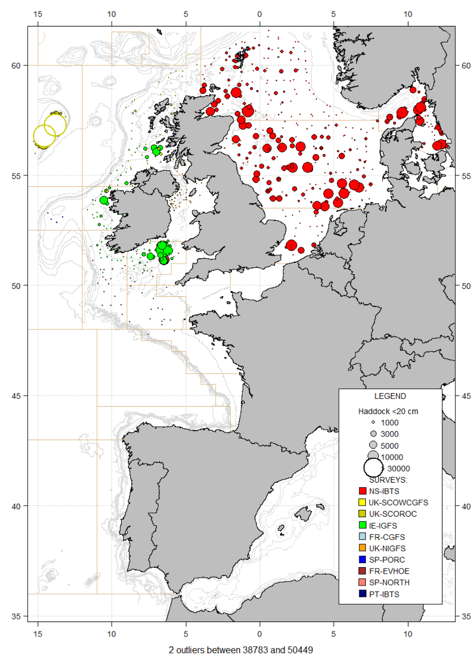

Figure A7.4. Catches in numbers per hour of 0-group haddock *Melanogrammus aeglefinus* (<20cm) in summer/autumn 2021 IBTSurveys.

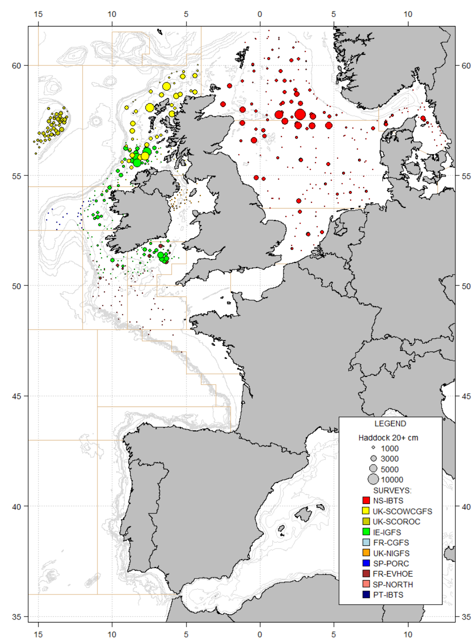

Figure A7.5. Catches in numbers per hour of 1+ group haddock *Melanogrammus aeglefinus* (≥20cm) in summer/autumn 2021 IBTSurveys.

The catchability of the different gears used in the NEA surveys is not constant. Therefore, the following maps do not reflect proportional abundance across the areas, but within each survey

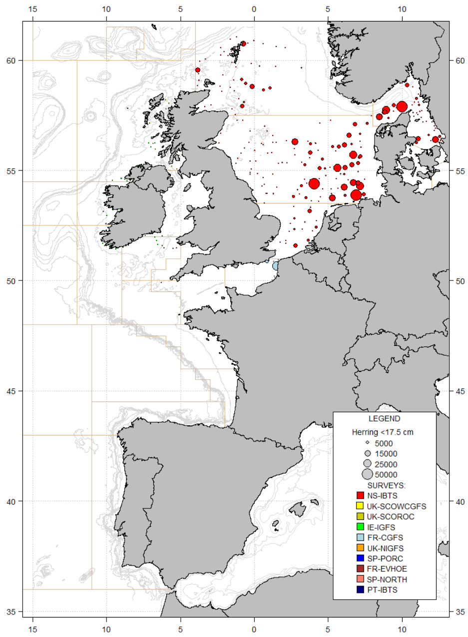

Figure A7.6. Catches in numbers per hour of 0-group herring *Clupea harengus* (<17.5 cm) in summer/autumn 2021 IBTSurveys.

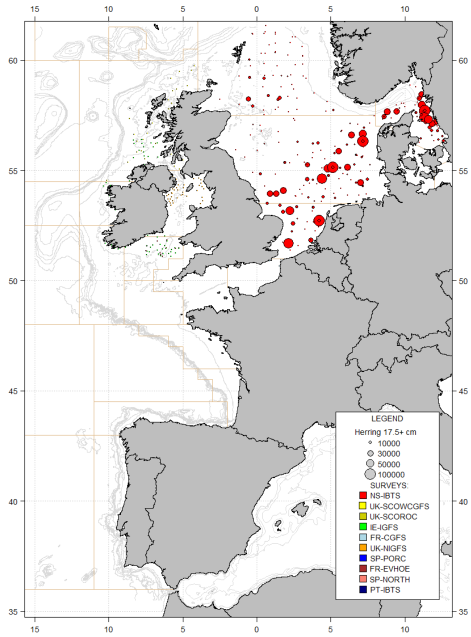

Figure A7.7. Catches in numbers per hour of 1+ group herring *Clupea harengus* (≥17.5 cm) in summer/autumn 2021 IBTSurveys.

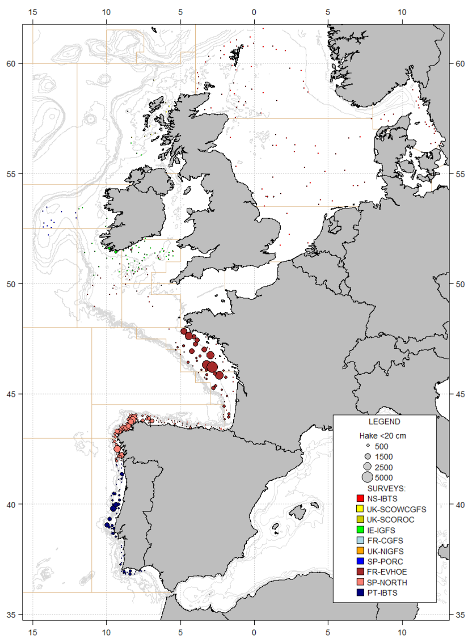

Figure A7.8. Catches in numbers per hour of 0-group European hake *Merluccius merluccius* (<20cm) in summer/autumn 2021 IBTSurveys.

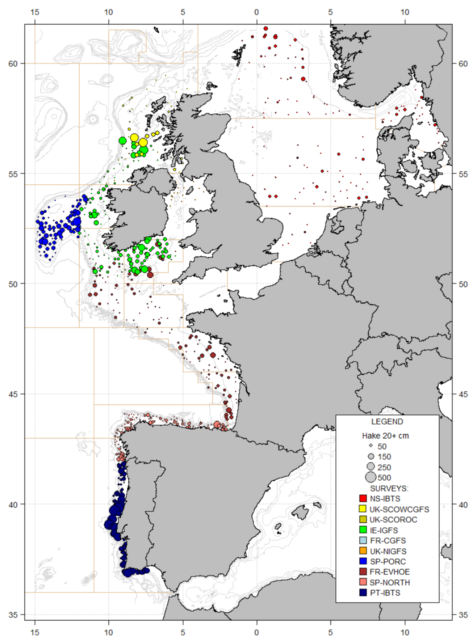

Figure A7.9. Catches in numbers per hour of 1+ group European hake *Merluccius merluccius* (≥20cm) in summer/autumn 2021 IBTSurveys.

The catchability of the different gears used in the NEA surveys is not constant. Therefore, the following maps do not reflect proportional abundance across the areas, but within each survey

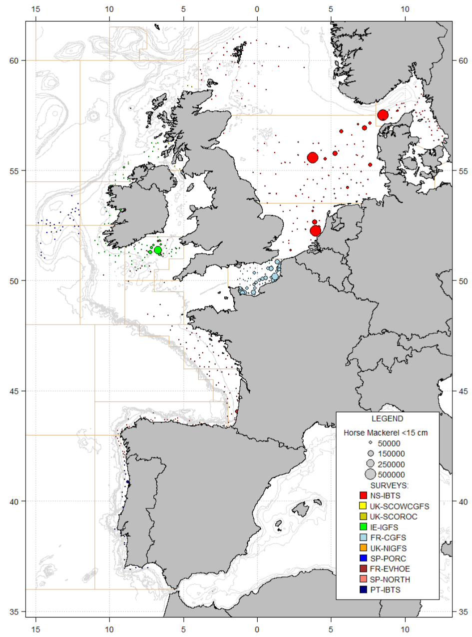

Figure A7.10. Catches in numbers per hour of 0-group horse mackerel T*rachurus trachurus* (<15 cm) in summer/autumn 2021 IBTSurveys.

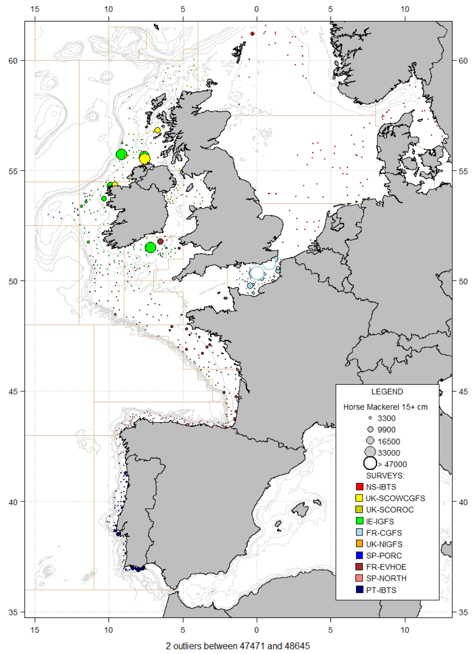

Figure A7.11. Catches in numbers per hour of 1+ group horse mackerel *Trachurus trachurus* (≥15 cm) in summer/autumn 2021 IBTSurveys.

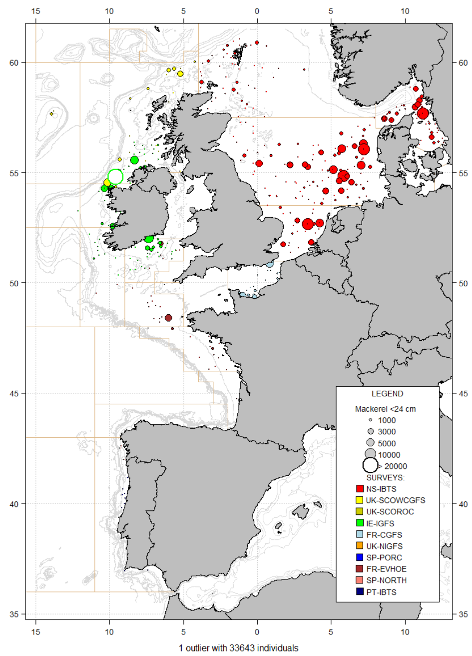

Figure A7.12. Catches in numbers per hour of 0-group mackerel *Scomber scombrus* (<24 cm) in summer/autumn 2021 IBTSurveys.

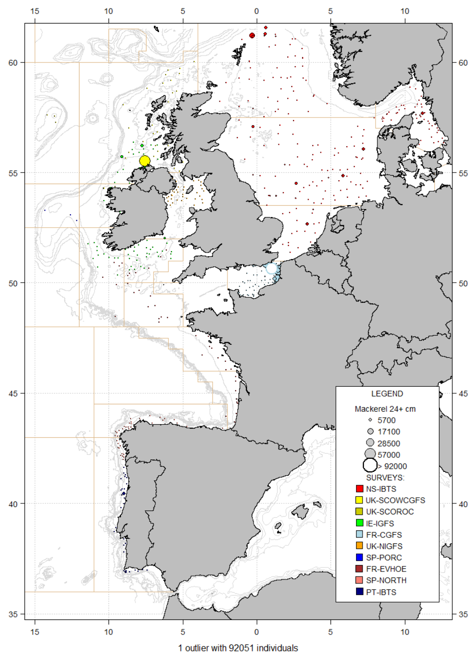

Figure A7.13. Catches in numbers per hour of 1+ group mackerel Scomber scombrus (≥24 cm) in summer/autumn 2021 IBTSurveys.

The catchability of the different gears used in the NEA surveys is not constant. Therefore, the following maps do not reflect proportional abundance across the areas, but within each survey

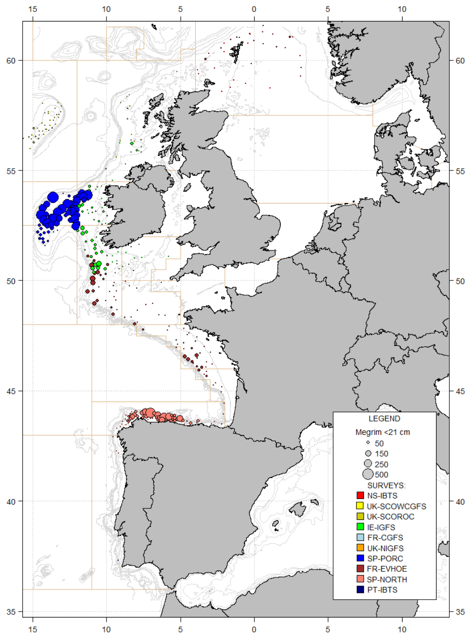

Figure A7.14. Catches in numbers per hour of megrim recruits *Lepidorhombus whiffiagonis* (<21 cm) in summer/autumn 2021 IBTSurveys.

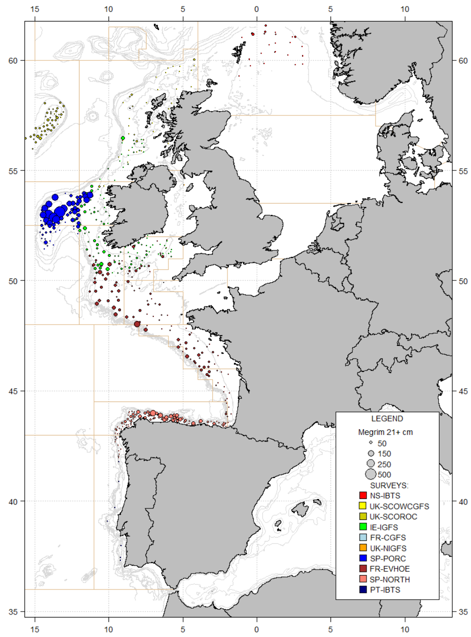

Figure A7.15. Catches in numbers per hour of 2+ group megrim *Lepidorhombus whiffiagonis* (≥21 cm) in summer/autumn 2021 IBTSurveys.

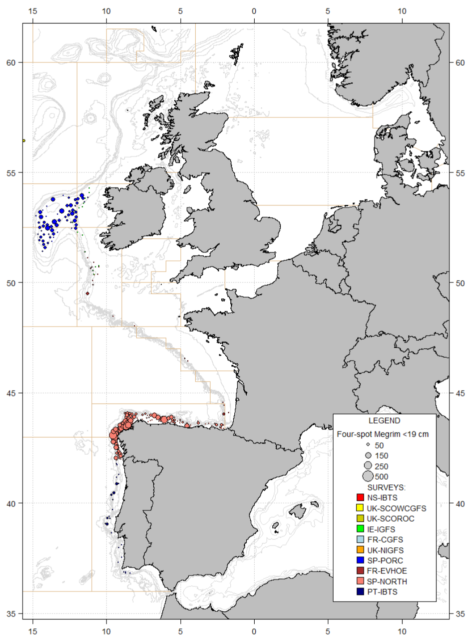

Figure A7.16. Catches in numbers per hour of recruits of four-spotted megrim *Lepidorhombus boscii* (<19 cm) in summer/autumn 2021 IBTSurveys.

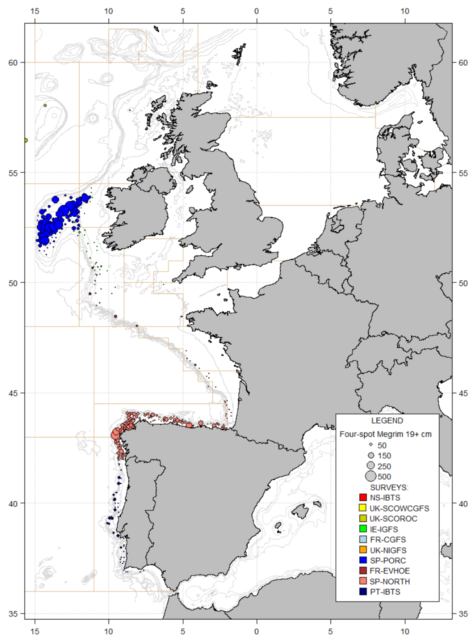

Figure A7.17. Catches in numbers per hour of 2+ group four-spotted megrim *Lepidorhombus boscii* (≥19 cm) in summer/autumn 2021 IBTSurveys.

The catchability of the different gears used in the NEA surveys is not constant. Therefore, the following maps do not reflect proportional abundance across the areas, but within each survey

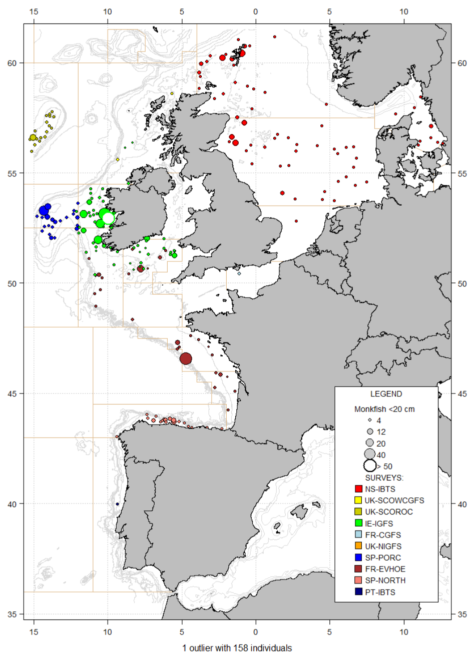

Figure A7.18. Catches in numbers per hour of 0-group anglerfish *Lophius piscatorius* (<20 cm) in summer/autumn 2021 IBTSurveys.

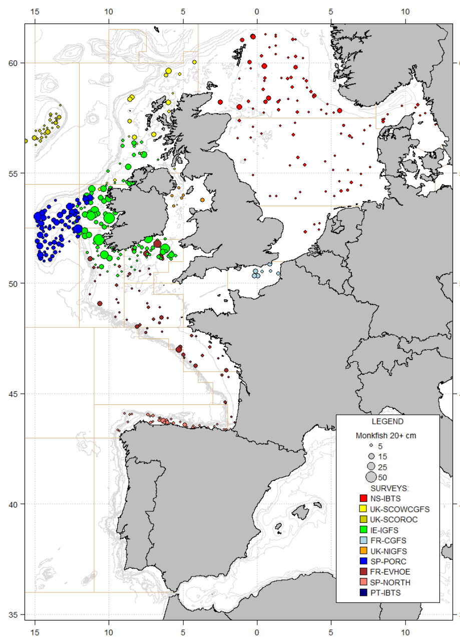

Figure A7.19. Catches in numbers per hour of 1+ group anglerfish *Lophius piscatorius* (≥20 cm) in summer/autumn 2021 IBTSurveys.

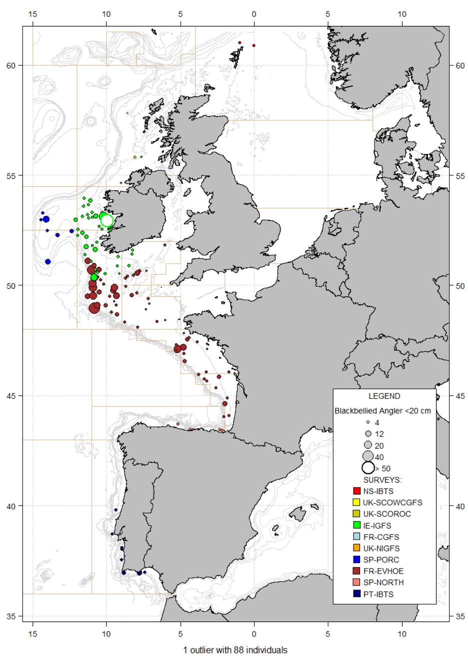

Figure A7.20. Catches in numbers per hour of 0-group black-bellied anglerfish *Lophius budegassa* (<20 cm) in summer/autumn 2021 IBTSurveys.

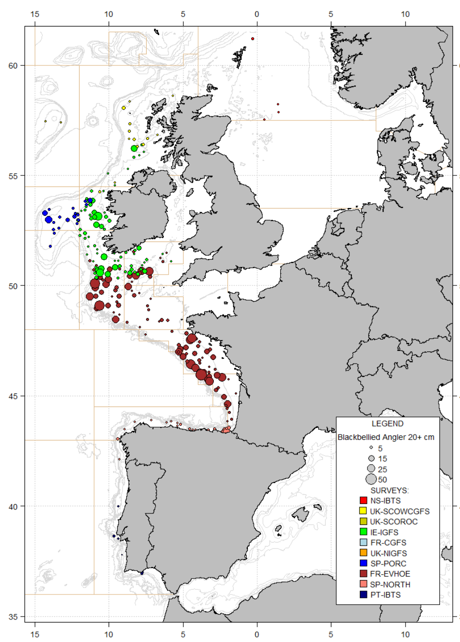

Figure A7.21. Catches in numbers per hour of 1+ group black-bellied anglerfish *Lophius budegassa* (≥20 cm) in summer/autumn 2021 IBTSurveys.

The catchability of the different gears used in the NEA surveys is not constant. Therefore, the following maps do not reflect proportional abundance across the areas, but within each survey

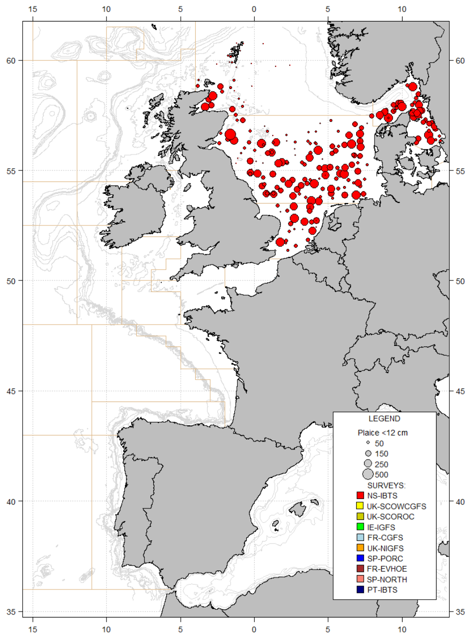

Figure A7.22. Catches in numbers per hour of 0-group plaice *Pleuronectes platessa* (<12 cm) in summer/autumn 2021 IBTSurveys.

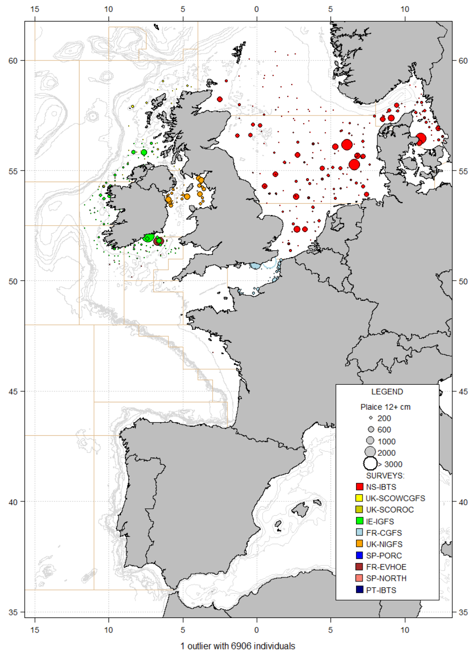

Figure A7.23. Catches in numbers per hour of 1+ group plaice *Pleuronectes platessa* (≥12 cm) in summer/autumn 2021 IBTSurveys.

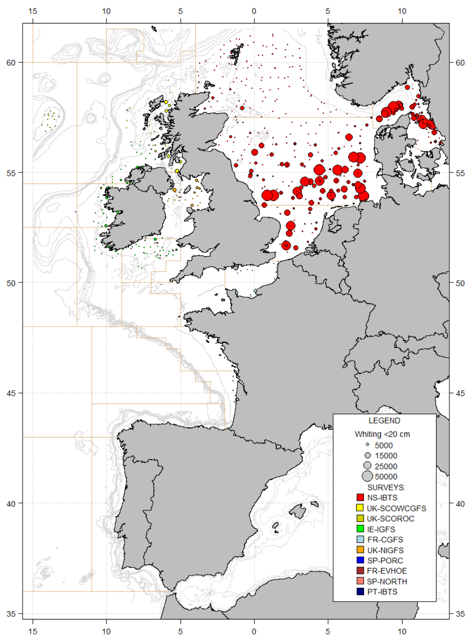

Figure A7.24. Catches in numbers per hour of 0-group whiting *Merlangius merlangus* (<20 cm) in summer/autumn 2021 IBTSurveys.

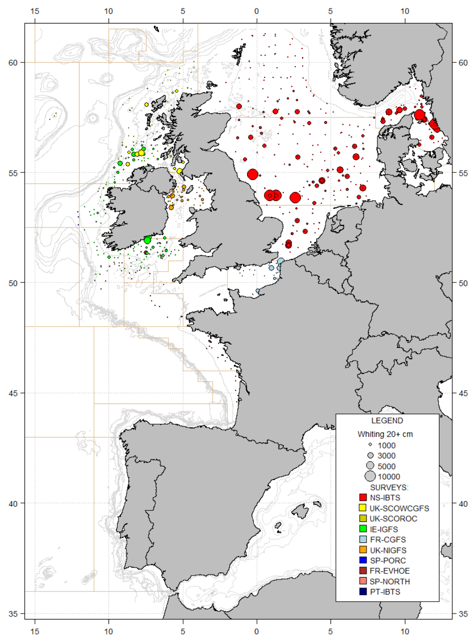

Figure A7.25. Catches in numbers per hour of 1+ group whiting *Merlangius merlangus* (≥20 cm) in summer/autumn 2021 IBTSurveys.

The catchability of the different gears used in the NEA surveys is not constant. Therefore, the following maps do not reflect proportional abundance across the areas, but within each survey

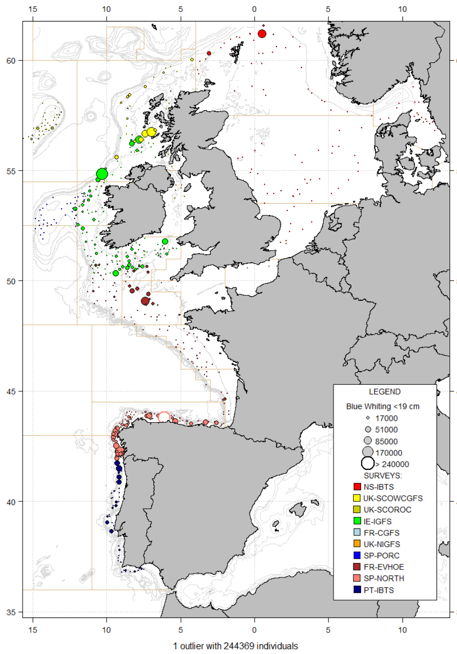

Figure A7.26. Catches in numbers per hour of 0-group blue whiting *Micromesistius poutassou* (<19 cm) in summer/autumn 2021 IBTSurveys.

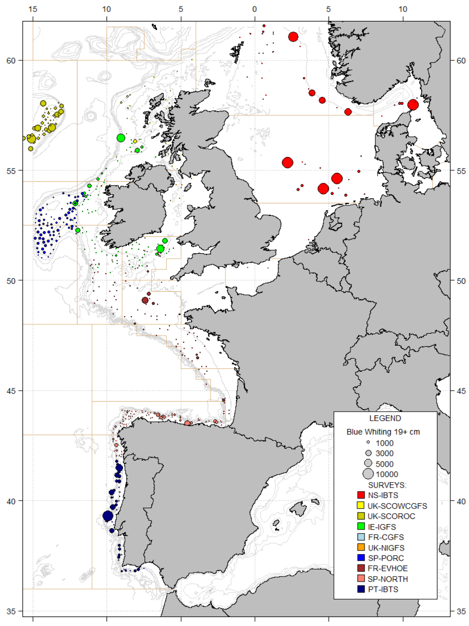

Figure A7.27. Catches in numbers per hour of 1+ group blue whiting *Micromesistius poutassou* (≥19 cm) in summer/autumn 2021 IBTSurveys.

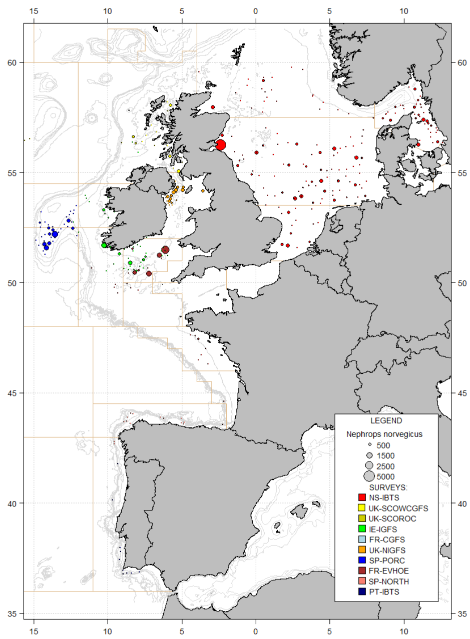

Figure A7.28. Catches in numbers per hour of Norway lobster *Nephrops norvegicus* in summer/autumn 2021 IBTSurveys.

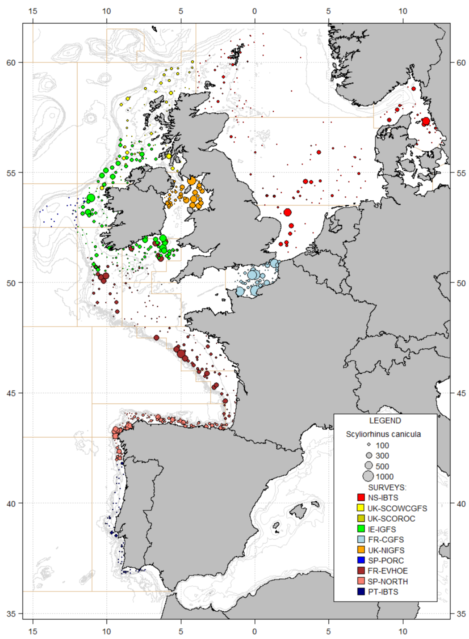

Figure A7.29. Catches in numbers per hour of lesser-spotted dogfish *Scyliorhinus canicula* in summer/autumn 2021 IBTSurveys.

The catchability of the different gears used in the NEA surveys is not constant. Therefore, the following maps do not reflect proportional abundance across the areas, but within each survey

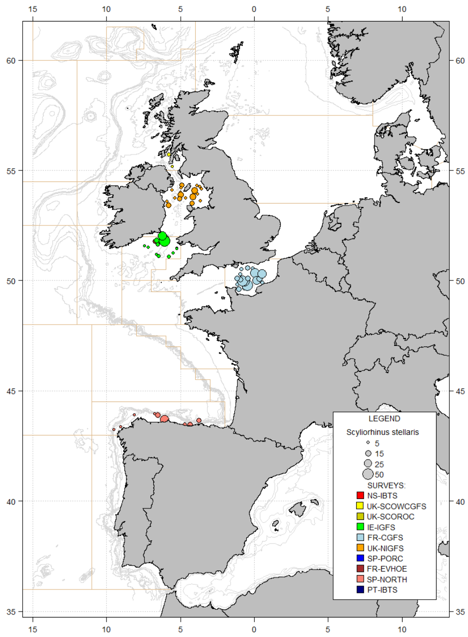

Figure A7.30. Catches in numbers per hour of nurse hound *Scyliorhinus stellaris* in summer/autumn 2021 IBTSurveys.

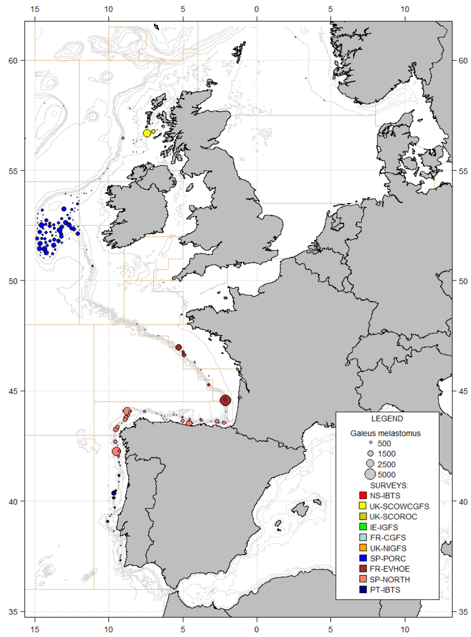

Figure A7.31. Catches in numbers per hour of black-mouthed dogfish *Galeus melastomus* in summer/autumn 2021 IBTSurveys.

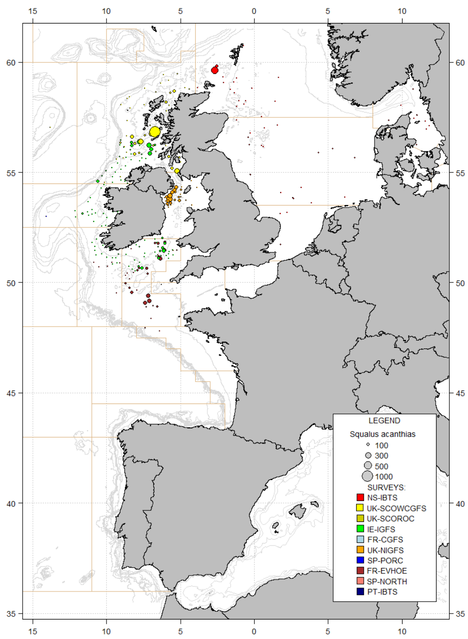

Figure A7.32. Catches in numbers per hour of spurdog *Squalus acanthias* in summer/autumn 2020 IBTSurveys.

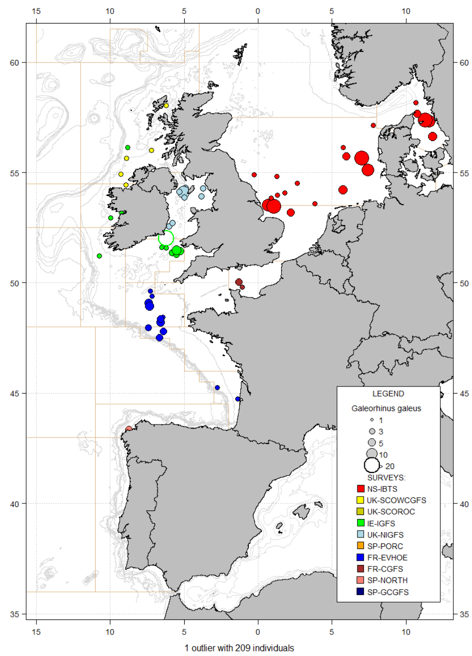

Figure A7.33. Catches in numbers per hour of tope *Galeorhinus galeus* in summer/autumn 2020 IBTSurveys.

The catchability of the different gears used in the NEA surveys is not constant. Therefore, the following maps do not reflect proportional abundance across the areas, but within each survey

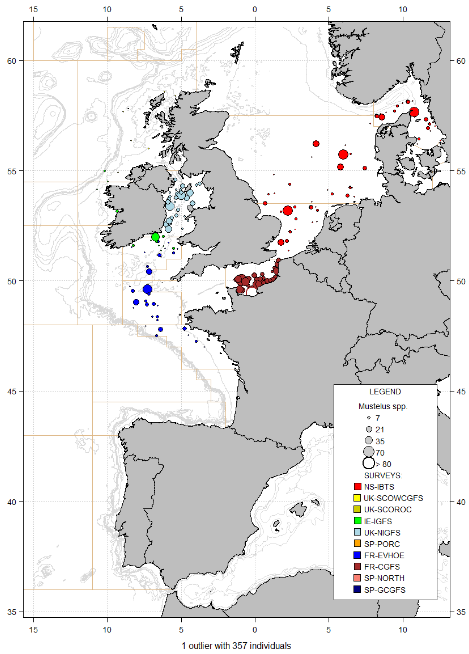

Figure A7.34. Catches in numbers per hour of smooth-hound *Mustelus* spp. in summer/autumn 2021 IBTSurveys.

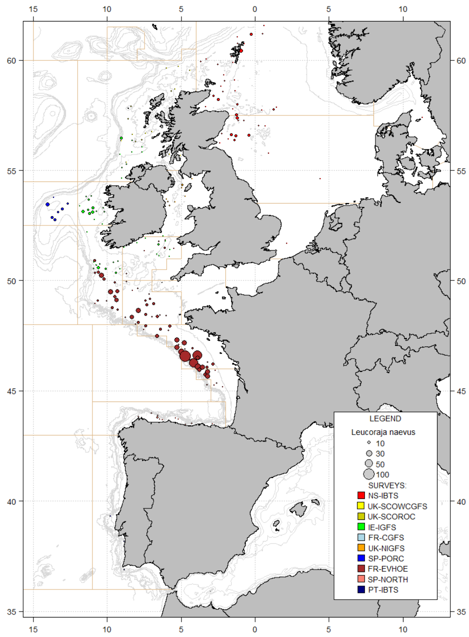

Figure A7.35. Catches in numbers per hour of cuckoo ray *Leucoraja naevus* in summer/autumn 2021 IBTSurveys.

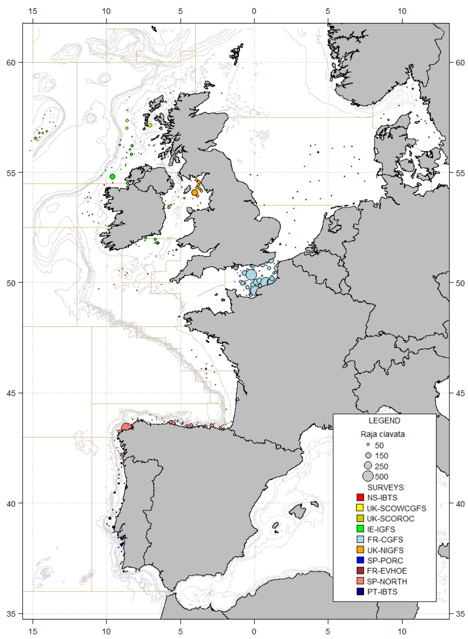

Figure A7.36. Catches in numbers per hour per hour of thornback ray *Raja clavata* in summer/autumn 2021 IBTSurveys.

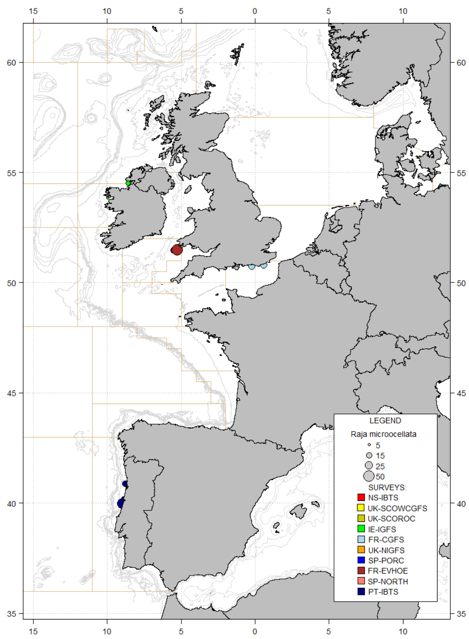

Figure A7.37. Catches in numbers per hour per hour of small-eyed ray *Raja microocellata* in summer/autumn 2021 IBTSurveys.

The catchability of the different gears used in the NEA surveys is not constant. Therefore, the following maps do not reflect proportional abundance across the areas, but within each survey

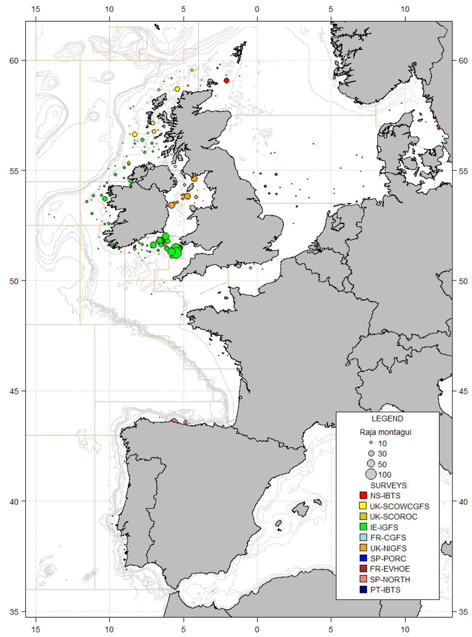

Figure A7.38. Catches in numbers per hour per hour of spotted ray *Raja montagui* in summer/autumn 2021 IBTSurveys.

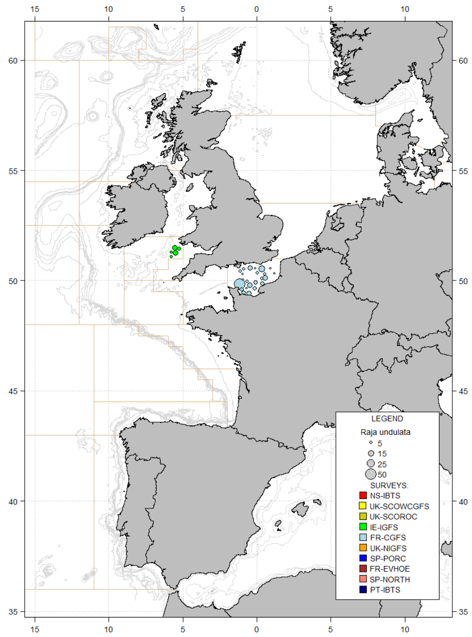

Figure A7.39. Catches in numbers per hour per hour of undulate ray *Raja undulata* in summer/autumn 2021 IBTSurveys.

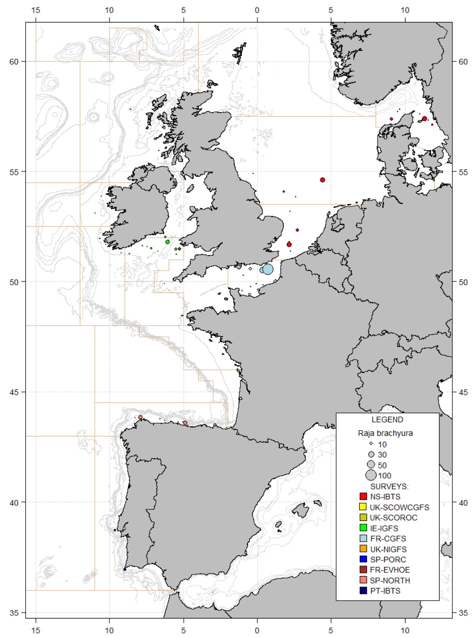

Figure A7.40. Catches in numbers per hour per hour of blonde ray *Raja brachyura* in summer/autumn 2021 IBTSurveys.

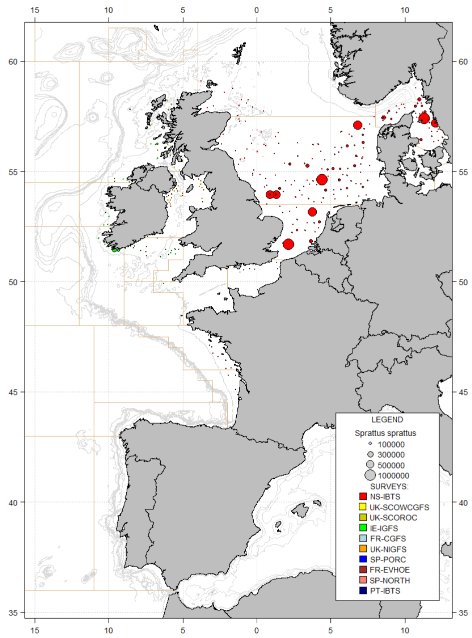

Figure A7.41. Catches in numbers per hour per hour of European sprat Sprattus sprattus in summer/autumn 2021 IBTSurveys.

The catchability of the different gears used in the NEA surveys is not constant. Therefore, the following maps do not reflect proportional abundance across the areas, but within each survey

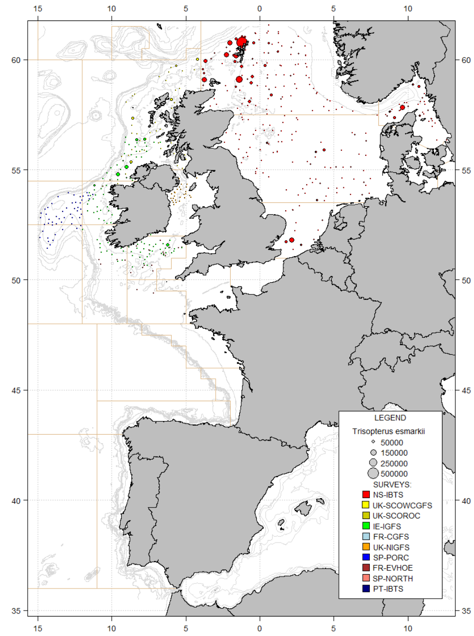

Figure A7.42. Catches in numbers per hour per hour of Norway pout *Trisopterus esmarkii* in summer/autumn 2021 IBTSurveys.

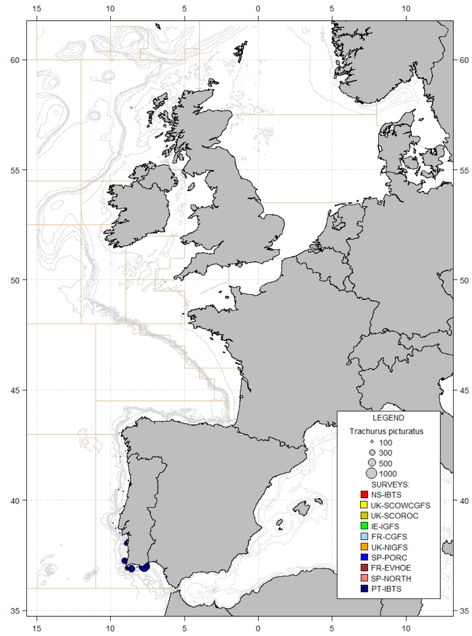

Figure A7.43. Catches in numbers per hour per hour of blue jack mackerel *Trachurus picturatus* in summer/autumn 2021 IBTSurveys.

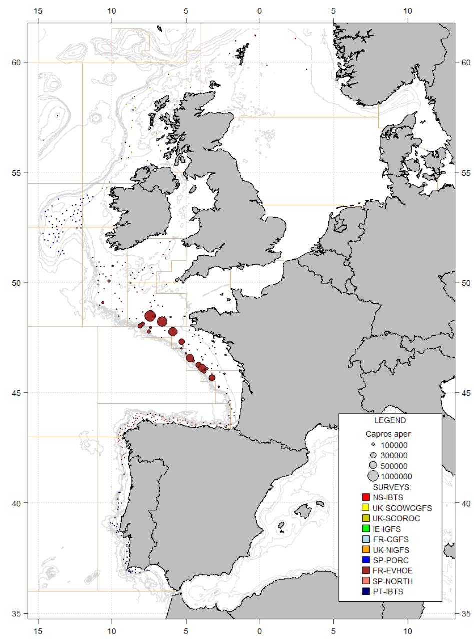

Figure A7.44. Catches in numbers per hour per hour of boarfish *Capros aper* in summer/autumn 2021 IBTSurveys.

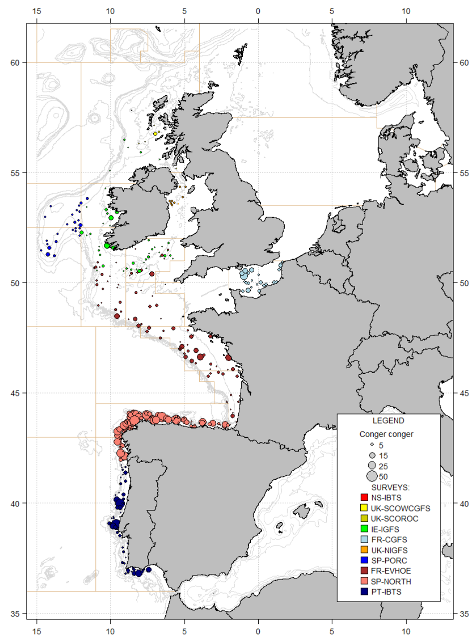

Figure A7.45. Catches in numbers per hour per hour of conger eel *Conger conger* in summer/autumn 2021 IBTSurveys.

The catchability of the different gears used in the NEA surveys is not constant. Therefore, the following maps do not reflect proportional abundance across the areas, but within each survey

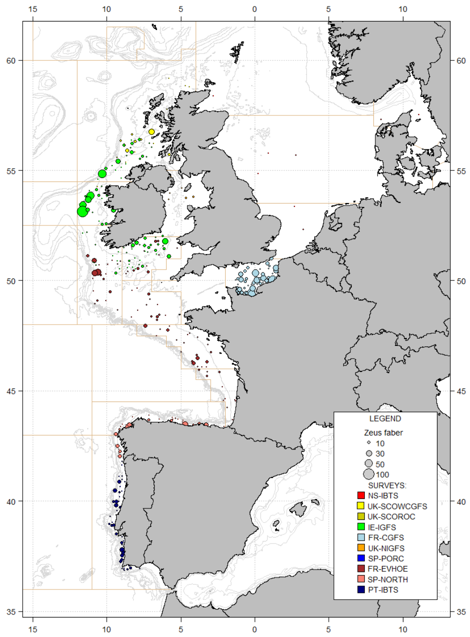

Figure A7.46. Catches in numbers per hour per hour of John dory *Zeus faber* in summer/autumn 2021 IBTSurveys.

Annex 8: Working Document on "Systematic error in the DATRAS-variables CatchWgt and CatCatchWgt"

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Summary

Data exploration of NS-IBTS exchange data, downloaded in February 2022 from the ICES data portal DATRAS, revealed a systematic error in the variables *CatchWgt* and *CatCatchWgt.* These variables indicate the catch weight per species and haul (and, in case of *CatCatchWgt*, also per size category). When plotting the *CatchWgt* reported for German hauls in DATRAS against the original data from the German national database (GND), DATRAS-reported values were 1/100 of those reported in the German national database for all years prior to 2004, the year in which the reporting format in DATRAS was changed. Subsequent visual inspection of *CatchWgt* reported in DATRAS for the other IBTS nations indicated that such deviances were a widespread phenomenon, with data being markedly lower before than after a certain point in time of the IBTS time-series. The years in which *CatchWgt* altered from conspicuously low to realistic magnitudes, however, varied per country. Additional observation of the data table confirmed unrealistically low weight data being reported in certain years of the 1990's and early 2000's. A possible explanation for the observed deviations might be ambiguity in the unit in which catch weight data were requested until 2003 and/or conversion errors in DATRAS with the establishment of the exchange data format.

Data and Data Exploration

The variable *CatchWgt* can directly be extracted from DATRAS into the software R (R Core Team, 2021), using the function *getCatchWgt()* from the package icesDATRAS (Millar, Large & Magnusson, 2019). For demonstration of the structural issue found in the data, a test dataset was downloaded with the following specifications:

> *getCatchWgt(survey =* ***"NS-IBTS"****, years =* ***1990:2007****, quarters =* ***3****, aphia =* ***aphia****)*

The species included in the object *aphia* are listed in Table 1.

Table 1.Species and corresponding Aphia IDs that were included in the test dataset.

Species	Aphia
Clupea harengus	126417
Microstomus kitt	127140
Gadus morhua	126436
Melanogrammus aeglefinus	126437
Arnoglossus laterna	127126

Biomass and abundance data in DATRAS are partly standardized to values/ hour of hauling, which is indicated by a "C" (short for "CPUE") in the variable *DataType* for the respective rows. To obtain the "raw" data, transformation of *CatchWgt* was performed in those rows:

$$CatchWgt_{raw} = (CatchWgt_{CPUE} * HaulDur) / 60\ min$$

where *HaulDur* is the measured haul duration. Since the weight data in the GND are reported in kg, *CatchWgt*, which is usually reported in grams, was converted into kilograms, using the formula:

$$CatchWgt_{kg} = CatchWgt_{raw}/1000$$

Finally, the *CatchWgt* dataset was filtered for German hauls and plotted with year on the x-axis and biomass in kilograms on the y-axis (biomass is $CatchWgt_{kg}$ *per species and haul*), along with the weight data per species and haul as reported in the German national database (Figure 1).

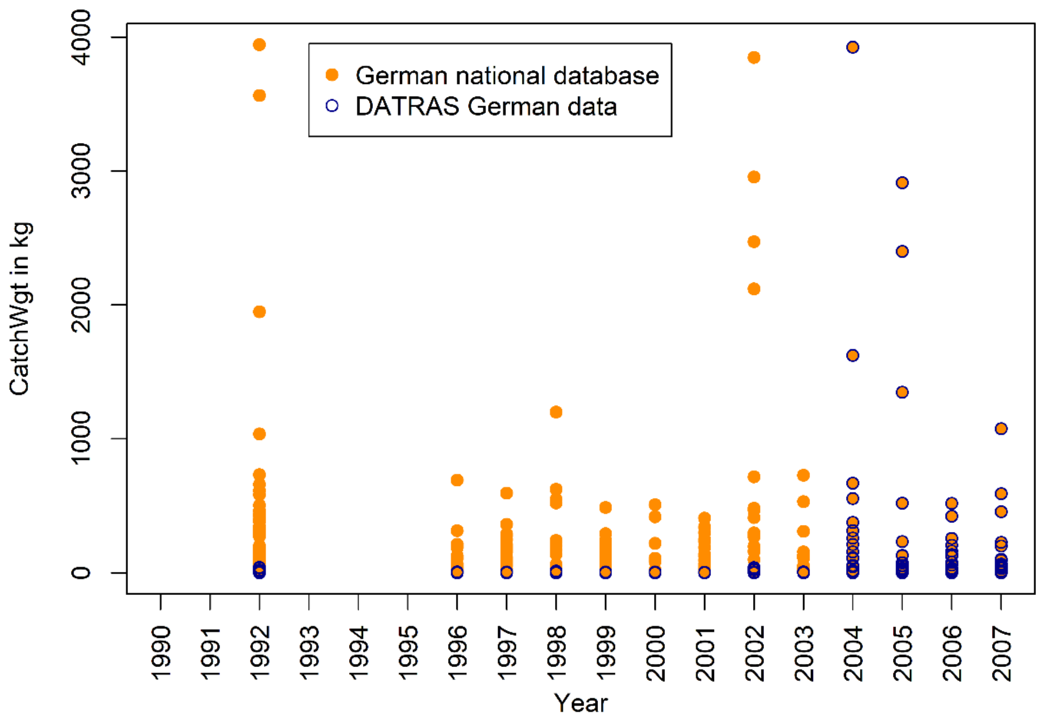

Figure 1. Plot of the variable CatchWgt as reported for German hauls in DATRAS (blue circles) and, for means of comparison, the original weight data in the German database (orange points), for a test dataset including five species in summer NS-IBTS surveys between 1990 and 2007. Catch weights of > 2000 kg per haul were only found for herring (Clupea harengus).

Visual inspection indicated a strong divergence between the two datasets prior to 2004. The DATRAS *CatchWgt*-data were all clustered close to zero for the years 1992 and 1996–2003, while weight data in the GND were spread between values of close to zero and 4000 kg. From 2004 onwards, the weight data in the two datasets were identical.

To find out whether only German hauls were concerned, e.g. due to systematic reporting errors prior to 2004, or whether a structural issue was at hand, the DATRAS data from the test dataset were subsequently plotted for each NS-IBTS reporting nation individually, albeit without the option to compare to the respective national database (Figure 2). Comparing these plots, it became evident that hauls of all nations were affected by this issue, however, the actual years for which erroneous data were reported prior to 2004 differed by country. English hauls were, as German hauls, affected in all years prior to 2004, while Norwegian hauls were affected prior to 2003, Danish hauls prior to 2000 and Swedish hauls prior to 1999, as far as can be interpreted from the plots. For Scottish hauls, weight data for the years 1992, 1994, and since 1997 were reported on DATRAS in a realistic order of magnitude, however this was not the case in the years 1991, 1993, 1995 and 1996. The Netherlands and France do not participate in summer (Q3) IBTS surveys currently, and are hence not represented by separate panels in Figure 2. They did, however, report values for Q3 during the years 1991–1997, and these available *CatchWgt*-data in the test dataset were likewise affected.

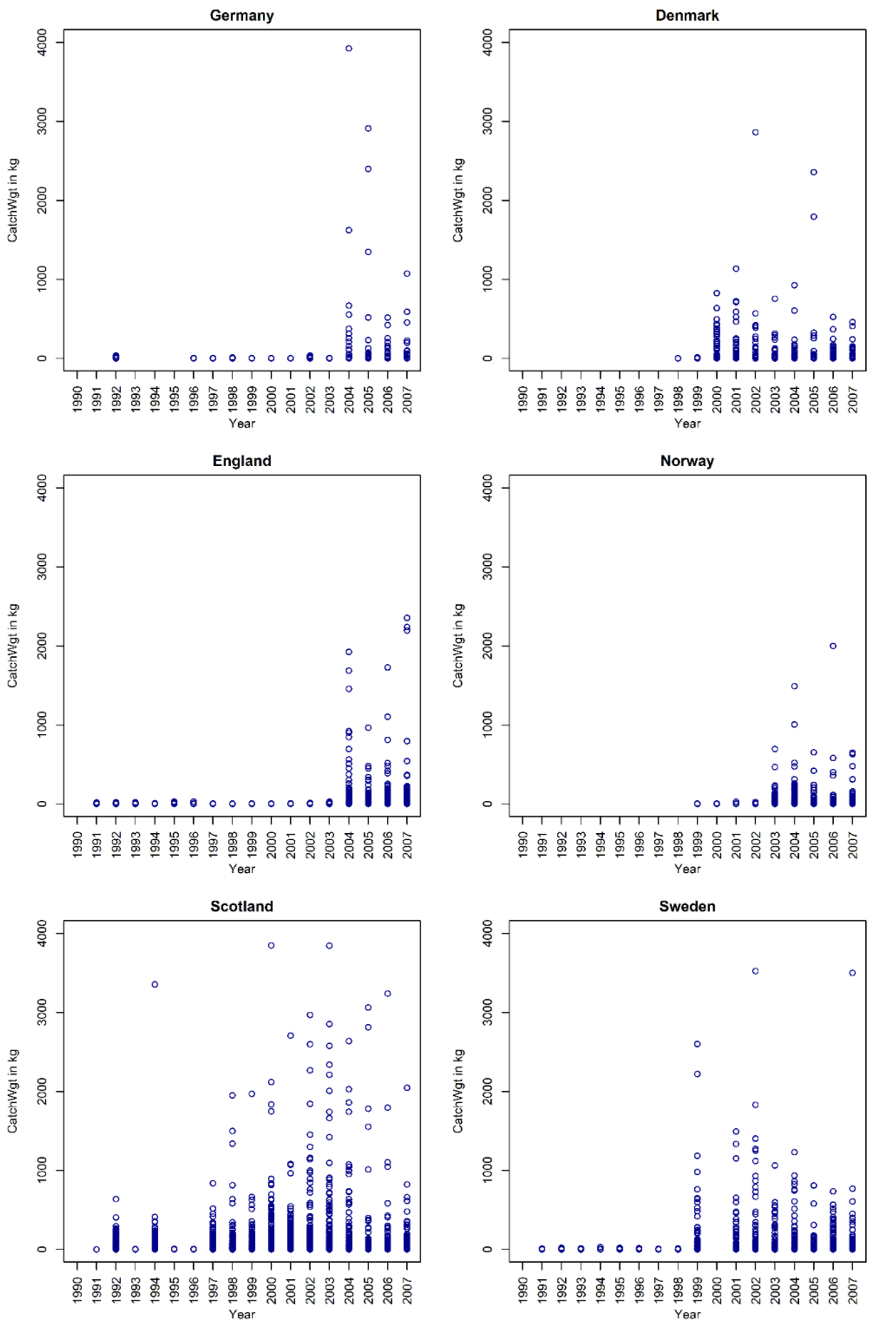

Figure 2. CatchWgt data of the NS-IBTS nations, obtained from DATRAS for summer IBTS surveys in the period 1990 to 2007 for a subset of five species. Catch weights of > 2000 kg per haul were only found for herring (Clupea harengus).

Data downloaded with the function *getCatchWgt* provide no information on the number and size of individuals for which *CatchWgt* was reported. To gain more insight into the abundance and size structure, the HL-table in exchange format was additionally downloaded from ICES DATRAS Data Portal (accessed on 1 February 2022), using the specifications:

Data products:	Exchange Data → HL
Survey:	NS-IBTS
Quarters:	3
Years:	1990–2007
Ships:	All

The downloaded data were filtered further to only include the species specified in Table 1. Since weight and abundance data (variables *CatCatchWgt* and *TotalNo*, respectively) were provided not only per species and haul but within these also per size category, the total number of individuals (*TotalNo_allCat*) and total weight (*CatchWgt*) per species and haul (but not size category) were calculated and added as columns to the table for comparison. Furthermore, weight was converted into kilograms and added to the data table as variable *CatchWgt_kg*.

Visual inspection of the data table revealed that the *CatchWgt_kg* was suspiciously low in the years for which the plots indicated data deficiencies. For illustration purposes, two exemplary excerpts from the data table are depicted in Figure 3 (the downloaded dataset and the R-code can be shared upon request for closer inspection). In the first example, the total number of cods caught in this particular haul was 258, with length classes ranging from 21 to 56 cm. The associated catch weight according to the data table was 760 grams. In the second example, 30 lemon soles with a length between 16 and 33 cm had a combined weight of 49 grams, according to the data table. For Dutch hauls, all *CatCatchWgt*, and thus also *CatchWgt*, were indicated as missing (-9).

Discussion – Potential Cause of Error

A systematic error in the magnitude of the variable *CatchWgt* has been identified, concerning the data of all member states to the North Sea IBTS. Reporting of the issue to the ICES Data Centre revealed that this error has already been known for several years, which was confirmed by a corresponding entry in the Table 3 "DATRAS News and updates", dated 15 February 2016, accessed on 4 March 2022). In this entry, the ICES Data Centre announced in the description that it would collect additional data in order to get behind the issue and fix it. Given that no such correction has been performed until today, it must be assumed that the cause of the error has not yet been identified. Closer investigation of historical IBTS documents, however, has brought forward a potential explanation.

In Addendum II of Revision VI of the Manual for the International Bottom Trawl Surveys (IBTS) from 1999 (IBTSWG, 1999), an overview of the then used data uploading format was given, including the units in which the variables ought to be reported. Catch weight at that time was reported as variable *Catch weight/hour*, and the accompanying comment requested these data to be "in 100g". This expression leaves room for misinterpretation, as it can be understood either as "rounding the data to the nearest 100g" or "reporting using 100g as the unit". It is assumed that these misinterpretations are at the root of both the structural deviances in weight data and the temporal variation in the occurrence of deviances between countries.

Table 3. Excerpts of the test data table downloaded in exchange file format with the specifications stated in the text. The light blue boxes highlight abundance variables, the dark blue boxes highlight catch weight variables, orange boxes highlight length classes.

	Country	Ship	Year	Quarter	StNo	HaulNo	ValidAphiaID	ScientificName_WoRMS	CatIdentifier	TotalNo	TotalNo_allCat	CatCatchWgt	CatchWgt	CatchWgt_kg	LngtClass	LngtCode	HLNoAtLngt
6	DE	06W2	1992	3	000664	1	126436	Gadus morhua	1	258	258	760	760	0.760	30	1	22
7	DE	06W2	1992	3	000664	1	126436	Gadus morhua	1	258	258	760	760	0.760	35	1	12
8	DE	06W2	1992	3	000664	1	126436	Gadus morhua	1	258	258	760	760	0.760	40	1	6
9	DE	06W2	1992	3	000664	1	126436	Gadus morhua	1	258	258	760	760	0.760	28	1	24
10	DE	06W2	1992	3	000664	1	126436	Gadus morhua	1	258	258	760	760	0.760	21	1	6
11	DE	06W2	1992	3	000664	1	126436	Gadus morhua	1	258	258	760	760	0.760	23	1	2
12	DE	06W2	1992	3	000664	1	126436	Gadus morhua	1	258	258	760	760	0.760	33	1	18
13	DE	06W2	1992	3	000664	1	126436	Gadus morhua	1	258	258	760	760	0.760	26	1	18
14	DE	06W2	1992	3	000664	1	126436	Gadus morhua	1	258	258	760	760	0.760	56	1	2
44136	GB	74CZ	1997	3	72	22	127140	Microstomus kitt	1	30	30	49	49	0.049	21	1	2
44137	GB	74CZ	1997	3	72	22	127140	Microstomus kitt	1	30	30	49	49	0.049	28	1	4
44138	GB	74CZ	1997	3	72	22	127140	Microstomus kitt	1	30	30	49	49	0.049	33	1	2
44139	GB	74CZ	1997	3	72	22	127140	Microstomus kitt	1	30	30	49	49	0.049	22	1	4
44140	GB	74CZ	1997	3	72	22	127140	Microstomus kitt	1	30	30	49	49	0.049	16	1	2
44141	GB	74CZ	1997	3	72	22	127140	Microstomus kitt	1	30	30	49	49	0.049	27	1	2
44142	GB	74CZ	1997	3	72	22	127140	Microstomus kitt	1	30	30	49	49	0.049	23	1	2
44143	GB	74CZ	1997	3	72	22	127140	Microstomus kitt	1	30	30	49	49	0.049	26	1	6
44144	GB	74CZ	1997	3	72	22	127140	Microstomus kitt	1	30	30	49	49	0.049	20	1	4
44145	GB	74CZ	1997	3	72	22	127140	Microstomus kitt	1	30	30	49	49	0.049	19	1	2
133879	NL	64T2	1991	3	25	25	126437	Melanogrammus aeglefinus	1	5820	5820	-9	-9	-0.009	37	1	8
133880	NL	64T2	1991	3	25	25	126437	Melanogrammus aeglefinus	1	5820	5820	-9	-9	-0.009	26	1	168
133881	NL	64T2	1991	3	25	25	126437	Melanogrammus aeglefinus	1	5820	5820	-9	-9	-0.009	28	1	72
133882	NL	64T2	1991	3	25	25	126437	Melanogrammus aeglefinus	1	5820	5820	-9	-9	-0.009	39	1	4
133883	NL	64T2	1991	3	25	25	126437	Melanogrammus aeglefinus	1	5820	5820	-9	-9	-0.009	30	1	24
133884	NL	64T2	1991	3	25	25	126437	Melanogrammus aeglefinus	1	5820	5820	-9	-9	-0.009	35	1	8
133885	NL	64T2	1991	3	25	25	126437	Melanogrammus aeglefinus	1	5820	5820	-9	-9	-0.009	11	1	320
133886	NL	64T2	1991	3	25	25	126437	Melanogrammus aeglefinus	1	5820	5820	-9	-9	-0.009	22	1	120
133887	NL	64T2	1991	3	25	25	126437	Melanogrammus aeglefinus	1	5820	5820	-9	-9	-0.009	10	1	1120

Given the absence of similar errors after 2003, the year in which much of the current structure of DATRAS was set up (IBTSWG, 2003), conversion errors from the old to the new reporting format within DATRAS (*Catch weight/hour* to *CatchWgt* or *CatCatchWgt*) might be the reason for the structural error. On the other hand, the establishment of the exchange format in 2003, including the variable *CatCatchWgt* with an unambiguous reporting unit, might have simply rendered the risk of misinterpretation of reporting units obsolete in the years going forward, while old errors remained uncorrected. Correction of these errors will therefore require the ICES Data Centre to revisit its algorithms used for the setup of the DATRAS exchange format in 2003, and for national data submitters to reconsider the data prior to 2003 (or, more specifically, the years for which suspiciously low *CatchWgt* and *CatCatchWgt* values are reported from their respective nations).

Acknowledgements

I wish to thank Ingo Wilhelms from the Thünen Institute of Sea Fisheries for his collaboration in investigating the potential cause of the data error. He found the document "Manual for the International Bottom Trawl Surveys. Revision VI. ICES CM 1999/D:2, Addendum 2" and provided it to me. Furthermore, I want to thank Anne Sell for her comments on the first draft. This work was conducted within the project BioWeb, funded through the Federal Ministry of Education and Research (BMBF) / (PTJ) within the framework of KüNO (funding reference: 03F0861B).

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Annex 9: Working Document on "Identification of *Mustelus spp.* in the North Sea using morphology and genetics"

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Abstract

Visual distinction between *Mustelus asterias* (starry smoothhound) and *Mustelus mustelus* (common smoothhound) is difficult due to ambiguous morphological traits, concerning specifically the possible absence of white spots and the position of fins. We therefore tested other morphometric measurements (internarial space and nostril width) and compared the results with genetic analyses. In all investigated 15 *Mustelus* spp. from the southern North Sea, morphometrics measurements revealed dimension, which are typical of *M. asterias*, although eight of the specimens were initially identified as *M. mustelus,* based on the positions of their fins. Subsequent DNA barcoding confirmed that all 15 individuals were M. *asterias*. The results concord with previous genetic studies that also failed to find *M. mustelus* in the northern North-eastern Atlantic.

Background

During the IBTS surveys, some nations have been recording both species, *M. asterias* and *M. mustelus*, while others exclusively report *M. asterias*, or rely on aggregation to the genus level and only report *Mustelus* sp. This inconsistency may result (a) from different identification criteria applied, or (b) from different levels of expertise and (c) lacking awareness of earlier publications, which state the only *M. asterias* is to be found in the North Sea. However, under ongoing climatic changes and associated range shifts, it cannot be fully excluded that also species which have typically occurred further south only, would shift their distribution ranges northward within the North Atlantic. Therefore, the presumption would not appear justified that all future catches of *Mustelus* individuals in the North Sea will need to be assigned to *M. asterias*, only.

Visual identification of elasmobranch species can be fraught with difficulties. In particular, juveniles of many shark and ray species may resemble each other. This is also the case for two species of *Mustelus* found in the North-eastern Atlantic: *M. asterias* (starry smoothhound) and *M. mustelus* (common smoothhound). In addition, juvenile tope (*Galeorhinus galeus*) can also be confused as a smoothound species. The absence of white spots of *M. mustelus* is sometimes used as a diagnostic trait, together with other also potentially ambiguous morphological traits (e.g. relative position of fins). However, it has been shown that the spots may be highly variable, faint or even absent in individuals of *M. asterias,* making their absence an unsuitable criterion for the distinction between both species (Farrell et al. 2009). Consequently, while the presence of white spots helps to identify *M. asterias*, their absence is not a reliable criterion for *M. mustelus*. Therefore, other morphological and morphometric features have been proposed for the distinction between both species (Ellis and Brown; unpubl.; Branstetter, 1984). While it has been shown that DNA-based methods can be used to assign unambiguous species status for the three species (Farrell et al. 2009), a fast and easy method is needed for the identification on board. Therefore, we here set out to explore a combination of specific morphometric measurement with a genetic confirmation through a DNA barcoding approach to evaluate species status of 15 sharks caught in the southern North Sea during the 3rd quarter IBTS with R/V Dana in September 2021, of which 7 and 8 individuals were initially identified as *M. asterias* and *M. mustelus* respectively, using visual identification.

Material and methods

Tissue samples of visually identified mustelid sharks were collected on the 3rd quarter IBTS with R/V Dana between 4th and 9th September 2021. Basic information on the sampled individuals are listed in Table 1 and the catch locations are shown in Figure 1.

The preliminary visual identification of the two *Mustelus* species was done based on the position of pectoral and the first dorsal fin, i.e. posterior margin of pectoral fin under middle of first dorsal fin for *M. asterias* and posterior margin of pectoral fin before or under origin of first dorsal fin for *M. mustelus* (Quéro et al., 2003; Ellis and Brown, unpubl.).

Lateral view photographs were taken for documenting the length of the individuals, the position of the fins and presence/absence of white spots. Additionally, ventral view photographs of the head should allow describing other morphological characteristics such as the shape of the teeth, mainly to ensure that confusion with tope is excluded, and to allow measuring internarial distance and nostril width (Figure 2; FAO 1984; Ebert et al., 2021) after the survey. The two types of simple photographs were taken aboard during the measurements of the live individuals, and dimensions measured afterwards through an open source image analysis software (ImageJ).

Table 1. Basic information on *Mustelus* spp. samples selected during the 3rd quarter IBTS with R/V Dana for later analysis onshore.

Shark ID	Station number	Sex	Length (cm)	Weight (kg)	Visual designation onboard
Haj 1	184	Male	91	2.480	*M. asterias*
Haj 2	184	Female	98	3.740	*M. asterias*
Haj 3	184	Female	81	1.620	*M. asterias*
Haj 4	184	Female	113	5.560	*M. asterias*
Haj 5	184	Female	102	4.340	*M. asterias*
Haj 6	193	Female	80	1.780	*M. mustelus*
Haj 7	203	Male	105		*M. mustelus*
Haj 8	224	Male	64	0.926	*M. mustelus*
Haj 9	224	Female	68	1.112	*M. mustelus*
Haj 10	224	Female	63	0.848	*M. mustelus*
Haj 11	224	Female	67	1.026	*M. mustelus*
Haj 12	224	Male	68	1.044	*M. mustelus*
Haj 13	224	Female	56	0.570	*M. asterias*
Haj 14	224	Female	61	0.812	*M. asterias*
Haj 15	239	Male	94	2.600	*M. mustelus*

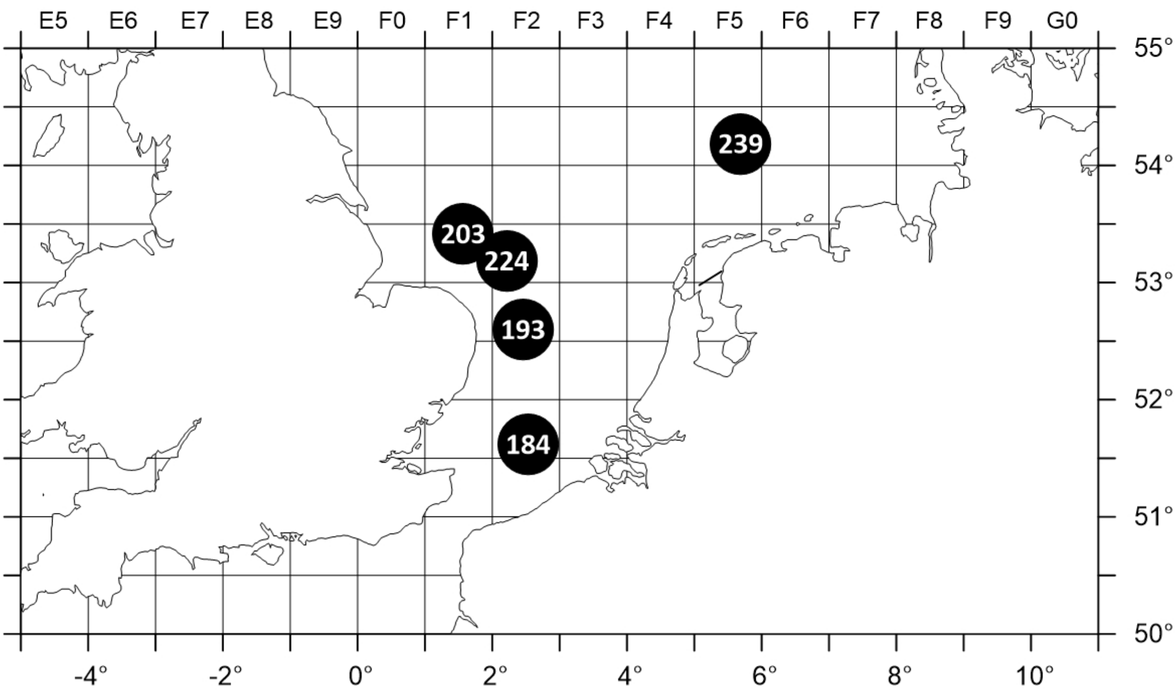

Figure 1. Sampling locations for the 15 *Mustelus* spp. during the 3rd quarter IBTS with R/V Dana in September 2021. Symbol labels denote station numbers as given in Table 1.

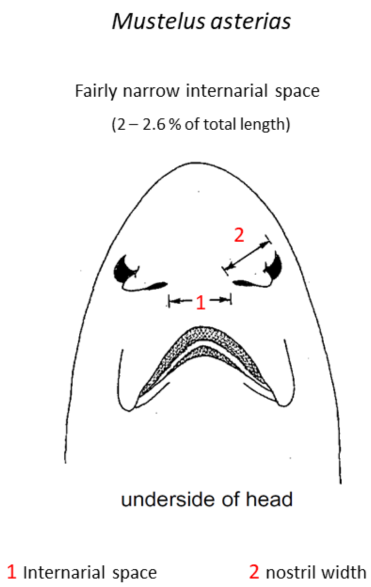

Figure 2. Image with indication of internarial distance and the nostril width for *M. asterias* and *M. mustelus* (Compagno, 1984).

Internarial distance in relation to total length were not used because the photographs were taken on different scale. Instead, the ratio of internarial distance and nostril width was examined (Branstetter, 1984; Marino et al., 2018).

DNA barcoding

Tissue samples were taken onboard of R/V Dana from visually identified specimens and frozen individually in plastic tubes filled with ethanol. DNA was extracted from all tissue samples using the Chelex Resin method (Walsh et al. 1991). For DNA barcoding, a 655 base pair region of the mitochondrial cytochrome oxidase subunit I gene (COI) was amplified using the primers (F1 and R2) described in Ward et al. (2005). PRC products were Sanger sequenced using the F1 primer on a SeqStudio Genetic Analyzer (Applied Biosystems). Sequences were trimmed to 337 base pair using the Geneious Prime software (Geneious Prime 2022.0.1 https://www.geneious.com). Matching COI sequences of *M. asterias* (13), *M. mustelus* (14) and *Galeorhinus galeus* (14) were downloaded from the NCBI (National Center for Biotechnology Information, USA) sequence database (https://www.ncbi.nlm.nih.gov/). Subsequently, the known species sequences (NCBI database) and the (unknown) species sequences from this analysis, were aligned in MAFFT (Katoh and Standley 2013), implemented in Geneious Prime. Phylogenetic reconstruction was performed with the software MEGA7 (Kumar et al. 2016) to produce a “Neighbor-Joining” tree (including 100 bootstraps) based on the number of base pair differences among individual specimen barcode sequences.

Results

Morphological and morphometric characteristics

Examples for the preliminary visual designations to species of the smoothhounds are shown in Figures 3 and 4. Shark #5 represents a typical *M. asterias* with the white spots well present whereas #15 is missing the white spots but the posterior margin of pectoral fin is under the origin of first dorsal fin.

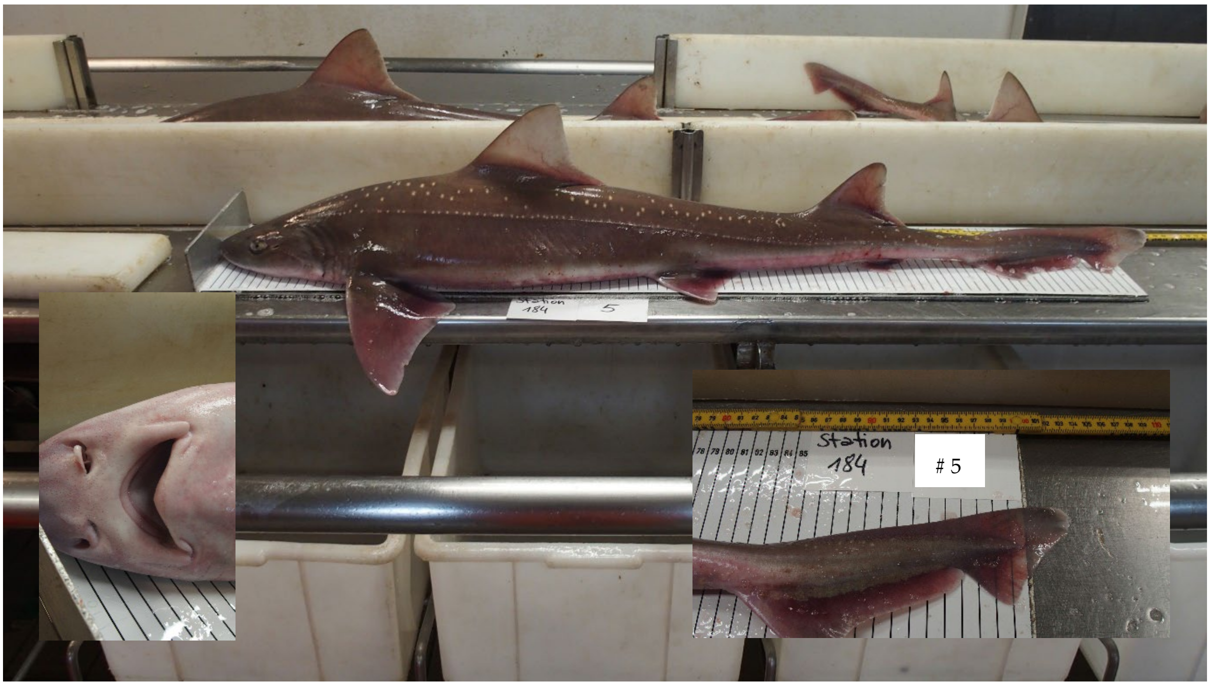

Figure 3. Examples for visually designated *M. asterias* (#: ID as in given in Table 1, all photos were taken by Anne Sell).

In contrast, for shark #6 the posterior margin of pectoral fin is located almost before the origin of first dorsal fin (Figure 4), and the specimen was thus preliminary classified as *M. mustelus*. This assignment, however, was not confirmed neither by morphometric characters nor by the genetical analysis later.

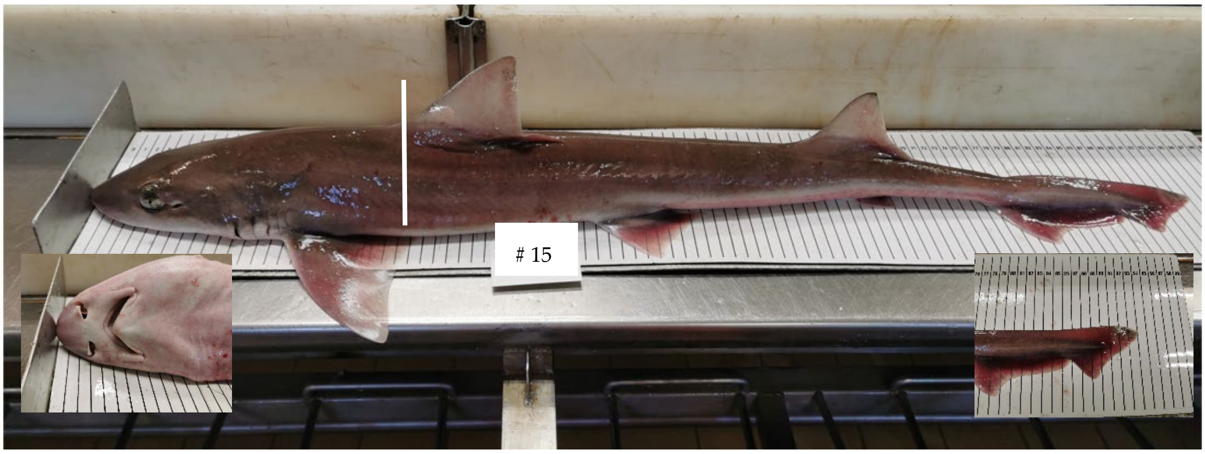

Figure 4. Examples for visually designated *M. mustelus* (#: ID as in given in Table 1, all photos were taken by Anne Sell).

The ratio of the internarial distance [1] to the individual nostril's width [2] was measured for twelve individuals (haj #4 to haj #15), and result in a mean ratio of [1]-to-[2] of 1.21 (Table 2). This value agrees with Branstetter (1984), according to whom the ration should amount 1.2 to 1.3 for *M. asterias*, representing a rather narrow internarial distance, compared to a ratio of > 1.4 (Branstetter, 1984) or ≥ 1.5 (Marino et al., 2018), which would be expected for *M. mustelus*.

Table 2. Morphometric measurements on laboratory photographs of *Mustelus* individuals.

Shark ID	Station number	Internarial space [1] [units on photo]	Nostril width [2] [units on photo]	Ratio [1-to-2] [units on photo]
Haj 4	184	676	574	1.18
Haj 5	184	524	450	1.16
Haj 6	193	530	419	1.26
Haj 7	203	704	644	1.09
Haj 8	224	481	371	1.30
Haj 9	224	498	470	1.06
Haj 10	224	448	378	1.19
Haj 11	224	672	604	1.11
Haj 12	224	485	374	1.30
Haj 13	224	437	329	1.33
Haj 14	224	539	420	1.28
Haj 15	239	403	319	1.26
	Min:	403	319	1.06
	Max:	704	644	1.33
	Mean:	533	446	1.21

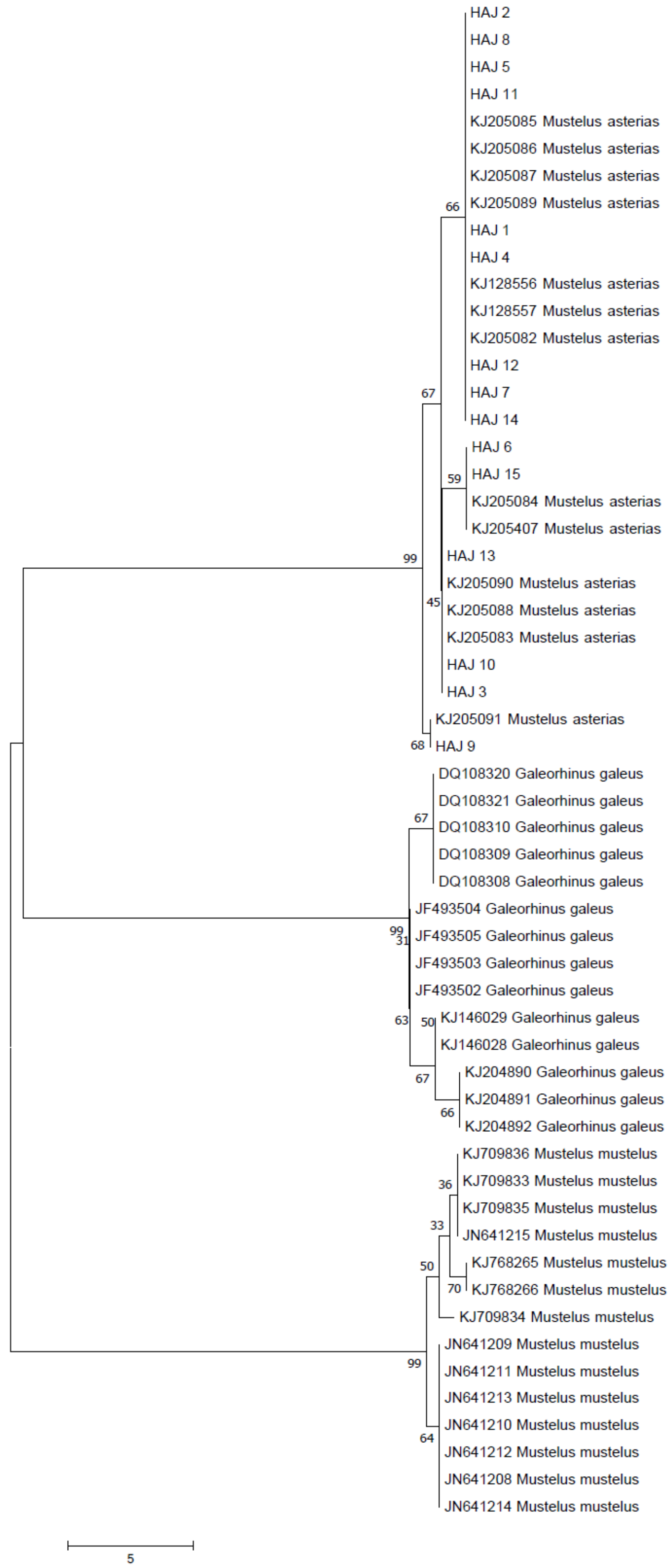

Figure 5. Neighbor-Joining tree of known *M. asterias, M. mustelus* and *G. galeus* barcoding sequences and sequences from the "unknown" individuals from this study (Haj 1–Haj 15). Letter/number code represents the sequence reference in the NCBI database. The bar (5) is a scale for the number of base pair differences between sequences. Numbers on branches represent the bootstrap support for that particular branch in the tree.

Genetics

All samples of *Mustelus* spp. collected were successfully extracted, sequenced and provided barcoding sequences of sufficient length (337 bp) for unequivocal species identification. The neighbor-joining tree (Figure 5), showed that all sequences downloaded from NCBI (National Center for Biotechnology Information) sequence database grouped in three well-defined clusters with high sequence divergence and high bootstrap support (99%) according to the species label. This indicates that the NCBI sequences were representative of the three species. All the 15 *Mustelus* samples from the southern North Sea collected during the survey with R/V Dana in September 2021 (Haj 1–Haj 15) clustered with the *M. asterias* sequences from NCBI, thus strongly suggesting that all individuals sampled in our study are *M. asterias*. Furthermore, there were no indications of a closer genetic affiliation between the individuals visually identified as *M. mustelus* (Haj 6 - Haj 12, Haj 15) as they were found in all three branches of the *M. asterias* cluster.

Discussion

Based on the DNA barcoding analysis outlined above, there is unambiguous evidence that all 15 samples of *Mustelus spp.* are *M. asterias*. This finding is in line with previous genetic analysis by Farrell et al. (2009), who used a simple species-specific mtDNA analysis, to assess the species status of 431 *Mustelus* spp. sampled from the Irish Sea, the Celtic Sea, the Bristol Channel and the North Sea. Of these 43 were designated visually, by survey scientists based on external characters, as *M. mustelus* and the remaining 388 as *M. asterias*. Like here, they were all genetically identified as *M. asterias*.

Our results correspond to those of Farrell et al. (2009), who suggested that *M. mustelus* may be rare or even completely missing in the North Sea. Thus, the historically described species distribution (e.g. Branstetter, 1984) based on morphological, morphometric and meristic characteristics may be confounded because these partially overlap between the two species and considerable variation occurs within the species. This is leading to the perception, that *M. mustelus* is a more southern species, with no verified records north of Portugal (Carl and Møller, 2019) and does neither occur in the North Sea nor in the Celtic Sea (Farrell et al., 2015).

Morphometric analyses, which we performed on simple photographs taken during the handling and measurement of the animals aboard, confirmed that the obtained ratio for the dimensions nostril width and internarial space (inter-nostril distance) were in the range, which is typical of *M. asterias*, but not of *M. mustelus*. We therefore propose that whenever possible during even a short handling time of life individuals, such photographs should be taken to verify the species identification afterwards.

If requested for fisheries management and biodiversity assessments, a more large-scale combined genetic and morphometric survey of *Mustelus* spp. across the whole North-eastern Atlantic could shed light on the present species boundaries and areas of mixing.

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Annex 10: Working Document on “Effect of trawl speed on catchability”

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Introduction

The ICES workshop on the Further Development of the New IBTS Gear (WKFDNG) discussed and worked on the development of the new survey gear for the North Sea IBTS and how to implement this gear. One of the discussions in the workshop focused on the affect of fishing speed on the catches. This discussion arose as one of the two proposed new gears being designed to fish at a lower speed than the current survey speed of ~4 knots. A second part of this discussion was directed at which speed and, related to that, distance should be used, speed over ground (SOG) or speed through water (STW; (ICES, 2022), chapter 4.3).

The discussion resulted in many relevant arguments, but concluded that there was limited evidence direct available to support the various arguments. Therefore, it was proposed to do a literature review on the effect of speed on the catchability. This review is presented here.

The searching for literature on the affect of speed on catchability resulted in a small number of studies (Table 1) that provide direct relations between trawl speed and the abundance (at length) of fish caught. This were experiments directed at the effect of speed or inference based on survey data executed at different speeds (Adlerstein and Ehrich, 2002, Manjarrés-Martínez *et al.*, 2015). Next to these studies, various field experiments with variable trawl speeds were found, focusing on gear performance rather than on catchability directly. The affect on gear performance is then used to hypothesize on catch efficiency. These hypotheses are based upon studies on the behaviour of fish in a trawl path and on studies on swimming speed and endurance of fish. These types of studies are also included in separate sections of this review.

As studies on the affect of trawl speed on catchability are limited, we present all the studies we could find. However, these studies are from different areas with different species compositions and also use different gears under different protocols. This makes it difficult to translate results from those studies directly to the situation of the IBTS.

Overview of studies

Studies on direct affect of speed on catchability

A study on speed having a direct relation with the current IBTS, is done with the GOV as an addition to the German IBTS on the Walther Herwig III in offshore waters off the Scottish coast (Adlerstein and Ehrich, 2002). They fished according to the IBTS protocol 30 minutes with a speed of 4 knots, and afterwards calculated the achieved SOG on the GPS coordinates and corrected STW using the measured currents. The SOG of the 27 hauls, despite targeted at 4 knots, varied between 3.7 and 5.2 knots, while the STW varied between 3.5 and 5.3 knots. Analysing the catches of these hauls means it incorporates the direct effect of speed, the changes in gear performance, and the change in swept-area. The SOG provides the information of swept-area, while STW provides information on the volume of water. The results show that with a higher SOG, thus a larger swept-area, the catch rates of small haddock (*Melanogrammus aeglefinus*) and whiting (*Merlangius merlangus*), grey gurnard (*Eutrigla gurnardus*) and dab (*Limanda limanda*)increased. An increase of SOG from 4 to 5 knots resulted in a factor two increase in these species, indicating that there is more in play than only the increase in swept-area. At the same time catches of Norway pout, large withing and large haddock were not affected. Higher STW, thus fishing a large volume, resulted in larger catches of Norway pout (*Trisopterus esmarkii*), whiting and small haddock.

Another study in the North Sea off the Norwegian coast used a Minihopper, a smaller version of a Codhopper (see drawings in (Dahm *et al.*, 2002) to study the affect of towing speed on cod-end selectivity. A change in speed might affect the geometry of the cod-end and/or the ability of fish to escape. The cod-end used was made from 4 mm double PE netting with 100 mm nominal inside mesh opening, 5.5 m long and 120 meshes in circumference with five meshes from each panel taken into the selvedges to yield 100 open meshes. The cod-end was used on a research vessel (RV Solea) and a commercial trawler at the same time and grounds. Due to practical reasons the cover of the cod-end to study escapement differed between the two vessels. The SOG was 3.0±0.5 kn or 4.0±0.5 kn. The tow duration was determined based on the size of the catch (500-1000 kg). The species caught sufficiently in the 40 tows, 20 on each vessel, were cod (*Gadus morhua*) and haddock. However, it was not possible to draw any definitive conclusions regarding the effect of trawl speed on the selectivity of the cod-end. However, parts of the datasets gave some indication for a decrease of haddock selectivity with increasing speed and an increase in cod selectivity with increasing speed.

A study in the Bering Sea used AFSC poly Nor'eastern bottom trawls which were towed at 2.5, 3.0 and 3.5 knots speed through water (Weinberg *et al.*, 2002). They looked at the escapement under the footrope. They found that Pacific cod (*Gadus macrocephalus*), walleye pollock (*Theragra chalcogramma*) and Pacific halibut (*Hippoglossus stenolepis*) were not affected by trawl speed. Capture efficiency for skates *Bathyraja spp.* decreased with increasing trawl speed. Capture efficiencies for arrowtooth flounder (*Atheresthes stomias*) and flathead sole (*Hippoglossoides elassodon*) decreased with increasing trawl speed with different effects on different length classes. The results indicate an effect of species behaviour. Catchability of species living close to the bottom that respond to an approaching gear by diving down or digging themselves into the bottom, is likely to be affected most by a footrope that is less heavy or even comes off the bottom during the haul.

This affect of fish behaviour is also indicated by the analysis of Colombian survey data (Manjarrés-Martínez *et al.*, 2015). Over the years survey hauls were performed at a range of speeds (0.6–4.5 kn). The difference in speed was partially explained by year, by depth, region and weather conditions. Overall there was no effect of trawling speed found on the total catches (other than the effect of a difference in swept-area). Looking within regions a negative effect was shown of speed on the total catch. Which by the authors is assigned to the behaviour of the local fish community, having relatively many fish that tend to escape below the footrope.

Studies on gear performance

Most other studies involving speed experiments focused on the affect of speed on specific parts of the gear. The gear aspects mentioned in relation to speed were:

1) bottom contact, specifically the footrope (Somerton and Weinberg, 2001, Weinberg, 2003)
2) the width of the wings (Weinberg, 2003, Galbraith, 1986)
3) headline hight (Weinberg, 2003, Galbraith, 1986, Smolowitz, 1983)
4) cod-end selectivity (Dahm *et al.*, 2002)

The door and wing spread, the headline height and the bottom contact of the footrope are all aspects in guiding fish into the actual net and the cod-end. Towing speed might also affect the retainment within the net and the cod-end.

An experiment on the affect of speed on the bottom contact of the footrope was done with the AFSC poly Nor'eastern bottom trawl in the Bering Sea at two depths (Somerton and Weinberg, 2001). The gear was fished at speeds of 2.0–5.0 knots measured as STW at the headline. At speeds below 2.5 knots the bobbins were rolling over the seabed, while at a speed of 3.0 knots the centre bobbins were already about 1.8 cm off the bottom but still made a mud cloud. At a speed of 5.0 knots the bobbins were about 14.8 cm off the ground, which likely was an underestimation as the bottom contact sensor was lifted off the bottom as well. This experiment also looked at the affect of STW on the wing spread. Wing spread initially increased with STW to a maximum at about 2.5–3.0 knots, and then decreased to a relative minimum at about 4.5–5.0 knots. This pattern of change was quite similar at both depths.

A similar experiment was done with a 83/112 Eastern flatfish trawl with comparable results. At low STW the footrope was on the ground, from 3 knots the footrope was about 1.1 cm off the ground, increasing to 4.9 cm at 5.0 knots (Weinberg, 2003). In this experiment also the wing spread was measured. At low STW < 2.8 knots the wing spread was lowest (doors fell down), at 3.0 knots the maximum wing spread was reached after which it decreased slightly with higher speeds. At the lowest STW the headline increased to 1.9-3.8 m, while at STWs from around 3.0 knots and above the headline stabilized.

Similar results were obtained from a crustacean trawl in Chilian waters, where increasing towing speed (probably SOG, but not certain from the paper) from 1.3 up to 2.2 knots resulted in an increase in net spreading and a reduction in footrope bottom contact (Queirolo *et al.*, 2012).

As the study by Weinberg (2003) showed, the headline height is influenced by the fishing speed. The headline height influences the chance of encountering fish species in the water column (Smolowitz, 1983). A lower headline height also increases the chance of escaping the net, especially for species that naturally escape upwards. This is mentioned in Adlerstein and Ehrich (2002), in relation to the reduction in headline observed at higher towing speeds during their experiments. The Weinberg study however showed that in their experiment the headline stabilized from around 3 knots and above, which is the speed range expected for the new IBTS gear.

The current IBTS gear, the GOV, was also used in a speed experiment in which the headline stayed more or less stable over the whole range of SOG from 2.5–5 knots (Galbraith, 1986). The same study showed that the door spread increased with increasing speed, while the wing spread seemed to stay more stable. The higher pressure against the doors at higher speed theoretically explains this, although a reduction in door spread at higher speeds is also observed (Breen, 2004), specifically at shallower depths (Wathne, 1959). Wathne (1959) also showed that the upward pressure of the headline or kite increased more than the outward pressure of the doors.

Increasing towing speed results in increasing drag of the cod-end (which increases with increasing catch) (Beverton and Margetts, 1963, Smolowitz, 1983, O'Neill *et al.*, 2005). The speed can also influence the shape of the meshes and the tension on the netting. At higher speeds the shape of the meshes collapses, reducing the selectivity. An experimental setup made clear that increasing the speed reduced the escapement of fish through the meshes (Gabr *et al.*, 2007).At lower speeds the fish could easier manoeuvre to get through the meshes, but also the tension on the twine is less so that more fish are able to squeeze through, which does not affect all species in the same manor (O'Neill *et al.*, 2016). Higher towing speeds let to more injuries in the fish squeezing themselves through the meshes. These aspects combined with the mesh size affect the length selectivity of the nets.

Studies on swimming speed and endurance of fish

The results of the studies on the direct affect of towing speed on the catch and on the gear aspects are not straightforward. There is large variability and in some cases even contradicting results. These can be attributed to the specifics of the gear and the circumstances in which they are used.

However, in most cases the behaviour of the species is seen as the reason for the differences in results.

The affect of towing speed on the catches is affected by the individual escape behaviour, position in the water column, swimming speed and endurance. The species that tend to bury or escape towards the seabed are affected by the affect of speed on the bottom contact of the footrope. Species that tend to escape upward are more affected by the position of the headrope. While species that tend to escape sideways from to trawl path, by a quick burst like the squid species, are more affected by the detection of the gear and the speed of the gear itself but also by the spread of the wings and the doors. This behaviour occurs just in front or in the mouth of the gear, it also extends backwards towards the cod-end, where the behaviour influences the chance of escaping through the meshes.

One the main aspects of fish escaping retainment is the swimming speed they can reach and the endurance, e.g. the time they can maintain this speed. Video observations show that fish tend so swim along with the net just ahead of the footrope or in the mouth of the net[1]. This is only possible when the fish are able to reach a similar swimming speed as the towing speed for a reasonable duration. Speeds above their maximum swimming speed results in fish being overrun by the net. In case of a herding gear, increased speed could also result in failure of herding the fish, as they can keep up the speeds and fall back over the sweep (Sistiaga *et al.*, 2015).

The behaviour of fish species differs while swimming along with the gear. Plaice (*Pleuronectes platessa*), long rough dab (*Hippoglossoides platessoides*), tend to zigzag and seek for shelter (Godø *et al.*, 1999). Other species just cruise along with the gear for longer periods. This behaviour is shown in haddock that maintains cruising speed in front of the gear, and when towing speed is increased this cruising speed is accompanied with bursts to stay ahead of the gear (Hemmings, 1973). The actual behaviour in front of the gear can be influenced by density-dependence (Godø *et al.*, 1999).

The fish swimming along with the gear are overrun by the gear ending up further towards the cod-end at the moment they change their swimming direction, as they are then unable to maintain the swimming speed to swim along with the net. This is relevant in relation to escapement. As soon as the fish decide to escape, it is likely that they are actually retained in the net, unless the burst speed is large enough to escape on either side of the net. The same occurs in the net and the cod-end: when a fish changes direction to swim towards an open mesh to escape, the net overruns it resulting in the fish ending up further in the cod-end. This makes it difficult for fish to escape through the meshes.

Similar underwater observations showed that there are clear differences in endurance. Specific species, or length classes, tend to appear in order in the cod-end: the slowest swimmers with short endurance first, followed by other species for which speed or towing duration outlast their capabilities. For the southern North Sea, lesser weever (*Echiichthys vipera*) was mentioned as a bad swimmer that often appears first in the codend (Pers. commun. P. Molenaar WMR). Fish able to swim at the towing speed for the duration of hauls, or fish encountered later in the haul that is not yet exhausted, are able to escape from the trawl path when hauling starts, and as a result the speed of the gear decreases. For some species like mackerel (*Scomber scombrus*) underwater observations have shown that not only the fish in front or in the mouth of the net can

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1 https://www.youtube.com/watch?v=D39NuSMxWlk&ab_channel=havforskningen, https://www.youtube.com/watch?v=5FzUXmssAtE&ab_channel=havforskningen

escape when hauling starts, but also fish already further in the net are often able to escape that moment unless they are exhausted.

An extensive overview of work on the swimming speed, burst speed and endurance of fish species is provided by He (1993). The speed and endurance depend on the species and the body size of the species. Larger individuals are able to reach higher maximum speeds and maintain those speeds longer than smaller fish of the same species. It also depends on the environmental conditions where swimming speeds and endurance increases with higher temperatures (He, 1991). The condition of the fish plays a role as well, lower conditions due to illness, parasites, reduced feeding in e.g. winter or spawning season, reduces the fish capabilities (Martínez *et al.*, 2003, Winger *et al.*, 1999). For some species swimming capabilities may be reduced due to developing large gonads. The swimming speed and endurance are correlated (Breen *et al.*, 2004); higher swimming speeds can be maintained for a shorter period of time (reduced endurance; see Figure 3 of He, 1991 and Figure 3 of He, 1993). The shown example of cod indicates that cod of <36 cm can maintain the speed of 1.4 m/s (2.7 knots) for less than 10 minutes. Another example is of haddock, which, up to a length of ~40 cm at temperatures of ~9.8 °C, were able to reach maximum speeds of ~1.0 m/s. They were able to maintain this speed only for a short period of time (<10 min; (Breen *et al.*, 2004). Results of herring and saithe (*Pollachius virens*) indicate similar results with saithe of ~50cm which were able to maintain speeds of ~1.5 m/s for about 10 minutes (see Figure 3 of He, 1993). Herring of 25 cm was able to perform similarly, while saithe of 25 cm were only able to maintain speeds of ~1.0 m/s for 10 minutes. One of the fastest species in the North Sea is mackerel. These were able to reach and maintain speeds of 6 times their body size for 10 minutes (25cm: 1.5 m/s; 50 cm: 3 m/s=5.8 knots) and they can reach burst speeds of 19 times their body size.

Discussion and conclusions

Towing speed has an affect on the performance of the gear and on the catch efficiency. In the case of the gear performance the overall picture of the change in bottom contact, gear geometry, and drag are more or less consistent: with increased speed bottom contact reduces, wing spread increases to a maximum at a certain speed and decreases at higher speed, and drag increases. However, the actual details depend on the specifics of the gears and the rigging. It is most important that the designed gear is used at suitable speed ranges. If a gear is able to maintain bottom contact and settle at its preferred geometry it should perform similar to other gears that maintain bottom contact and similar geometry, independent of the speed ranges. This does not mean the gears catch the same amount and composition of fish as that is largely determined by the behaviour and capabilities of the fish.

At lower speeds there is a bigger chance for fish to escape from a correctly functioning gear. The time to react when detecting the gear is longer, and fish can easier outperform the gear by swimming at constant speed or by bursts. Moreover, at lower speeds the fish are able to swim longer ahead of the net, potentially for the duration of the haul, specifically in case of scientific hauls of only 30 minutes or shorter. The current speed of the GOV, as well as the lower speed proposed for the new gear are actually well above the maximum speeds that most species can reach. This is not the case for the best swimmers like mackerel. The capacities of mackerel already outperform the current speed of the GOV, especially the burst speed but also the regular swimming speed of the larger individuals. A reduction in towing speed is likely to reduce the catches of mackerel. More fish will escape the approaching gear or burst out of the trawl path. Next to that more mackerel will be able to swim along the gear for the whole duration of the haul or be able to swim out of the gear when hauling starts.

Another aspect that needs to be considered is that a potential affect of towing speed is larger during summer survey than during winter survey. The higher temperatures in summer allow fish to swim faster and increase endurance. However, even at higher temperatures the currently proposed towing speed is faster than most fish can swim. This difference will likely reduce with increasing temperatures under the predicted climate change.

Currently towing speed is determined by the speed of the vessel over the ground and is recorded as the distance travelled. There is a difference in recording SOG compared to STW. It would be best to measure both on the gear. It can be considered to design the new survey using STW taking into account the affect of the water current on the catch efficiency and the behaviour of species. Maintaining constant trawl STW would reduce variability of trawl survey catch per unit effort for some species and sizes (Weinberg *et al.*, 2002).

Reducing trawl STW or SOG will decrease the swept-area covered in a 30 minute haul. This reduces the chance of encountering organisms. Especially, the chance of catching rare species is further reduced, and with that comparing trawls with different fromwing speeds needs some consideration in biodiversity analysis. This aspect however already plays a role in comparing the hauls of the current IBTS with the GOV where there is a standard duration but a difference in towing speed between some countries.

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